Print ISSN : 2393-8234
Online ISSN : 2454-6011

Frontiers in Crop Improvement

VOLUME 10 SPECIAL ISSUE-II JULY 2022

Website : www.asthafoundation.in

ASTHA FOUNDATION
MEERUT (U.P.) INDIA

ASTHA FOUNDATION®

Website : www.asthafoundation.in

EXECUTIVE COUNCIL FOR FRONTIERS IN CROP IMPROVEMENT JOURNAL (2022)

President	–	Dr. S.P. Singh, Aligarh
Vice President	–	Dr. Bijendra Pal, Hyderabad
		Dr. Pooran Chand, Meerut
		Dr. Yogendra Kumar Singh, Kanpur
Secretary	–	Smt. S. Rani, Meerut
Joint Secretary	–	Pratap Bhan Singh, Udaipur
		Dr. Shobhana Gupta, Gwalior
Treasurer	–	Dr. Rajendra Kumar, Saharanpur
Members	–	Dr. Pradip Kumar, Meerut
		Dr. Rohit Rana, Shamli

PATRON

Dr. A.K. Singh, Former Vice Chancellor, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) India

ADVISORY BOARD

Dr. Ashok Kumar Singh, Deputy Director General (Agriculture Extension), ICAR, New Delhi, India
Dr. J.S. Sandhu, Vice Chancellor, S.K.N. Agriculture University, Jobner, Rajasthan, India
Dr. Punya Prasad Regmi, Vice Chancellor, Agriculture & Forestry University, Rampur, Chitwan, Nepal
Dr. O.N. Singh, Vice Chancellor, Birsa Agricultural University, Rachi, Jharkhand, India
Dr. Ram Lakhan Singh, Vice Chancellor, Nilamber-Pitamber University, Medininagar, Palamu, Jharkhand, India
Dr. R.P. Singh, Vice Chancellor, Swami Keshwanand Rajasthan Agriculture University, Bikaner, Rajasthan, India
Dr. C.N. Ravishankar, Director & Vice Chancellor, ICAR-Central Institute of Fisheries Education, Mumbai, India
Dr. S.K. Chaturvedi, Vice Chancellor, Rani Laxmibai Central Agricultural University, Jhansi (U.P.) India
Dr. John Farrington, Overseas Development Institute, 111, Westmisted Bridge Road, London SE1, 7JD, UK

EXECUTIVE COUNCILLORS

Dr. R. Lokesha, Shivamogga
Dr. H.C. Nanda, Raipur
Dr. S.K. Biswas, Kanpur
Dr. Shobhana Gupta, Gwalior
Dr. Amritbir Riar, Switzerland
Dr. U.S. Tiwana, Ludhiana
Dr. V.P. Singh, Pantnagar
Dr. C. Narendra Reddy, Hyderabad
Dr. R.J. Hagger, England
Dr. U.K. Tripathi, Kanpur
Dr. S.S. Gaurav, Meerut
Dr. A.K. Chaudhary, Patna

EDITORIAL BOARD

Chief Editor

Dr. S.P. Singh
CSAUAT-ARS, Kalai, Aligarh

Executive Editors

Dr. B.V. Tamburne, UAS, Raichur
Dr. S.C. Gaur, BRD (PG) College, Deoria
Dr. Brajendra, ICAR-IIRR, Hyderabad
Dr. A.S. Jeena, GBPUAT, Pantnagar

EDITORS

Dr. H. Eswaran, USA
Dr. Dilip Kumar Jha, Nepal
Dr. Bijendra Pal, Hyderabad
Dr. Shweta, Kanpur
Dr. Pradip Kumar, Meerut
Dr. Rohit Rana, Shamli
Dr. Laxmikant Sharma, Junagadh
Dr. M.K. Tripathi, Gwalior
Dr. T.C. Suma, Raichur
Dr. Chamindri Witharana, Sri Lanka
Dr. Anil Kumar, Sabour
Dr. M.Vignesh, New Delhi
Dr. Bilal Ahmed Lone, Srinagar
Dr. Amit Kumar, Srinagar
Dr. Hiranmayee Nayak, Bhubneswar
Dr. Robin Kumar, Kumarganj
Dr. Harish Pal Bhati, Meerut
Dr. Dhinu Yadav, New Delhi
Dr. Tom Farrington, England
Dr. Tek Bahadur Gurung, Nepal
Dr. Binay Kumar Chakraborty, Bangladesh
Dr. Raj Mohan Sharma, Ganj Basoda
Dr. S.B. Singh, Ludhiana
Dr. P.B. Singh, Udaipur
Dr. Omkar Singh, Shamli
Dr. Nirupma Singh, New Delhi
Dr. Vijay Kr. Kurmaliker, Raichur

JOURNAL SUBSCRIPTION

Individual Fee		Inland	Foreign
Ordinary (Annual) Membership	–	Rs. 1000/-	$ 500
Life membership	–	Rs. 4000/-	$ 2000

Institutional Fee		Inland	Foreign
Institutional (Annual) Membership	–	Rs. 3000/-	$ 2000
Institutional (10 Years) Membership	–	Rs. 15000/-	$ 7000

The life membership fee may be paid by Bank Draft/Cheque/Bank Transfer in favour of **Frontiers in Crop Improvement** and **payable at Meerut.** Payment by out station cheques must include **Rs. 100/-** extra towards bank charges. Correspondence regarding membership subscription and any other matters on the journal should be addressed to **Dr. S.P. Singh, President, ASTHA FOUNDATION,** Suman Villa, 85, Phool Bagh Colony, Main Road, Meerut-250002 (U.P.),Cell : **09450068438, 08273775051,** *E-mail :* **dr.sp.singh24@gmail.com** | *Website:* **www.asthafoundation.in**

MEMBERSHIP FORM
FRONTIERS IN CROP IMPROVEMENT JOURNAL
Astha Foundation, Meerut, (U.P.) INDIA
Website : www.asthafoundation.in

To,
Dr. S.P. SINGH
Scientist (Plant Breeding), A.R.S., Kalai, Aligarh (C.S.A. University of Agriculture and Technology, Kanpur)
President, Astha Foundation, Meerut (U.P.) INDIA
Chief Editor, Frontiers in Crop Improvement Journal, Meerut (U.P.) INDIA
Correspondence to : **Dr. S.P. Singh,** Suman Villa, 85, Phool Bagh Colony, Main Road, Meerut-250 002 (U.P.) INDIA
Cell : **09450068438, 08273775051,** E-mail : **dr.sp.singh24@gmail.com**

Dear Sir,

Please enrol me as a Life/Annual Member of ..... (Biodata enclosed). I am enclosing herewith a draft of Rs..... (in words..... .....), having Draft No..... Dated..... for Life/Annual Subscription and it enrolled, agree to abide by its rules and regulations.

1. Full Name (In capital Letters).....
2. Designation.....
3. Aademic and professional qualification.....
4. Specialization.....
5. Institute / Organisation where employed.....
6. Address for correspondence.....
   .....
   City.....State.....
   Pin Code ..... Telephone No. (STD Code).....
   Office ..... Residence.....
   Mobile No..... E-mail.....
7. Permanent Home Address.....
   .....
   City..... State.....
   Pin Code..... Telephone No. (STD Code) .....
   Office..... Residence .....
   Mobile No..... E-mail .....

Dated..... Signature.....

JOURNAL SUBSCRIPTION

Individual Fee		Inland	Foreign
Ordinary (Annual) Membership	–	Rs. 1000/-	$ 500
Life membership	–	Rs. 4000/-	$ 2000

Institutional Fee		Inland	Foreign
Institutional (Annual) Membership	–	Rs. 3000/-	$ 2000
Institutional (10 Years) Membership	–	Rs. 15000/-	$ 7000

The life membership fee may be paid by Bank Draft/Cheque/Bank Transfer in favour of **Frontiers in Crop Improvement** and **payable at Meerut.** Payment by out station cheques must include **Rs. 100/-** extra towards bank charges. Correspondence regarding membership subscription and any other matters on the journal should be addressed to **Dr. S.P. Singh, President, ASTHA FOUNDATION,** Suman Villa, 85, Phool Bagh Colony, Main Road, Meerut-250002 (U.P.),Cell : **09450068438, 08273775051,** *E-mail :* **dr.sp.singh24@gmail.com** | *Website:* **www.asthafoundation.in**

GUIDELINES TO THE CONTRIBUTORS

The journal publishes original research papers, review articles and short communications in plant genetic resources, plant breeding, plant biotechnology, genetics, cytogenetics and seed research etc. The manuscripts will be accepted for publication from members of the executive body of journal. All the manuscripts will be referred. The responsibility for any statement in the article rests entirely with the concerning authors. The manuscripts should be submitted, in duplicate, to Chief Editor of the Journal. A paper will not be accepted for publication unless all the authors are member of the Frontiers in Crop Improvement Journal. A paper will not be published without printing/processing formalities. The authors are advised to prepare their manuscripts according to the following guidelines:

Preparation of the Text : Each full length research paper must not exceed 8-10 typed pages including tables and illustrations. However, the review articles may contain 15-20 typed pages. Short communication should not exceed 3-5 typed pages in which no separate abstract and other sections are needed. Manuscripts should be typed on one side of bond paper of 22x28 cm. double space and throughly revised before submission. Numerical data and calculations should be carefully checked. No editing or material changes at the proof stage will be permitted unless the extra cost is paid by the authors involved.

Short Title : A short title not exceeding 45 letters, should be typed at the top of the first page in First letters capital and underlined.

Title : Title should be brief, specific and informative, typed in all capitals, scientific name in italics/underlined.

Authors : Names of authors to be typed, in all capitals unaccompanied by their degrees, titles etc.

Address : Address of the institution where the work was carried out be given below the name(s) of author(s). Present address of correspondence should be given as footnote indicating by asterisk the author to whom the correspondence are to be addressed.

Abstract : A brief abstract, not exceeding 250 words, of the principal points and important conclusions should be typed.

Key words : The Abstract should be followed by not exceeding ten key words indicating the contents of the research article.

Introduction : This should be brief and without headings related to the aim of the study. The review of the literature should be pertinent to the theme of the paper. Extensive review and unnecessary detail of earlier work should be avoided.

Materials and Methods : It should inform the reader about appropriate methodology etc. but if known methods have been adopted, only references be cited. It should comprise the experimental design and techniques.

Results and Discussion : It should be combined to avoid repetition. The results should not be repeated in both tables and figures. The discussion should relate to the significance of the observations.

Tables and Figures : Tables should be typed on separate sheet with first letter capital, table numbers followed by the title of the table. For each figure, a glossy print or original drawing should be submitted. The size of the figure should not exceed 8.5 cm. x 15.0 cm. Captions and legends to illustrations should be typed on separate sheet of paper. Line drawings and photographs should contain figure number and authors name on the back with soft lead pencils. Colour photographs will be printed on special request and on payment of extra printing charges which will be communicated after receiving the specific request.

Acknowledgments : It should be mentioned only assistance received in real terms, and financial grant provided by an agency.

References : References should be cited in text by numbers in brackets (for review articles with author name will be cited in text). Listing of references by S. No. in accordance with their order of text citation. Author's names to be written in normal sequence, with surname first, followed by initials (in double space), year in bracket.

Journal name/book name, volume number (underlined/etelic) and page number. The following style of the references should be followed as :

1. Johnson H.W., Robinson H.E. and Comstock R.E. (1955). Estimate of genetic and environmental variability in soybean. *Agron. J. 47* : 314-318
2. Allard R.W. (1960). Principles of Plant Breeding, *John. Wiley and Sons, Inc.* New York.
3. Palmer J.D. (1992). In : *Cell Orgenelles* (R. G. Herman, Editor) Springerù Verlag, Vienna. 99-133.
4. Weber D.R (1967). On the Interaction of Nonhomologous Segments of Chromosomes in *Zea mays. Unpubl. Ph.D. Thesis, Indiana University,* Bloomington, Indiana, USA. (For Indian Universities, Country name not to be indicated).
5. Chandola R.P., Bhatnagar C.P. and Sah Sudha (1971). Nature of variability induced by radiations. In : *Proc. Int. Symp on use of Isotopes, Radiations in Agriculture and Animal Husbandry Research,* New Delhi 46-50.

Published by **Dr. S.P. Singh, Chief Editor** on behalf of **Astha Foundation,** Suman Villa, 85, Phool Bagh Colony, Main Road, Meerut-250002 (U.P.) INDIA. Cell : **09450068438, 08273775051,** E-mail: **dr.sp.singh24@gmail.com,** Printed at New Rishabh Offset Printers, Delhi Road, Meerut, Cell : 09456662805 and Composed by Yash Computer, Meerut (U.P.), Cell : 08979897661

Print ISSN : 2393-8234
Online ISSN : 2454-6011

Frontiers in Crop Improvement

Chief Editor : **Dr. S.P. Singh**

Volume 10 **Special Issue-II** **July 2022**

NAAS Rating - 4.67

Peer Reviewed, Refereed and Indexed Journal

ASTHA FOUNDATION
MEERUT (U.P.) INDIA
Website : www.asthafoundation.in

Frontiers in Crop Improvement, Volume 10 (Special Issue-II) July 2022

Contents

Research Papers/Articles		Page No.
1.	Feeding pattern of dairy animals in Eastern Zone of Utter Pradesh **Shiv Bachan and R.K. Pal**	703-705
2.	Underutilized fruit crops : Nutritional composition, potential health benefits and assuring food security **Shivani Kumari and Sonika Sharma**	706-712
3.	Antioxidant activity in germinated buckwheat **Shreeja Kulla, Suchiritha Devi S., Jessie Suneetha W. and Neeraja Prabhakar B.**	713-716
4.	Nutrient content and uptake of wheat varieties as influenced by agronomic practices under late sown condition **Sintu Malik, Pawan Kumar and Parveen Kumar**	717-720
5.	Survey for elite type mango (*Mangifera indica* L.) by using inflorescence, leaf, fruit and pulp descriptors **Sonal D. Jadhav, V.N. Shinde and Vijaysinha Kakade**	721-727
6.	Bioefficacy of different botanical extracts against thrips, scirtothrips dorsalis (Hood) on bell pepper **Sonam Sharma, Vijay Kumar, B.P. Nautiyal, Manish Gupta and Pankaj Bahuguna**	728-732
7.	Detection and identification of hidden infestation by *Callosobruchus Species* belonging to family bruchidae **Subham Kumar, Sumit Kumar, Kavita Gupta and Mahesh Kumar**	733-738
8.	Kinetic of Nitrogen Mineralization by Using Various Organic Manures in Pune Region of Maharashtra **Subhash Singh and Roopali Patel**	739-743
9.	Best fitting mathematical model for assessing nitrogen mineralization in Maharashtra region **Subhash Singh and Roopali Patel**	744-752
10.	Awareness of rural people about Covid-19 in Namkum Block of Ranchi District of Jharkhand **Sudhanshu, Alan Dan, Shaon Chakraborty, Abhinav Singh and Virendra Pratap**	753-755
11.	Trend analysis of temperature and precipitation over beed District of Marathwada Region, Maharashtra using RClimDEX Model **Sujeet Deshmukh, D. Ushasri, Dhanaji Sawant and Dhiraj Gardi**	756-761
12.	Trend analysis of temperature and precipitation over Osmanabad District of Marathwada Region, Maharashtra using RClimDEX Model **Sujeet Deshmukh, D. Ushasri and Vishal Wale**	762-767
13.	A study of seed characterization of okra {*Abelmoschus esculentus* (L.) Moench} genotypes **Sunil Kumar, S.K. Dhankhar, Monika Yadav, Archana Brar and Amit Kumar**	768-771
14.	Field screening of *Vigna radiata* (L.) Wilczek genotypes against mungbean yellow mosaic virus **Sunny Thakur, Stuti Sharma, Shraddha Tomar, Priya Tiwari, Nidhi Pathak and Shailja Goswami and R. Shiv Ramakrishnan**	772-775
15.	Farm power availability among all agro-climatic zones in uttar pradesh-A comparative study **Tarun Kumar Maheshwari, Vipin Kumar Verma and Pankaj Kumar**	776-780
16.	Variability study in pod characters and germination parameters in *Pterocarpus marsupium* among different provenances of Odisha **T.L. Mohanty, P. Mallick, H. Nayak, M.C. Behera, S.G. Nair, B. Parimanik and S. Behera**	781-784
17.	Temporal study of area, production and productivity of coffee in Kodagu District and Karnataka State **Thanuja P., G.L. Meena, Satish Kumar Yadav and Babita Kumari**	785-788
18.	Effect of non-genetic factors on production performance of *Pandharpuri* buffalo maintained at organized dairy farm **U.S. Gaikwad, V.R. Dhangada, M.G. Mote, S.A. Dhage and R.B. Shende**	789-792
19.	Bio-chemical study on kashi pragati of okra cultivar in respect with organics and biofertilizers **Umakant Singh, Amit Kumar Pandey, Birendra Prasad, Santosh Kumar and Manoj Kumar**	793-796
20.	Effect of organic manures and biofertilizers on nutrient concentration of Okra (*Abelmoschus esculentus* (L.) Moench) **Umakant Singh, Amit Kumar Pandey, Birendra Prasad, Santosh Kumar, Manoj Kumar, Ashutosh Singh and Ashwini Choudhary**	797-800

21.	Forward and backward linkages followed by the farmers in redgram based farming system **Ashok Kumar Melkeri, S.K. Meti, S.B. Goudappa and Suresh S. Patil**	801-804
22.	Agroforestry systems and there importance in agriculture : A review **Devi Lal Dhaker, L.R. Yadav, Govardhan Lal Kumhar, Rayapati Karthik, Shivam Maurya Rajendra Bairwa and Dalip**	805-811
23.	Three-dimensional (3D) printing–A future boom to food industry **P. Geetha**	812-815
24.	Soil moisture management to increase leaf yield in mulberry, morus alba L. and silk cocoon production in Southern dry climatic zones of Tamil Nadu **A. Mahimasanthi, S. Rajaram, Babulal and Pankaj Tiwari**	816-820
25.	Morphological characterization of chow-chow [*Sechium edule* (Jacq.) Sw.] in North East India **M.M. Shulee Ariina, Khamrang Mathukmi, Konjengbam Ramit Singh, Hau Ngaih Lian, M. Jangyukala and S. Kikatemjen Ozukum**	821-823
26.	Economic of rose crop in Chittorgarh District of Rajasthan **Narender Sevta, Hari Singh and Giridhari Lal Meena**	824-830
27.	To study the seasonal incidence of insect pests on brinjal crop under organic farming **Pradeep Kumar Gautam, Hemant Swami, Lekha, Gaurang Chhangani, Mahaveer Meena, Piyush Sharma and Mahendra Yadav**	831-835
28.	Public private partnership (PPP)—An emerging tool for economic growth **Shwetha Shree B. and H. Basavaraja**	836-840
29.	Sowing dates and fodder maize genotypes have promising influence on growth parameters studied under temperate Kashmir conditions **Umer Rashid Bhat, Bilal Ahmad Lone, Zahoor Ahmad Dar, Mohd Aslam Dar, Tauseef Ahmad Bhat, Tanveer Ahmad Ahngar, Faisul ur Rasool, Fayaz Ahmad Bahar, Mohammad Anwar Bha and Iqra Mushtaq**	841-845
30.	Sowing Dates and Genotypes of Maize Showed Profound Impact on Dry Matter Accumulation and Green Fodder Yield **Umer Rashid Bhat, Bilal Ahmad Lone, Mohd Aslam Dar, Zahoor Ahmad Dar, Tauseef Ahmad Bhat, Faisul ur Rasool, Fayaz Ahmad Bahar and Mohammad Anwar Bhat**	846-850
31.	Comparative performance of pandharpuri buffalo calves under different rearing systems **V.G. Patil, S.M. Bhokre, A.V. Khanvilkar and K. Vijay**	851-854
32.	Evaluation of fungicides and biocontrol agents against wilt disease of coriander caused by *Fusarium oxysporum* f. sp. *corianderii* **V. Kumar, Pooja, K.C. Singh and P. Bahuguna**	855-858
33.	Genetically modified crops-a promising innovation for enhancing food security and role of extension in diffusing GM technology **Chappidi Venkata Pujitha, Sundar Barman and B. Jaswanth Naik**	859-865
34.	Interaction effect of plant geometry and cultivars on physiology, yield and quality parameters of turmeric (*Curcuma longa L.*) **Vaqar Malik, I.S. Naruka, Dhanesh Kumar Raidas and O.P. Dhurve**	866-869
35.	Measuring price forecasting for market information system in the mustard crop in Mahendergarh District of Haryana **Veer Sain, Gulab Singh and Manoj Sharma**	870-877
36.	Variability and correlation coefficient analysis in elite germplasm of groundnut (*Arachis hypogaea* L.) **Vicky Yadav, P.B. Singh, Dikshita Joshi, Devendra Jain, Vishal Pareek, Anjali Sharma and Sarita Choudhary**	878-882
37.	Bio-efficacy and phytotoxity evaluation of mancozeb 35% sc against disease complex of apple **Vijay Kumar and Tannu Rani**	883-887
38.	Effect of foliar spray of agrochemicals on physiological growth parameters at different growth stages of rice (*Oryza sativa* L.) crop **Begum Yasmeen, Patil, R.P., Harish Menpadi and Mahanthashivayogayya**	888-893
39.	ZBNF : An ideal approach to improve soil fertility for sustainable agriculture in India **Zaira Shireen Hasan and Darakhshinda Anwer**	894-900
40.	To study on correlation coefficient and path analysis for yield and its components in wheat (*Triticum aestivum* L. em. Thell) **Aditya Kumar, Vimlesh Kumar, P.N. Singh and S.C. Gaur**	901-906
41.	Seasonal incidence of major insect pests of pigeon pea [*Cajanus caja*n (L.) Millsp.] **Ankita Yadav, Anil Vyas, Mohd. Monish, A.K.S. Pratihar, Rajesh Choudhary, S.K. Dhabhai and Saif Ali Khan**	907-910
42.	Impact of bio-fertilizer on plant growth and yield attributing traits of french bean (*Phaseolus vulgaris*) var. HPR-35 **Bakuru Pavan Praneeth, Bineeta Michael Bara and Prashant Kumar Rai**	911-914

43.	Farmer movement in India's Independence **Bhawna Sinha**	915-917
44.	Diversity analysis in spanish bunch type groundnut (*Arachis hypogaea* L.) **Dikshita Joshi, P.B. Singh, Vicky Yadav, Vishal Pareek, Harshlata Regar and Aliza Maryam**	918-923
45.	An analysis of consumer buying behaviour and preference for mango pulp in Bardoli City of South Gujarat **Paulomee Dhimar and Swati Sharma**	924-928
46.	Assessment of genetic diversity for quantitative traits in common wheat (*Triticum aestivem* L. em Thell) twenty genotype **Pradeep Kumar Yadav, Kaushal Singh and S.C. Gaur and P.N. Singh**	929-931
47.	Assessment of yield losses due to insect pests in mustard **Raj Veer Yadav and Vipin Kumar**	932-934
48.	Effect of integrated nutrient management through organic sources on chickpea in Bundelkhand reason **Rajnarayan Singh, Abhishek Patel, Pravesh Shrivashtav and Akansha Gupta**	935-936
49.	Effect of phytoplasma on metabolites of healthy and diseased plant of Brinjal (*Solanum melongena* L.) **Reema Upadhyay**	937-938
50.	Consumers' buying behaviour towards online food and grocery shopping from organized retailers in Ahmedabad City **Sachin Sutariya and Swati Sharma**	939-943
51.	Challenges and opportunities for climate change education in India : A critical review **Sanjay Kumar**	944-949
52.	Estimation of genetic variability, heritability and genetic advance for yield and yield related traits in bread wheat (*Triticum aestivum* L.) genotypes **Shivani Chaudhary, Abhishek Rai and Mahendra**	950-953
53.	Eco-friendly management of chilli leaf curl disease complex under field condition **Smriti Akodiya, Shaik Munnysha, Mamta, Ramavath Abhi and Manisha**	954-956
54.	To study on correlation coefficient and path analysis for yield and its components in bread wheat (*Triticum aestivum* L. em. Thell) genotypes **Sonal Kumari and S.C. Gaur**	957-963
55.	To estimate genetic divergence in bread wheat (*Triticum aestivum* L. em. Thell) genotypes **Sonal Kumari and S.C. Gaur**	964-968
56.	Influence of insecticides on the development of pest resistance of diamondback moth (*Plutella Xylostella*) **Taheera Ansari and Sushil Kumar**	969-976
57.	Evaluation of various strain of button mushroom for their cultural, morphological and yield attributes **Vijay Kumar, Lakhanapuram Hemanth Kumar and Sonal**	977-984
58.	To study on correlation coefficient and path analysis for yield and its components in wheat (*Triticum aestivum* L. em. Thell) **Vimlesh Kumar, Aditya Kumar, P.N. Singh and S.C. Gaur**	985-990
59.	Screening of guava (*Psidium guajava* L.) cultivars for the kymore plateau of Madhya Pradesh **Deepak Singh, D.P. Sharma, S.K. Pandey N.R. Rangare and Gourav Gupta**	991-996
60.	Performance of growth and flowering response of marigold on rice bund condition in Chhattisgarh plains **Gunjan Jha and L.S. Verma**	997-1000
61.	Effect of different pre-sowing seed treatments on seed germination and seedling growth of fruit crops : A review **Manish Kumar, Sushil Sharma, Hardeep, Deepak Sangwan and Asheesh Kumar**	1001-1009
62.	study on marketing trends of rice and maize of pan seed company in Ramanujganj and Daltonganj Blocks **Manjeet Singh and Md. I.A. Ansari**	1010-1016
63.	Cracking in fruit crops – A review **N.R. Rangare, D.P. Sharma, Anay Rawat, Narayanlal, Suchi Paroha and H.K. Rahangdale**	1017-1022
64.	Genetic variability, heritability and genetic advance analysis in aerobic rice (*Oryza sativa* L.) **Parul Devi, D.K. Dwivedi, N.A. Khan, Rakesh Patel and Sabia Ahad**	1023-1025
65.	Water use efficiency in tomato crop under command area of betwa river basin, District Vidisha, Madhya Pradesh **S.K. Sharma, R.K. Bhatnagar and P.K. Jaga**	1026-1029
66.	**Effect of potassium and zinc on nutrient content and uptake of isabgol (*Plantago ovata* Forsk.)** **Chetana Sharma, M.K. Kaushik, Jagdish Choudhary, Dharampal Singh and N.K. Padiwal**	1030-1033

67.	The effect silicon and plant growth regulators (PGR's) on biological parameters of fruit borer *Helicoverpa armigera* (Hübner) **Mahendra Yadav, S. Ramesh Babu, S.K. Dhabhai, Anil Vyas, Devendra Jain, Beerendra Singh, Pradeep Kumar Gautam, Piyush Sharma, Mahaveer Meena and J. Kavipriya**	1034-1038
68.	Studies of genetic variability in groundnut (*Arachis hypogaea* L.) **Mukesh Chandra Meena, P.B. Singh, Amit Dadheech and Deepak Meena**	1039-1043
69.	Creating entrepreneurship through business education **Pradeep Dwivedi**	1044-1046
70.	Character association and path analysis in groundnut (*Arachis hypogaea* L.) **Raju Lal, P.B. Singh and Manmohan Singh**	1047-1054
71.	Effect of nano urea on nutrient content and economics of wheat (*Triticum aestivum* L.) under restricted irrigation condition **Ritesh Patidar, J, Choudhary, Roshan Choudhary, Manish Tomar, Kannoj and Ruchika Choudhary**	1055-1058
72.	The effect of the push-pull strategies on egg parasitoids of fall armyworm, *Spodoptera frugiperda* in Kharif Maize **S.K. Dhabhai, S. Ramesh Babu, Mahendra Yadav, M.K. Mahla, Arvind Verma, M.L. Ojha, Beerendra Singh, Pawan Gahlot, Ankita Yadav, Mohd. Monish and Piyush Sharma**	1059-1062
73.	An example of precis(e) varietal recommender system in wheat **Durgesh Kumar Kharwar, Shri Niwas Singh, Pratap Narayan Singh and S.C. Gaur**	1063-1066
74.	Bio-efficacy of organic treatments against major lepidopteran predators of lac insect **Mahaveer Meena, Hemant Swami, Lekha, Gaurang Chhangani, Pradeep Kumar Gautam, Piyush Sharma, Mahendra Yadav and Neeraj Kumar Meena**	1067-1069
75.	Influence of abiotic factors on the seasonal occurence and parasitization pperformance of *Campoletis chlorideae* (Uchida), a larval parasitoid of *Helicoverpa armigera* (Hübner) in chickpea **Piyush Sharma, M.K. Mahla, S. Ramesh Babu, Hemant Swami, Sheenam Bhateja, Pradeep Kumar Gautam, Mahendra Yadav, Mahaveer Meena, Mohd. Monish and S.K. Dhabhai**	1070-1073
76.	Variability and path analysis in isabgol (*Plantago ovata* L. forsk.) **Rahul Khatik, Amit Dadheech, N.K. Padiwal, Ajay Sharma and Rohini Nain**	1074-1076
77.	Effect of organic management of nutrients and bio-stimulants on profitability of wheat (*Triticum aestivum* L.) **Rajesh Choudhary, Roshan Choudhary, S.K. Sharma, D.P.S. Dudi, S.K. Yadav, R.K. Jain, Gajanand Jat, Shivani Meena and Ashok Kumar Samota**	1077-1079
78.	Detection, identification and management of common storage grain insect-pests during quarantine processing **Subham Kumar and Kavita Gupta**	1080-1089
79.	Influence of electric, magnetic and biofiliming on growth and yield attributing traits on mustard (*Brassica juncea* L.) **Venkata Chalapathi Maganti, Bineeta Michael Bara and Prashanth Kumar Rai**	1090-1094
80.	Effect of biochar on soil nutrients availability after harvest of wheat (*Triticum aestivum* L.) under water stress condition **Naresh Kumar, S.K. Intodia, M.K. Kaushik, R.H. Meena and Devendra Jain**	1095-1098
81.	Individual and combined effect of seed priming with biofertilizers on seedling parameters of wheat (*Triticum aestivum* L.) **Akumalla Melle Sugandha, Bineeta. M. Bara, Prashanth Kumar Rai and D. Filomina**	1099-1102
82.	Assessment of different priming methods on growth and seed yield attributes of french bean (*Phaseolus vulgaris* L.) var. Arka suvidha **Mereddy Sai Krishna Reddy, Bineeta Michael Bara and Prashant Kumar Rai**	1103-1106
83.	Impact of salinity on germination percentage and seedling growth in wheat (*Triticum aestivum* L.) var. DBW–303 **Mangali Siva Prasad, Bineeta Michael Bara and Prashant Kumar Rai**	1107-1110
84.	Comparative study of magnetic, electric and bio-filming seed treatments on growth, yield and yield attributes of chickpea pusa-362 (*Cicer arietinum* L.) **Ponugoti Kavya, Bineeta Michael Bara, Prashant Kumar Rai and Rachuri Niyanth**	1111-1115
85.	Effect of sulphur and biofertilizers on nutrient content and uptake in fenugreek (*Trigonella foenum-graecum* L.) **Ashok Kumar Samota, P.C. Chaplot, J. Choudhary, R.H. Meena, Narendra Kumar Bhinda, Manish Tomar, Rajesh Choudhary and Satya Narayan Gurjar**	1116-1118
86.	Effect of zinc and boron on growth, yield attributes and quality of chickpea (*Cicer arietinum* L.) **Kartik Salvi, S.C. Meena, Lokesh Gupta, Vinod Sahran, Gajanand Jat and Shalani Pilania**	1119-1125
87.	Impact of foliar application of nano nitrogen and nano zinc on yield attributes and yield of mustard (*Brassica juncea* L.) **Kriti Sharma, R.H. Meena, S.C. Meena, Devendra Jain, K.D. Ameta, Neha Khardia and Deshraj Meena**	1126-1130

88. Enhancing productivity and quality of barley (*Hordeum Vulgare* L.) using silicon in low moisture areas 1131-1133
Surekha Panchal, M.K. Kaushik, Jagdish Choudhary and Ram Hari Meena

89. Application of bio-inoculants, salicylic acid and plant growth regulators on growth and yield attributing characteristics of mustard (*Brassica juncea* L.) var. PA5232 1134-1138
Madhav Reddy, Bineeta M. Bara and Abhishek Kumar Pal

90. assessment of bottle gourd germplasm for morpho-phenological, growth and fruit yield characters under semi-arid conditions of Haryana, India 1139-1145
D.S. Duhan, Jagat Singh and Vikas Gill

91. Multivariate analysis revealing genetic divergence in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes 1146-1151
D.S. Duhan, Vikas Gill and Jagat Singh

Published by **Dr. S.P. Singh, Secretary** and **Chief Editor** on behalf of **Astha Foundation**, **Suman Villa,** 85, Phool Bagh Colony, Main Road, Meerut-250002 (U.P.) India, Cell : 09450068438, 08273775051, **Email : dr.sp.singh24@gmail.com, Website : www.asthafoundation.in**, Printed at New Rishabh Offest Printers, Delhi Road, Meerut, Cell : 09456662805 and Composed by Yash Computer, Meerut (U.P.) Cell : 08979897661.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 703-705 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Feeding Pattern of Dairy Animals in Eastern Zone of Utter Pradesh

Shiv Bachan[1] and R.K. Pal[2]
[1]*Department of Animal Husbandry and Dairying, U.P. College, Varanasi, Uttar Pradesh*
[2]*Department of Animal Husbandry and Dairying, T.D. College, Jaunpur, Utter Pradesh*

Abstract

Feeding pattern is a most important segment of animal rearing and near about 65 to 70 percent accountability through feeding in total cost of animal production. The information was collected from the record of two districts of eastern zone of Utter Pradesh, namely Varanasi and Ghazipur and also stratified in two groups urban and rural areas during (October 2020 to March 2022). Feeding pattern of green fodder at sampled dairy farm of urban areas have not green fodder for feeding in milch animals. Frequency of feeding only 24% of dairy owners daily provided green fodder and 76% are given as per availability. 17.50% dairy owners chaffing green fodder and mixing with straw and 75% are given without mixing straw, 87.52% dairy owners provided straw as a dry and 12.50% are given as wet conditions. 12.50 % of dairy owners used concentrate properly and 87.52 % as sprinkle in urban areas.

Introduction

Uttar Pradesh has 1st rank of milk production in India and account for about 25.70 million tones or about 18% contribute in total milk production of India. All most all of this produced by individual households containing of small, marginal farmers and landless group of families occupied in rearing of milk stock (1 to 3 cows/buffaloes per family) as a side business or main activity for their livelihood. Increasing rate of milk production Uttar Pradesh increasing milk production at the rate of 6.67 percent in the financial year 2019. The milk productivity per animal units is very low compared to other major milk producing states of the country. National Commission on Agriculture observed that Qualitative and Quantitative insufficiency of feed and fodder in the country is one of the main impediments in the way of inculcate of livestock production (Anonymous,1976).

India has one of the largest livestock population (Approx.512.06 millions) in the world, and one of its rememberable characteristics is that almost its entire feed requirement is met from crop residues and by product grasses weeds and leaves gathered from cultivated and uncultivated lands, and grazing on common land and harvested field. Land allocation to cultivated of green fodder crop is limited and has hardly ever exceeded 5 percent of the grasses cropped area (GOI 2009). Most of these studies also generated estimates of nutritional requirements of livestock as to find the gap between feed availability and requirement. The availability of different feeds was assumed qual to their production, and production was equal to actual consumption.

The poor nutrition especially during the dry season is also a major constraint to animal production. Crop residues- e.g. straw, stores is generally used as fodder and meet a small production of the total fodder needs except in eastern region where cultivated grass and other fodder crops do make a contribution to fodder requirement. In addition to forage, animals need concentrate to feed supplements, such as minerals and vitamins. Considering to actue- shortage to input and services, optimum livestock production is a management concern and need to strength after careful security at grass root level.

Materials and Methods

The data of present study were collected from the Eastern Plain Zone (EPZ) of Utter Pradesh which contribute for about 25% of dairy animal population in the state. Two districts of Varanasi divisions were selected randomly. The districts were Varanasi and Ghazipur. Data on urban trust or developed colonies of the districts was obtained. These colonies - constitute to the urban area of the two districts. Accordingly, the selected districts were stratified into two strata viz.(i) urban area and (ii) rural area. From each strata, two sampling units (first phase sampling units) were randomly selected. Two community development blocks of the rural strata (one from each selected district) were randomly selected as the first phage units. The randomly selected community development blocks were Harahua in Varanasi district and Mardah in Ghazipur district. The information was collected during 2020 to 2022. The two sampling units selected from urban strata were Narayanpur colony in Varanasi district and Ghazipur proper in Ghazipur district. Similarly the list of all the community development blocks of Varanasi and Ghazipur districts was obtained to constitute the rural strata. A complete list of wards of selected colonies (urban strata) and villages (rural strata) was prepared, two

Table-1 : Feeding Pattern of Green Fodder on Sampled Dairy Farms. Per cent

Particulars	No of Sampled Dairy Owner	Buffalo				Cow			
		Frequency		Chaffing and mixing with straw		Frequency		Chaffing and mixing with straw	
		Daily	As per availability	Yes	No	Daily	As per availability	Yes	No
Urban	100.00	24.00	76.00	15.67	84.33	0.00	100.00	15.67	84.33
Small	(24.00)	(6.00)	(18.0)	(4.00)	(20.00)	(0.00)	(24.0)	(4.00)	(20.00)
Medium	100.00	25.00	75.00	28.00	72.00	0.00	100.00	25.00	75.00
	(8.00)	(2.00)	(6.00)	(2.00)	(6.00)	(0.00)	(8.00)	(2.00)	(6.00)
Large	100.00	0.00	100.00	13.50	86.50	13.50	86.50	50.00	50.50
	(8.00)	(0.00)	(0.80)	(1.00)	(7.00)	(1.00)	(7.00)	(4.00)	(4.00)
Mean	100.00	0.00	80.02	17.50	82.50	2.50	97.50	25.o2	75.02
	(13.33)	(0.00)	(10.65)	(2.33)	(11.50)	(0.33)	(13.50)	(3.33)	(10.00)
Rural	100.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
Small	(24.00)	(24.00)	(0.00)	(24.00)	(0.00)	(24.00)	(0.00)	(24.00)	(0.00)
Medium	100.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
	(8.00)	(8.00)	(0.00)	(8.00)	(0.00)	(8.00)	(0.00)	(8.00)	(0.00)
Large	100.00	75.00	25.00	100.00	0.00	75.00	25.00	100.00	0.00
	(8.00)	(6.00)	(2.00)	(8.00)	(0.00)	(6.00)	(2.00)	(8.00)	(0.00)
Mean	100.00	95.02	5.00	100.00	0.00	85.02	15.00	100.00	0.00
	(13.33)	(11.67)	(1.66)	(13.33)	(0.00)	(11.86)	(1.67)	(13.33)	(0.00)

Table-2 : Pattern of Dry Fodder and Concentrate Feeding on Sampled Dairy Farms. Percent

Particulars	No. of sampled dairy owners	Feeding of straw		Feeding concentrate		Frequency of feeding concentrate	
		Dry	Wet	Properly	Sprinkle	During	Only
Urban	100.00	84.33	15.67	13.50	86.50	13.50	86.50
Small	(24.00)	(20.00)	(4.00)	(3.00)	(21.00)	(3.00)	(21.00)
Medium	100.00	86.50	13.50	0.00	100.00	12.00	88.00
	(8.00)	(7.00)	(1.00)	(0.00)	(8,00)	(2.00)	(6.00)
Large	100.00	100.00	0.00	25.00	75.00	25.00	75.00
	(8.00)	(8.00)	(0.00)	(2.00)	(6.00)	(2.00)	(6.00)
Mean	100.00	87.52	12.50	12.50	87.52	12.50	85.52
	(13.33)	(11.67)	(1.67)	(1.67)	(11.67)	(1.67)	(11.60)
Rural	100.00	0.00	100.00	100.00	0.00	100.00	0.00
Small	(24.00)	(0.00)	(24.00)	(24.00)	(0.00)	(24.00)	(0.00)
Medium	100.00	0.00	100.00	100.00	0.00	100.00	0.00
	(8.00)	(0.00)	(8.00)	(8.00)	(0.00)	(8.00)	(0.00)
Large	100.00	0.00	100.00	100.00	0.00	100.00	0.00
	(8.00)	(0.00)	(8.00)	(8.00)	(0.00)	(8.00)	(0.00)
Mean	100.00	43.76	56.26	56.26	O.00	56,26	0.00
	(13.33)	(5.83)	(7.50)	(7.50)	(0.00)	(7.50)	(0.00)

wards from each colony and two villages from each community development block were randomly selected as phase-2 sample.

Results and Discussion

This is a basic chapter of research and contains the analytical results based on the face- face interaction and interview of dairy owners of urban and rural areas. The investigation was carried out during 2020-2021 and 2021-2022. The data obtained all over the course of investigation has been illustrated by table and. The results have been analyzed by statistically and logically interpreted. The research involved in general status of dairy owners and feeding pattern of dairy animals.

Feeding pattern of green fodder adopted at sampled dairy farms are presented in Table-1. Fodders are not available for feeding of milch animals in urban areas. Only 24.00% of livestock owners were provided green fodder to animals, the chaffing of fodder and mixing with straw was followed by 17.50% of owners. Remain of dairy owners were provided un-chaffed fodder to the animals. The chaffing practices and mixing in wheat straw was highest in medium dairy owners. The availability of was quite differ in rural areas where 97.50% of owners were giving daily green fodder daily. All the dairy farmer were providing green fodder just after chaffing and mixing with straw.

Method of concentrate feeding plays an important

role in proper feed utilization. The discussion regarding dry fodder and concentrate feeding have been summarized in Table-2. It indicates that 86.50% medium dairy owners of urban area were given feed to animals as dry or mixing with little quantity of water and large urban livestock owners do not soak or even wet the straw with water to fed animals. There were only 15.67% and 13.50% small and medium dairy owners who provide straw after mixing with water. Dairy owners of rural areas were providing straw only after proper mixing with water.

The concentrate feeding after proper mixing was used by 12.50% of urban dairy owners. Table indicates that 87.52% owners provided the concentrate by sprinkling over the feed. It is notable that such practices of concentrate feeding were regularly followed during milking. Feeding practices of concentrates in rural areas was quite before milking after soaked and mixed with straw.

Dry straw and small quantity of concentrate was giving all most dairy owners, showed that urban areas dairy owners do not take much care in feeding. On one hand technique of urea treated straw is available on other hand dairy owners are feeding their animals with untreated straw. It seems important that department of Animal Husbandry and Dairying should be organise the demonstration camps of urea straw treatment for awareness of livestock keepers. Here they can get maximum benefit from straw by improving its digestibility. Straw and concentrates are not provided even to cater the maximum nutritional demand. Straw was given for maintenance feed to take milk. Offering concentrate during milking is in practices with the objectives of obtaining maximum milk with less quantity of feed. This also reduces the cost of milk production. The whole picture indicates that urban dairy owners are very much commercialised. In rural aeras since straw and concentrates are available with farmers and dairy owners are morally connected to animals, according they take much care for their animals.

References

1. Al, Haditttu, A. N; Jassim, A.H and Salman, A. D. (1995) . The effect of feeding broiler litter during ensilage on the nutritive value of silage. J. Agric. Water Resources Res. Anim. Prod. 7: 167-168.
2. Anido, D. Too . F.; Tomboly , B. M ukaoa Mugorwa E, Lahlou Kaoai A. and Sovani S. (1997). Effect of mollasses urea block (MUB) on dry matter intake, growth reproductive performance and control of gastrointestinal nematode infection grazing menz ram lambs. Small Ruminant Research, 27: 163-71.
3. Bedi, S.P.S. and Khan, S.A. (1978). Annual Progress Report of Animal Nutrition Div. at IVRI, Izzatnagar.
4. Chaudhary, R.B.; Tripathi, S.C .and Tripathi, P. K. (1993). It is harmful to milk animals with injection. Pashu Poshan Anusandhan Darshan. 3(1): pp 1, 16.
5. Gupta, B.N. (1981). Dairy cattle feed resources and feeding practices in the north eastern states. National Dairy Research Institute, Karnal (ICAR). Publication No.
6. Mishra, A.K. and Dwivedi, P.N. (1995). Feed resource availability and traditional livestock production practices in Bundelkhand. In: Animal Report. IGFRI, Jhansi.
7. Ranjhan, S.K. (1993). Animal nutrition and feeding practices. Published by Vikash Publishing House Pvt. Ltd., New Delhi.
8. Pal, R.K, Bachan Shiv and Anand, K.B, (2021). Studies on feed consumption and nutritional status on lactating murrah buffaloes of rural areas of Kushinagar District U.P. Progressive Research—An international Journal Volume 16 (1): 47-50.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 706-712 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Underutilized Fruit Crops : Nutritional Composition, Potential Health Benefits and Assuring Food Security

Shivani Kumari* and Sonika Sharma
Department of Food and Nutrition, Punjab Agricultural University, Ludhiana, Punjab, 141 004, India
**Corresponding Author Email : shivani1982007@pau.edu*

Abstract

Many fruit crops originate in India, and the majority of them are exclusive to its producing region. Commercial cultivation is lacking, despite its strong nutritional and therapeutic potential. Fruits that are underutilized are also rich in dietary, nutritional, and medicinal value. Underutilized fruit crops have the ability to provide economic security by providing employment and generating high profits from raw and value-added product sales. If appropriately focused, the value added products of these fruits are projected to capture national and international markets. By addressing the dietary requirements of vulnerable individuals, the consumption of underused fruit crops can give nutrition to the poor and needy. Fruit crops provide a great source of carbs, lipids, proteins, energy, vitamins and minerals, and dietary fibre since they are underutilized. These underutilized fruit crops and product assets can be used to promote health, alleviate hunger, and minimize infection risk. The introduction of new product sources will bring previously untapped, neglected, and overlooked plants into the mainstream of plant utilization. The review study focuses on the nutritional, culinary, and medical significance of these underutilized fruits, as well as their impact on health.

Key words : *Underutilized fruits, nutritional value, medicinal potential, health, disease, value-added product.*

Introduction

Micronutrient deficiencies affect one-third of the world's population, and the problem has been known for a long time. Malnutrition, in particular, manifests itself in the guise of concealed hunger (Tontisirin *et. al.* 2002). Micronutrients are required in very small amounts yet are essential for the body's fundamental functions and are important in the prevention of numerous diseases. Because fruits are high in nutrients, phytochemicals, minerals, and antioxidants, they are also known as defence foods. Fruits also help to decrease cholesterol and fat levels because they contain soluble dietary fibre. Fruit cultivars with antioxidant properties have been shown to improve immunity during the COVID-19 pandemic. Fruits can also aid in the treatment of constipation, sleeplessness, anaemia, and stomach aches (Singh and Bhatnagar, 2019).

The most common cause of these deficits is a lack of routine consumption or usage of fruits and vegetables. Underutilized fruit crops have unknown nutritional value, a short shelf life, little customer awareness, and a bad reputation, and are therefore referred to as poor people's food. Several neglected fruit crops have therapeutic characteristics and are used in Ayurvedic and Homeopathic medicine. Some wild fruits, which are known as underutilized fruit plants and a source of income for local people, have been found as having more nutritional content than cultivated fruits.

These fruit crops have been included in world-wide action plans after successfully raising attention among decision-makers. Because of the abundance of natural antioxidants such as beta carotene, vitamin C and E, phenolic compounds such as anthocyanin, and other flavonoids, fruits and vegetables have a variety of qualities including antioxidant, anti-inflammatory, and anti-cacinogenic properties.

There are thousands of distinct edible fruit and vegetable kinds accessible that have the ability to combat the challenges and are less expensive, readily available, but neglected. These underutilized fruit species have the potential to provide a high level of micronutrient content, including minerals, vitamins, and a variety of bioactive substances. As a result, the current review paper focuses on many nutritionally abundant yet underutilized Indian fruits.

Consumption of underutilized fruits : Plants have long been a part of local cultures and traditions, according to Salvi (2016). Many underappreciated species serve an important role in preserving cultural diversity relating to health, food, religious rituals, and social interactions. Focusing attention on overlooked and underutilized species is an effective way to promote a diverse and healthy diet and combat micronutrient deficiencies, also known as hidden hunger, and other dietary deficiencies, which primarily affect the most vulnerable communities and rural poor people in developing countries. Local people have been using these plant species for decades, but due to a lack of local knowledge, their traditional

applications are being forgotten. Several underutilized species can contribute significantly to a healthier diet for local communities.

Consumption of underutilized fruits has long been documented. They were and still are used for traditional and therapeutic uses by the tribal parts of society. During crises, the Bhil tribe of Madhya Pradesh relied on various underused plants, as evidenced by the Bhil tribe of Dhar district. They use various parts of underutilized plants, including as leaves, fruits, and seeds, which can be consumed raw or cooked. They ate the 'kasha,' which can be considered either fruit or vegetables. The common fruit 'Sandeshra' satisfies both hunger and thirst (Quamra *et al.* 2006). Furthermore, edible plants are the most important component of traditional Himalayan diets in northern India.In the Aravalli highlands of Rajasthan's Mewar district, several species of undiscovered fruit bearing plants can be found. Solanum incanum L, Tamarindus indica Linn, Pedalium murex, Aegele maemelos (L) Correa, Emblica officinali, Helicteres isora, Tribulus terrestris, Ziziphus mauritiana Lam are the principal fruits reported to be utilized as medicine. These fruits are high in bioactive chemicals and are consumed by tribal people in the area (Katewa *et al*.2004).

Kumar *et al*. (2013) undertook an ethnobotanical inventory in the rural parts of Uttar Pradesh's Kannauj district. According to the findings, the rural community of Kannauj district consumes 25 unknown plant species belonging to 18 groups as vegetables. The majority of the time (68%) leaves and young stems are used, followed by fruits (18%), flowers, and tubers (7 %).

These underutilized and local fruits are quite popular among tribal tribes, but despite their popularity, people are still not embracing these fruit crops for farming purposes, which might assist the society obtain nutritious food and revenue (Mahaptra and Panda 2012). In addition, there are 46 different types of popular fruits in Orissa's tribal group that are edible but not consumed by the rest of the population. Karmata, Pakare, Korkotta, Badru, Oserwa, Bankundri, Lawa, Kongat Pinder, and others are cooked and consumed as vegetables, while others are consumed raw (Sinha and Lakra, 2005).

Underutilized Fruits Provide Health Advantages And Medicinal Uses :

AONLA Amalaki/Amla (*Emblica officinalis) :* Aonla (*Emblica officinalis*) belongs to the Euphorbiaceae family and is also known as Indian gooseberry. Aonla is a deciduous fruiting plant found in many Indian states. Aonla offers healing and beneficial health properties dating back to ancient India. Because aonla is highly acidic and has an astringent flavour, the raw organic product is used. Aonla products are highly nutritious and include a significant amount of vitamin C for therapeutic purposes. Aonla mash organic products have 200-900 mg of vitamin C, and aonla product juice has 20 times the amount of vitamin C as a squeezed orange (Singh and Singh, 2004).

Aonla Fruit Products : Murabba, triphala, and chawanparash were among the products made from aonla, while newer items include aonla sweets, jam, juice, chutney, vinegar, squash, pickle, and sharbat. Aonla powder was also developed for usage in a range of food products (Hasan *et. al.* 2010).

Aonla's medicinal significance : Vitamin C is most abundant in the Aonla fruit. Aonla is a constipation, diuretic, aperient, and laxative with many nutritional benefits. It is used as a cooling agent and to cure scurvy, sleeplessness, and sun strokes. Haemorrhage and leucorrhoea (Hasan *et. al.* 2010) are two other conditions for which it is beneficial. Scurvy was treated with dried aonla powder during WWII. Phenols and tannins abound in Aonla. Scurvy, TB, asthma, diabetes, bronchitis, iron deficiency, colds, flu, and hair greying are some of the diseases for which Aonla is prescribed. Chayvanprash and triphala are two ayurvedic tonics made from it (Kalra, 1998).

Aonla is a common element in hair tonics and is also included in shampoo and hair colour. It keeps hair's colour and lustre while also strengthening the roots. Hair growth and pigmentation are both improved. It also prevents premature greying and hair loss. Because it contains vitamin C and other phenolic substances, Aonla acts as an anti-oxidant and helps to prevent premature ageing. Aonla lowers blood sugar levels in diabetic patients by stimulating an isolated population of cells that generate insulin. (Iyer and colleagues, 2009).

The Chemical Composition of Aonla Fruit : (Source: Singh et al. (2004)

Nutrients	Nutrient value per 100g edible portion
Moisture (%)	80.22 to 89.36
TSS (°B)	10.32 to 16.00
Acidity (% citric acid)	1.25 to 3.24
rin86Ascorbic acid (mg/100g)	200 to 1500
Reducing sugar (%)	1.04 to 4.09
Non-reducing sugar (%)	3.05 to 7.23
Total sugar (%)	2.11 to 8.68
pH	2.20 to 3.21
Tannin (% gallotannic acid)	0.35 to 0.64
Protein (%)	0.65 to 0.98
Pectin (% Ca pectate)	0.44 to 0.78
Total sugars (%)	7 to 9.6
Reducing sugars (%)	1.04 to 4.09
Non-reducing sugars (%)	3.05 to 7.23

Lasora (*Cordia myxa* L.) : The Boraginaceae family includes Lasora. Gonda, Lasora, and lehsua are all names for Lasora. Except in high hills and moderate temperatures, Lasora may be grown across India. It's a medium-sized perennial tree with a twisted stem. Lassoda produces little fruits in clusters that are eaten as a traditional vegetable and pickle.

Lasora Fruit Products : Unripe green fruits are commonly utilised as pickles and vegetables. According to Chandra *et al*. (1994) it supplies food (pickles and vegetables), fuel wood, and timber, and hence plays a critical role in the rural economy of arid regions. According to Singh (2001), fruits are sometimes dehydrated after blanching and served as a vegetable during the off season. Glue is usually made from the sticky pulp of ripe fruits. Since the availability of conventional veggies is restricted (April–May), unripe fresh fruits are typically used for vegetable and pickle.

Lasora's Medicinal Uses : Lasora (*Cordia myxa* L) is an essential component of traditional medicine. According to Sofowora *et al* (1993), polyphenols found in the Lasora fruit contain antibacterial, anti-inflammatory, anti-allergic, antiviral, and anti-neoplastic properties. Rapisarda *et.al.* (1997*)* discovered that the leaves of Cordia myxa, as well as those of many other species in the same genus, have been employed in traditional medicine in many countries for the treatment of many ailments. Many of these purported effects have been attributed to their recognised antioxidant, free radical scavenger, and metal chelator properties. The existence of secondary metabolites such as alkaloids, saponin, steroid, and polyphenols has contributed to its therapeutic efficacy as well as physiological activity.

Bael (*Aegle marmelos Linn*) : Bael (*Aegle marmelos* Linn) is a Rutaceae tree that is also known as the Bale organic product tree. Bael is also known by other names such as koth bel, vilam palam, kothu, stone apple, bright apple, Bengal quince, Japanese harsh orange, and so on. Bael is high in nutrients such as calcium, phosphorus, iron, vitamin C, thiamine, riboflavin, niacin, and carotene, among others.

Bael is a well-known Ayurvedic plant whose roots, bark, stem, blooms, leaves, and organic compounds are used in India for a variety of medicinal purposes and treatments, including respiratory disorders, ulcers, loose bowels, and clogs. . Every part of the plant, including the stems, barks, roots, leaves, flowers, and fruits at all stages of maturity, has medicinal value and has been used in various ayurvedic medicines for the treatment of specific disorders like respiratory disorders, constipation, ulcer, diarrhoea, dysentery, and many others for a long time (Hasan, *et al* 2010).

Bael Fruit Products : Sherbet and syrup created from mash are organic products made from bael. Bael has been transformed into a variety of products such as natural products, which are also used in the preparation of powder, protect, nectar, and toffee (Rakesh *et al.* 2005).

Table-1 : Bael Fruit Nutritional Values (% or per 100 g) Neeraj et al 2017, and Paricha, 2004 are sources.)

Components	Value (%)	Components	Value (%)
Water (moisture)	64.2	Potassium	0.6
Protein	1.8	Iron	0.3
Fat	0.2	Vitamin A (IU)	186
Mineral	1.5	Vitamin B1	0.01
Fiber	2.2	Nicotinic acid	0.9
Carbohydrate	30.6	Riboflavin	1.2
Calcium	0.09	Vitamin C	0.01
Phosphorus	0.05	Calorific value	129

Bael's medicinal significance : Because of the large amount of steroids, alkaloids, coumarins, and oil found in plant leaves, roots, seed, and bark, they have hypoglycemic, antipyretic, antifungal, antiproliferative, pain alleviating, immune-modulatory, and insecticidal effects (Neeraj *et al.* 2017; (Patil R.H (2009).

The organic substance Bael contains Marmelosin, which is used to treat gastrointestinal problems. The bael-based organic product is considered one of the best sources of riboflavin. Because of the high concentration of Aegeline in bael leaf, it is also used for weight loss. The Bael organic product is primarily used to treat diarrhoea, peptic ulcers, and loose bowels, as well as as a diuretic and to recuperate from respiratory problems (Iyer and colleagues, 2009).

BER/ Indian Jujube (*Zyziphus mauritiana*) : Ber is a fruit native to Indo-China and India. Ber is a member of the Rhamnaceae family and is also known as Indian Jujube (*Zyziphus mauritiana*). Vitamin C is abundant in fruits that range in colour from greenish yellow to reddish brown (85-95 mg per 100 g). Vitamin C was identified in greater quantities in the fruit meat around the seed than in the fruit skin. It is a good fruit tree for desert and semi-arid regions in tropical and subtropical climates where most fruit crops cannot be cultivated due to a lack of irrigation infrastructure and harsh soil and climatic conditions (Krivencov, 1970).

Ber is an organic product that is primarily consumed fresh and in its dried form. Ber is a naturally occurring product that contains sugar, phenolic compounds, vitamin A, B complex, ascorbic acid, and minerals such as calcium, phosphorus, and iron. Ber and its natural products provide food to the body, as well as many therapeutic benefits such as nutrient absorption and blood purification. Ber has phenolic chemicals that have

anti-cancer qualities and decrease and neutralise free radicals, which are cancer-causing agents.

Ber fruit Product : Ber is used to make chutney, ber jam, ber murabba, ber sweets, ber pickle, ber powder, ber safeguard, and other ber treats, as well as ber wine. Ber leaf extract is used to treat bleeding gums and a sore throat. Fever, ulcer, and wound healing are all helped by ber powder (Diengngan and Hasan 2014).

The root and bark extracts aid in bowel movement and avoid constipation. Ber natural products are high in calcium, phosphorus, and iron, all of which help to restore bone quality and are used to treat osteoporosis and other bone abnormalities. Ber increases blood flow and ensures smoother blood distribution because it is high in iron and phosphorus.

Chemical Composition Fresh Fruit of Ber (Source: Morton (1960)

Nutrients	Nutrient value per 100g edible portion
Moisture (%)	82.01
Carbohydrate (g)	5.4-10.5
Protein (g)	0.8
Fat (g)	0.07
Fibre (g)	0.60
Calcium (mg)	25.5
Phosphorus (mg)	26.8
Iron (mg)	0.76-1.8
Vitamin B3 (mg)	0.02-0.024
Vitamin C (mg)	65.8-76.0
Vitamin A (carotene) mg	0.021

Ber's Medicinal significance : Ber contains a high level of Vitamin A and C, thus products made from Ber can help prevent colds and hacks, as well as increase immunity and vigour while lowering weariness. Ber is also high in vitamin A and B-complex vitamins.

The fruits can also be used to make a variety of items such as dried ber, chutney, murabba, and jelly. Dysentery and diarrhoea can be treated using a decoction made from the plant's root and bark. The seeds have a calming effect and are used in conjunction with buttermilk to relieve nausea, vomiting, and stomach pain in pregnant women. Ber's dry ready-to-use organic product is a gentle diuretic.

The bark glue can also help avoid stiffness and reduce gout symptoms. Ber leaves are used to treat liver problems, asthma, and fevers, and when an astringent is needed, such as on wounds, they are combined with catechu. The decoction of ber bark is used to treat diarrhoea and soothe gum disease, and bark glue is applied to wounds. Ber is also high in flavonoids, which aid to prevent cancer and reduce oxidative stress.

Karonda (*Carissa carandas L.*) : *Carissa carandas* L.*,* a member of the Apocynaceae family, is a popular Indian food. It's a hardy, drought-resistant natural product plant that thrives in a variety of soils. It generates astringent berry-sized products that are often used as a fixing or additional material to pickles and tastes. Karonda and its products have a bitter and astringent flavour. Karonda has a lot of macronutrients including grain, protein, and fat fibre, as well as a lot of micronutrients like iron, vitamin C, and calcium.

Karonda fruit Product : Karonda is commonly used as a flavouring or addition to Indian dishes and cool beverages. Jam, sauce, carissa cream, pickles, sauces, and chutney are all made using natural ingredients. It's also used as a substitute for apples in apple tarts, along with cloves and sugar to season the natural product.

Natural goods are normally conscious of green chilies to form a wonderful dish served with chapattis in many parts of India. As a substitute for raisins, dried organic foodstuffs were used. When the ready natural product is cooked, it produces sticky latex, but it still yields a rich crimson juice that cools to clear, making it a delicious cooling drink in the summer.

Chemical Composition of Karonda Fruit : Source: Tripathi *et al* (2013)

Nutrients	Nutrient value per 100g edible portion	
	Fresh Fruit	Dried Fruit
Energy (Calorie)	42	364
Moisture (%)	91	18.4
Protein (%)	1.1	2.3
Carbohydrate (%)	2.9	67.1
Fat (%)	2.9	9.6
Mineral (%)	-	2.8
Calcium (mg)	2.1	160
Phosphorus (mg)	28	60
Iron (mg)	-	39.1
Vitamin –C (mg)	200-500	1

Karonda's Medicinal significance : Karonda is commonly used to treat fever, intestinal illness, blood purifier, epilepsy, cerebral pain, nerve problem, pain relief, tingling, and leprosy. The unripe natural product made from karonda has cooling, astringent, acidic, antiscorbutic, stomachic, and anthelmintic properties. Alkaloids, flavonoids, saponins, and a variety of cardiovascular glycosides, triterpenoids, phenolic compounds, and tannins are the key bioactive chemicals found in karonda that give therapeutic benefits (Rahmatulla *et al.* 2009).

Karonda products contain nutritional substances such as cortisol, cortisone, caryophyllene, carindone, lupeol, carissic corrosive, carinol, ascorbic corrosive, and -sitosterol, which are used to cure intestinal worms, pruritus, biliousness, and scabies. In the case of remittent

fever, karonda leaf decoctions are given. For infection restoration, leaf separate is applied remotely. Karonda fruit is an antiscorbutic that can also help with stomach aches, anaemia, and is antihelmintic (Virmani *et al.,* 2017).

Phalsa *(Grewia subinaequalis)* : Phalsa is an Indian root bush or small tree that belongs to the Tiliaceae family. It's been around since the Vedic times. Phalsa has been found thriving in Punjab, Uttar Pradesh, Rajasthan, Haryana, Madhya Pradesh, West Bengal, and other parts of southern India. On a commercial basis, phalsa goods are largely produced in India's northern and western regions. During the summer, the ready phalsa items are used fresh or cooked into rejuvenating foods derived from the ground. It has a lot of nutrients in it.

The phalsa fruit and its derivatives are rich in a variety of vitamins and minerals, as well as substances with strong anti-cancer potential. Anthocyanin, carotenoids, and flavonoids are abundant in phalsa fruits and products. Due to the presence of potassium, phalsa products play an important function in improving digestion and maintaining circulatory strain. Different portions of the phalsa plant have different pharmacological effects due to the appropriate amount of nutrients, proteins, amino acids, and minerals, as well as bioactive substances such as phenolics, flavonoids, tannins, and anthocyanins.

Phalsa's Fruit Products : Phalsa goods are new, such as pastries and energising soda pops like squash, Sherbet, and others, which have been enjoyed in India for a long time throughout the summer.

The Chemical Composition of phalsa fruit : (Source : Gopalan (2002)

Nutrients	Nutrient value per 100g edible portion
Moisture (%)	80.8
Carbohydrate (%)	21.1
Protein (%)	1.5
Fat (%)	0.9
Fibre (%)	1.2
Calcium (mg)	129
Phosphorus (mg)	39
Potassium (mg)	375
Iron (mg)	3.1
Vitamin B3 (mg)	0.3
Vitamin C (mg)	22
Vitamin A (carotene) ug	419

Phalsa's Medicinal significance : The unripe phalsa is exposed to reduce stress and blood concerns such as fever, has a cooling effect on the body, and sexual enhancer effects that fight thirst and sensation. Anticancer, antibacterial, antiemetic, and anti-platelet activities are all found in Phalsa Leaves. It can also help with urinary problems.

Jamun (*Syzygium cuminis keels*) : The Myrtaceae family includes jamun. In India and other tropical and subtropical regions of the world, it is a common forest tree. The tree is economically significant since most of its parts, such as the bark, leaves, seed, and fruits, are utilized as alternative medicines to cure a variety of ailments. It is a significant underutilized organic product yield and an important indigenous commercial prestige product in the country. Jamun is a mostly restorative plant that has been used in several traditional medical frameworks. The tree is ideal for windbreaks and estates on the side of the road.

Jamun is a healthy fruit that has a good number of phenolics compounds, flavonoids compounds, carotenoids, glucoside, and anthocyanins, among other theraupetic advantages. The alkaloid jambosine, atilwllin, and glycoside jambolin found in jamun seeds stop the diastatic transformation of starch into sugar. Consumption of jamun and its products aids in the treatment of diabetes, ulcers, and reduces the risk of degenerative diseases such as cancer, as well as reducing macromolecular oxidation and oxidative pressure (Kubola *et al.* 2011).

Jamun fruit Product : It's a seasonal fruit that's best eaten fresh to get the most nutrients. For its gorgeous and appealing purple colour, fruits are also processed to make jam, jellies, squash, vinegar, and ice cream. Jams, beverages, squashes, and wine are some of the ready-to-eat natural goods made from Jamun.

Jamun organic product is used to make a high-quality vinegar that has an appealing, clear purple colour, a pleasant aroma, and a mellow flavour. In addition, Jamun is well-known for producing high-quality wine. The matured juice of Jamun natural product has also been used to make cognac and refined alcohol known as "jambava." Sauces can also be made with the juice of ready-to-eat organic jamun products, just like drinks.

The Chemical Composition of Jamun Fruit. (Source Raza (2015)

Nutrients	Nutrient value per 100g edible portion	
	Fruit	Seed
Moisture (%)	82.19	16.34
Crude protein (%)	2.15	1.97
Crude fat (%)	0.83	0.65
Crude fiber (%)	1.76	4.19
Ash (%)	2.04	2.18

Jamun' Medicinal significance : Jamun powder is made from the seeds of the jamun fruit, which helps to lower the sugar level in pee and has anti-diabetic and gastro-protective qualities. The ingestion of leaves and bark, as well as their products, aids in the control of

circulatory strain and gum drainage. The Jamun seeds are used to cure a variety of ailments, the most common of which is diabetes mellitus (Sagrawat *et al.* 2006).

Jamun can help reduce diabetes-related thirst by reducing the volume of pee produced and decreasing insulin usage. Organic product mash includes a huge amount of anthocyanin, which reduces the risk of many illnesses and can be a good source of distinctive food colourants for the food processing industry (Chaudhary and Mukhopadhyay, 2012).

For clinical purposes, the jamun tree's bark, leaves, seeds, and generated product with theraupatic qualities are all used. Jamun is used in well-known traditional diabetes treatments to assist people manage their blood sugar levels. The tree is rich in phytochemicals such as glycoside jambolin, tannins, gallic acid, anthocyanins, terpenoids, and other minerals. They can be utilized as a nutraceutical because of its various health-promoting components. The fruits are purple black in colour when fully ripe, with a high anthocyanin content. Jamun's glucosides prevent starch from being converted to glucose, reducing blood glucose levels.

Traditionally, the entire plant, as well as the majority of the plant's active components, has been used for medical purposes. Different portions of jamun tree are used to treat diabetes as an alternative medicine. Several studies have shown that the fruits, seeds, and stem bark have anti-diabetic properties.

Limitations in underutilized fruit crops : Many factors contribute to the underutilization of diverse fruit crops, including a lack of social practise knowledge and mindfulness among the cultivating network regarding the healthy and therapeutic value. Locals do not have much knowledge on how these fruit crops provide jobs.

Other factors are at play since proper propagation tactics have yet to be created, as well as a dearth of study in the case of these fruit crops. Desirable seeds, as well as planting materials, are in short supply. There is no exhibiting organisation or foundation office for natural items that are underutilized.

Promotion of underutilized fruits : Promotion of the establishment of processing industries for underused fruit crops (jams, jellies, fermented goods, etc.) and industries for the manufacture of resins, gums, and other materials, as well as lifestyle products such as cosmetics, should be encouraged. Appropriate propagation methods and agro-techniques should be used for their development and enhancement. The crops are processed infrequently or not at all. Because they do not require external efforts such as irrigation or fertilization, underutilized fruit crops can be employed for sustainable land use.

These crops are readily available since they are local crops that are gathered from the wild or grow in home gardens, providing food security to the community. Undomesticated landraces have adapted to a wide range of environments and can occasionally withstand situations that high-bred cultivars can't.

Because of the low external input needs, it has been suggested that underused crop production can be combined with organic certification, providing growers with niche market opportunities. Furthermore, underused crops are a part of mixed cropping systems such as home gardens, terraces, and agro forestry systems. These underutilized crops are included into the farming system since they are better suited to difficult conditions than domesticated commercial crops. If one crop or variety fails due to unforeseen circumstances, another may be available to supply food or money in its place.

Conclusions

In the current socioeconomic situation, when our country is confronted with severe problems like COVID-19 pandemic, malnutrition, hidden hunger, poverty, and unemployment, there is a need to explore alternatives for better nutrition in order to maintain demand and supply chains for nutritious food items, particularly horticultural crops. Exploring unknown species of neglected horticulture crops is the best strategy to find nutritional alternatives.

These underutilized fruit crops and product assets can be used to promote health, alleviate hunger, and minimize infection risk, improve immunity. The introduction of new product sources will bring previously untapped, neglected, and overlooked plants into the mainstream of plant utilization. The underutilized fruit crops are not only a source of food and nutrients for local populations, but they may also be a source of money if they are handled properly. Numerous more underutilized fruit crops can help local people not just as food, but also as medicinal plants.

Underutilized fruit and vegetable crops are high in vital nutrients like minerals and vitamins and have been adapted to horticulture with limited information. Food security and sustenance are improved by more imaginative work with underutilized fruit crops. Horticultural crops that are underutilized are nutritionally dense and well-suited to low-input farming. The usage of these fruits will benefit from better cooperation among all offices involved in discovery, development, and progress. Strategies should be developed, particularly at the public and municipal levels, to generate, make accessible, and reduce the limits of creating good seed material, planting material, in-vitro or tissue refined material.

References

1. Chaudhary, B., and Mukhopadhyay, K. (2012). Syzygium cumini (L.) Skeels: A potential source of nutraceuticals. *Int J Pharm Biol Sci*, *2*(1), 46-53.
2. Diengngan, S. and Hasan, A.M. 2014. Impact of climate change on fruit crops. International conference on Horticulture for nutritional Livelihood and Environmental Security in Hills.
3. Gopalan, C., Nutritive value of Indian Foods, *National Institute of Nutrition, Indian Council of medical research*, Hydrabad. 53 (2002).
4. Hasan, M.A., Singh, S.R., Majhi, D., Devi, H.L. and Singh, Y. (2010). Significance of minor fruits in health care. Proceeding of Botanicals in Integrated Health Care, 4(2):162-166.
5. Iyer, U., Joshi, A., Dhruv, S. 2009. Impact of amla (*Emblica officinalis*) supplementation on the glycemic and lipidemic status of type 2 diabetic subjects. *J Herbal Medicine and Toxicol* 3(2): 15-21.
6. Kalra, C.L. (1998). The chemistry and technology of aonla (*Emblica officinalis*) a resume. *Indian Food Packer,* 42(4): 67-82.
7. Katewa, S.S., Chaudhary, B.L., Jain, A. (2004). Folk herbal medicines from tribal area of Rajasthan, India. *Journal of Ethnopharmacolog.* 92: 41–46.
8. Krivencov, V.I., Karahanova, S.V., Savina, G.G. 1970. Bjull. Gos. Nikitsk. Bot Sada 2: 57- 59.
9. Kubola, J., Siriamornpun, S. and Meeso, N. (2011). Phytochemicals, vitamin c, and sugar content of thai wild fruits. *Food Chemistry,* 126(3): 972-981
10. Kumar, A. (2013). Ethnobotanical study of wild vegetables used by rural communities of Kannauj district, Uttar Pradesh. *Emirates Journal of Agriculture.* 25(10): 760-766.
11. Mahaptra, A.K. and Panda, P.C. (2012). Nutrient Analysis of Some Selected Wild Edible Fruits of Deciduous Forests of India: an Explorative Study towards Non Conventional Bio Nutrition. *Advance Journal of Food Science and Technology.* 4(1): 15-21.
12. Morton, J., The Emblic (*Phyllanthus emblica* L.), *Economic Botany*. 14: 119-128 (1960).
13. Neeraj, Vinita Bisht and Vishal Johar. (2017). Bael (*Aegle marmelos*) Extraordinary Species of India: A Review. *Int. J. Curr. Microbiol. App. Sci.* 6(3): 1870-1887. doi: https://doi.org/10.20546/ijcmas.2017.603.213
14. Parichha Saswati (2004). Bael (*Aegle Marmelos*): Nature's Most Natural Medicinal Fruit". Orissa Review.
15. Patil R. H., Chaudhary B. & Settipalli S.(2009),"Antifungal and Antiaflatoxigenic activity of Aegle marmelos Linn.", *Pharmacognosy Journal,* Volume 1, No. 4.
16. Raza, A., Proximate Composition of Jamun (*Syzygium cumini*) Fruit and Seed". *American-Eurasian Journal of Agricultural and Environmental Sciences.* 15: 1221-1223 (2015).
17. Rakesh, Dhawan SS, Arya SS. (2005). Product Development: Processed Products of Bael. *Processed Food Industry*, 8(10): 25-27.
18. Rakesh, Dhawan SS, Arya SS. (2005). Product Development: Processed Products of Bael. *Processed Food Industry*, 8(10): 25-27.
19. Quamra, S.R., Roy, J., & Mishra, D.K. (2006). Food consumption pattern and associated habits of the Bhil tribe of Dhar district of Madhya Pradesh. In *Proceedings of National Symposium on Tribal health, Regional Tribal Medical Centre, ICMR, Jabalpur* (pp. 211-219).
20. Rahmatullah, M., Noman, A., Hossan, M.S., Rashid, M.H., Rahman, T., Chowdhury, M. H., & Jahan, R. (2009). A survey of medicinal plants in two areas of Dinajpur district, Bangladesh including plants which can be used as functional foods. *American Eurasian Journal of Sustainable Agriculture*, *3*(4), 862-876.
21. Rapisarda, A., Iauk, L. and Ragusa, S., Micro morphological study on leaves of some Cordia species used in traditional medicine. *EconBot*. 51(4): 385–391 (1997).
22. Sagrawat, H., Mann, A. and Kharya, M. (2006). Pharmacological potential of Eugenia jamuna: A Review. *Pharmacogenesis Magazine,* 2: 96-104.
23. Salvi, J. and Katewa, S.S. (2016).Underutilized wild edible plants as a potential source of alternative nutrition *International Journal of Botany Studies,* 1(4): 32-36.
24. Singh, I. S., Minor fruits and their uses. *Indian J Hortic.* 58(1/2): 178–182 (2001).
25. Singh, V. and Singh, P. (2004). A review of Physico-chemical characteristics of aonla (Emblica officinalis Gaertn) cultivars. *Journal of Ecophysiology,* 7: 73-76.
26. Singh, U., Proximate Composition, available Carbohydrates, Dietary Fibres and Anti-Nutritional factors in bael (*Aegle Maemelos* L.) Leaf, Pulp and Seed Powder". *International Journal of Scientific and Research Publications.* 2: 1-4 (2012).
27. Singh, Y. and Bhatnagar, P. (2019). An overview of the inherent potential of underutilized fruits. International Journal of Pure and Applied Bioscience, 7(3): 86-103.
28. Sinha Rekha and Lakra Valeria.(2005).Wild tribal food plants of Orissa. *Indian Journal of Traditional Knowledge.* 4(3): 246-252.
29. Sofowora, E. A., Medicinal plants and traditional medicine in Africa. Spectrum Books Ltd. Ibadan, pp 55–71 (1993).
30. Tontisirin, K., Nantel, G., & Bhattacharjee, L. (2002). Food-based strategies to meet the challenges of micronutrient malnutrition in the developing world. *Proceedings of the Nutrition Society.* 61(02), 243–250.
31. Tripathi, P. C. and Karunakaran, G., Production technologies of minor fruits with special emphasis on Kodagu. Souvenir and Abstracts, SYMSAC-VII, Madikeri, Karnataka. November 27- 29, Pp. 97-105 (2013).
32. Virmani, R., Virmani, T., Singh, C., Sorout, G. and Gupta, J. (2017). The hidden potential of natural herb karonda (*Carissa Carandas*). *Research in Pharmacy and Health Sciences*, 3(2): 294-302.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 713-716 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Antioxidant Activity in Germinated Buckwheat

Shreeja Kulla[1], Suchiritha Devi S.[1*], Jessie Suneetha W.[2] and Neeraja Prabhakar B.[3]

[1]*Post Graduate and Research Centre, PJTSAU, Rajendranagar, Hyderabad - 500 030*

[2]*PJTSAU-Krishi Vigyan Kendra, Wyra, Khammam-507165*

[3]*Department of Horticulture, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad-500030*

Corresponding Author Email : sucharithadevi.hyd@gmail.com

Abstract

Buckwheat is the most consumed pseudo cereal with high nutritional and bioactive compounds. Germination is considered to be an effective process for improving the functionality and reducing the antinutritional factors in grains. Germination of buckwheat has significantly increased free radical scavenging activity through DPPH assay method. Total flavonoid and phenolic content have decreased and no difference was observed between the raw and germinated buckwheat for preliminary phytochemical screening of secondary metabolites.

Key words *: Buckwheat, flavonoids, phenolic content, phytochemical screening.*

Introduction

Buckwheat is a pseudo cereal belonging to polygonaceae family and grows mainly in the northern hemisphere with Russia and China as main producers of buckwheat in the world. The consumption has become increasingly popular in the United States, Canada, and Europe [1]. It is characterized as functional food due to its active components with biological activity and healing properties like flavonoids, phenolic acids, phytosterols, *etc*. [2,3]. Rutin and quercetin compose the major part of bioactive compounds in buckwheat with antioxidant, antimicrobial and anti-inflammatory activities [4,5]. The quantified phenolic compounds in buckwheat are caffeic acid, rutin, vitexin, quercitrin, quercetin and kaempferol [6]. Zhang *et al*. (2015) identified 11 phenolic compounds in buckwheat that include orientin, isoorientin, vitexin, isovitexin, rutin, kamperol 3 rutinoside, quercitrin, myricetin, luteolin, quercetin and kampferol [7]. It is known that phenolic compounds like rutin, quercetin, *etc*. cannot be produced in human body and therefore it is important to take them with food for free radical scavenging. Wang *et al*. (2009) observed the reduction of chronic disease risk by using buckwheat bran extract in their *in-vivo* studies [8]. Kawa *et al*. (2003) reported the reduction of serum glucose level by feeding buckwheat to rats [9]. Regular intake of buckwheat can reduce the blood glucose concentration and the risk of diabetes in humans [10].

It is important to understand the effect of processing on functional components in buckwheat. Researchers have studied the effect of processing on a few functional components in buckwheat. Im *et al*. (2003) stated that temperature and heating time adversely affected rutin in buckwheat grit cakes [11]. Orsak *et al*. (2001) observed that low dose of ɑ radiation (50 Gy) could increase rutin content of buckwheat seeds whereas at higher doses (100 Gy) it decreased [12]. Heating of buckwheat at a temperature of 150°C reduced phenolic compounds with the loss higher by the prolongation of time [13]. Jozinovic *et al*. (2012) concluded that the extrusion of corn meal with buckwheat flour caused to decrease in the antioxidant activity and total phenolic content [14]. Zielinska *et al*. (2007) observed similar results of reduction of antioxidant capacity in buckwheat after roasting [15]. Sensoy *et al*. (2006) reported that the optimization of temperature and time during processing could help to maintain phenolic compounds [16].

Germination of bioactive compound rich buckwheat promises increased antioxidant activity. In this study, we investigated the effect of germination on presence of phytochemicals, total flavonoid content, total phenolic content and antioxidant activity of common buckwheat (*Fagopyrum Esculentum* Moench).

Materials and Methods

Buckwheat (*Fagopyrum Esculentum*Moench) was procured from Assam Agricultural University, Jorhat, India.

Preparation of germinated buckwheat : Germinated buckwheat was prepared as procedure given by [17]. Buckwheat was soaked in distilled water for 12 hrs, then shifted to sterilized petri plates which were covered with filter paper and were placed in biochemical oxygen demand incubator at 30ºC for 48 hours. Germinated buckwheat was dried at 65°C in a tray drier for 5-6 hours. Dried sprouts were then milled using a grinder; obtained flour was sieved and stored in plastic bags for the analysis.

Table-1 : Phytochemical screening of germinated buckwheat.

S. No.	Phytochemicals	Name of test	Raw buckwheat	Germinated buckwheat
1.	Carbohydrates	Molisch test	++	++
2.	Alkaloids	Mayer's test	-	-
		Wagner's test	+	+
		Hager's test	+	+
3.	Proteins	Kjeldahl method	++	++
4.	Amino acids	Ninhydrin test	+	+
5.	Flavonoids	With ammonia solution	+	+
6.	Fixed oils and fats	Foam test	-	-
7.	Terpenoids	-	+	+
8.	Cardiac glycosides	-	-	-
9.	Steroids	Liebermann Burchard test	-	-
10.	Saponins	Foam test	-	-
11.	Tannins	$FeCl_3$ test	-	-
12.	Phlobatinins	With HCl	-	-
13.	Phenols	Ferric chloride test	+	+
		Liebermann's test	+	+
14.	Quinones	With conc. HCl	-	-

Note : All screening tests were carried out in triplicates.
(- = Not detected, + = detected, ++ = strongly detected)

Preparation of extracts : Firstly 2.0 g of germinated buckwheat flour was subjected to extraction by cold maceration in 100.0 ml of methanol for 24 hours followed by centrifugation at 3000 rpm for 10 min and filtered through Whatman No. 41 filter paper to obtain clear extracts. The clear filtrates were collected and preserved at 4°C until further use.

Preliminary phytochemical screening : The preliminary tests of carbohydrate, alkaloids, proteins, amino acids, flavonoids, fixed oils, terpenoids, cardiac glycosides, steroids, tannins, phlobatins, phenols and quinones were carried out by following the procedure given by Harbourne [18].

Total phenolic compounds, total flavonoid content and free radical scavenging assay : Total phenolic compounds were determined according to a modified method of Slinkard and Slingleton [19]. Total flavonoid content was done as per the procedure given by Meda [20]. Free radical scavenging assay by DPPH method as described by Dorman [21].

Results and Discussion

Phytochemical screening of germinated buckwheat : The phytochemicals also known as phytonutrients are naturally occurring substances found in plants. These substances have been found to be beneficial to human health as well as possessing antioxidant activity. Phytochemicals could act as an antioxidant and anti-inflammatory. It plays vital role in detoxification of harmful and deleterious chemicals of the body [22].

The preliminary phytochemical screening for bioactive components in methanol extracts of selected germinated buckwheat flour like carbohydrates, alkaloids, tannins, phenols, terpenoids, and flavonoids were analysed and presented in Table-1. Carbohydrates strongly detected by Molisch test indicated the presence of monosaccharide. Mayer's test failed to show alkaloids but Wagner's test and Hager's test detected alkaloids in raw and germinated buckwheat. Amino acids, flavonoids and terpenoids were detected and proteins were strongly detected in raw and germinated buckwheat. Fixed oils and fats, cardiac glycosides, steroids, saponins, tannins, phlobatinins and quinones were not detected in germinated and ungerminated buckwheat. The phytochemical screening of 5 buckwheat varieties of aqueous and ethanolic extracts revealed the presence of alkaloids, glycosides, saponins, diterpenes, flavonoids, coumarins, phytosterols, lignins and terpenoids [23].

Total flavonoid and phenolic content : Buckwheat is recognized as a good source of flavonoids with a potential to inhibit lipoprotein oxidation and to reduce the risk of cardiovascular diseases [24]. Results exhibits the decrease of flavonoid content in buckwheat after germination was presented in Table-1. The flavonoid content before germination was 10.25 g/ml and 8.06 g/ml after germination. Lin et al. (2009) studied the effect of germination on flavonoid content in different varieties of legumes [4]. There was decrease of flavonoid content in azuki bean after germination; whereas in soyabean varieties flavonoid content has decreased after one day of

germination but after four days it has increased. This may be due to pigmentation loss but it regains later.

Phenolic moieties present in the molecular structure of natural antioxidants often help in enhancing their antioxidant activity. Total phenolic content differed depending on the buckwheat varieties and extractions method used [25]. Vollmannova *et al*. (2013) observed total phenolic contents of five buckwheat varieties varied between 138.10 -286.99 GAE mg/100g, whereas Mikulajova *et al*. (2016) evaluated 22 cultivars of buckwheat and total phenolic content ranged from 89.7 to 145.6 GAE mg/100g [26,27]. The results indicated that decreased phenolic content was due to germination. The phenolic content of raw buckwheat was 20.20ìg/ml and lowered to 16.39ìg/ml after germination (Figure 1). This reduction was due to loss of pigmentation when germination occurred and depended on the germination time and drying temperature. Xu *et al*. (2009) found an increase of phenolic content in oats at different germination times of 12, 24, 36 and 48hrs [28]. Mares *et al*. (2017) stated that there was decrease in phenolic content immediately after germination but afterwards it has shown an increment in white sesame [29]. This was justified that germination releases the phenolic compounds that were connected and then increases the quantity of total phenolics [30]. Similar results were reported in germinated minor millets by Kulla *et al.* [31].

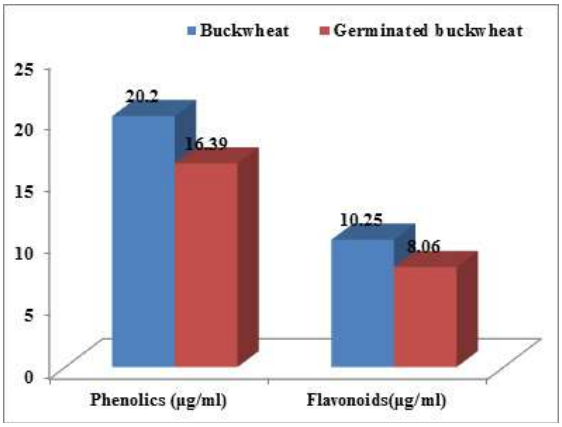


Figure-1: Total phenolic and flavonoid content.

Free radical scavenging activity assay by DPPH method : The antioxidant activity of crude extracts in methanol was carried out using *in-vitro* antioxidant models in comparison with ascorbic acid, a known antioxidant because of its ability to impair the formation of free radicals in the intracellular substances throughout the body. Antioxidants react with DPPH, which was a stable free radical and convert it to 1,1-diphenyl-2-picryl hydrazine. The degree of discoloration indicated the radical scavenging potential of the antioxidant components. All 24 cultivars of buckwheat showed significant scavenging activity against DPPH radicals [27]. IC_{50} was obtained by interpolation of linear regression analysis from the data obtained at various concentrations. Lower IC_{50} value indicates the more antioxidant activity. The antioxidant activity of buckwheat was increased with germination as IC_{50} value of germinated buckwheat (1.86) was lower than the raw buckwheat with 2.60. Antioxidant activity of germinated buckwheat increased by 32.36% compared to raw ones. Similar results were observed by Zhang *et al*., (2015) and highest radical scavenging activity of buckwheat was at 72 hours of germination [7]. Ratha and Jhon (2017) stated an increased antioxidant activity of buckwheat seeds after germination may be due to increase in few polyphenolic compounds and ascorbic acid content [32].

Conclusions

Germination can enhance nutritional content and antioxidant activity. It can be concluded that, by selecting optimum germination time and drying temperature of buckwheat could increase the phenolic content and antioxidant activity. It is suggested that germination of buckwheat for more than 48 hours is potential in terms of improving bioactive compounds. Value addition with germinated buckwheat flour improves biological and healthy activities such as hypocholesterolemic, hypoglycemic, anticancer, and anti-inflammatory.

Acknowledgement

The authors thank honourable Vice Chancellor of Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad for his encouragement.

References

1. Shreeja, K.; Devi, S.S.; Suneetha, W.J. and Prabhakar, B.N. (2019). Formulation of Payasam with Germinated Buckwheat Milk. *Int. J. Curr. Microbiol. App. Sci.* 8(2): 948-51.
2. Torbica, A.; Hadnaðev, M. and Hadnaðev, T.D. (2012). Rice and buckwheat flour characterisation and its relation to cookie quality. *Food Research International.* 48(1): 277-83.
3. Shreeja, K.; Devi, S.S.; Suneetha, W.J. and Prabhakar, B.N. (2020). Formulation and Organoleptic Evaluation of Germinated Buckwheat (*Fagopyrum Esculentum* Moench) Flour Incorporated Idly. *Chemical Science Review and Letters.* 9(33): 134-137.
4. Lin, L.Y.; Liu, H. M.; Yu, Y.W.; Lin, S.D. and Mau, J.L. (2009). Quality and antioxidant property of buckwheat enhanced wheat bread. *Food Chemistry.* 112(4): 987-91.
5. Maigorzata, W.R.; Joanna, H. and Konrad, P.M. (2015). Effect of solid-state fermentation with Rhizopus oligosporus on bioactive compounds and antioxidant capacity of raw and roasted buckwheat groats. *Italian Journal of Food Science.* 27(4): 424-31.

6. Peng, L.X.; Zou, L., Tan, M.L.; Deng, Y.Y.; Yan, J.; Yan, Z.Y. and Zhao, G. (2017). Free amino acids, fatty acids and phenolic compounds in Tartary buckwheat of different hull colour. *Czech Journal of Food Sciences.* 35(3): 214-22.
7. Zhang. Z.L.; Zhou, M.L.; Tang, Y.; Li, F.L.; Tang, Y.X.; Shao, J. R.; Xue, W.T. and Wu, Y. M. (2012). Bioactive compounds in functional buckwheat food. *Food research international.* 49(1): 389-95.
8. Wang, M.; Liu, J.R.; Gao, J. M.; Parry, J.W. and Wei, Y.M. (2009). Antioxidant activity of tartary buckwheat bran extract and its effect on the lipid profile of hyperlipidemic rats. *Journal of agricultural and food chemistry.* 57(11): 5106-12.
9. Kawa, J.M.; Taylor, C.G. and Przybylski, R. (2003). Buckwheat concentrate reduces serum glucose in streptozotocin-diabetic rats. *Journal of Agricultural and Food Chemistry.* 51(25): 7287-91.
10. Lu, M.J.; Zhang, H.W., Zhang, Y.H.; Tong, W.; Zhao, Y.; Shan, S. and Liu, H. (2002). An epidemiological study on relationship between buckwheat in diet and the prevalence rate of Diabetes Mellitus as well as blood glucose concentration'. *Modern Preventive Medicine.* 29: 326-7.
11. Im, J.S.; Huf, H.E. and Hsieh, F.H. (2003). Effects of processing conditions on the physical and chemical properties of buckwheat grit cakes. *Journal of agricultural and food chemistry*. 51(3):659-66.
12. Orsák, M.; Lachman, J.; Pivec, V.; Hamouz, K. and Vejvodová, M. (2001). Changes of selected secondary metabolites in potatoes and buckwheat caused by UV, gamma-and microwave irradiation. *Rostlinna Vyroba.* 47(11): 493-500.
13. Dietrych-Szostak, D. and Oleszek, W. (1999). Effect of Processing on the flavonoid content in Buckwheat (Fagopyrum e sculentum Möench) grain. *Journal of Agricultural and Food Chemistry.* 47(10): 4384-7.
14. Jozinoviæ, A.; Šubariæ, D.; Aèkar, Ð.; Babiæ, J.; Klariæ; I.; Kopjar, M. and Lendiæ, K. (2012). Influence of buckwheat and chestnut flour addition on properties of corn extrudates. *Croatian journal of food science and technology.* 4(1): 26-33.
15. Zielinska, D.; Szawara-Nowak, D. and Michalska, A. (2007). Antioxidant capacity of thermally-treated buckwheat. *Polish Journal of Food and Nutrition Sciences.* 57(4): 465-70.
16. ¤ensoy, Í.; Rosen, R.T.; Ho, C.T. and Karwe, M.V. (2006). Effect of processing on buckwheat phenolics and antioxidant activity. *Food Chemistry.* 99(2): 388-93.
17. Shreeja, K.; Devi, S. and Suneetha, J. (2019). Development and evaluation of germinated buckwheat (Fagopyrum esculentum Moench) flour incorporated dosa. *IJCS*. 7(6): 1236-8.
18. Harborne, J.B. (1993). Phytochemistry. Academic press, London. 89-131.
19. Slinkard, K. and Singleton, V.L. (1977). Total phenol analysis: automation and comparison with manual methods. *American journal of enology and viticulture*. 28(1): 49-55.
20. Meda, A.; Lamien, C.E.; Romito, M.; Millogo, J and Nacoulma, O.G. (2005). Determination of the total phenolic, flavonoid and proline contents in Burkina Fasan honey, as well as their radical scavenging activity. *Food chemistry.* 91(3): 571-577.
21. Dorman, H.D.; Bachmayer, O.; Kosar, M. and Hiltunen, R. (2004). Antioxidant properties of aqueous extracts from selected Lamiaceae species grown in Turkey. *Journal of Agricultural and Food Chemistry.* 52(4): 762-70.
22. Praveena, R.J. and Estherlydia, D. (2014). Comparative study of phytochemical screening and antioxidant capacities of vinegar made from peel and fruit of pineapple (Ananas comosus l). *International Journal of Pharma and Bio Sciences.* 5(4): 394-403.
23. Bhaduri, N.P.; Prajneshu, M.; Gaur, M. and Suri, S. (2016). Seed Germination Behaviour and Preliminary Screening of Bioactive Components in Buckwheat (*Fagopyrum* spp.). *Seed.* 2(1): 121-30.
24. Izydorczyk, M. S.; McMillan, T.; Bazin, S.; Kletke, J.; Dushnicky, L. and Dexter, J. (2014). Canadian buckwheat: A unique, useful and under-utilized crop. *Canadian Journal of Plant Science.* 94(3): 509-24.
25. Inglett, G. E.; Rose, D. J.; Chen, D.; Stevenson, D. G. and Biswas, A. (2010). Phenolic content and antioxidant activity of extracts from whole buckwheat (Fagopyrum esculentum Möench) with or without microwave irradiation. *Food Chemistry.* 119(3): 1216-9.
26. Vollmannova, A.; Margitanova, E.; Tóth, T.; Timoracka, M.; Urminska, D.; Bojòanská, T. and Èièová, I. (2013). Cultivar influence on total polyphenol and rutin contents and total antioxidant capacity in buckwheat, amaranth, and quinoa seeds. *Czech Journal of Food Sciences.* 31(6): 589-95.
27. Mikulajová, A.; Šedivá, D.; Hybenová, E. and Mošovská, S. (2016). Buckwheat cultivars—phenolic compounds profiles and antioxidant properties. *Acta Chimica Slovaca.* 9(2): 124-9.
28. Xu, J.G.; Tian, C.R.; Hu, Q.P.; Luo, J.Y.; Wang, X.D. and Tian, X.D. (2009). Dynamic changes in phenolic compounds and antioxidant activity in oats (Avena nuda L.) during steeping and germination. *Journal of Agricultural and Food Chemistry.* 57(21): 10392-8.
29. Mares, L.F.; Passos, M.C. and Menezes, C.C. (2018). Interference of germination time on chemical composition and antioxidant capacity of white sesame (Sesamum Indicum). *Food Science and Technology.* 38: 248-53.
30. Kaukovirta-Norja, A.; Wilhelmson, A. and Poutanen, K. (2004). Germination: a means to improve the functionality of oat. *Agriculture and Food Science.* 13: 100-112.
31. Kulla, S.; Hymavathi, T.V.; Kumari, B.A.; Reddy, R.G. and Rani, C.V.D. (2021). Impact of germination on the nutritional, antioxidant and antinutrient characteristics of selected minor millet flours. *Annals of Phytomedicine*. 10(1): 178-184.
32. Ratha, P. and Jhon, D.Y. (2017). Increase of rutin, quercetin, and antioxidant activity during germinated buckwheat (*Fagopyrum esculentum* Moench) fermentation. *Ferment Technol.* 6(147): 2.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 717-720 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Nutrient Content and Uptake of Wheat Varieties as Influenced by Agronomic Practices under Late Sown Condition

Sintu Malik, Pawan Kumar and Parveen Kumar
Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana
Email : sintumalik01@gmail.com

Abstract

Wheat is very important crop for food security recognized as "King of cereals" having high productivity and high production. Due to increasing population and changing climatic conditions, there is urgent need to study the best suited agronomic management practices. The present investigation was conducted during *Rabi* season of 2018-19 and 2019-20 at Research Farm of Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India). The experiment was carried out in last week of December in which six varieties (WH 1124, WH 1105, HD-2967, HD 3059, WH 1021 and HD-3086) were taken in main plot against six seeding treatments (T_1- Recommended seed rate (100 kg ha^{-1}), T_2- 25% higher seed rate (dry) than recommended with 18 cm row spacing, T_3- 25% higher seed rate (dry) than recommended + reduced row spacing (15cm), T_4- 25% higher seed rate (soaked) than recommended + reduced row spacing (15cm), T_5- 25% higher seed rate (soaked) than recommended + reduced row spacing (15cm) + 25% higher NPK than recommended, T_6- 25% higher seed rate (soaked) than recommended + reduced row spacing (15cm) + 25% higher NPK than recommended + 2.5% urea + 0.5% $ZnSO_4$ spray at anthesis) in sub plot with three replication. Maximum NPK uptake in grain was recorded under T_6 (25% higher seed rate (soaked) than recommended + reduced row spacing (15cm) + 25% higher NPK than recommended + 2.5% urea + 0.5% $ZnSO_4$ spray at anthesis) seeding in both years . Among varieties, highest NPK uptake was estimated under HD 3086 and lowest in variety WH 1021. HD 3086 and WH 1124 variety could be recommended with T_6 seeding treatment for maximum productivity of wheat.

Key words *: Variety, Seeding treatment, Nutrients, Seed rate, Spacing*

Introduction

Wheat (*Triticum aestivum* L.) is the world's largest cereal crop because of the acreage it occupies and has been described as the 'King of Cereals', because of high productivity and the prominent position it holds in the international food grain trade. It is the second most important staple food after rice consumed by 65% of the population in India and is likely to increase further due to changes in food habits. The total area under the crop is about 30.8 mha with 98.51 mt production and 3200 kg/ha productivity (FAOSTAT, 2017). Haryana contributes 13.3% towards national production of wheat from the 8.9% of wheat growing area of the country, with an average productivity of nearly 4 tonnes ha^{-1}. Many factors are responsible for low yield of wheat crop in the country but among these sowing time and varietal selection are important. According to agro-climatic conditions, selection of suitable crop varieties may play crucial role in realizing the optimum production of any crop commodity (Singh et al., 2008). The crop under late sowing suffers due to sub-optimal temperature at sowing which causes delayed germination, slow growth, development and low yield. Delay in Wheat sowing is mainly due to late harvesting of Kharif crops in northern part of country. Generally, crop growth is slow due to low temperature and poor tillering is due to delay in sowing. The negative effects of delayed sowing were caused by environmental limitations including adverse weather factors such as low temperature during vegetative growth, shortened duration of various phases of crop development, and increased temperature during the grain-filling period (Alam *et al*. 2022). The higher crop production can be achieved through adopting the best suited agronomic practices under changing climatic conditions. Early sowing at optimum temperature with optimum plant population enhances the growth and nutrient uptake of wheat. The optimum seeding rate depends on temperature, sowing date and type of varieties. With delay in sowing the seed rate increases due to poor plant stand, where more plants are produced with higher seed rate per unit area resulting in higher intra-crop competition which affect the yield and production cost. Similarly, lower plant population produces lower grain yield due to higher vegetative growth and space wastages. Different varieties respond differently to applied nutrient fertilizer and hence differ in their yield potential. Therefore to minimize the effect of temporal variation, optimum

Table-1 : Effect of wheat varieties as influenced by agronomic practices on NPK content of wheat.

Varieties	N%				P%				K%			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
WH 1105	1.86	1.91	0.40	0.45	0.28	0.28	0.08	0.08	0.34	0.37	1.20	1.37
WH 1124	1.88	1.95	0.45	0.55	0.29	0.30	0.09	0.09	0.36	0.39	1.25	1.36
HD 3059	1.87	1.94	0.42	0.49	0.29	0.29	0.08	0.09	0.35	0.37	1.22	1.34
HD 2967	1.78	1.82	0.39	0.44	0.28	0.29	0.07	0.08	0.33	0.36	1.16	1.35
WH 1021	1.62	1.64	0.37	0.41	0.26	0.27	0.07	0.08	0.33	0.35	1.13	1.26
HD 3086	1.92	1.99	0.45	0.51	0.31	0.32	0.10	0.09	0.37	0.38	1.26	1.37
C.D at 5%	0.032	0.029	0.007	0.008	0.004	0.005	0.001	0.001	0.005	0.006	0.019	0.020
Seeding Treatments												
T_1	1.82	1.88	0.41	0.47	0.29	0.29	0.08	0.08	0.35	0.37	1.19	1.29
T_2	1.77	1.83	0.40	0.45	0.28	0.28	0.08	0.08	0.34	0.35	1.17	1.23
T_3	1.74	1.80	0.39	0.45	0.27	0.27	0.07	0.08	0.32	0.33	1.15	1.25
T_4	1.85	1.89	0.42	0.47	0.29	0.30	0.08	0.08	0.33	0.38	1.21	1.35
T_5	1.87	1.91	0.42	0.50	0.30	0.30	0.09	0.09	0.36	0.39	1.24	1.44
T_6	1.89	1.94	0.43	0.52	0.30	0.30	0.09	0.09	0.38	0.41	1.27	1.49
C.D at 5%	0.037	0.047	0.007	0.008	0.007	0.005	0.001	0.002	0.006	0.006	0.023	0.025

Table-2 : Effect of wheat varieties as influenced by agronomic practices on NPK uptake in grain of wheat.

Varieties	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
WH 1105	79.96	85.09	12.18	12.41	14.50	16.61
WH 1124	89.82	96.63	13.98	14.77	17.28	19.57
HD 3059	84.31	91.77	12.91	13.63	15.93	17.70
HD 2967	76.37	79.89	11.79	12.83	14.22	15.93
WH 1021	51.41	54.34	8.36	8.93	10.50	11.48
HD 3086	92.60	99.64	15.00	15.72	17.66	19.08
C.D at 5%	1.53	1.36	0.25	0.23	0.27	0.33
Seeding Treatments						
T_1	76.07	81.00	12.02	12.63	14.61	15.94
T_2	75.44	80.97	11.70	12.33	14.55	15.52
T_3	73.36	78.51	11.19	11.74	13.50	14.42
T_4	79.01	84.84	12.40	13.20	13.90	16.80
T_5	84.03	89.58	13.24	13.97	16.34	18.24
T_6	86.55	92.46	13.66	14.42	17.18	19.44
C.D at 5%	1.90	2.33	0.34	0.34	0.37	0.45

sowing date, plant population and varietal selection according to environmental conditions are the best agronomic practices to increase the growth, yield traits and yield of the wheat. Henceforth, the present study was conducted to study the nutrient content and uptake of wheat as influenced by agronomic practices under late sown condition.

Materials and Methods

The present investigation was conducted at Research farm of Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India for two consecutive years during (Rabi season) 2018-19 and 2019-20. The treatments consisted of six varieties (WH 1124, WH 1105, HD-2967, HD 3059, WH 1021 and HD-3086) and six seeding treatments (T_1-Recommended seed rate (100 kg ha^{-1}), T_2-25% higher seed rate (dry) than recommended with 18 cm row spacing, T_3-25% higher seed rate (dry) than recommended + reduced row spacing (15cm), T_4-25% higher seed rate (soaked) than recommended + reduced row spacing (15cm), T_5- 25% higher seed rate (soaked) than recommended + reduced row spacing (15cm) + 25% higher NPK than recommended, T_6- 25% higher seed rate (soaked) than recommended + reduced row spacing (15cm) + 25% higher NPK than recommended + 2.5% urea + 0.5% $ZnSO_4$ spray at anthesis) were sown at last week of December with three replications using strip plot design during both years having plot size of 3 m × 4 m. the soil of the

Table-3 : Effect of wheat varieties as influenced by agronomic practices on NPK uptake in straw of wheat.

Varieties	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
WH 1105	23.64	26.78	4.91	4.51	80.78	70.93
WH 1124	31.08	36.72	6.32	6.01	94.45	83.95
HD 3059	27.23	32.08	5.54	5.21	87.20	80.11
HD 2967	23.32	26.52	4.57	4.41	80.58	69.31
WH 1021	18.30	20.76	3.75	3.65	62.47	57.59
HD 3086	30.22	35.13	6.23	6.58	92.73	86.65
C.D at 5%	0.47	0.52	0.11	0.10	1.50	1.42
Seeding Treatments						
T_1	24.87	28.41	4.88	4.88	77.14	72.51
T_2	24.92	28.12	4.90	4.78	76.64	72.32
T_3	24.34	27.64	4.91	4.54	76.95	70.43
T_4	25.75	29.10	5.19	5.02	83.01	74.37
T_5	26.70	31.67	5.64	5.44	90.36	78.34
T_6	27.22	33.06	5.80	5.71	94.11	80.56
C.D at 5%	0.57	0.55	0.17	0.11	2.18	1.54

experimental site was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. NPK content in grain and straw at harvest was determined. For analysis of NPK oven dried plant material (grain and straw at harvest) from each plot was grinded separately with grinder. Nitrogen (Nessler's reagent method, Lindner, 1944), phosphorus (Vanado- molybdo-phosphoric acid yellow colour method, Jackson, 1973) and potassium (Flame photometer method, Richards, 1954) contents in sample were analyzed.

The uptake of each nutrient was computed as :

$$\text{Nutrient uptake by grain (kg/ha)} = \frac{\text{Nutrient content in grain (\%)} \quad \text{Grain yield (kg / ha)}}{100}$$

$$\text{Nutrient uptake by grain (kg/ha)} = \frac{\text{Nutrient content in straw (\%)} \quad \text{Straw yield (kg / ha)}}{100}$$

Results and Discussion

The data pertaining to nutrient content is presented and HD 3086 recorded highest nitrogen content of 1.92 and 1.99 per cent in grain which do not differ significantly with other varieties i.e WH 1124, HD 3059, WH 1105, HD 2967 and WH 1021 respectively while the seeding treatments increased significantly with increase in 25 percent higher dosage of NPK application than recommended in T_5 and T_6 treatments in both rabi seasons (Table 1). Similar trend was followed by potassium where HD 3086 recorded highest K content of 0.37 percent followed by WH 1124 and T_5 and T_6 treatments recorded 0.24 and 0.27 percent content (2018-19) against highest N content of 0.39 percent in WH 1124 in grain. HD 3086 and WH 1124 both variety recorded highest phosphorus content while T_4, T_5, T_6 treatment in grain (2018-19). This was mainly due to increase in nutrient content as well as higher grain and straw yield with increasing NPK levels. Among varieties HD 3086 and WH 1124 recorded maximum while T_6 have maximum N content in straw among seeding treatments (2018-19) against WH 1124 variety and T_6 treatment (2019-20) while P and K content in straw among both years do not differ significantly among varieties and seeding treatments. This might be due to the fact that at higher levels of fertility (NPK) indeed assured the quality of these nutrients to crops. Similar results were reported by Ahmad *et al*., 2007, Sheoran *et al*., 2015 and Patra *et al*., 2017.

Maximum NPK uptake in grain was recorded under T_6 (25% higher seed rate (soaked) than recommended + reduced row spacing (15cm) + 25% higher NPK than recommended + 2.5% urea + 0.5% $ZnSO_4$ spray at anthesis) seeding in both years (Table-2). Among varieties, highest NPK uptake was estimated under HD 3086 while it was found lowest in variety WH 1021. However seeding treatments T_6 and T_5 were found significantly at par with each other during both rabi seasons. This might be due to higher NPK content and more biomass (Maurya *et al.* 2014). Data pertaining to nutrient uptake in wheat straw as affected by varieties and seeding methods were presented in Table-3. Among varieties, highest nitrogen uptake was recorded under WH 1124 during both rabi reasons which was found significantly at par with HD 3086 while it was recorded lowest in variety WH 1021. HD 3086

recorded maximum uptake of NPK and among seeding treatments, T_6 treatment was highest. However T_6 and T_5 treatments are significantly at par with each other. This might be due to higher NPK concentration and biomass (Kumar and Kumawat, 2014). Similar findings were reported by Davari *et al.* (2012).

Conclusions

Wheat variety HD 3086 and WH 1124 having significant at par results, therefore both varieties could be recommended with 25% higher seed rate (soaked) than recommended with reduced row spacing (15cm) and 25% higher NPK than recommended + 2.5% urea + 0.5% $ZnSO_4$ spray at anthesis to achieve optimum nutrient uptake which will ultimately increase the yield. Therefore, HD 3086 and WH 1124 could be adopted under these conditions and require more research on these aspect to validate the results of present study.

References

1. Ahmad R.S, Khan S.M, Arshad M.A, Mamood M. H (2007). Growth and yield response of wheat (*Triticum aestivum* L.) and maize (*Zea-mays* L.) to nitrogen and L-Ttryptophan enriched compost. Pakistan. *Journal of Botany* 39(2): 541-549.
2. Alam M S, Kumar R and Patel J N. 2022. Effect of sowing dates and varieties on the nutrient uptake and economics of Wheat crop (Triticum aestivum L.) under changing climate. *The Pharma Innovation Journal;* 11(2): 533-538.
3. Davari MR, Sharma S N, Mirzakhani M (2012). The Effect of combinations of organic materials and biofertilisers on productivity, grain quality, nutrient uptake and economics in organic farming of wheat. *J. Org. Syst.* 7(2): 26-35.
4. Jackson, M.L. (1973) Soil chemical analysis. *Prentice Hall of India Pvt. Ltd.,* New Delhi. pp. 214-221.
5. Kumar R and Kumawat N. 2014. Effect of sowing dates, seed rates and integrated nutrition on productivity, profitability and nutrient uptake of summer mungbean in Eastern Himalaya. *Archives of Agronomy and Soil Science* 60(9): 1207–27.
6. Lindner, R.C. (1944) Rapid analytical methods for some of the more common inorganic constituents of plant tissues. *Plant Physiology,* 19, 76-86.
7. Maurya P, Kumar V, Maurya K K, Kumawat N, Kumar R and Yadav M P. 2014. Effect of potassium application on growth and yield of wheat varieties. *Bioscan* 9(4): 1371–3.
8. Patra B and Singh J. 2018. Effect of Priming, Biofertilizers and Nitrogen Levels on Yield and Nutrient Uptake by Wheat. *International Journal of Current Microbiology and Applied Science.* 7(07): 1411-1417.
9. Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils; USDA Hand Book No. 60, United State Salinity Laboratory.
10. Sheoran H S, Duhan B S, Grewal K S and Sheoran S. 2015. Grain yield and NPK uptake of wheat (*Triticum aestivum* L.) as influenced by nitrogen, vermicompost and herbicide. *African Journal of Agricultural Research* 10(42): 3952–61.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 721-727 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Survey for Elite Type Mango (*Mangifera indica* L.) by using Inflorescence, Leaf, Fruit and Pulp Descriptors

Sonal D. Jadhav[1*], V.N. Shinde[2] and Vijaysinha Kakade[1]
[1]*ICAR-National Institute of Abiotic Stress Management, Pune, Maharashtra, India*
[2]*Department of Horticulture, VNMKV, Parbhani, Maharashtra, India*
**Corresponding Author Email : sonaljadhavagri@gmail.com*

Abstract

Variations in plants can be characterized or evaluated by using visual, physical and biochemical attributes. This study aimed at determining diversity in mango germplasm from the, to identify the best genotype for table and juice purpose. A survey was conducted to collect, characterize and document the unique mango grown by the farmers of semi-arid climate of Parbhani district (Maharashtra). A total of 29 International Plant Genetic Resources Institute (IPGRI) descriptors for mango (3 for inflorescence, 8 for mature fruit, 9 for ripe fruit, 8 for leaf and 1 for stone character) were selected for use in the assessment of 30 mango accessions from this district. The observations were taken from flowering, leaf, mature and ripe fruit characters during the year 2019-20. Among the different accessions, accession 15 (12.4cm) and 20 (16cm) had maximum fruit length, whereas accession 22 (240g) had large fruit weight. The highest pulp weight and juice (%) were recorded in the accession 9, 22 & 24 (150 g each) and accession 24 (65.78%) respectively. Skin thickness was observed thicker in accession 15 (1.77mm). Considering the fruit length, fruit and pulp weight, flesh colour and Juice percentage observed during this study, it can be concluded that the accession 9, 20, and 22 are suitable for juice purpose whereas accessions like 15 is suitable for table purpose being good in juice percentage, pulp weight, Turpentine flavour and firmness of flesh, fruit size, skin thickness. The accession 24 is suitable for both the purposes.

Key words : *Characterization, diversity, morphological characters, descriptors, accession.*

Introduction

Mango (*Mangifera indica* L.) is member of family Anacardiaceae, is one of the choicest fruit in the world (De Candolle, 1904 and Popenoe, 1927). Mango has been listed as third most important fruit crop after banana and pineapple in terms of area and production. Mango trees grow to an impressive size and under favourable conditions it may attain a height of 25 meter. Mango trees are mostly evergreen and erect. In India, mango ranks first in terms of area with 2.31 million ha, second in respect of production with 22.35 million tonnes and with a productivity of 7.3 million tonnes/ha, (NHB, 2018-19). Andhra Pradesh is considered as a centre of diversity for mango with a rich diversity of named local cultivars and unnamed local land races. The International Plant Genetic Resources Institute (IPGRI) of Rome, Italy, has established a list of descriptors for mango that includes the morphological traits of plant, leaves, flowers, fruits and seeds and provides a universal format for the characterization of mango genetic resources (IBPGR, 1989; IPGRI, 2006)

Morphological characterization is a simple, formal and standardized method of identifying and presenting mango's genetic diversity. Assessment of morphological variation in fruit crops usually requires the availability of fruits. The fruiting season is unfortunately limited for most fruit crops. However, even in the off-fruiting season, farmers, grafters, nursery managers and breeders still require to discriminate mango varieties in such times as during selection and discrimination of rootstock or even during artificial pollination. This necessitates the identification of mango vegetative descriptors that can be used in the absence of fruits. The main objective of this study's was to determine diversity in mango germplasm both local and improved varieties, using descriptors for mango plant that excluded fruit characteristics. This will enable the effective utilization of mango's genetic resources especially in breeding programme for sustainable improvement of this crop.

Materials and Methods

The present investigation entitiled "Survey for elite type mango (*Mangifera indica* L.) by using inflorescence, leaf, fruit and pulp descriptors in Parbhani district" was undertaken at college of agriculture, Vasantaro Naik Marathawada Krishi Vidyapeeth, Parbhani Maharashtra State during the year 2019-2020. In general the region falls between 18-20° North latitude and 75-78° East longitude. The general elevation of parbhani 409 m above mean sea level. A total of 29 International Plant Genetic Resources Institute (IPGRI) descriptors for mango (3 for inflorescence, 8 for mature fruit, 9 for ripe fruit, 8 for leaf

Table-1 : Inflorescence descriptors of different mango accession.

Varieties	Inflorescence : Length	Inflorescence : colour	Inflorescence : Position
Accession1	Long	Yellowish green	Terminal
Accession2	Medium	Green with red patches	Terminal
Accession3	Long	Light green	Terminal
Accession4	Medium	Green with red patches	Terminal
Accession5	Long	Green with red patches	Terminal
Accession6	Long	Green with red patches	Terminal
Accession7	Medium	Yellowish green	Axillary
Accession8	Medium	Yellowish green	Terminal
Accession9	Medium	Yellowish green	Terminal
Accession10	Long	Green with red patches	Terminal
Accession11	Long	Green with red patches	Terminal
Accession12	Medium	Yellowish green	Terminal
Accession13	Medium	Light green	Terminal
Accession14	Long	Yellowish green	Axillary
Accession15	Long	Light green	Terminal
Accession16	Long	Green with red patches	Terminal
Accession17	Long	Green with red patches	Terminal
Accession18	Long	Green with red patches	Terminal
Accession19	Long	Light green	Terminal
Accession20	Medium	Green with red patches	Axillary
Accession21	Medium	Green with red patches	Terminal
Accession22	Medium	Light green	Terminal
Accession23	Long	Green with red patches	Terminal
Accession24	Long	Green with red patches	Terminal
Accession25	Medium	Yellowish green	Terminal
Accession26	Medium	Yellowish green	Terminal
Accession27	Long	Yellowish green	Terminal
Accession28	Medium	Light green	Terminal
Accession29	Long	Light green	Terminal
Accession30	Long	Green with red patches	Terminal

and 1 for stone character) were selected for use in the assessment of 30 mango accessions from this district.

Materials required for taking observations

1. Digital Vernier Caliper
2. Penetrometer device

Inflorescence descriptors : Fully mature inflorescence at full bloom from each of the sampled tree was collected from all the direction and recorded as per IPGRI descriptors. Inflorescence length of mango accessions was recorded from the base to the tip using Digital Vernier Caliper and expressed as; Short, Medium and Long. Inflorescence colour observed visually on main and secondary axes and recorded as per IPGRI descriptors as; Pink, Light green, Yellowish green and Green with red patches. Inflorescence position was observed visually by noting presence of inflorescence at terminal or axillary bud and was recorded as; Terminal or Axillary.

Leaf descriptors : Ten leaves were collected at 3rd and 4th position from tip of tree bearing shoot from all the direction of the tree and average of this was used to represent the observation. Leaf blade length was determined from an average of ten mature leaves per tree, measured from the base to the tip of the leaf blade and expressed as; Short, Medium and Long. Leaf blade width was determined by measuring the widest part of the leaf blade for ten leaves per tree and expressed as; Narrow, Medium and Broad. Leaf blade ratio calculated by dividing leaf length by its breadth and expressed as; Small, Medium and Large. Leaf blade shape was evaluated using IPGRI visual appraisals (on an average of ten leaves per tree sample) and indicated as Ovate, Elliptic and Oblong.

Mature fruit descriptors : Average of 10 fruits measured from the base to the tip of the fruit with the help of Vernier Caliper and expressed in centimeter and expressed as; Short, Medium, Long. Width of average of 10 fruits measured the distance between the two farthest end perpendicular to the longitudinal axis was measured in

Table-2 : Leaf descriptors of different mango accession.

Varieties	Leaf blade : Length	Leaf blade : Width	Leaf blade ratio Length/Width	Leaf blade : Shape
Accession1	Medium	Medium	Medium	Elliptic
Accession2	Medium	Medium	Medium	Elliptic
Accession3	Long	Medium	Large	Elliptic
Accession4	Medium	Medium	Medium	Ovate
Accession5	Short	Narrow	Small	Elliptic
Accession6	Medium	Medium	Medium	Elliptic
Accession7	Medium	Narrow	Medium	Elliptic
Accession8	Medium	Broad	Medium	Elliptic
Accession9	Medium	Broad	Medium	Elliptic
Accession10	Long	Narrow	Large	Elliptic
Accession11	Medium	Narrow	Medium	Elliptic
Accession12	Long	Broad	Large	Ovate
Accession13	Medium	Narrow	Medium	Elliptic
Accession14	Medium	Broad	Large	Elliptic
Accession15	Medium	Medium	Medium	Elliptic
Accession16	Medium	Narrow	Medium	Elliptic
Accession17	Short	Medium	Small	Elliptic
Accession18	Medium	Medium	Medium	Elliptic
Accession19	Medium	Medium	Medium	Elliptic
Accession20	Medium	Broad	Large	Ovate
Accession21	Long	Narrow	Large	Elliptic
Accession22	Short	Medium	Small	Elliptic
Accession23	Medium	Narrow	Medium	Elliptic
Accession24	Medium	Narrow	Medium	Elliptic
Accession25	Medium	Medium	Large	Elliptic
Accession26	Long	Narrow	Large	Elliptic
Accession27	Long	Medium	Large	Elliptic
Accession28	Medium	Broad	Medium	Ovate
Accession29	Short	Narrow	Small	Elliptic
Accession30	Medium	Medium	Medium	Elliptic

centimeters with the help of Vernier Caliper and expressed as; Narrow, Medium, Broad. Ratio was calculated by dividing fruit length by its width and expressed as; Small, Medium, Large Color of mature fruits of each accession was observed visually and recorded as; Only yellow, only green, Green and yellow, Green and orange, Green and pink, Green and red, Green and purple.

Ripe fruit and pulp descriptors : The weight of individual fruit was recorded by electrical balance and average weight of fruit was recorded in grams and categories as: Small, Medium, Large. The weight of pulp was worked out by deducting the weight of skin and stone from the total weight of the fruit and its percentage was computed and categories as: Small, Medium, and High. Calculate juice percentage by dividing the juice weight by the total fruit weight. Multiply this by 100 to get the percentage. Fruit skin colour of fully ripe fruits of each accession was observed visually using horticulture colour chart and recorded as; Green, Yellow green, Green and yellow, Yellow, Yellow orange, Yellow and orange, Orange, Yellow and red, Orange and red, Orange and purple, Red and purple, Purple. The thickness of the skin was determined by separating the epidermis from the flesh with a knife of average 10 fruits and expressed in mm and expressed as; Thin, Medium, Thick**.** Flesh colour of completely ripe fruits was observed visually among following categories as per IPGRI descriptors as; Greenish yellow, Light yellow, Medium yellow, Light orange, Medium orange, Dark orange. The firmness of flesh was obtained by withdrawing a small portion of epidermis from the central area of the fruit on both sides to introduce the penetrometer device and recorded as; Soft, Medium, Firm. Juiciness was observed visually and recorded as per IPGRI descriptors as; Low, Medium, High. Presence of turpentine flavour was observed and was recorded as per IPGRI descriptors as; Absent, Present

Table-3 : Mature fruit descriptors of different mango accession.

Varieties	Mature fruit : Length	Mature fruit : Width	Mature fruit ratio : Length/Width	Mature fruit : Colour of skin
Accession1	Short	Medium	Small	Green and yellow
Accession2	Short	Narrow	Small	Green and yellow
Accession3	Short	Narrow	Small	Green and yellow
Accession4	Medium	Narrow	Medium	Only green
Accession5	Short	Narrow	Small	Green and orange
Accession6	Medium	Narrow	Medium	Only green
Accession7	Short	Narrow	Small	Green and yellow
Accession8	Short	Narrow	Small	Only Green
Accession9	Medium	Medium	Small	Green and yellow
Accession10	Medium	Narrow	Medium	Green and yellow
Accession11	Short	Narrow	Medium	Green and yellow
Accession12	Short	Narrow	Small	Only green
Accession13	Medium	Narrow	Medium	Green and yellow
Accession14	Short	Narrow	Small	Only green
Accession15	Medium	Narrow	Medium	Green and yellow
Accession16	Short	Narrow	Small	Green and red
Accession17	Short	Narrow	Small	Green and yellow
toAccession18	Short	Narrow	Small	Green and yellow
Accession19	Medium	Narrow	Medium	Only green
Accession20	Long	Medium	Large	Only green
Accession21	Short	Narrow	Small	Only green
Accession22	Short	Narrow	Small	Only green
Accession23	Short	Narrow	Small	Green and yellow
Accession24	Medium	Narrow	Small	Only green
Accession25	Short	Narrow	Medium	Green and yellow
Accession26	Short	Narrow	Small	Green and red
Accession27	Short	Narrow	Small	Green and red
Accession28	Short	Narrow	Small	Green and yellow
Accession29	Short	Narrow	Small	Green and yellow
Accession30	Short	Narrow	Small	Green and yellow

Results and Discussion

Inflorescence descriptors : Flowering is one of the most important phonological stages of the mango crop production. The type of inflorescence observed in mango varieties was panicle inflorescence. Length of inflorescence grouped as short, medium and long. Medium length of inflorescence found in 13 accessions while long inflorescence length was found in remaining 17 accessions.

The inflorescence colour was also observed different in mango accessions. Inflorescence colour was recorded on main and secondary axes and varied as per IPGRI descriptors. The inflorescence colour in most of the varieties varied from yellowish green, light green to green with red patches. 9 accessions had yellowish green, 7 accessions possessed light green and remaining 14 accessions exhibited green with red patches colour of inflorescence. Inflorescence position was observed visually and was recorded as per IPGRI descriptors. As presented in Table 1, Among 30 accessions 27 accessions had terminal positioned inflorescence and 3 accessions had axillary position inflorescence.

Leaf descriptors : The leaf colour varied from genotype to genotype and within the varietal variation was observed between young and full grown (mature) leaves. Leaf blade length grouped as short, medium and long. Short leaf blade length was found in 4 accessions, medium leaf blade length was found in 20 accessions and remaining 6 accessions had long leaf blade length. The results are supported by the finding reported by Leaf blade width grouped as narrow, medium and broad. Narrow leaf blade width was found in 11 accessions, Medium leaf blade width was found in 13 accessions and 6 accessions had broad leaf blade width. The results are also observed by Galvaz-Lopez *et al*. (2010), Igbari *et al*. (2019). Data regarding variation among accessions on leaf length: breadth ratio presented in Table 2 Leaf blade ratio

Table-4 : Ripe fruit and pulp descriptors of different mango accession.

Varieties	Fruit weight	Pulp weight	Juice percentage	Ripe fruit : Predominant colour of skin
Accession1	Large	Medium	Low	Green and yellow
Accession2	Medium	Medium	Medium	Yellow
Accession3	Small	Small	Low	Green and yellow
Accession4	Medium	Small	Low	Green
Accession5	Medium	Small	Low	Green and yellow
Accession6	Medium	Medium	Medium	Green
Accession7	Medium	Medium	Medium	Green and yellow
Accession8	Small	Small	Low	Green and yellow
Accession9	Large	High	High	Green and yellow
Accession10	Medium	Medium	Medium	Green and yellow
Accession11	Small	Small	Medium	Green and yellow
Accession12	Medium	Medium	Medium	Green
Accession13	Large	Medium	Low	Green and yellow
Accession14	Medium	Medium	Medium	Green
Accession15	Large	High	High	Green and yellow
Accession16	Small	Small	Low	Green and yellow
Accession17	Medium	Medium	Medium	Green and yellow
Accession18	Medium	Medium	Medium	Green
Accession19	Medium	Medium	Medium	Green
Accession20	Large	High	High	Green
Accession21	Small	Small	Medium	Green and yellow
Accession22	Large	High	High	Green and yellow
Accession23	Medium	Medium	Medium	Green and yellow
Accession24	Large	High	High	Green
Accession25	Small	Medium	Medium	Green and yellow
Accession26	Small	Medium	Medium	Green and yellow
Accession27	Medium	Medium	Medium	Yellow and red
Accession28	Small	Medium	Medium	Green and yellow
Accession29	Medium	Medium	Medium	Green and yellow
Accession30	Medium	Medium	Medium	Green and yellow

grouped as small, medium and large. Among the 30 accessions 4 accessions had small leaf blade ratio, 17 accessions had medium leaf blade ratio and remaining 9 accessions had large leaf blade ratio. Leaf blade shape among the selected accessions varied from elliptic to ovate. It was found that majority 26 mango accessions had elliptic leaf blade shape while 4 accessions had ovate leaf blade shape. Raza *et al.* (2017) also mentioned same result.

Fruit and pulp descriptors : A wide range of variability in respect of various fruit characters viz., fruit length, width, colour, etc. A wide range of variation was observed among the accessions in respect of fruit length. Among 30 accessions, 21 accessions had short fruit length while 8 accessions had medium fruit length and only one accession had long fruit length viz., accession-20. Jadhao *et al.* (1998), Mitra and Mitra (2001). The data presented in Table 2 shows that width of the fruit varied from accessions to accessions. Fruit width recorded as narrow, medium and broad. 27 accessions had narrow width and remaining 3 accessions had medium width. Das *et al.* (2007), Rymbai *et al.* (2015), Igbari *et al.* (2019), Thakur *et al.* (2017). Fruit length: width ratio grouped as small, medium and large. Among 30 accessions 21 accessions had small fruit length: width ratio while 8 accessions had medium fruit length: width ratio and only one had large fruit length: width ratio viz., accession-20. Among 30 accessions, 10 accessions had only green colour of skin, 17 accessions had green and yellow colour of fruit skin and remaining 3 accessions viz., accession-16, accession- 26, accession-27 had green and red skin colour of mature fruit. (Abdelrahman (2009), Ahmed and Mohmed (2015), Igbari *et al.* (2019).

Weight of ripe fruit among 30 accessions varied from accession to accession. 8 accessions had small fruit weight, 15 accessions had medium fruit weight and remaining 7 accessions had large fruit Rymbai *et al.* (2015), Singh Gill *et al.* (2015). Pulp weight of fruit among 30 accessions varied from accession to accession. 7 accessions had small pulp weight, 18 accessions had medium pulp weight and remaining 5 accessions had high pulp weight Rymbai *et al.* (2015). 7 accessions had low juice percentage and 18 accessions had medium juice percentage and remaining 5 accessions had high juice

Table-5 : Ripe fruit and pulp descriptors of different mango accession.

Varieties	Ripe fruit : Thickness of skin	Ripe fruit : Main color of flesh	Ripe fruit : Firmness of flesh	Ripe fruit : Juiciness	Ripe fruit : Turpentine flavour
Accession1	Thin	Dark orange	Soft	Medium	Absent
Accession2	Thin	Medium yellow	Soft	Medium	Present
Accession3	Thin	Light yellow	Soft	Low	Present
Accession4	Thin	Light yellow	Soft	Medium	Absent
Accession5	Thin	Medium yellow	Firm	Medium	Present
Accession6	Thin	Dark orange	Soft	Medium	Absent
Accession7	Thin	Light yellow	Soft	Low	Present
Accession8	Thin	Dark orange	Soft	High	Absent
Accession9	Thin	Dark orange	Juicy	High	Absent
Accession10	Thin	Dark orange	Firm	High	Absent
Accession11	Thin	Light yellow	Soft	Low	Present
Accession12	Thin	Light yellow	Soft	Low	Present
Accession13	Thin	Light yellow	Soft	Medium	Absent
Accession14	Thin	Medium yellow	Soft	Low	Present
Accession15	Thick	Dark orange	Soft	Medium	Absent
Accession16	Thin	Light yellow	Soft	High	Absent
Accession17	Medium	Light yellow	Soft	Low	Absent
Accession18	Thin	Light yellow	Firm	Low	Present
Accession19	Medium	Medium orange	Soft	Medium	Absent
Accession20	Medium	Dark orange	Juicy	High	Absent
Accession21	Thin	Light yellow	Soft	Low	Absent
Accession22	Thin	Light yellow	Juicy	High	Absent
Accession23	Thin	Light yellow	Soft	Low	Present
Accession24	Thin	Light yellow	Juicy	High	Absent
Accession25	Thin	Medium orange	Soft	Low	Absent
Accession26	Thin	Medium orange	Soft	Low	Present
Accession27	Thin	Light yellow	Soft	Low	Present
Accession28	Thin	Light yellow	Soft	Low	Present
Accession29	Thin	Light yellow	Soft	Low	Present
Accession30	Thin	Light yellow	Soft	Medium	Absent

percentage. (Das *et al*. (2007). The mango accessions having different fruit colour such as yellow, green, green and yellow, yellow and red, etc. Observations pertaining to skin colour of ripe fruit are given in Table 4. 8 accessions had green colour while 20 accessions had green and yellow skin colour only one accession had yellow colour viz., accession-2 and remaining one accession viz., accession-27 had yellow. (Mukherjee (1997), Desai and Dhandar (2000).

The skin thickness of 26 accessions (86.67) had thin and 3 accessions (10.00%) had medium skin thickness and 1 accession (3.33%) had thick skin thickness i.e., accession 15(1.77mm). The 17 accessions (56.67%) had light yellow colour of flesh, 7 accessions (23.33%) had dark orange and 3 accessions (10.00%) had medium yellow and 3 accessions (10.00%) had medium orange colour of flesh. 14 accessions had found low juiciness followed by 9 accessions had found medium juiciness and remaining 7 accessions had high juiciness in pulp. Finding corroborates with their results obtained by Kumar (2000), Avilan and Rodriguez-Ruiz (2001), Khan *et al.* (2015), Singh (2018). Out of 17 accessions turpentine flavour had absent and 13 accessions had turpentine flavour present. The results showed that 13 accessions (43.33%) had turpentine flavour present and 17 accessions (56.67%) had turpentine flavour absent.

Conclusions

The overall assessment of the results of present investigation on the “Survey for elite type mango (*Mangifera indica* L.) by using Inflorescence, Leaf, Fruit and Pulp Descriptors in Parbhani district” concluded that, A research work was taken up with the objective to develop mango descriptors, which enables the identification of varieties for varietal registration and also for improvement programmes. Descriptors were

developed based on the guidelines that are envisaged in PPA&FA act 2001.

Among the different accessions, accession 15 (12.4cm) and 20 (16cm) had maximum fruit length, whereas accession 22 (240g) had large fruit weight. The highest pulp weight and juice (%) were recorded in the accession 9, 22 & 24 (150 g each) and accession 24 (65.78%) respectively. Skin thickness was observed thicker in accession 15 (1.77mm). Considering the fruit length, fruit and pulp weight, flesh colour and Juice percentage observed during this study, it can be concluded that the accession 9, 20, and 22 are suitable for juice purpose whereas accessions like 15 is suitable for table purpose being good in juice percentage, pulp weight, Turpentine flavour and firmness of flesh, fruit size, skin thickness. The accession 24 is suitable for both the purposes.

It is indicated that the selected accessions should be collected and studied for the further improvement of local mango by breeding and for the cultivation purpose.

References

1. Abdelrahman, E.A. (2009). *Characterization and evaluation of different mango (Mangifera indica* L.*) cultivars in Shendi Area. (Doctoral Disseration*). Sudan Academy of Sciences.
2. Ahmed, T.S.H and Mohamed Z.M.A. (2015). Genetic diversity of mango (*Mangifera indica* L.) cultivars in Shendi area. *Extensive Journal of Applied Sciences*, 3(6): 219-224.
3. Avilan, L., Rodriguez and Ruiz, J. (2001). Selection of leading mango cultivars in Venezuela. *Trop.Fruits Newslett.* 40/41: 10-12.
4. Das, B.K., Ray, D.P., Acharya, G.C. (2007). Genetic variability in mango germplasm of Orissa. *Indian J. Hort. Sci.,* 64(1): 29-33.
5. De Candolle, A. (1904). Origin of Cultivated Plants. Kegan Paul, Trench, London.
6. Desai, A.R. and Dhandar, D. G. (2000).Variation in physico-chemical and morphological genetic characters of some mango varieties of Goa. *Acta Horticulture,* 509: 243-249.
7. Galvez-Lopez, D., Salvador-Figueroa, M., Adriano-Anaya, L. and Mayek-Perez, N. (2010). Morphological characterization of native mangoes from Chiapas, Mexico. *Subtrop. P. Sci.* 62: 18-26.
8. Igbari, A.D., Nodza,G.I., Adeusi, A.D. and Ogundipe, O.T. (2019). Morphological characterization of mango (*Mangifera Indica* L.) cultivars from South-West Nigeria. *Ife Journal of Science* vol. 21, no.1.
9. International Board for Plant Genetic Resources (IBPGR) (1989). Descriptors for Mango. Rome, Italy. 22 pp.
10. International Plant Genetic Resources Institute (IPGRI) (2006). Descriptors of Mango (*Mangifera indica* L.). Rome, Italy. 44 pp.
11. Jadhao, B.J., Kulwal, V.K., Mahorkar and Joshi, P.S. (1998). Physico-chemical characters of some mango cultivars grown under Akola condition. Abstract of National Symposium on mango production and export, central Institude for Subtropical Horticulture, Lucknow, 25-27, June p10.
12. Khan, A. S., Ali, S., Khan, I. A. (2015). Morphological and molecular characterization and evaluation of mango germplasm : an overview. *Scientia Horticulturae*194: 353-366.
13. Kumar, N. (2000). A note on pulp characteristics of some mango varieties. *The Orissa J. Hort.*, 28(2): 100-105.
14. Majumder, D.A.N., Hassan, L., Rahim, M.A. and Kabir, M.M. (2012). Genotypic and phenotypic variability in mango (*Mangifera indica* L.) *Bangladesh Journal ofAgricultural Research,* 37(4): 683-690.
15. Mitra, S.and Mitra, S.K. (2001). Studies on physio-chemical characteristics of nineteen mango varieties grown in West Bengal. *Indian Agriculturis*t, 45(3/4): 215-219.
16. Mukherjee, S.K. (1997). Introduction: Botany and importance. In: The mango Botany, Production and Uses 1st edition (R. E. Litz Ed.), CAB International, Wallingford, UK. pp. 1-19.
17. NHB (2018-19). Indian Horticulture Database, National Horticulture Board, Guragon, India. http://www.nhb.gov.in/area_production. html.
18. Popenoe, W. (1927). Manual of tropical and sub-tropical fruits, Macmillan, New York, USA.
19. Raza, S.A, Khan, A.S., Khan, I.A., Rajwana, I.A., Ali, S., Khan, A.A. and Rehman, A. (2017). Morphological and physiological diversity in some indigenous mango (*Mangifera indica* L.) germplasm of Pakistan. *Pakistan Journal of Agricultural Sciences,* 54(2): 287-297.
20. Rymbai, H., Patel, C. R., Ahlawat, T. R., and Patel, N. L. (2015). Studies on fruit and yield traits in indigenous coloured varieties of mango (*Mangifera indica* L.) in South Gujarat, India. *J. Hortl. Sci.* Vol. 10(1): 94-98.
21. Singh Gill, M., Navprem, S., Singh, N. and Gill, P .P. S. (2015). Performance of mango cultivars under sub-mountane zone of sub-tropics of India. *Acta Hortic.*1066.
22. Singh, A. (2018). *Morphological and molecular characterization of indigenous mango (Mangifera indica* L.*) germplasm of Jammu region.* (*Doctoral Dissertation).* University of Agricultural Science and Technology of Jammu (J&K). Retrieved from https://krishkosh.egranth.ac.in/dispbitstream?han=1/58. Accessed on 20/08/2020.
23. Thakur, N. S., Kumar, D, Thakur, A., Hamid. (2017). Studies on quality characteristics of seedling mango fruits from different locations of Himachal Pradesh. *J. of Hill Agril.* 8(3): 288-292.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 728-732 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Bioefficacy of Different Botanical Extracts against Thrips, *Scirtothrips dorsalis* (Hood) on Bell Pepper

Sonam Sharma[1], Vijay Kumar[2*], B.P. Nautiyal[3], Manish Gupta[4] and Pankaj Bahuguna[5]

[1]*Department of Entomology, College of Horticulture, VCSGUUHF, Bharsar Pauri, Garhwal, U.K., 246123*

[2]*Department of Plant Pathology, College of Horticulture, VCSGUUHF, Bharsar, Pauri Garhwal, U.K., 246123*

[3]*College of Horticulture, VCSGUUHF, Bharsar, Pauri Garhwal, U.K., 246123*

[4]*Department of Entomology, College of Horticulture, VCSGUUHF, Bharsar, Pauri Garhwal, U.K., 246123*

[5]*Department of Basic and Soil Science, College of Horticulture, VCSGUUHF, Bharsar, Pauri Garhwal, U.K., 246123*

***Corresponding Author Email :** vijaykumar.india28@yahoo.in*

Abstract

The present investigation was undertaken to evaluate the bioefficacy of different botanical extracts against Thrips, *Scirtothrips dorsalis* (Hood) on Bell pepper crop. A field experiment was conducted in Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal during year 2020–21. In Randomized Complete Block Design by selecting the five plant (three leaves each one from top, middle and lower part) out of nine and spraying them with botanical extracts viz., Neem leaf extract @ 5% (*Azadirachta indica*), Tulsi leaf extract @ 5% (*Ocimum sanctum*) Marigold leaf extract @ 5% (Tagetes minuta), Sitafal leaf extract @ 5% (*Annona squamosa*), Lantana leaf extract @ 5% (*Lantana camara*), Aloe Vera leaf extract @ 5% (*Aloe barbadensis*), Ginger leaf extract @ 5% (*Zingiber officinale*), Nirgundi leaf extract @ 5% (*Vitex negundo*) and Garlic leaf extract @ 5% (*Allium sativum*) two times in field condition at 22 days interval. After 1st and 2nd both spray the highest per cent reduction in thrips population (60.77%) and maximum yield (13.99 q/ha) over pre treatment was recorded in Neem leaf extract @ 5%. The toxicity of botanical extracts against the pest thrips Scirtothrips dorsalis. The neem leaf extract was found to be the most promising as it gave the highest per cent reduction in thrips population in comparison to other treatments while lowest per cent reduction was seen in the Aloe Vera @ 5%. Farmers will be benefited with our research as they may replace the chemical pesticides with botanicals.

***Key words :** Bio-efficacy, bell pepper, Scirtothrips dorsalis, per cent reduction.*

Introduction

Bell pepper (*Capsicum annuum* L.) belongs to family Solanaceae. It is also called to us as Capsicum, sweet pepper or Shimla Mirch. It is one of the popular and beneficial as well as vegetable crop grow in all direction the world. Bell pepper is cultivated in particularly of the world, in temperate region of South America and central and European countries, sub-tropical and tropical region of Asian continent mainly in China and India (Hebbar *et al*., 2011). Bell pepper is grown in 24 thousand hectare in India, with an average production of 306 thousand MT and its productivity is 12.75 MT/ha (NHB Data Base, 2018). Bell pepper is cool season crop, but it can be grown full the year under poly house condition. Favourable day temperature of 25-30? with relative humidity of 50-60%. Different abiotic, biotic and physiological control in bell pepper production under polyhouse condition, of which harm caused by insects plays great role in depletion in quality and quantity of yield.

Thrips, *Scirtothrips dorsalis* (Order- Thysanoptera, Family- Thripidae) are minute, fringed wings with slender insects, best seen with a hand lens. Thrips have rasping and sucking mouthparts that allow them to feed on plant juices or sap and they are continuously found in flowers and leaves which involve agriculture crops (Robinson, 2005). Asymmetrical mouth part in thrips and right mandible are absent mouth cone consists of labrum, labium and maxillae. The insects *Scirtothrips dorsalis*, *Bemisia tabaci, Helicoverpa armigera, Spodoptera litura, Thrips tabaci,* etc are peste of national importance. Butani, (1976) describe above 20 insect species on Bell pepper. Thrips attacked on bell pepper crop and causes yield losses to range between 50 to 90 per cent Rajput *et al*., (2017). Thrips transmit plant viruses in the *Tospovirus, Carmovirus, Sobemovirus and Machlomovirus* genera (Jones, 2005). These mentioned problems show towards another control method which is use of botanicals extracts for the well control of these devastating pests that is not only price effective, dependable but also eco-friendly and safe for human health. Some plant products have pesticide (botanicals) properties against sucking pests. Neem extracts have been shown to decrease feeding, intimidate pests, slow growth of insects and affect oviposition activity. Garlic contains 28% carbohydrates, 2.3% organosulfur compounds, 2% protein, 1.2% amino acid, 0.15% lipids and anti-oxidant properties of garlic.

Materials and Methods

Field preparation and transplanting : An experimental area

Table-1 : Efficacy of different botanical extracts against population of thrips, Scirtothrips dorsalis 1st spray.

Treatments	Botanicals	Con. (%)	No. of thrips/3 leaves 1st application					
			Pre count	3 DAS	7 DAS	11 DAS	15 DAS	Pooled Mean
T1	Control	-	5.51 (2.55)	5.81 (2.61)	6.13 (2.67)	5.92 (2.63)	5.99 (2.64)	5.96 (2.63)
T2	Tulsi leaf	5	4.32* (2.30)	4.07* (2.25)	3.32* (2.07)	2.98* (1.99)	3.18* (2.04)	3.38* (2.09)
T3	Neem leaf	5	4.47* (2.34)	3.34* (2.08)	2.32* (1.82)	2.16* (1.78)	2.32* (1.82)	2.54* (1.87)
T4	Marigold leaf	5	5.03* (2.45)	4.88* (2.42)	4.08* (2.25)	3.71* (2.17)	3.98* (2.23)	4.16* (2.27)
T5	Sitafal leaf	5	4.61* (2.36)	4.03* (2.24)	3.26* (2.06)	2.94* (1.98)	3.19* (2.04)	3.35* (2.08)
T6	Lantana leaf	5	4.85* (2.42)	3.74* (2.17)	2.72* (1.92)	2.55* (1.88)	2.69* (1.92)	2.92* (1.97)
T7	Aloe vera leaf	5	5.18* (2.48)	4.95* (2.44)	4.22* (2.28)	3.85* (2.20)	4.17* (2.27)	4.29* (2.30)
T8	Ginger Rhizome	5	4.76* (2.40)	4.52* (2.35)	3.78* (2.18)	3.43* (2.10)	3.68* (2.16)	3.85* (2.20)
T9	Nirgundi leaf	5	4.91* (2.43)	3.88* (2.20)	2.95* (1.98)	2.65* (1.91)	2.82* (1.95)	3.07* (2.01)
T10	Garlic bulb	5	4.62* (2.37)	3.95* (2.22)	3.12* (2.03)	2.67* (1.91)	2.89* (1.97)	3.16* (2.03)
	SE(d)	-	0.01 (0.02)	0.02 (0.005)	0.03 (0.009)	0.01 (0.004)	0.01 (0.003)	0.14 (0.03)
	C.D. (0.05)	-	0.02 (0.005)	0.04 (0.01)	0.07 (0.02)	0.03 (0.008)	0.02 (0.007)	0.28 (0.06)

( ) = Values in parentheses are square root transformed, DAS-Days after Spray
*Significant at 5% level of significance compared with control.

Table-2 : Efficacy of different botanical extracts against thrips, *Scirtothrips dorsalis* (Hood) on 2nd spray.

Treatments	Botanicals	Con. (%)	No. of thrips/3 leaves days after 2nd spray					
			Pre count	3 DAT	7 DAT	11 DAT	15 DAT	Pooled mean
T1	Control	-	5.71 (2.59)	5.88 (2.62)	6.15 (2.67)	6.06 (2.65)	6.25 (2.69)	6.08 (2.66)
T2	Tulsi leaf	5	4.22* (2.28)	3.85* (2.20)	3.51* (2.12)	3.07* (2.01)	3.34* (2.08)	3.44* (2.10)
T3	Neem leaf	5	4.24* (2.28)	3.25* (2.06)	2.45* (1.85)	1.48* (1.57)	1.56* (1.60)	2.18* (1.77)
T4	Marigold leaf	5	4.95* (2.44)	4.75* (2.39)	4.54* (2.35)	4.36* (2.31)	4.83* (2.41)	4.62* (2.37)
T5	Sitafal leaf	5	4.48* (2.34)	3.92* (2.21)	3.46* (2.11)	2.94* (1.98)	3.18* (2.04)	3.37* (2.09)
T6	Lantana leaf	5	4.65* (2.37)	3.68* (2.16)	2.95* (1.98)	2.07* (1.75)	2.19* (1.78)	2.72* (1.92)
T7	Aloe vera leaf	5	5.08* (2.46)	4.77* (2.40)	4.58* (2.36)	4.27* (2.29)	4.66* (2.38)	4.57* (2.36)
T8	Ginger Rhizome	5	4.66* (2.37)	4.33* (2.31)	4.02* (2.24)	3.65* (2.15)	3.93* (2.22)	3.98* (2.23)
T9	Nirgundi leaf	5	4.73* (2.39)	3.81* (2.19)	3.12* (2.03)	2.34* (1.82)	2.53* (1.88)	2.95* (1.98)
T10	Garlic bulb	5	4.48* (2.34)	3.85* (2.20)	3.26* (2.06)	2.65* (1.91)	2.86* (1.96)	3.15* (2.03)
	SE(d)	-	0.01 (0.003)	0.02 (0.004)	0.03 (0.008)	0.02 (0.007)	0.02 (0.005)	0.22 (0.05)
	C.D (0.05)	-	0.02 (0.006)	0.04 (0.009)	0.06 (0.017)	0.05 (0.014)	0.04 (0.011)	0.46 (0.12)

( ) = Values in parentheses are square root transformed, DAS-Days after Spray
*Significant at 5% level of significance compared with control.

Table-3 : Efficacy of different botanical extracts against thrips, *Scirtothrips dorsalis* (Hood) overall pooled.

Treatments	Botanicals	Con. (%)	No. of thrips/3 leaves overall pooled mean			
			pooled mean 1st spray	Pooled mean 2nd spray	Overall pooled mean	Percent Reduction
T1	Control	-	5.96 (2.63)	6.08 (2.66)	6.02 (2.65)	-
T2	Tulsi leaf	5	3.38* (2.09)	3.44* (2.10)	3.41* (2.1)	43.31
T3	Neem leaf	5	2.54* (1.87)	2.18* (1.77)	2.36* (1.82)	60.77
T4	Marigold leaf	5	4.16* (2.27)	4.62* (2.37)	4.39* (2.32)	27.10
T5	Sitafal leaf	5	3.35* (2.08)	3.37* (2.09)	3.36* (2.08)	44.12
T6	Lantana leaf	5	2.92* (1.97)	2.72* (1.92)	2.82* (1.95)	53.13
T7	Aloe vera leaf	5	4.29* (2.30)	4.57* (2.36)	4.43* (2.33)	26.39
T8	Ginger Rhizome	5	3.85* (2.20)	3.98* (2.23)	3.92* (2.21)	34.95
T9	Nirgundi leaf	5	3.07* (2.01)	2.95* (1.98)	3.01* (2)	49.94
T10	Garlic bulb	5	3.16* (2.03)	3.15* (2.03)	3.16* (2.03)	47.57
	SE(d)	-	0.14 (0.03)	0.22 (0.05)	0.16 (0.04)	-
	C.D (0.05)	-	0.28 (0.06)	0.46 (0.12)	0.37 (0.09)	-

( ) = Values in parentheses are square root transformed
* Significant at 5% level of significance compared with control.

Table-4 : Efficacy of different botanical extracts on the Yield of bell pepper and increase fruit yield over control.

Treatments	Botanicals	Dose (%)	Fruit Yield Kg/plot	Fruit Yield (q/ha)	Increasefruit yield over control (%)
T1	Control	5	0.08	3.29	-
T2	Tulsi leaf	5	0.20*	8.23	150
T3	Neem leaf	5	0.34*	13.99	325
T4	Marigold leaf	5	0.18*	7.40	125
T5	Sitafal leaf	5	0.22*	9.05	175
T6	Lantana leaf	5	0.32*	13.16	300
T7	Aloe vera leaf	5	0.19*	7.81	137.5
T8	Ginger Rhizome	5	0.21*	8.64	162.5
T9	Nirgundi leaf	5	0.28*	11.52	250
T10	Garlic bulb	5	0.23*	9.46	187.5
	SE(d)		0.02	-	-

of 136.08 m^2 was ploughed thoroughly with the power tiller followed by two cross tilling and it was leveled with the help of a leveler. After the field was ploughed it was divided into 30 plots (each plot 1.8m× 1.35m) having proper irrigation channels, path and space so that the different replication and plots cloud be marked. Seeding of bell pepper variety California wonder were raised in nursery and 30 to 35 days old seedling were transplanted in main field.

Treatment and method of application : The plots were sprayed with seven treatments viz., Neem leaf @ 5%, Lantana leaf @ 5%, Nirgundi leaf @ 5%, Garlic bulb @ 5%, Aloe Vera leaf @ 5%, Ginger rhizome @ 5%, Marigold leaf @ 5% and Sitafal leaf @ 5% using a hand sprayer with duromist nozzle, when the thrips population reached Economic Threshold Level.

Data collection and Statistical analysis : The observations were recorded from five randomly selected and tagged plants from each plot with sampling of 3 leaves per plant from upper, middle and lower portion of the tagged plant.

The data of percent reduction in thrips population after 3, 7, 11 and 15 days of spraying of botanical extracts was calculated by using Abbot's formula, (1925).

$$\text{Per cent reduction} = \frac{C - T}{C} \quad 100$$

Where,

T = Treatment

C = Control

Yield

$$\text{Yield (q/ha)} = \frac{\text{Yield Plot}}{\text{Plot size}} \quad \frac{10{,}000}{100}$$

Result and Discussion

In an experiment, we evaluated 10 botanical extracts like Neem leaf extract @ 5%, Tulsi leaf extract @ 5%, ginger rhizome extract @ 5%, garlic bulb extract @ 5%, Nirgundi leaf extract @ 5%, Lantana leaf extract @ 5%, Aloe Vera leaf extract @ 5%, Marigold leaf extract @ 5%, Sitafal leaf extract

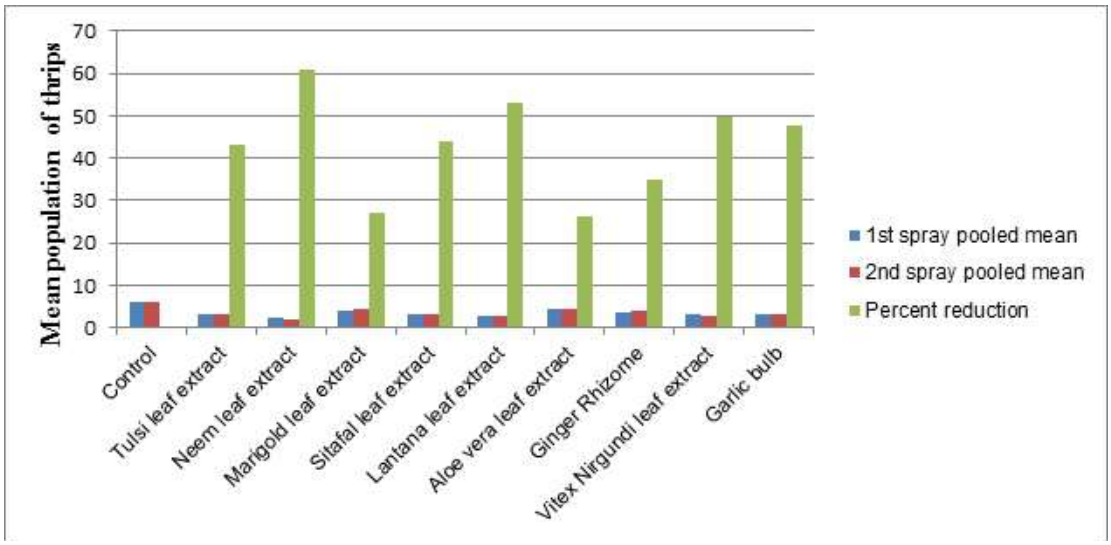


Fig-1 : Efficacy of different botanical extracts against thrips, *Scirtothrips dorsalis* (Hood) overall pooled.

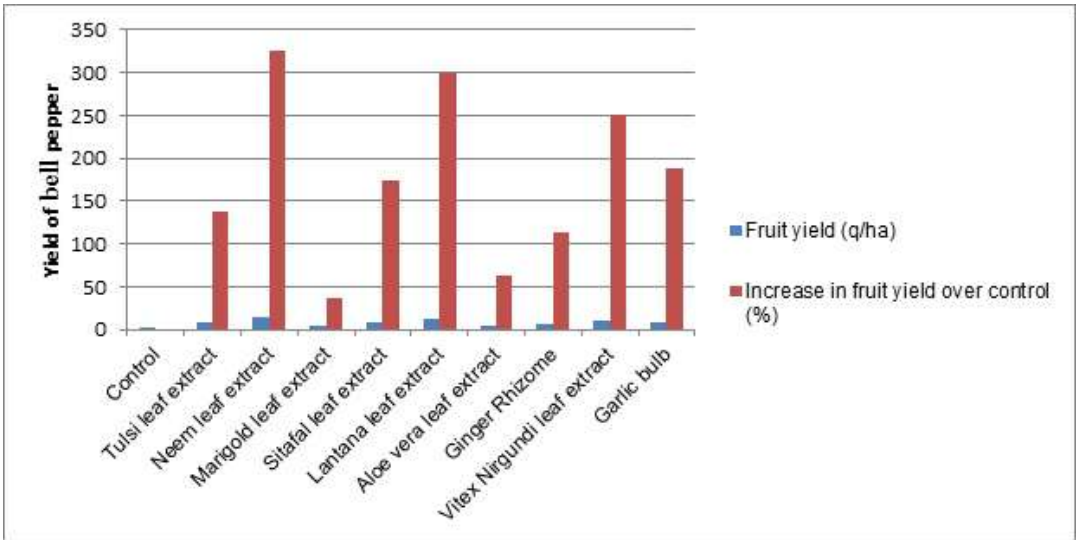


Fig-2 : Efficacy of different botanical extracts on the Yield of bell pepper and increase fruit yield over control.

@ 5% and an untreated check (sprayed only with water) to observe the efficacy of the botanical extracts against bell pepper thrips, one day before spraying and after 3, 7, 11 and 15 day of spraying respectively.

Result of first spray : Three day after the first spray, all the treatments were significantly effective in reducing the thrips population comparison to untreated control. The most promising plant extracts against thrips were found to be Neem leaf extract and Lantana leaf extract with the pooled mean of (2.54 thrips/3 leaves) and (2.92 thrips/3 leaves) than rest of the treatments. Similar observations were recorded by Fiaz *et al*. (2012) Neem (*A. indica*) leaf extract, 5% concentration were tested for their repellency effects against thrips. Data were recorded at 24, 48, 72 hrs, and 7 days intervals after application. Results revealed that neem leaf extract proved to be the most effective plant derivative against thrips. In case of thrips all plant derivatives controlled thrips population significantly. The next best treatment was found to be Nirgundi and garlic (3.07 thrips/3 leaves) and (3.16 thrips/3 leaves).

Result of second spray : The second spray was done 22 days after the first spray. The result of 2nd spray also came out in similar fashion as the first spray. Again the best treatment against thrips was found to be Neem leaf extract and Lantana leaf extract with pooled mean of (2.18 thrips/3 leaves) and (2.72 thrips/3 leaves). Similar observations were recorded by Singh *et al.* (2014) to evaluate the efficacy of certain biopesticides against *Thrips tabaci.* Sathua *et al*. (2017) Bio-efficacy of different botanicals *Allium sativum* extract, *Allium cepa* extract and NSKE were investigated against chilli thrips. Botanicals, NSKE 5% caused maximum mortality of 64.50%, while garlic and onion extract showed comparatively less performance with 55.98% and 51.53% respectively. The next best treatment was found to be Nirgundi and Garlic (2.95 thrips /3 leaves) and (3.15 thrips/3 leaves) which at par with Lantana and Nirgundi leaf extract.

The per cent reduction over control in plot treated with Neem leaf extract was found to be 60.77% followed by Lantana leaf extract, Nirgundi leaf extract, Garlic leaf extract with 53.13, 49.94 and 47.57 respectively. Similar observations were recorded by Patel and Kumar (2017) who conducted an experiment in field conditions and applied botanicals against chilli thrips, they concluded that the Neem oil, NSKE and Garlic sap extract gave up to 53.22%, 48.11% and 47.13% reduction in thrips population.

Yield : The yield of bell pepper crop under different treatment varied from 3.29 to 13.99 q/ha. Maximum yield (13.99 q/ha) was recorded from the plot treated with Neem leaf extract @ 5% and followed by Lantana leaf extract and Nirgundi leaf extract with 13.16 and 11.52 q/ha respectively. Similar observations were recorded by Padaliya *et al*., (2018) who conducted an experiment under field condition of different botanicals against thrips, *Scirtothrips dorsalis.* Different application of neem leaf extract 10 per cent found the most effective followed by, garlic bulb extract @ 5 per cent and ginger rhizome extract @ 5 per cent with yield 2275, 2252 and 2238 kg/ha, respectively. In our study, the minimum yield was found in Marigold leaf extract (7.40 q/ha) followed by Aloe Vera leaf extract (7.81 q/ha). Increase in yield over control and found that the maximum yield over control percentage was in treatment T3 Neem leaf extract (325%), Lantana leaf extract (300%) and Nirgundi leaf extract (250%) while minimum yield over control percentage was found in Aloe Vera leaf extract (137.5%) and Marigold leaf extract (125%). Singh *et al.* (2014) reported that increase the yield over control from which Lantana obtained highest yield (97.67 q/ha) and Neem (96.02 q/ha).

Conclusions

To study on botanical extracts were found to be effective against bell pepper thrips. Among all the botanical extracts Neem leaf extract @ 5% was found to be highly effective against *Scirtothrips dorsalis* while Aloe Vera extract @ 5% was less effective. These botanical extracts could therefore be considered as alternatives to control the pest of bell pepper crop.

References

1. Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*. 18: 265-267.
2. Anonymous, 2018. Statistical Data Base of the National Horticulture Board and Ministry of Agriculture, Government of India.
3. Butani, D.K. 1976. Pest and diseases of Chillies and their control. Pesticides, 10: 38-41
4. Fiaz, M., Hameed, A., Hasan, M. and Wakil, W. 2012. Efficacy of plant extracts on some cotton (*Gossipium hirsutum*) pests: Amrasca bigutulla bigutulla Ishida and Thrips tabaci Lindeman. *Pakistan J. Zool.,* 44 (1): 277-283.
5. Hebbar, S.S., Balakrishan, B., Prabhakar, M., Srinivas, V., Anil, K.N., Ravi, K., Girija, G., Debi, S., Sudhakar, R.V., Doijode, D., Hegde, M.R. and Rao, M.S., 2011. Protected cultivation of capsicum. IIHR Technical Bulletin: 22.
6. Jones, D.R. 2005. Plant viruses transmitted by thrips. *European Journal of Plant Pathology* 113: 119–157.
7. Padaliya, S.R., Thumar, R.K., Pipaliya, G. K. and Bhagora, J.K. 2018. Bio-efficacy of Different Botanicals against Thrips, Scirtothrips dorsalis Hood Infesting Bt Cotton *International Journal Current Microbiology Applied Science* 7(7): 2893-2903
8. Patel, V.D. and Kumar, A. 2017. Field efficacy of certain botanical and chemical insecticides against chilli thrips [Scirtothrips dorsalis (Hood)] on Chilli (*Capsicum annuum* L.) *Journal of Pharmacognosy and Phytochemistry* 6(4) 497-499
9. Rajput, V.S., Prajapati, B.G., Pareek, A. and Patel, P.S. 2017 Studies on Population Dynamics of Major Insect Pests Infesting Chilli (*Capsicum annum* L.) *International Journal Pure Applied Biosciences* 5 (6): 1465-1470
10. Robinson, W.H. 2005. Handbook of Urban Insects and Arachnids. Cambridge: Cambridge University Press.
11. Sathua, S.K., Reddy, M.S.S., Sulagitti, A. and Singh, R.N. 2017. Bio-efficacy of various insecticides and botanicals against chilli thrips (*S. dorsalis* Hood) and their comparative cost: Benefit analysis in chilli crop *Journal of Entomology and Zoology Studies* 5(2): 130-134.
12. Singh, D.K., Verma, T.C., Aswal, S. and Aswani, G. 2014. Effect of Different Botanical Pesticides Against Thrips tabaci on *Garlic Crop Asian Agri-History* 18 (1): (57–61) 57.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 733-738 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Detection and Identification of Hidden Infestation by *Callosobruchus* Species Belonging to Family Bruchidae

Subham Kumar[1], Sumit Kumar[1] and Kavita Gupta[2]
[1]*Department of Plant Protection, C.C.S. University Campus, Meerut-250004*
[2]*Division of Plant Quarantine, NBPGR, PUSA Campus, New Delhi-110012*

Abstract

The present study, three species viz. *C. chinensis, C. maculatus and C. analis* were taken up for studying their detection, identification and management. Since these insects cause hidden infestation, the detection was done through X-ray radiography using MX 200 Faxitron machine which is for real-time detection of insects inside the grains. After detection, the insects were retrieved and mounted for their identification up to species level. The identification was undertaken based on morphological characters of the three species. The differentiating characters including those of antenna, elytra, hind leg, pygidium and genitalia were studied for all the three species. Management options available such as mechanical cleaning, salvaging through X-ray, fumigation using EDCT (Ethylene Dichloride Carbon Tetrachloride) mixture at normal atmospheric pressure (NAP) and ambient temperature and vacuum fumigation have also been discussed.

Key words : *X-ray radiography machine, infested seed samples (mungbean, cowpea, gram and pigeon pea), Electron microscope, fumigants (EDTC) and fumigation chamber (Atmospheric and Vacuum fumigation).*

Introduction

The members of the family Bruchidae have long been reported to destroy the seed of the leguminous plants but a number of them are now known to attack the seed or are associated with the flowers or leaves of plants belonging to other families such as Compositae, Malvaceae, Convolvulaceae, Anacardiaceae, Rosaceae, Umbelliferae, Papaveraceae and Palmae. They are not only serious pests of the edible pulses, beans, lentils and peas but also attack the pods and the seeds of the wild forest, medicinal and ornamental plants. The available literature on bruchidae shows that over 1,500 species have so far been recorded from different parts of the world. The bruchidae fauna of India, however, has not been properly explored and very few species are represented in the collections of the Indian Agricultural Research Institute, New Delhi and Forest Research Institute, Dehradun, and even these are neither properly identified nor adequately described. At NBPGR, the world bruchid literature was compiled and a database on bruchids developed. It also included digitized keys for their identification Research work has accordingly been carried out and collections have been made of bruchids from different parts of North-West India with a view to study and establish the identity of the various species, listing their host plants, determining their specific ranges and assigning them to their appropriate systematic positions. The present study was undertaken to detect the presence of bruchid infestation in mungbean, cowpea and gram seeds through X-ray image analysis and to identify the retrieved.

Materials and Methods

The present investigation on "Detection and identification of hidden infestation by *Callosobruchus* species belonging to family bruchidae" were carried out in the Entomology laboratory, division of plant quarantine, at NBPGR, New Delhi during 2012-2013.

Infested seed materials : Four infested seed samples namely: mungbean, cowpea, gram and pigeon pea were collected from the division of germplasm conservation, NBPGR, New Delhi. The seed sample were brought to the Entomology laboratory of division of plant quarantine at NBPGR, New Delhi for further study.

Mechanical cleaning : All the seed lots were cleaned mechanically (hand picking) by removing the insects, stages thereof, infested, discoloured, deformed and shriveled seeds.

Grain material for standardization of X-ray radiography : Experiments for standardization of radiography were undertaken on mungbean, cowpea, gram and pigeon pea.

X-ray machine : The X-ray machine available at National Bureau of Plant Genetic Resources is standard cabinet X-ray machine of Faxitron series. The machine gives soft X-ray radiation enough for studying seed in smaller quantities. The machine has all built in safety features protecting those working in the vicinity from exposure to the radiation (Fig.-1).

The seeds are spread in a small plastic tray and exposed to soft X-rays generated at 19-26 kv. For

Fig.-1 : Faxitron SR MX 200 real-time X-ray machine for detection of hidden infestation of bruchids in seeds.

19-25 second depending on the seed size using the real time X-ray machine, Model No. Faxitron SR MX-200. As the machine is real-time, it automatically gives the X-ray radiograph on the monitor (Fig.-2).

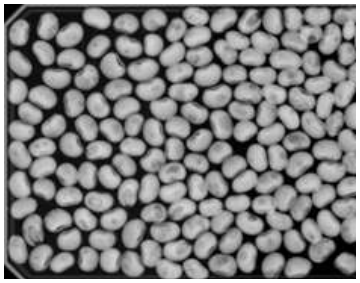


Fig.-2 : Image of seed plate after X-ray exposure.

Infested seeds are clearly distinguishable from healthy ones on the monitor. The exposed plate is gently removed from the X-ray machine without disturbing the seed geometry. The infested seeds (as seen in the X-ray radiograph) are then handpicked from the seed sample with original geometry retained an X-ray tray/plate.

Identification of interceptions : The infested seeds separated by handpicking after X ray radiography are soaked overnight, the seed teased open and the insect removed from inside (Fig.-3).

(a) Mung bean

(b) Cow pea

(c) Gram

(d) Pigeon pea

Fig.-3 : Infected seed collected through X-ray Radiography machine and after soak in water.

Examined the insect stage by binocular microscope to identify the taxonomic and morphological characters with the help of identification key (Fig.-4).

Fig.-4 : Examined the insect stage by binocular microscope.

Results and Discussion

The following section describe in details the various insect pests detected with the help of x-ray.

Radiography machine. Their taxonomic details are also elaborated and the morphological characters, life cycle as study have been described :

Test insects :

(*i) Callosobruchus chinensis*

(ii) Callosobruchus maculatus

(iii) Callosobruchus analis

1. Taxonomic characters of *Callosobruchus chinensis*

Head : Brown or black broader at posterior and frons craniate, its surface covered with white setae. Eyes bulbous, strongly emarginated and surface of canthus covered with white or golden setae, maxillary palpi black, protruding. Antennae dark brown, segments 3-11 serrate in female, pectinate and often margined with black in male.

Pronotum : Sub-conical, dark brown or black, its surface covered with light brown setae, with two medium prominent callosities in its posterior region, callosities covered with shining white and orange setae.

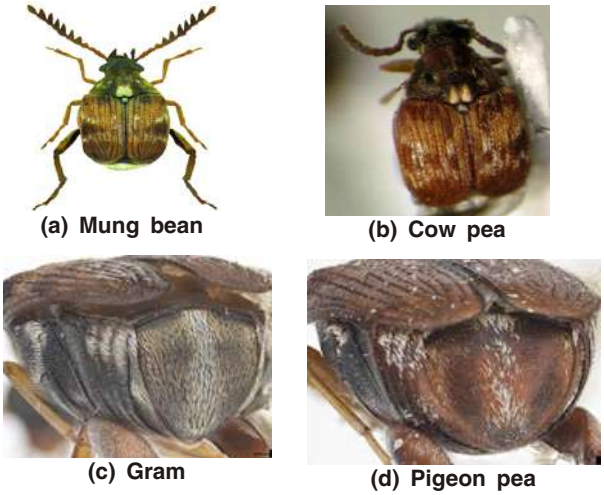
Scutellum : Squarish and covered with white setae.

Elytra : Elongate, quadrangular, rounded at apical margins, their ground colour entirely reddish or red intercepted by black spaces, striae punctuate, striae 3-8 abbreviated at apex, a pair of tubercles present at the bases of 3rd and 4th striae, humeral callosities well developed, surface of each elytron covered with three transverse rows of setae, a broad row of golden setae in the anterior region and two narrow rows of white setae in the middle, the rest of the elytral surface not covered with setae.

Legs : Usually reddish with the pretarsi black, sometimes dark brown with the coxa and hind femora black,

bicarinate on inferior margins, each carina bearing an apical tooth, outer tooth larger and blunt, inner tooth narrow and pointed, hind tibia produced into a spine at its internal apical end.

Pygidium : Dark brown or black, vertical, uniformly covered with pale setae in male, oblique and with distinct median row of white setae and scarce pale setae elsewhere in female (Fig.-5).



(a) Mung bean **(b) Cow pea**

(c) Gram **(d) Pigeon pea**

Fig.-5 : *Callosobruchus chinensis* identified in infested mungbean seed through stereobinocular Microscopic observations (a). Male, (b). Female, (c). Male pygidium, and (d). Female pygidium.

Phallus : Narrow, elongated, 1.73 mm long, parameres flattened at their distal ends, each provided with a distinct apical papilla carrying a pair of setae, success devoid of setae, with a pair of lateral chitinized toothed plates, exophallic valve acuminate, proximal lobe of the spermatheca broad, distal lobe short and narrow.

Size : Small sized 3.23 to 3.36 mm in male and 3.43 to 3.56 mm in female.

Hosts : *Arachishypogoea, Cajanuscajan, C. indicus, Cassia javanica, C. tora, Cicer arietinum, Cyamopsis tetragonolobus, Dolichus biflorus, D. lablab, D. lablab var. lignosus, Dolichus monocalis, Dolichus* sp., *Glycine hispida, Lathyrus odoratus, L. sativus, Lens esculenta, Lens* sp., *Nelumbo nucifera, Phaseolus aconitifolius, P. angularis, P. articulatus, P. aureus, P. calcaratus, P. lunatus, P. Mungo, P. radiatus, P. vulgaris, Pisumarvense, P. sativum, Viciafaba, Viciafaba var. equina, Vicia*sp., *Vignacatjang, V. catjang var. sinensis, V. cylindrica, V. oligosperma, V. sesquipedalis, V. sinensis, V. unguiculata, Voandzeiasubterranea.*

Distribution : Widely distributed in plains and hills all over India.

1. Taxonomic characters of *Callosobruchus maculatus* (F.)

Head : Black, elongate, frons carinate, eyes emarginated, canthus broad and covered with pale setae. Antennae testaceous, dark brown or black, subserrate in female, longer and serrate in male.

Pronotum : Subconical, usually black, sometimes dark brown and with a pair of posterior median callosities covered with dense pale setae on the rest of the surface thinly scattered with a pair of prominent lateral white spots in female.

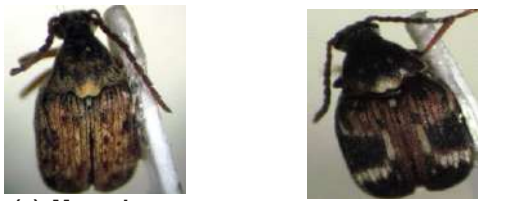
Scutellum : Quadrangular and bearing white setae.

Elytra : Elongate, about twice as long as broad, with 4th and 5thstriae stopping short of other striae; their ground colour in the female commonly testaceous having well defined median and apical black and occasionally with an additional humeral black spot but may be entirely testaceous or entirely black, white pubescence on each elytron disposed along the median black spot but may be entirely testaceous or entirely black, white pubescence on each elytron disposed along the median black spot as a longitudinal band of white setae on the third interstria making the mesal border, a narrow transverse band on the 4th-9th intersteriae forming the anterior edge, and a broader band across the same interstriae comprising the posterior edge, the white pubescence thus assuming the form of two C-shaped areas with their bases facing each other; the ground colour of elytra in the male usually testaceous with median or apical black naked areas or both sometimes entirely testaceous, the testaceous parts covered over by golden setae.

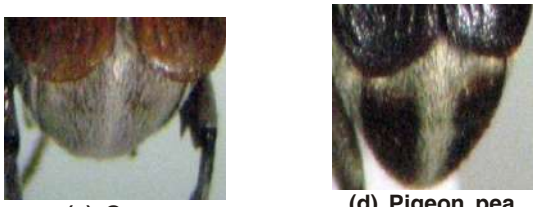
Legs : Testaceous, hind legs sometimes dark brown, hind femur bicarinate below, inner carina with a narrow pointed tooth near apex, outer carina with a short comparatively blunt process.

Pygidium : In the female oblique, either entirely testaceous or black interrupted by a median testaceous stripe, the latter covered over by white pubescence which may spread laterally along the anterior border for varying extent, rest of the surface carrying sparse golden setae (Fig.-6d), pygidium in the male vertical, either entirely testaceous or testaceous with black posterolateral spots, its surface uniformly clothed with golden setae which may aggregate densely to from median line (Fig.-6).

Phallus : short, broad, 1.57 mm long, parameres elongated, free and flattened at tips which reach beyond the tip of exophallic valve, success region of endophallus beset with numerous thickly set lateral spines, its two lobes of the spermatheca almost sub-equal and the proximal slightly broader than the distal.



(a) Mung bean (b) Cow pea



(c) Gram (d) Pigeon pea

Fig.-6 : *Callosobruchus maculatus* identified in infested cowpea seed through stereobinocular microscopic observation (a). Male, (b). Female, (c). Male pygidium, and (d). Female pygidium.

Size : moderate, length 3.29 mm to 4.95 mm in male and 4.01 mm to 4.81 mm in female.

Host : *Acacia arabica, Arachis hypogea, Cajanuscajan, C. indicus, Cercis Canadensis, Cicerarietinum, Dolichusbiflorus, D. Cyprus, D. lablab, D. monocalis, D. sesquipedalis, D. sudanensis, Dolichus*sp., *Glycine hispida, G. max, Gossypium*sp.,*Lathyrusclymenum, L. sativus, Lens esculenta, Medicagociliaris, Phaseolusaconitifolius, P. acutifolius, P. angularis, P. articulatus, P. aureus, P. Lunatus, p. mungo, P. radiatus, P. vulgaris, Pisumsativum, Pisum*sp.,*Viciaervilia, V. faba, Vignacatjang, V.unguiculata, Voandzeiasubterranea.*

Distribution : Widely distributed in plains and hills all over India.

1.Taxonomic characters of *Callosobruchus analis* (F.)

Head : Small, dark brown, frons carinate, covered with pale setae, antennae testaceous, sub-serrate, eyes emarginated, canthus broad and clothed with pale white setae.

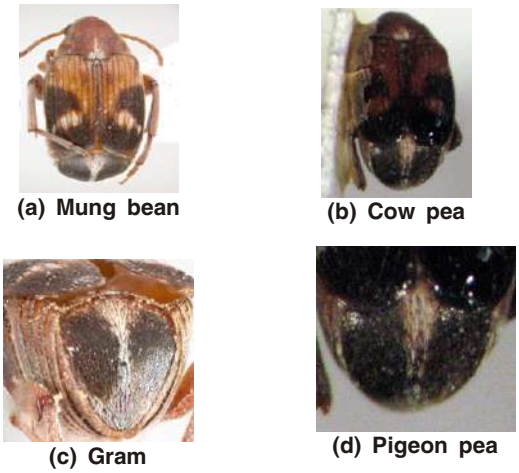
Pronotum : Sub-conical, dark-brown, surface covered with sparsely scattered golden setae, a prominent double patch of whitish setae present at its posterior end in the middle and a median longitudinal depressed line in line with the frontal carina.

Scutellum : Quadrangular, covered with dull white or shining white setae.

Elytra : Dark-brown or light brown, each with dull central and apical black spot, the two joining each other along their outer ends, each elytra about twice as long as broad, with striae 4 and 5 stopping short of the other striae near the apical end, humeral callosities well developed, brown parts of the elytra covered over with golden setae, black spots naked, a prominent oval patch of white setae present in between the black spots and third interstria sometimes covered by white setae in front of the white patches (Fig. 16a and b).

Legs : Testaceous, hind pair darker than the others, hind femur bicarinate below, each carina with a sub-apical spine, inner spine short and pointed, outer spine larger and blunt and hind tibia flattened and produced at its apical outer end into a prominent process.

Pygidium : Black, vertical in male, oblique in female, with a median band of white setae in both the sexes (Fig.-7).



(a) Mung bean (b) Cow pea

(c) Gram (d) Pigeon pea

Fig.-7 : *Callosobruchus analis* identified in infested gram seed through stereobinocular microscopic observations. (a). Male, (b). Female, (c). Male pygidium, and (d). Female pygidium.

Phallus : Moderately developed, 1.41 mm long, parameres completely free, flattened at ends into spoon-like structure, saccus of endophallus with a few thick pointed medium spines and a pair of lateral chitinizedtoothed plates, rest of the endophallic surface covered with short blunt tubercles; exophallic valve larger, conical; proximal lobe of spermatheca elongated and broad, distal lobe short and pointed.

Size : Moderate, length 3.64 mm to 3.96 mm in male and 3.22 mm to 3.89 mm in female.

Host : *Abrus precatorius, Acacia arabica, Cajanus cajan,* C. *indicus, Canavalia ensiformis, Cicer arietinum, Crotolaria* sp., *Dolichos biflorus, D. cyprus, D. lablab, D. lablab* var. *lignosus, D. lablab* var. *typicus, Glycine hispida, G. max, Lathyrus sativus, Lens esculenta, Phaseolus acontifolius, P. acutifolius, P. articulatus, P. aureus, P. calcaratus, P. lunatus, P. mungo, P. radiatus, P. vulgaris,Physostigma venenosum, Pisum sativum, Vicia faba*, *Vigna catjang, V. sesquipedalis, V. sinensis, V. unguiculata* and *Voandzeia subterranea.*

Distribution : Widely distributed in plains and hills all over India.

Table-1 : Showing sexually dimorphic characters in *Callosobruchus* spp.

S. No.	Name of species	Male	Female
1.	*C. chinensis* (L.)	Antennae long and pectinate; a pair of tubercles present at the bases of 3rd and 4th striae of each elytron.	Antennae short and sub-serrate; elytral tubercles absent.
2.	*C. maculatus* (F.)	Antennae long and deeply serrate; elytra without distinct C-shaped areas of white pubescence; pygidium uniformly covered with golden setae.	Antennae short and sub-serrate; white pubescence on the elytra forming two distinct C-shaped areas with their bases facing each other; pygidium with a pair of black postero-lateral spots.
3.	*C. analis* (F.)	Each elytron with a pair of black naked spots separated by a patch of dull white setae; Pygidium vertical. Antennae slightly thick.	Each elytron with a pair of dark black spots separated by a patch of shining white setae; pygidium oblique. Antennae slightly thin.

Life cycle of bruchid : Adult beetle is 3-4 mm long, female being larger, brownish in colour, broader at shoulders and rounded posteriorly. There are dark patches on elytra and thorax. Adults show sexual dimorphism. Males possess deeply emarginated or indented eyes and prominently serrate antennae, while in female these characters are not distinctly marked. Tip of abdomen in females is exposed while in males it is covered by elytra. They are active beetles and readily fly when disturbed. Fecundity is about 100 eggs per female. Eggs are whitish, elongated and stuck on the grains or on pods and sometimes on the surface of the container. Incubation period is 3-6 days. Grubs are scarabeiform or cruciform, plump and with short legs and yellowish in colour. First instar larvae bear functional legs and a pair of thoracic plates to facilitate boring into the seeds. They feed on the inner contents of the grain and may damage several grains during development. Larval period may vary between 12 and 20 days. Pupation takes place inside the grain and pupa is dark brown in colour. Occasionally, pupation may take place outside the grain in a cocoon made of excretory matter. Completion of life cycle takes 4-5 weeks and there may be 6-7 overlapping generations in a year (Fig.-8).

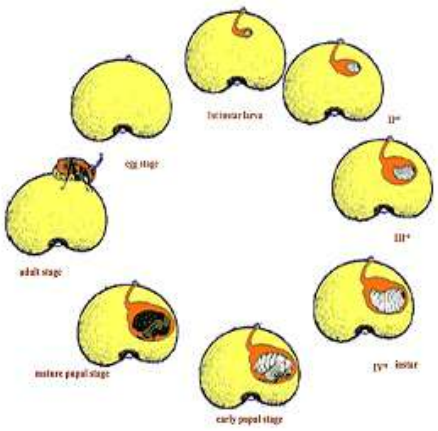


Fig.-8 : Life cycle of bruchid.

Disinfestations treatments in quarantine : Disinfestations treatment commonly used in quarantine include fumigation, X-ray radiography, mechanical cleaning, etc. Apart from these, irradiation, cold, heat, controlled atmosphere and combination treatments are gaining popularity as these are supposedly safe and environment friendly. Their use is being extensively explored world-wide as alternatives to the use of chemicals, especially the most widely used quarantine fumigant, methyl bromide and Ethylene Dichloride-Carbon Tetrachloride, which has been designated as an ozone layer depleting substance and is likely to be phased out in near future.

Conclusions

The genus *Callosobruchus* has been of concern as the major pests of legumes in field as well as in storage. Its species are destructive to leguminous seeds and some of the major hosts of *Callosobruchus* species are *Cicer, Cajanus, Cyamopsis, Cynodon, Dolichos, Glycine, Lens, Pisum, Phaseolus, Pueraria, Sesbania, Vicia, Vigna* and *Voandzeia*. The genus *Callosobruchus* Pic. is comprised of about 30 species, distributed in warm parts of the Old World, a few of which are introduced to the new world; of these, 19 species have been reported from various geographical regions of India viz. *Callosobruchus analis*, *C. antennatus*, *C. cajanus*, *C. chinensis*, *C. dolichosi*, *C. indica*, *C. maculatus*, *C. madurensis*, *C. montanus*, *C. nigripennis*, *C. orientalis*, *C. phaseoli*, *C. theobromae*, *C. anjaliae*, *C. sukhanensis, C. multinigrus*, *C. antenniferus*, *C. sasangirensis*, and *C. stoutus*. However, in all of above mentioned species, some of the major pest species are *C. chinensis, C. maculatus, C. analis, C. cajanus, C. phaseoli*, and *C. theobromae*, which caused major damage to pulses during the storage.

Therefore, during the present study, three species viz. *C. chinensis, C. maculatus and C. analis* were taken up for studying their detection, identification and management. Since these insects cause hidden

infestation, the detection was done through X-ray radiography using MX 200 Faxitron machine which is for real-time detection of insects inside the grains. After detection, the insects were retrieved and mounted for their identification upto species level. The identification was undertaken based on morphological characters of the four species. The differentiating characters including those of antenna, elytra, hind leg, pygidium and genitalia were studied for all the three species. Management options available such as mechanical cleaning, salvaging through X-ray, fumigation using EDCT (Ethylene Dichloride Carbon Tetrachloride) mixture at normal atmospheric pressure (NAP) and ambient temperature and vacuum fumigation have also been discussed. The present study gives an insight into the detection, identification and management aspects of the *Callosobruchus* spp. and these findings would be a useful reference for future students and researchers interested in the important field of storage entomology.

References

1. Arora, G.L. (1977). Taxonomy of the Bruchidae (Coleoptera) of Northwest India. Part I. *Adults. Orient. Insects Suppl.*, 7: 2-5.
2. Arora, G.L. (1977). Taxonomy of the bruchidae (Coleoptera) of northwest India. Part I. *Adult. Oriental Insects (Supplement),* 7: 132-134.
3. Bhalla, S., Kapur, M.L., Lal, B., Verma, B.R. and Singh, C. (2002). Quarantine risk associated with exchange of plant genera carrying hidden infestation. *Indian Journal of Plant Genetic Resources,* 15(2): 160-163.
4. Gupta, K., Ruquaeya, B., Gupta, C.S., Bhalla, S., Kapur, M.L., Lal, B. and Singh, C. (2011). The digital library on Bruchids. Available at http://202.141.12.150/bruchid-library/ accessed on 20.8.2011.
5. Pajni, H.R. and Gupta, I.J. (1975). *Callosobruchusindica* sp. nov.from Chandigarh (Coleoptera: Bruchidae). *Orient. Insect.,* 9: 447-449.
6. Singh, S.C. and Kumari, R. (2000). A study of the biology of *Callosobruchuschinensis* (L.) infesting stored pulses in India. *Ind. J. Entomol.*, 62(4): 319-322.
7. Singh, T. (1979). A key to the north-west Indian Bruchidae. *Entomologist's Monthly Magazine,* 113: 219-231.
8. Singal, S.K. and Pajni, H.R. (1990). Six new species of *Callosobruchus* Pic.from India (Coleoptera: Bruchidae). *Polsk. Pism. Entomol.,* 59: 761-782.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 739-743 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Kinetic of Nitrogen Mineralization by Using Various Organic Manures in Pune Region of Maharashtra

Subhash Singh[1*] and Roopali Patel[2]

[1]*Collage Agriculture, Pune, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722 India*

[2]*Assam Agriculture University, Jorhat, Assam-785013 India*

**Corresponding Author Email : subhash2014.ss@gmail.com*

Abstract

The mathematical description of N mineralization in soils like parabolic model, exponential model, hyperbolic model, zero order models etc, is a possible 3 approach to characterize and quantify the organic matters pool and mineralization constant rate. The single exponential model most widely used for soil N mineralization, although other types have also been tested. Several kinetic models are often used to estimate the kinetic of N mineralization, thus a model is selected based on the highest coefficient of determination (r2) and the lowest standard error (Wijanarko and Purwanto, 2016). The N mineralization capacity through long term incubation procedures. From their studies they proposed an asymptotic model of time course of N mineralization, making it possible to calculate the N mineralization potential of the soils (Stanford and Smith, 1972). Kinetics parameters in mineralization study can be potentially used to access the mineralization-immobilization process in soils under varying environmental and management conditions. Nitrogen-use efficiency can be enhanced through the understanding of N-mineralization potential of different organic source.

Key words : *Oragnic manure, N-mineralization, kinetic equation.*

Introduction

In recent past, there is a renewal interest on the use of organic resources in agricultural for maintaining soil organic matter, improving soil quality and supplying plant nutrient for sustainable crop production. The use of organic waste in the amendment of agricultural soils can be beneficial for crops, and the same time, provide an efficient and cost effective method for its disposal. The organic fraction of manure can significantly increase soil aggregation, infiltration, microbial activity, structure, and water-holding capacity and can reduce soil compaction and erosion. Therefore, it gives real benefits of applying these organic materials to soil. The determination of N mineralization potential in soil after organic amendments allows the evaluation of N dynamics in the soil and its true effectiveness in economic and ecological effect (Pedra *et al.,* 2011).

The incorporation of organic manures into soil is considered a good management practices because it stimulates soil microbial activity and increases soil fertility through mineralization. Inceptisol are in medium range of organic matter which is the backbone for the sustainability of soil fertility and productivity. An improved understanding of the competing processes of N mineralization and N immobilization, along with their temporal dynamic's, may improve our ability to manage N cycling, increase Nitrogen use efficiency (NUE) by minimizing N losses whatever the form, and increase the sustainability of agricultural system that utilize typically applied organic N sources (Cabrera *et al.,* 2005).

Stanford and Smith (1972) were establishing the N mineralization capacity through long term incubation procedures. Kinetics parameters in mineralization study can be potentially used to access the mineralization-immobilization process in soils under varying environmental and management conditions. Nitrogen-use efficiency can be enhanced through the understanding of N-mineralization potential of different organic sources. The aim of present study was to determine and compare N mineralization rate, under laboratory condition amended with different organic residues in Inceptisol. The suitability of organic residues as a source of N depends to great extent on its mineralization of N in relation to crop demand.

Materials and Methods

The present investigation was carried out to quantify the N mineralization rate of different organic manures in Inceptisol soil at field capacity moisture regimes (0.33 bar). A laboratory incubation experiment was carried out with (8 Treatment) eight organic manures thresee replication with CRD Design sources at Division of Soil Science and Agricultural Chemistry, College of Agriculture Pune-05, Maharashtra, during the year 2016-2017.

Materials

Soil : Bulk soil (0-15cm) was obtained from the

Table-1 : Oragnic manure.

Treatment	Organic manure	Source
T_1	Farm Yard Manure (FYM)	Agronomy Division College of Agriculture
T_2	Vermicompost	College of Agriculture
T_3	Press mud cake Vasantdada Suger Institute	Manjari (BK)
T_4	Press mud compost Vasantdada Suger Institute	Manjari (BK)
T_5	Poultry manure Animal Husbandry and Dairy Science	College of Agriculture
T_6	Coco pit compost	College of Agriculture, Baramati
T_7	Urban compost Municipal corporation	Pune
T_8	Urban compost Municipal corporation	Pune
T_9	Spent mushroom compost AICRP	Mushroom Project

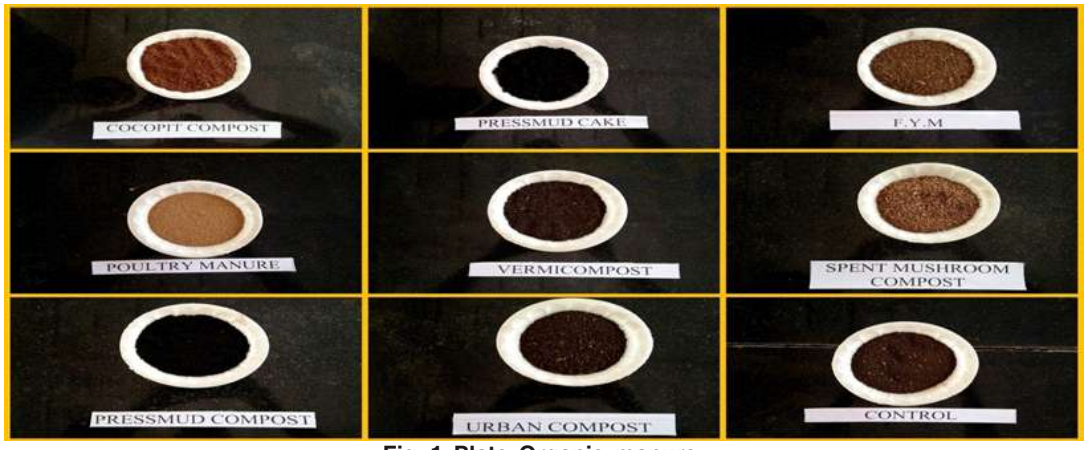


Fig.-1 Plate Organic manure.

Fig.-1, Plate-2 : General view of N mineralization incubation study due to various organic manure sources.

experimental farm (block-15B), of Agronomy Division, College of Agriculture Pune-05. The soil is an Inceptisol family of Typic Haplustept. Soil was air dried, in shade and grounded in wooden mortar and pastle, passed through 2 mm sieve and used for conducting the experiment. The physical and chemical characteristics of soil used are given in Table-1.

Organic manure : The eight value added organic manures were collected from different locations (Table-1) and used in the present laboratory incubation. Study the procedure of organic manures were passed through a 2 mm sieve and analyzed for further used.

Statistical analysis : The data obtained in replicated experiments conducted were analyzed statistically by the methods described by Panse and Sukhatme (1967). All statistical analysis was performed with the help of programme prepared in Excel software.

Where,

y = mineralization of N (mg/kg)

x = time (h)

a = intercept

b = slope, The cumulative data of mineralization of

Table-2 : Kinetics equations used in the study.

S. No.	Kinetic equations	Expression forms	References
1.	Zero order reaction	y = a + b x	Martin and Sparks (1983)
2.	First order reaction	y = a + b x	Martin and Sparks (1983)
3.	Second order reaction	1/y = a + b x	Havlin and westfall (1985)

nitrogen (NH_4-N + NO_3-N) was used for the calculations of rate of mineralization and intercept. All statistical analysis was performed with the help of programme prepared in Excel software.

Results and Discussion

Coefficient of determination of zero order, first order and second order for NH_4-N, NO_3-N and NH_4-N + NO_3-N: Data pertaining to the Coefficient of determination of zero order, first order and second order kinetic model tested for periodical NH_4-N, NO_3-N and NH_4- N+NO_3-N release in inceptisol soils of College of Agriculture, Pune after additions of organic manures in Table-1 to 2, respectively. The above three kinetic equations were used to describe the kinetics of N Mineralization in inceptisol soil after addition of N @ 100 mg N kg-1 through various organic manures. The results of statistical analysis obtained by plot, which were fits between the equations and experimental data and calculated coefficient of determination (r^2) release constant (a and b). The result showed that by using a zero order kinetic equations recorded the higher r^2 values (r^2 =0.974 to 0.984) in all the treatments in respect of NH_4-N + NO_3-N as compared with first order and second order kinetic equations. Zero order and first order kinetic equations are more suitable to describe N mineralization than second order kinetic equation. The Zero and first order kinetic equations recorded higher r^2 value than second order equation has been recorded by the addition of organic manures in Typic Hapludults by Wijanarko and Purwanto (2016). Dou *et al.* (1996) also recorded similar result of N mineralization in respect of zero order and first order kinetic equation. Similar trend was also recorded in release of NH_4-N and NO_3-N (Table-19 and 20). It indicates that among the three equations zero order equation could be used for predicting the release pattern of forms of N released in inceptisol by the addition of organic manures. However, the second order equation is inferior as compared with zero and first orders model as it records the lower value of r2 in release of forms of N by the addition of various sources of organic manures.

Mineralization N (NH_4-N, NO_3-N and NH_4-N + NO_3-N) release constants (a and b) : The constants a and b of each equation represent the intercept and the slope of the linear curves resulting from plotting the mineralized N vs. time (Table-1 to 2) mineralization rate constants were calculated for Inceptisol soils using the zero-order, first-order and second-order equations by the addition of N @ 100 mg kg^{-1} . The constant b mirrors the release rate of the mineralization of nitrogen (Simard and N?dayegamiye, 1993 and Pedra *et al.,* 2011). The highest rate of mineralization (b= 6.14) and intercept (110.610) were 46 observed due to the addition of poultry manure for zero-order kinetic equations by the addition of poultry manure as compared with rest of the treatments and first order and second order equations and it was followed by vermicompost (Table-2). It attributes to the higher content of nitrogen in the original material. Control treatment observed the lowest values of rate constant and intercept in zero order equation. More or less similar rate constant values (-0.0001 to -0.0002) has been recorded in all the sources of organic manure and control treatment in case of second order mathematic model and these values were not affected by the addition of organic matter (Table-2). If higher negative values of b could be indication of inadequate mineralized N release from clay complex. The negative value of rate constants (b values) for potassium chloride was also reported by Ghiri and Jaberi (2013) in the release of kinetics of potassium. The much variation in intercept and rate constant was noticed in the zero order equation which was not observed in the first and second order equations. It might be because of the soil taxonomy, clay mineralogy, pH, CaCO3, adsorption, desorption, diffusion of the soils, and mathematical equations tested and quality of organic manures to be used for crop production. These results are in agreement with results obtained by Wijanarko and Purwanto (2016) but the higher values of rate and intercept was observed in this study. This might be because of initial rate of NH4-N released (a and b parameters) are dependent on clay content in soil.

The values of the rate constant (b values) obtained from soil samples after addition of various sources of organic manure could be used in combination with routine soil tests for predicting crop requirement for the N availability to crops. The lower b values of second-order (also referred as rate constant) were observed as compared with the values .The second-order equation (1/y = a + b x) had the least fit for predicting the mineralization rate.

The results showed that the zero order equation constants also adequately described the kinetics of nitrogen amended with the various sources of organic manure in Inceptisol. The highest rate of mineralization

Table-1 : Intercept (a), slope (b) and coefficient of determination (r^2) values for the kinetic equations of cumulative NH_4-N as affected by various sources of organic manures.

S. No.	Treatment		T_1 FYM	T_2 Vermicom -post	T_3 Press mud cake	T_4 Press mud compost	T_5 Poultry manure	T_6 Coco-pit compost	T_7 Urban Compost	T_8 Spent mushroom compost	T_9 Control
						Kinetic equation					
1.	Zero order	A	22.19	25.41	21.22	24.53	4236	19.79	25.99	21.06	18.54
	y = a + bx	B	1.65	1.81	1.59	1.75	2.21	1.51	1.90	1.62	1.33
2.		r^2	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	First order	A	3.32	3.46	3.27	3.41	3.87	3.20	3.49	3.27	3.11
	y = a + b x	B	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		r^2	0.87	0.88	0.87	0.87	0.86	0.86	0.88	0.87	0.86
3.	Second order	A	0.04	0.03	0.04	0.03	0.02	0.04	0.03	0.04	0.05
	1/y = a + b x	B	-0.0004	-0.0004	-0.0005	-0.0004	0.0430	-0.0005	-0.0004	-0.0005	-0.0006
		r^2	0.67	0.69	0.67	0.68	0.68	0.67	0.69	0.67	0.66

Table-2. Intercept (a), slope (b) and coefficient of determination (r^2) values for the kinetic equations of cumulative NO_3-N as affected by various sources of organic manure.

S.No.	Treatment		T_1 FYM	T_2 Vermi-compost	T_3 Press mud cake	T_4 Press mud compost	T_5 Poultry manure	T_6 Coco-pit compost	T_7 Urban Compost	T_8 Spent mushroom compost	T_9 Control
	Kinetic equation	a	52.57	56.51	42.01	53.92	68.24	32.48	60.18	47.19	30.72
1.	Zero order	b	3.01	3.56	2.68	3.17	3.92	2.42	3.71	2.81	2.14
	y = a + b x	r^2	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
		a	4.12	4.24	3.93	4.17	4.41	3.72	4.30	4.02	3.64
2.	First order	b	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	y = a + b x	r^2	0.88	0.89	0.88	0.88	0.89	0.88	0.89	0.87	0.88
		a	0.02	0.01	0.02	0.02	0.01	0.03	0.01	0.02	0.03
3.	Second order	b	0.002	0.0002	0.0002	0.0002	-0.0001	-0.0003	-0.0002	-0.0002	-0.0003
	y = a + b x	r^2	0.69	0.71	0.69	0.70	0.71	0.69	0.71	0.68	0.69
		a	52.57	56.51	42.01	53.92	68.24	32.48	60.18	47.19	30.72

Table-3. Intercept (a), slope (b) and coefficient of determination (r^2) values for the kinetic equations of cumulative NH_4-N+ NO_3-N as affected by various sources of organic manures.

S. No.	Treatment		T_1 FYM	T_2 Vermi compost	T_3 Press mud cake	T_4 Press mud compost	T_5 Poultry manure	T_6 Coco-pit compost	T_7 Urban Compost	T_8 Spent mushroom compost	T_9 Control
		A				Kinetic equation					
1.	Zero order	B	74.7	81.91	63.22	78.45	110.61	52.26	86.17	68.24	49.26
	y = a + b x	r^2	4.66	5.37	4.27	4.92	6.14	3.93	5.61	4.43	3.47
		A	0.98	0.98	0.98	0.98	0.98	0.97	0.98	0.98	0.98
2.	First order	B	4.49	4.62	4.35	4.55	4.87	4.18	4.67	4.41	4.11
	y = a + b x	r^2	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		A	0.87	0.89	0.88	0.88	0.88	0.87	0.89	0.87	0.87
	Second order	B	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
3.	y = a + b x	r^2	0.0001	-0.0001	0.0002	-0.0001	-0.0001	-0.0002	-0.0001	-0.0001	0.0002
		A	0.69	0.70	0.68	0.69	0.70	0.68	0.70	0.67	0.68

(b= 6.14) and intercept (110.61) were observed due to the addition of poultry manure for zero-order mathematical model by the addition of poultry manure as compared with rest of the treatments (Table-2).

Conclusions

Coefficient of determination of zero order, first order and second order reactions for NH_4-N, NO_3-N and NH_4-N + NO_3-N: The result showed that by using a zero order kinetic equation recorded the higher r2 values (r2 =0.97 to 0.98) in all the treatments in respect of NH_4-N + NO_3- N as compared with first order and second order kinetic equations. Zero order and 55 first order kinetic equations are more suitable to describe N mineralization than second order kinetic equation. Mineralization N (NH_4-N, NO_3-N and NH4-N, NO_3-N) release constants (a and b) of zero order, first order and second order reactions: The highest rate of mineralization (b= 6.137) and intercept (110.610) were observed due to the addition of poultry manure for zero-order kinetic equation by the addition of poultry manure as compared with rest of the treatments and first order and second order equations and it was followed by vermicompost

Control treatment observed the lowest values of rate constant and intercept in zero order equation. More or less similar rate constant values (-0.0001 to -0.0002) has been recorded in all the sources of organic manure and control treatment in case of second order kinetic equation and these values were not affected by the addition of organic matter. Zero order equation recorded the mean rate constant (b=4.754) and intercept (73.875), respectively. The much variation in intercept and rate constant was noticed in the zero order equation which was not observed in the first and second order equations.

Conclusions

Among the different organic manures poultry manures recorded more values of NH_4-N, NO_3-N and NH_4-N + NO_3-N throughout the incubation period over rest of the treatments. The rate of release NH_4-N was slow at 0 and 15 days after incubation and it was sharp increased a peak rate at 45 days of incubation fallowed by gradual decline thereafter in all organic manures amended treatments. 3. The application of all the sources of organic manures increased the potential N mineralization by 28.4 per cent to 80.10 per cent over the control. The potential N mineralization ranged from 3.27 to 5.89 mg kg-1 day-1 due to different treatment.

References

1. Arps, J.J. , (1944) Analysis of decline curv. Issued as T.P. 1758 in *Petrolium Technology, September.*
2. Cabrera, M.L., Kissel, D.E. and Vigil, M.F. (2005). Nitrogen mineralization from organic residues. *Journal of Environmental Quality* 34: 75-79.
3. Hazewinkel, M., ED. (2001). “Linear equation”. Encyclopedia of Mathematics, Springer, ISBN 978-1-55608-010-4.
4. Kumar, A., and Consul, P.C. (1979) Negative Moments of a Modified Power Series Distribution and Bias of the Maximum Likelihood Estimator. *Conmunications in Statistics,* 33(2): 151–166
5. Martin, H. W. and Sparks, D. L. (1983). Kinetics of nitrogen release from two coastal plain soils. *Soil Science Society of America Journal,* 47: 883-887.
6. Panse, V.G. and Sukhatme, P.V. (1967) Statistical methods for agricultural workers. ICAR, New Delhi, 2nd Ed. pp. 96.
7. Pedra, F., Polo, A., Carranca, C., Ribeiro, A. and Domingues, H., (2011). Kinetics model fitted to nitrogen mineralization potential in soil amended with municipal compost and urban sewage sludge. Dynamic soil, Dynamic plant, Global science books.
8. Stanford, G.and Smith, S.J.(1972) Nitrogen Mineralization Potentials of Soils. *Soil science Society of America Journal,* 36, 465–472.
9. Wijanarko, A. and Purwanto, B. H., (2016) Comparison of two kinetics models for estimating N mineralization affected by different quality of organic matter in Typic Hapludults. *Journal of degraded and mining land management.* ISSN:2339-076x(e); 2502-2458(p), number 3: 577-583.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 744-752 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Best Fitting Mathematical Model for Assessing Nitrogen Mineralization in Maharashtra Region

Subhash Singh[1*] and Roopali Patel[2]

[1]*College Agriculture, Pune, Mahatma Phule Krishi Vidyapeeth, Rahuri-413722 India,*

[2]*Assam Agriculture University, Jorhat, Assam-785013 India*

**Corresponding Author Email : subhash2014.ss@gmail.com*

Abstract

In recent past, there is a renewal interest on the use of organic resources in agricultural for maintaining soil organic matter, improving soil quality and supplying plant nutrient for sustainable crop production. Nitrogen is commonly deficient and limits crop production in cultivated soils of the tropics. The main source of N for crops of the mineralization of soil organic manures, organic inputs, and biological nitrogen fixation. The quality of organic material is reflected in the carbon (C), nitrogen (N) and C/N ratio. These quality indicators are useful in predicting the N turnover and mineralization of organic residues. Generally, manures with low C/N ratio (lesser than 10:1) result in greater N availability at the early stage of decomposition. Therefore it gives real benefits of applying these organic materials to soil organic materials to soil. Several kineatic model are often used to estimate the kinetic of N mineralization, thus a model is selected based on the highest coefficient of determination (r^2) and the lowest standard error Wijanarko and Purwanto, (2016). The N mineralization capacity through long term incubation procedures. From their studies they proposed an asymptotic model of time course of N mineralization, making it possible to calculate the N mineralization potential of the soils (Stanford and Smith, 1972). Kinetics parameters in mineralization study can be potentially used to access the mineralization- immobilization process in soils under varying environmental and management conditions. Nitrogen-use efficiency can be enhanced through the understanding of N-mineralization potential of different organic sources.

Key words *: Nitrogen mineralization, organic manure, fitting mathematical model.*

Introduction

In recent past, there is a renewal interest on the use of organic resources in agricultural for maintaining soil organic matter, improving soil quality and supplying plant nutrient for sustainable crop production. The use of organic waste in the amendment of agricultural soils can be beneficial for crops, and the same time, provide an efficient and cost effective method for its disposal. The organic fraction of manure can significantly increase soil aggregation, infiltration, microbial activity, structure, and water-holding capacity and can reduce soil compaction and erosion. Therefore, it gives real benefits of applying these organic materials to soil. The determination of N mineralization potential in soil after organic amendments allows the evaluation of N dynamics in the soil and its true effectiveness in economic and ecological effect Pedra *et al.*(2011). The incorporation of organic manures into soil is considered a good management practices because it stimulates soil microbial activity and increases soil fertility through mineralization. Inceptisol are in medium range of organic matter which is the backbone for the sustainability of soil fertility and productivity. An improved understanding of the competing processes of N mineralization and N immobilization, along with their temporal dynamic's, may improve our ability to manage N cycling, increase Nitrogen use efficiency (NUE) by minimizing N losses whatever the form, and increase the sustainability of agricultural system that utilize typically applied organic N sources Cabrera *et al.* (2005).

Stanford and Smith (1972) were establishing the N mineralization capacity through long term incubation procedures. Kinetics parameters in mineralization study can be potentially used to access the mineralization-immobilization process in soils under varying environmental and management conditions. Nitrogen-use efficiency can be enhanced through the understanding of N-mineralization potential of different organic sources. The aim of present study was to determine and compare N mineralization rate, under laboratory condition amended with different organic residues in Inceptisol. The suitability of organic residues as a source of N depends to great extent on its mineralization of N in relation to crop demand

Materials and Methods

The present investigation was carried out to quantify the N mineralization rate of different organic manures in Inceptisol soil at field capacity moisture regimes (0.33 bar). A laboratory incubation experiment was carried out with (8 Treatment) eight organic manures three replication with CRD Design sources at Division of Soil Science and

Table-1 : Oragnic manure.

Treatment	Organic manure	Source
T_1	Farm Yard Manure (FYM)	Agronomy Division College of Agriculture
T_2	Vermicompost	College of Agriculture
T_3	Press mud cake Vasantdada Suger Institute	Manjari (BK)
T_4	Press mud compost Vasantdada Suger Institute	Manjari (BK)
T_5	Poultry manure Animal Husbandry and Dairy Science	College of Agriculture
T_6	Coco pit compost	College of Agriculture, Baramati
T_7	Urban compost Municipal corporation	Pune
T_8	Urban compost Municipal corporation	Pune
T_9	Spent mushroom compost AICRP	Mushroom Project

Table-2 : Mathematical models used in the study.

S. No.	Mathematical model	Equations	Reference
1.	Exponential association	$Y = a\ (1–\exp^{–b}x)$	Stanfordandsmith (1972)
2.	Exponential	$Y = ae^{bx}$	Hazewinkel (2001)
3.	Exponential decline	$Y = q0\ e^{-x/a}$	Arps (1944)
4.	Hyperbolic decline	$Y = q0\ (1+b\ x/a)^{-1/b}$	Arps (1944)
5.	Linear Hazewinkel (2001)	$Y = a + bx$	Linear Hazewinkel (2001)
6.	Modified	$Y = ab^x$	Kumar and Consul (1979)

Table-3 : Kinetics equations used in the study.

S. No.	Kinetic equations	Expression forms	References
1.	Zero order reaction	$y = a + b\ x$	Martin and Sparks (1983)
2.	First order reaction	$y = a + b\ x$	Martin and Sparks (1983)
3.	Second order reaction	$1/y = a + b\ x$	Havlin and Westfall (1985)

Agricultural Chemistry, College of Agriculture Pune-05, Maharashtra, during the year 2016-2017.

Materials

Soil : Bulk soil (0-15cm) was obtained from the experimental farm (block-15B), of Agronomy Division, College of Agriculture Pune-05. The soil is an Inceptisol family of Typic Haplustept. Soil was air dried, in shade and grounded in wooden mortar and pastle, passed through 2 mm sieve and used for conducting the experiment.

Organic manure : The eight value added organic manures were collected from different locations (Table-2) and used in the present laboratory incubation. Study the procedure of organic manures were passed through a 2 mm sieve and analyzed for further used.

Statistical analysis : The data obtained in replicated experiments conducted were analyzed statistically by the methods described by Panse and Sukhatme (1967). All statistical analysis was performed with the help of programme prepared in Excel software.

Mathematical model : The disintegration constant (decay constant) of nitrogen mineralization were estimated through mathematical model. The best fit mathematical model had been judged. Cumulative values of ammoniacal nitrogen, nitrate nitrogen, ammoniacal + nitrate nitrogen along with incubation periods (days) were used as source of information to developed mathematical model. Among all the mathematical models mineralization of nitrogen with time was fitted with six mathematical models (Table 6). These six mathematical models were tested to determine which equations descried better for N release from the organic sources. Standard error (SE) and the coefficient of determinants (r2) were obtained by use of curve expert professional 2.4 software.

Where,

y = mineralization of N (mg/kg) x = time (h)

a = intercept b = slope The cumulative data of mineralization of nitrogen (NH_4-N + NO_3-N) was used for the calculations of rate of mineralization and intercept. All statistical analysis was performed with the help of programme prepared in Excel software.

Results and Discussion

Kinetics of nitrogen mineralization : To evaluate the best fitted mathematical model for assessing nitrogen mineralization the mathematical models were selected. Cumulative values of ammoniacal nitrogen, nitrate nitrogen and ammoniacal + nitrate nitrogen along with incubation periods (days) were used as source of information to developed mathematical model and found the intercept (a), slope (b) and coeff. of determination (r^2). Among all mathematical models six mathematical models were showed the best result for cumulative value of ammoniacal nitrogen, nitrate nitrogen and ammoniacal +

Plate-1 : General view of N mineralization incubation study due to various organic manure sources.

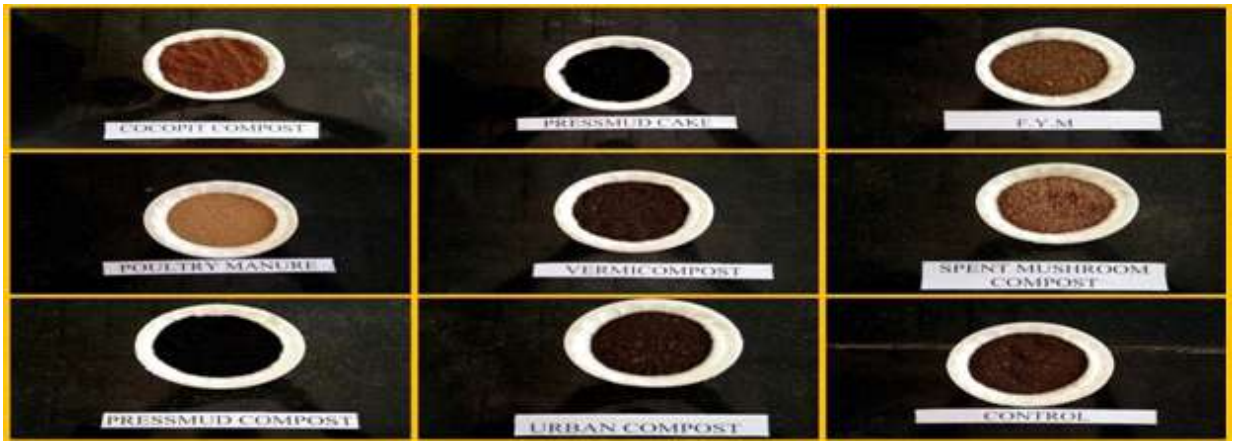


Plate-2 : Organic manure sources used for conducting laboratory incubation study.

nitrate nitrogen with incubation periods (days). The best fitted mathematical model was chosen on the basis of coeff. of determination (r^2) value followed by standard error value.

Coefficient of determination : NH_4-N Among the mathematical models total six mathematical models were recorded the higher value of coefficient of determination (r2) by using curve expert professional 2.4 software. In release of ammoniacal nitrogen in inceptisol soil (Table 13 and depicted Fig-5 to 6). It indicated that the six models can be used for predicting the release of NH4-N at various days of mineralization. Application of N @ 100 mg N kg-1 in inceptisol soil through FYM, vermicompost, press mud cake, press mud compost, urban compost, coco-pit compost, poultry manure, spent mushroom compost and control treatments recorded exactly similar and higher value of coefficient of determination (r^2 = 0.98) in exponential association, hyperbola decline and linear mathematical models. However, slightly lower value of coefficient of determination (r^2 = 0.96) was observed in poultry manure in exponential association model. The r^2 value is generally used for estimating equation. The r^2 value closer to 1.00 indicates good equation by Wijanarko and Purwanto (2016). In general, higher value of coefficient of determination and lower value of standard error could be used for judging the best fit mathematical models. The data from Table 13 showed that in exponential association, hyperbola decline and linear mathematical models were quite superior as compared with exponential, modified power and exponential decline in all the treatments. Among the six models hyperbolic model recorded the lowest value of standard error. All the organic sources and control treatment observed exactly similar value of r^2 and standard error except FYM treatment in exponential, modified power and exponential decline mathematical models. The data of r^2 is agreement with the observation of Simard and N?dayegamiye (1993), Pedra *et al.,* (2011).

Kinetic parameters of N mineralization for NH_4-N : The highest potential mineralization ammoniacal nitrogen N0 (278.22 mg kg^{-1}) was observed by the addition of poultry manure in exponential association model as compared with rest of the treatment and it was higher than mean measured value (223.24 wk^{-1}) and rate constant (0.02 wk^{-} 1) which is in agreement with the literature Benbi and Richter (2002). The higher K value could be due to the high of soil micro-organism and lower value of C/N ratio (10.60) and quality 34 activity of organic matter. The

Table-1 : Coefficient of determination (r^2) and standard error of the estimate (SE) of various kinetic models for cumulative NH_4-N in different treatments (organic sources).

S. No.	Treatment	T_1 FYM		T_2 Vermicompost		T_3 Press mud cake		T_4 Press mud compost		T_5 Poultry manure		T_6 Cocopit compost		T_7 Urban compost		T_8 Spent mushroom Compost		T_9 Control		Mean	
	Mathematical model	R	S.E.	R	S.E.	r	S.E.	R	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.
1.	Exponential Association	0.877	8.22	0.97	23.29	0.98	0.98	0.98	7.22	0.98	8.96	0.97	10.35	0.98	8.72	0.98	9.76	0.96	14.92	0.98	8.96
2.	Exponential	19.70	0.88	0.88	23.29	0.88	20.39	0.87	17.08	0.88	20.31	0.94	21.94	0.87	20.30	0.88	21.58	0.88	27.92	0.88	20.31
3.	Hyperbolic Decline	0.877	8.66	0.98	9.86	0.98	8.48	0.87	7.08	0.98	8.23	0.98	8.92	0.98	8.72	0.98	8.77	0.99	10.41	0.98	8.23
4.	Liner	0.877	9.77	0.97	10.93	0.97	0.97	0.97	8.29	0.98	9.37	0.98	10.09	0.97	9.86	0.97	10.09	0.97	14.15	0.98	9.37
5.	Modified liner	19.70	0.88	0.88	23.29	0.88	20.39	0.87	17.08	0.88	20.31	0.89	21.94	0.87	20.30	0.88	21.58	0.88	27.92	0.88	20.31
6.	Exponential Decline	19.70	0.88	0.88	23.29	0.88	20.39	0.87	17.08	0.89	21.94	0.89	21.94	0.87	20.30	0.88	21.58	0.88	27.92	0.89	21.94

Table-2 : Intercept (a), slope (b) and constant (q_0) values for the kinetic models for cumulative NH_4-N in different treatments (organic sources).

S. No.	Treatment		T_1 FYM	T_2 Vermicompost	T_3 Press mud cake	T_4 Press mud compost	T_5 Poultry manure	T_6 Cocopit compost	T_7 Urban compost	T_8 Spent mushroom Compost	T_9 Control
	Mathematical model	R	S.E.	R	S.E.	r	S.E.	R	S.E.	r^2	S.E.
1.	Exponential Association $y= a (1-exp^{-bx})$	a	229.18	251.55	216.41	239.20	278.22	204.39	264.48	223.22	178.31
		b	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01
2.	Exponential $Y=ae^{bx}$	a	44.30	49.35	42.72	47.76	70.05	40.42	51.27	43.01	36.47
		b	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02
3.	Hyperbolic decline $Y=q_0$ (1+ bx/a)-1/b	a	-5.28	-5.85	-4.81	-5.46	-6.27	-4.49	-4.79	-4.78	-4.77
		b	-1.31	-1.31	-1.31	-1.33	-1.32	-1.48	-1.34	-1.30	-1.32
		q_0	14.98	17.75	13.78	16.64	28.61	12.52	18.04	13.72	11.89
4.	Liner y= a+bx	a	22.18	25.43	21.22	24.53	42.36	19.79	25.99	21.06	18.54
		b	1.65	1.81	1.59	1.75	2.21	1.51	1.90	1.62	1.33
5.	Modified liner Y= ab x	a	44.30	49.35	42.72	47.76	70.05	40.42	51.27	43.01	36.47

Table-3: Coefficient of determination (r^2) and standard error of the estimate (SE) of various kinetic models for cumulative NO_3-N in different treatments (organic sources).

S. No.	Treatment	T_1 FYM		T_2 Vermicompost		T_3 Press mud cake		T_4 Press mud compost		T_5 Poultry manure		T_6 Cocopit compost		T_7 Urban compost		T_8 Spent mushroom Compost		T_9 Control		Mean	
	Mathematical model	R	S.E.	R	S.E.	r	S.E.	R	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.
1.	Exponential Association	0.9	19.3	0.9	22.43	0.97	16.05	0.97	20.52	0.96	26.78	0.98	13.33	0.97	23.81	0.97	16.9	0.97	12.1	0.97	19.04
2.	Exponential	0.9	40.3	0.9	40.37	0.89	31.28	0.90	36.76	0.90	43.35	0.89	28.85	0.90	41.42	0.89	33.3	0.89	25.5	0.90	35.70
3.	Hyperbolic Decline	0.9	12.8	0.9	14.56	0.99	11.20	0.99	13.02	0.99	14.39	0.99	11.49	0.99	14.38	0.99	11.2	0.99	9.90	0.99	12.56
4.	Liner	0.9	16.6	0.9	17.23	0.98	13.74	0.98	16.35	0.98	18.03	0.98	12.89	0.98	17.31	0.98	15.0	0.98	11.4	0.98	15.42
5.	Modified liner	0.8	35.9	0.9	40.37	0.89	31.28	0.90	36.76	0.90	43.35	0.89	28.85	0.90	41.42	0.89	33.3	0.89	25.5	0.90	35.20
6.	Exponential Decline	0.8	35.9	0.9	40.37	0.89	31.28	0.90	36.76	0.90	43.35	0.89	28.85	0.90	41.42	0.89	33.3	0.89	25.5	0.90	35.20

Table-4 : Intercept (a), slope (b) and constant (q_0) values for the kinetic models for cumulative NO_3-N in different treatments (Organic sources).

S. No.	Treatment		T_1 FYM	T_2 Vermicompost	T_3 Press mud cake	T_4 Press mud compost	T_5 Poultry manure	T_6 Cocopit compost	T_7 Urban compost	T_8 Spent mushroom Compost	T_9 Control
	Mathematical model										
1.	Exponential Association $Y=a\ (1-exp^{-bx})$	a	393.04	491.51	364.12	423.5	534.44	341.27	511.73	369.39	295.16
		b	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01
2.	Exponential $Y= aeb^x$	a	90.40	101.55	76.32	93.70	116.63	64.52	106.69	82.83	58.73
		b	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
3.	Hyperbolic Decline $y= q_0(1+bx/a)-1/a$	a	-6.76	-7.42	-6.60	-7.25	-8.25	-5.78	7.72	- 6.35	-6.02
		b	-1.40	-1.31	-1.33	-1.36	-1.33	-1.29	1.31	- 1.39	-1.31
		q_0	37.09	42.22	30.04	39.29	51.98	22.83	45.42	32.73	21.60
4.	Liner y= a=bx	a	52.57	56.51	42.00	53.92	68.24	32.48	60.18	47.18	30.72
		b	3.01	3.56	2.68	3.17	3.92	2.42	3.71	2.81	2.14
5.	Modifiedpower y=abx	a	90.40	101.55	76.32	93.70	116.63	64.52	106.69	82.83	58.73
		b	1.01	1.02	1.02	1.01	1.01	1.02	1.01	1.01	1.02
		q_0	90.40	101.55	76.32	93.70	116.63	64.52	106.69	82.83	58.73

Table-5 : Coefficient of determination (r^2) and standard error of the estimate (SE) of various kinetic models for cumulative NH_4-N+ NO_3-N in different treatments (organic sources).

S. No.	Treatment	T_1 FYM		T_2 Vermicompost		T_3 Press mud cake		T_4 Press mud compost		T_5 Poultry manure		T_6 Cocopit compost		T_7 Urban compost		T_8 Spent mushroom Compost		T_9 Control	
	Mathematical model	R	S.E.	R	S.E.	r	S.E.	R	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	S.E.	r^2	
1.	Exponential Association	0.97	28.10	0.97	32.58	0.97	24.51	0.97	30.08	0.9	21.4	0.97	34.33	0.97	34.3	0.977	34.3	0.977	
2.	Exponential	0.89	56.17	0.90	62.27	0.89	51.56	0.89	58.31	0.8	48.5	0.90	64.65	0.90	64.6	0.90	64.6	0.89	
3.	Hyperbolic Decline	0.99	21.04	0.99	23.38	0.99	19.90	0.99	21.78	0.9	20.1	0.99	24.14	0.99	24.1	0.99	24.1	0.99	
4.	Liner	0.97	25.97	0.98	27.24	0.98	23.58	0.98	26.41	0.9	22.6	0.98	28.15	0.98	28.1	0.98	28.1	0.98	
5.	Modified liner	0.89	56.17	0.90	62.27	0.89	51.56	0.89	58.31	0.8	48.5	0.90	64.65	0.90	64.6	0.90	64.6	0.89	
6.	Exponential Decline	0.89	56.17	0.90	62.27	0.89	51.56	0.89	58.31	0.8	48.5	0.90	64.65	0.90	64.6	0.90	64.6	0.89	

Table-6 : Intercept (a), slope (b) and constant (q_0) values for the kinetic models for cumulative NH_4-N+NO_3-N in different treatments (organic sources).

S. No.	Treatment	T_1 FYM	T_2 Vermicompost	T_3 Press mud cake	T_4 Press mud compost	T_5 Poultry manure	T_6 Cocopit compost	T_7 Urban compost	T_8 Spent mushroom Compost	T_9 Control
1.	Exponential Association $Y = a\ (1-e\ xp^{-bx})$	A	619.95	742.97	580.46	662.19	808.98	545.24	776.02	776.02
		B	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.01
2.	Exponential $Y = ae^{bx}$	A	134.64	150.88	119.02	141.43	186.68	104.95	157.93	157.93
		B	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02
3.	Hyperbolic Decline $Y = q_0(1+bx/a)^{-1/b}$	A	-6.26	-6.87	-5.91	-6.61	-7.47	-5.25	-7.00	-7.00
		B	-1.36	-1.31	-1.33	-1.35	-1.38	-1.31	-1.31	-1.31
		q0	52.08	59.95	43.79	55.91	80.54	35.32	63.4	63.41
4.	Liner $y = a+b^x$	A	74.75	81.91	63.22	78.45	110.61	52.26	86.1	86.17
		B	4.66	5.37	4.27	4.92	6.14	3.93	5.61	5.61
5.	Modified liner $y = ab^x$	A	134.64	150.88	119.02	141.43	186.68	104.95	157.9	157.93
		B	1.01	1.02	1.02	1.01	1.01	1.02	1.02	1.02
6.	Exponential Decline $Y=q_0e^{-x/a}$	A	-67.70	-66.51	-66.44	-67.45	-69.40	-65.08	-66.5	-66.58
		q0	134.64	150.88	119.02	141.43	186.68	104.95	157.9	157.93

variation of potential mineralization nitrogen (N_0) was observed in all the sources of organic manure. It might be because of organic matter has heterogeneous compound with varying degree of degradability and fraction of organic nitrogen present in the organic manures. The exactly similar rate constant value (0.01) was recorded in all the sources of organic manure including control treatment except poultry manure (Table-2). The lowest potential minaralizable N (178.31 mg kg^{-1}) was observed in control treatments. All the organic sources recorded higher potential minaralizable nitrogen as compared with control. Exactly similar value of rate constant has been observed in exponential association, exponential, hyperbola decline and modified power mathematical models in case of all the treatment except poultry manure. These results are in close agreement with the results of Deans *et al.,* (1986). The results showed that rate is not linear with time. The slight variation was observed in linear and exponential decline models in all the sources of organic manures. The results obtained in this study and the numerical value of r^2 and SE and graphical analysis of the models, it is possible to conclude that hyperbolic decline and exponential association models are the best to describe the mineralization process of cumulative ammoniacal N to be released to the soil to became available to plants by the addition of various sources of organic manures in inceptisol.

Coefficient of determination for NO_3-N : Among the various mathematical models total six mathematical models were recorded the higher value of coefficient of determination (r^2) by using curve expert professional 2.4 software, in release of nitrate nitrogen in inceptisol soil (Table-3 and). It indicates that the six models can be used for predicting the release of NO_3-N at various days of incubation. Application of N @ 100 mg N kg^{-1} in inceptisol soil through FYM, vermicompost, press mud cake, press mud compost, poultry manure, coco-pit compost, urban compost, spent mushroom compost and control treatments recorded exactly similar and higher value of coefficient of determination (r^2 = 0.99) in hyperbola decline in case of release of NO_3-N. All the treatments recorded similar value of coefficient of determination (r^2 = 0.98) in linear mathematical model. The mathematical model viz., modified power and exponential decline observed exactly similar value of coefficient of determination (r^2 = 0.89) in all the treatments. The result showed that the application of N @ 100 mg kg^{-1} through all the sources of organic manures recorded. Slightly lower value of coefficient of determination (r^2 = 0.90) observed in poultry manure in modified power and exponential decline as compared with rest of the models. The control treatments observed the lowest standard error in all the models as compared with all the sources of organic manures. Among the sources of organic manures the poultry manure registered the highest value of standard error in the entire models used which was followed by urban compost and vermicompost. Among the six models hyperbolic model recorded the lowest value of standard error. The data of r^2 value are in agreement with the observation of Simard and N?dayegamiye (1992), Wijanarko and Purwanto (2016). The results indicate that the either hyperbolic decline or linear model is the best fit for predicting the release of NO_3-N in soils incorporated with all the sources of organic manures and control treatment.

Kinetic parameters of N mineralization for NO^3-N : The highest potential mineralization nitrogen N0 (534.44 mg kg^{-1}) was observed by the addition of poultry manure in exponential association model as compared with rest of the treatments and it was higher than mean measured value (396.67 wk^{-1}) and rate constant (0.02 wk^{-1}) which is in agreement with the 38 literature Benbi and Richter (2002). The higher No value could be due to the high activity of soil micro-organism and lower value of C/N ratio (10.60) and quality of organic matter. The variation of potential mineralization nitrogen (N0) was observed in all the sources of organic manure. It might be because of organic matter has heterogeneous compound with varying degree of degradability and fraction of organic nitrogen present in the organic manure as well as content of total N and C/N ratio. The exactly similar rate constant value (0.01) was recorded in all the sources of organic manure including control treatment except poultry manure, vermicompost, press mud compost and spent mushroom compost in exponential association model (Table-4). The lowest potential minaralizable N was observed in control treatments in all the models. All the organic sources recorded higher potential minaralizable nitrogen as compared with control. More or less value of rate constant (b) has been observed in exponential association, exponential and modified power mathematical models in all the treatments. These results are in close agreement with the results of Deans et al., (1986). The slight variation was observed in linear and exponential decline and hyperbolic decline models in all the sources of organic manures and control treatments. The negative values of rate constant (b) were observed in hyperbola decline and exponential decline models in all the treatments. The results obtained in this study and the numerical value of r^2 and SE and graphical analysis of the models, it is possible to conclude that hyperbolic decline and exponential association models are the best to desirable the mineralization process of cumulative nitrate N to be released to the soil to became available to plants by the addition of various sources of organic manures in Inceptisol.

Coefficient of determination : NH4-N +NO3-N Total six mathematical models were recorded the higher value of coefficient of determination (r2) by using curve expert professional 2.4 software. In release of nitrate nitrogen in inceptisol soil (Table-5). It indicated that the six models can be used for predicting the release of NH4-N +NO3-N at various days of mineralization. Application of N @ 100 mg N kg^{-1} in inceptisol soil through FYM, vermicompost, press mud cake, press mud compost, urban compost, coco-pit compost, poultry manure, spent mushroom compost and control treatments recorded exactly similar and higher value of coefficient of determination (r2 =0.98) in exponential association, hyperbola decline and linear mathematical models. However slightly lower value of coefficient of determination (r 2 =0.96) observed in poultry manure in exponential association model. The r2 value is generally used for estimating equation, r^2 value closer to 1.00 indicate good equation Wijanarko and Purwanto (2016). In general higher value of coefficient of determination and lower value of standard error could be used for judging the best fit mathematical models. The data from Table 18 showed that in exponential association, hyperbola decline and linear mathematical models were quite superior as compared with exponential, modified power and exponential decline in all the treatments. Among the six models hyperbolic model recorded the lowest value of standard error. All the organic sources and control observed exactly similar value of r^2 and standard error except FYM treatment in exponential, modified power and exponential decline mathematical models. The data of r^2 agreement with the observation of Simard and N-dayegamiye (1992), Wijanarko and Purwanto (2016).

Kinetic parameters of N mineralization for NH_4-N+NO_3-N : The highest potential mineralization N, N0 (808.98 mg/kg) was observed by the addition of poultry manure in exponential association model as compared with rest of the treatment and it was higher than mean measured value (619.91 wk^{-1}) which is in agreement with the literature Benbi and Richter (2002) . The higher N value could be due to the high quantity of soil micro-organism and lower value of C/N ratio (10.60) and quality of organic matter. The variation of potential 42 mineralization nitrogen (N0) was observed in all the sources of organic manure. It might be because of organic matter has heterogeneous compound with varying degree of degradability and fraction of organic matter present in the organic manure. The exactly similar rate constant value (0.01) was recorded in all the sources of organic manure including control treatment except poultry manure, vermicompost, press mud cake, press mud compost, FYM, coco-pit compost and urban compost in linear model (Table 6). The least potential minaralizable N (776.02 mg kg-1) was observed in urban compost spent mushroom compost and control treatments. All the organic sources recorded higher potential minaralizable N as compared with control. Exactly similar value of rate constant has been observed in exponential association, exponential, hyperbola decline and modified power mathematical models in all the treatment except poultry manure, vermicompost, press mud cake, press mud compost, FYM, coco-pit compost and urban compost in linear model. These results are in close agreement with the results of Deans et al. (1986). The results showed that rate constant is not linear with time. The results obtained in this study and the numerical value of r2 and SE and graphical analysis of the models. It is possible to conclude that hyperbolic decline and exponential association models are the best to desirable the mineralization process of cumulative ammoniacal + nitrate N be released to the soil to become available to plants by the addition of various sources of organic manures in inceptisol.

Coefficient of determination : Zero order, first order and second order for NH_4-N, NO_3-N and NH_4-N + NO_3-N: Data pertaining to the Coefficient of determination of zero order, first order and second order kinetic model tested for periodical NH_4-N, NO_3-N and NH_4-N+NO_3-N release in inceptisol soils of College of Agriculture, Pune after additions of organic manures in Table 19 to 21, respectively. The above three kinetic equations were used to describe the kinetics of N Mineralization in inceptisol soil after addition of N @ 100 mg N kg^{-1} through various organic manures. The results of statistical analysis obtained by plot, which were fits between the equations and experimental data and calculated coefficient of determination (r^2) release constant (a and b). The result showed that by using a zero order kinetic equations recorded the higher r^2 values (r^2 =0.974 to 0.984) in all the treatments in respect of NH_4-N + NO_3-N as compared with first order and second order kinetic equations. Zero order and first order kinetic equations are more suitable to describe N mineralization than second order kinetic equation. The Zero and first order kinetic equations recorded higher r^2 value than second order equation has been recorded by the addition of organic manures in Typic Hapludults by Wijanarko and Purwanto (2016). Dou et al. (1996) also recorded similar result of N mineralization in respect of zero order and first order kinetic equation. Similar trend was also recorded in release of NH_4-N and NO_3-N (Table 19 and 20). It indicates that among the three equations zero order equation could be used for predicting the release pattern of forms of N released in inceptisol by the addition of organic manures. However, the second order equation is inferior as compared with zero and first orders model as it records the lower value of r2 in release

of forms of N by the addition of various sources of organic manures.

Mineralization N (NH_4-N, NO_3-N and NH_4-N + NO_3-N) : release constants (a and b): The constants a and b of each equation represent the intercept and the slope of the linear curves resulting from plotting the mineralized N vs. time (Table-1 to 2) mineralization rate constants were calculated for Inceptisol soils using the zero-order, first-order and second-order equations by the addition of N @ 100 mg kg^{-1} . The constant b mirrors the release rate of the mineralization of nitrogen(Pedra et al., 2011). The highest rate of mineralization (b= 6.14) and intercept (110.610) were 46 observed due to the addition of poultry manure for zero- order kinetic equations by the addition of poultry manure as compared with rest of the treatments and first order and second order equations and it was followed by vermicompost (Table 21). It attributes to the higher content of nitrogen in the original material. Control treatment observed the lowest values of rate constant and intercept in zero order equation. More or less similar rate constant values (-0.0001 to -0.0002) has been recorded in all the sources of organic manure and control treatment in case of second order mathematic model and these values were not affected by the addition of organic matter (Table 21). If higher negative values of b could be indication of inadequate mineralized N release from clay complex. The negative value of rate constants (b values) for potassium chloride was also reported by Ghiri and Jaberi (2013) in the release of kinetics of potassium. The much variation in intercept and rate constant was noticed in the zero order equation which was not observed in the first and second order equations. It might be because of the soil taxonomy, clay mineralogy, pH, CaCO3, adsorption, desorption, diffusion of the soils, and mathematical equations tested and quality of organic manures to be used for crop production. These results are in agreement with results obtained by Wijanarko and Purwanto (2016) but the higher values of rate and intercept was observed in this study. This might be because of initial rate of NH4-N released (a and b parameters) are dependent on clay content in soil. The values of the rate constant (b values) obtained from soil samples after addition of various sources of organic manure could be used in combination with routine soil tests for predicting crop requirement for the N availability to crops. The lower b values of second-order (also referred as rate constant) were observed as compared with the values .The second-order equation (1/y = a + b x) had the least fit for predicting the mineralization rate. The results showed that the zero order equation constants also adequately described the kinetics of nitrogen amended with the various sources of organic manure in Inceptisol. The highest rate of mineralization (b= 6.14) and intercept (110.61) were observed due to the addition of poultry manure for zero-order mathematical model by the addition of poultry manure as compared with rest of the treatments.

Kinetics of nitrogen mineralization:

Coefficient of determination : NH^4-N: The six mathematical models viz., Exponential association, Exponential, Hyperbolic decline, linear, Modified power , Exponential decline were recorded the higher value of coefficient of determination (r2) by using curve expert professional 2.4 software in case of cumulative release of NH4-N. Application of N @ 100 mg N kg-1 in inceptisol soil through FYM, vermicompost, press mud cake, press mud compost, urban compost, coco-pit compost, poultry manure, spent mushroom compost and control treatments recorded exactly similar and higher value of coefficient of determination (r2 =0.98) in exponential association, hyperbola decline and linear mathematical models. The exponential association, hyperbola decline and linear mathematical models were quite superior as compared with exponential, modified power and exponential decline in all the treatments in cumulative released of NH4-N. All the organic sources and control treatment observed exactly similar value of r2 and standard error except FYM treatment in exponential, modified power and exponential decline mathematical models.

NH_4-N + NO_3-N : Application of N @ 100 mg N kg^{-1} in inceptisol soil through FYM, vermicompost, press mud cake, press mud compost, urban compost, coco-pit compost, poultry manure, spent mushroom compost and control treatments recorded exactly similar and higher value of coefficient of determination (r^2=0.98) in exponential association, hyperbola decline and linear mathematical models in case of release of NH_4-N +NO_3-N. However, slightly lower value of coefficient of determination (r^2=0.96) observed in poultry manure in exponential association model. All the organic sources and control observed exactly similar value of r^2 and standard error except FYM treatment in exponential, modified power and exponential decline mathematical models.

Kinetic parameters of N mineralization:

NH_4N : The highest potential mineralization of ammoniacal nitrogen N0 (278.22 mg kg^{-1}) was observed by the addition of poultry manure in exponential association model as compared with rest of the treatment and it was higher than mean measured value (223.24 wk^{-1}) and rate constant (0.02 wk^{-1}).The variation of potential mineralization nitrogen (N0) was observed in all the sources of organic manure The lowest potential minaralizableN (178.31 mg kg^{-1}) was observed in control treatments. All the organic sources recorded higher

potential minaralizablenitrogen as compared with control. Exactly similar value of rate constant has been observed in exponential association, exponential, hyperbola decline and modified power mathematical models in case of all the treatment except poultry manure.

NO_3-N : The highest potential mineralization nitrogen N0 (534.44 mg kg^{-1}) was observed by the addition of poultry manure in exponential association model as compared with rest of the treatments and it was higher than mean measured value (396.67 wk^{-1}) and rate constant (0.02 wk^{-1}). The variation of potential mineralization nitrogen (N0) was observed in all the sources of organic manure. The lowest potential minaralizable N was observed in control treatments in all the models. All the organic sources recorded higher potential minaralizable nitrogen as compared with control. More or less value of rate constant (b) has been observed in exponential association, exponential and modified power mathematical models in all the treatments.

NH_4-N +NO_3-N : The highest potential mineralization, N0 (808.98 mg kg^{-1}) was observed by the addition of poultry manure in exponential association model as compared with rest of the treatment and it was higher than mean measured value (619.91 wk^{-1}) The exactly similar rate constant value (0.01) was recorded in all the sources of organic manure including control treatment except poultry manure, vermicompost, press mud cake, press mud compost, FYM, coco-minaralizable N as compared with control. Exactly similar value of rate constant has been observed in exponential pit compost and urban compost in linear model. The least potential minaralizable N (776.02 mg kg_1) was observed in urban compost spent mushroom compost and control treatments. All the organic sources recorded higher potential association, exponential, hyperbola decline and modified power mathematical models in all the treatment except poultry manure, vermicompost, press mud cake, press mud compost, FYM, coco-pit compost and urban compost in line association, exponential, hyperbola decline and modified power mathematical models in all the treatment except poultry manure, vermicompost, press mud cake, press mud compost, FYM, coco-pit compost and urban compost.

Conclusions

The numerical value of r^2 and SE and graphical analysis of the models, it conclude that hyperbolic decline and exponential association models are the best to describe the mineralization process of cumulative NH_4-N to be released to the 56 soil to become available to plants by the addition of various sources of organic manures in Inceptisol-5. The results concluded that hyperbolic decline and exponential association models are the best to describe the mineralization process of cumulative NO_3-N to be released to the soil to become available to plants by the addition of various sources of organic manures in Inceptisol. The lowest potential mineralizable N was observed in control treatments in all the models for NO_3-N. However, all the sources recorded higher potential mineralizable nitrogen as compared with control. More or less value of rate constant (b) has been observed in exponential association, exponential and modified power mathematical models in all the treatments. 6. The numerical value of r^2 and SE and graphical analysis of the models. It concluded that hyperbolic decline and exponential association models are the best to desirable the mineralization process of cumulative NH^4-N + NO^3 N be released to the soil after addition of various sources of organic manures.

References

1. Arps, J.J. , (1944) Analysis of decline curv. Issued as T.P. 1758 in *Petrolium Technology, September.*
2. Benbi, D. K., and Richter, J., (2002). A critical review of approaches to modeling nitrogen mineralization. *Biology and fertility of soils* 36: 168-183.
3. Cabrera, M.L., Kissel, D.E. and Vigil, M.F. (2005). Nitrogen mineralization from organic residues. *Journal of Environmental Quality* 34: 75-79.
4. Hazewinkel, M., ED. (2001). "Linear equation". Encyclopedia of Mathematics, Springer, ISBN 978-1-55608-010-4.
5. Kumar, A., and Consul, P.C. (1979) Negative Moments of a Modified Power Series Distribution and Bias of the Maximum Likelihood estimator Communications in Statistics, 33(2): 151–166.
6. Panse, V. G. and Sukhatme, P.V. (1967) Statistical methods for agricultural workers. ICAR, New Delhi, 2nd Ed. pp. 96.
7. Pedra, F., Polo, A., Carranca, C., Ribeiro, A. and Domingues, H., (2011). Kinetics model fitted to nitrogen mineralization potential in soil amended with municipal compost and urban sewage sludge. Dynamic soil, Dynamic plant, Global science books.
8. Stanford, G.and Smith, S.J. (1972). Nitrogen Mineralization Potentials of Soils. *Soil science Society of America Journal*, 36, 465–472.
9. Martin, H.W. and Sparks, D.L. (1983). Kinetics of nitrogen release from two coastal plain soils. *Soil Science Society of America Journal,* 47: 883-887.
10. Wijanarko, A. and Purwanto, B.H., (2016). Comparison of two kinetics models for estimating N mineralization affected by different quality of organic matter in Typic Hapludults. Journal of degraded and mining land management. ISSN:2339-076x(e); 2502-2458(p), number 3: 577-583.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 753-755 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Awareness of Rural People about Covid-19 in Namkum Block of Ranchi District of Jharkhand

Sudhanshu[1], Alan Dan[1], Shaon Chakraborty[2], Abhinav Singh[3] and Virendra Pratap[3]

[1]*Department of Agriculture Extension Education, SHUATS, Prayagraj, U.P.*

[2]*Krishi Vigyan Kendra, Deoghar, Jharkhand*

[3]*Ddepartment of Extension Education, ANDUAT, Kumarganj, Ayodhya, U.P.*

Corresponding Author Email : 24101995tiwari@gmail.com

Abstract

In recent days, Covid-19 has emerged as a significant threat to human beings. Keeping in mind the need for spreading awareness among rural people about COVID-19, a study was carried out in the Namkum block of the Ranchi district of Jharkhand from 1st April to 30th July 2020. A total of 160 rural people were selected from five different villages of Namkum block to assess the awareness in the minds of people about Covid-19. It was observed that the maximum number of respondents (63.65 %) had a medium level of awareness about the Covid-19 warning followed by a low-level percentage (19.69%) and a high-level percentage (16.66%) of awareness. It was seen that the rural people did not follow the guidelines set by the central as well as state governments due to low levels of proper knowledge about the hazards of COVID. We saw a prevalence of negative attitudes towards COVID-19 among these rural people. However, a significant association of awareness in the education level of respondents ($p < 0.05$) was observed. Thus, we see the existence of a need to impart knowledge and develop positive attitudes among the rural people towards COVID-19.

Key words : *Awareness, Covid-19, knowledge, attitude, hazards.*

Introduction

The novel coronavirus disease 2019 (COVID-19) caused by Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was initially diagnosed in Wuhan, Hubei Province (Mainland China). It has already started pandemic proportions, affecting the whole world in the minuscule of time [1,2,3]. As of April 30, 2020, >3.3 million cases of COVID19 cases had been confirmed resulting in 234,139 deaths worldwide [4].India reported its first COVID-19 case on January 30, 2020, and the numbers began to rise in late March 2020, ("Johns Hopkins Coronavirus Resource Center," 2020)[5]. Albeit at a low rate, which may be attributed to several government policies including stopping all international flights and implementing a nation-wide lockdown at an early stage of the pandemic.

To curb the surge in COVID cases, the Indian Ministry of Health and Family Welfare (MOHFW) along with state-level health departments has been providing information on COVID-19 through various ways like sub-national communication channels. The government has also launched a mobile app, Aarogya-Setu for spreading important information regarding this deadly disease. Despite these many measures, rural areas are witnessing an increase in the number of cases due to poor dissemination of information and migrant laborers.

Moreover, the lockdown in the wake of COVID-19 has disrupted economic activities and the supply chains significantly. In Jharkhand 371 new Covid-19 cases reported till 31 July 2020. In the Namkum block of Ranchi, According to Jharkhand Rai University, Namkum, Ranchi there are 30 t0 40 NSS volunteers working under the guidance of university and Unnat Bhart Abhiyan in the Namkum block of Ranchi to look into the grave situation of COVID in a rural area. They approached some of the rural areas like Namkum, Rajaulatu, Palandu, Sidraul& Rampur to spread awareness about COVID-19, impart them valuable knowledge about the importance of wearing a mask, how social distancing plays an important role in preventing the spread of COVID-19, and how to make yourself strong. They are also helping rural people in the installation and usage of the Aarogya-Setu app.

The Population Council of India is also planning to disseminate a mobile phone-based awareness among rural areas with the help of these NSS volunteers &UnnatBhart Abhiyan along with other non- governmental organizations. The present study was undertaken with the following objectives :

To study the socio profile of person effect by COVID 19

To study the knowledge about covid-19 or other virus was not adequate among the respondents

Research Methodology

Table-1: Socio-demographic characteristics of the respondents. (N=160)

S. No.	Characteristics	Frequency	Percentage
1.	**Age in Years**		
	18-28	55	34.38
	29-38	71	44.37
	39-48	34	21.25
2.	**Sex**		
	Male	87	54.37
	Female	73	45.63
3.	**Type of House**		
	Pakka	87	54.17
	Kacha	73	45.83
4.	**Education**		
	Illiterate	09	05.62
	Literate	104	65.00
	I.Sc. & Above	47	29.38
5.	**Religion**		
	Hindu	102	63.33
	Muslim	08	05.00
	Christian	51	31.67
6.	**Socio Economic Status**		
	Class-I		29.17
	Class-II		47.50
	Class-III		19.17
	Class-IV		04.16

The study was conducted in Namkum block of Ranchi district of Jharkhand. The selection was done purposely because the block is dominated by Scheduled caste & Scheduled tribe. Here, the incomeof residents mostly dependen on agriculture, allied sectors & labours. One hundred sixty respondents were selected randomly for this study. A pre tested and semi-structured questionnaire was developed to collect information and distributed to all selected respondent with proper oral instructions to answer the questions. In order to maintain their confidentiality, the respondents were asked not to mention their names on the questionnaire. In order to combine the various responses relating to awareness, scores were assigned to each response. A score of 1 was given to each correct response and 0 to each incorrect response. Data entry and analysis was made by using Statistical Package for Social Science (SPSS) software (Version 20.0). Collected data were analyzed with the application of appropriate statistics.

Results and Discussion

It is revealed from the Table-1 that majority of the respondents (61.67%) were male and 38.33 per cent were female, 44.17 per cent were of the age 28-38 years, followed by 34.17 per cent between the age group of 18-28 years and 21.66 per cent between 39-48 years. Most of the respondent's (54.17%) had pakka house followed by a short percentage holding kacha house (45.83%).

It was observed from table 1 that 65.00 per cent respondents were literate, 29.17 per cent had passed 10+2 and above, only 5.83 per cent respondents were found to be illiterate. Majority of the respondents (63.33%) were Hindu followed by 31.67 per cent being Christian and only 5.00 per cent respondents were Muslim. Similarly, 29.17 per cent of the respondents belonged to Socio-economic class I, followed by 47.50 per cent Class-II, 19.17 per cent Class-III and only 4.16 per cent belonging to Class IV.

The table-2 shows that 77.33 per cent respondents are partially and 26.67 per cent fully aware about COVID-19, 55 per cent respondents reported that there were some noticeable changes in village condition in the past few months. It was observed that 47.50 per cent partially considered COVID-19 as a serious problem whereas 38.33 completely considered it as serious problem, 45.84 per cent partially and 40.83 per cent were fully aware about rapid increases in Covid-19 patients. Majority of the respondents (64.17%) were fully aware about change in economic condition of rural people due to COVID-19 whereas 35.83 per cent respondents were partially aware about this change. It was also found that majority (63.33%) per cent of respondents were fully aware and 32.50 per cent partially aware about COVID-19 effects on social rituals. whereas 42.50 per cent partially and 40 per cent fully were aware about COVID-19 affects the rural life style. Some respondents also found to have least awareness about COVID-19 (15.83%), COVID-19 was considered as a serious problem (14.17%), COVID-19 affects social rituals (17.50%). Overall, it was found that majority of the respondents are partially aware about COVID-19 and its effects on human health and natural livelihood of rural people.

Sources of information regarding global warming :

Sl. No.	Source	Frequency	Percentage
1	Television	69	43.33
2	Radio	39	24.17
3	Internet	31	19.17
4	Friends	21	13.33
	Total	160	100

The data revealed in the above table is about the main sources of information for COVID-19 were television (43.33%), radio (24.17%), internet (19.17%) and friends (13.33%).

The table-3 communicates that there is positive and significance correlation between the age, programme/class with the level of awareness of the respondents regarding COVID-19. It may be due to the

Table-2 : Distribution of respondents by awareness towards Global warming. (N =160)

Sl. No.	Awareness	Fully aware	Partially aware	Least aware
1.	Familiarity about COVID-19	42 (26.67)	118 (73.33)	-
2.	Observed the village condition change in few months	88 (55.00)	47 (29.17)	25 (15.83)
3.	COVID-19 is consider as serious problem.	62 (38.33)	76 (47.50)	12 (14.17)
4.	Rapid increases in Covid-19 patient	65 (40.83)	73 (45.84)	22 (13.33)
5.	Economic condition of rural people change	103 (64.17)	57 (35.83)	-
6.	COVID-19 affects social rituals.	101 (63.33)	52 (32.50)	7 (4.17)
7.	COVID-19 affects the rural life style	64 (40.00)	68 (42.50)	28 (17.50)

Figure shows in parenthesis are percentage.

Table-3 : Relationship with the level of awareness and sociodemographic variables. Socio-demographic variables.

Sl. No.	Independent variable	Correlation coefficient r value
1.	Age	0.503**
2.	Sex	0.068
3.	Type of house	0.102
4.	Class/Programme	0.469**
5.	Religion	0.027
6.	Socio-Economic status	0.663**

**Denotes one percent significance level R^2=0.64

fact that majority of the respondents were 28-39 years and most of the respondents were literate or education level 10+ 12 or above. Thus, it indicated that the age and programme /class have positive bearing with the level of awareness of the respondents. Hence, the null hypothesis (H) was rejected and alternative hypothesis was accepted. The socio-economic status (on the basis of family income) of the respondents has been observed statistically positive and significantly correlated with awareness level of the respondents. Thus, the null hypothesis (Ho) was rejected and alternative hypothesis was accepted. Similar finding is also reported as.

Conclusions

It is concluded from the present study that most of the rural people were aware about the COVID-19. Their level of awareness towards the COVID-19 was average. Education and knowledge about COVID-19 or other virus was not adequate among the respondents. To further improve their existing awareness, it is essential to conduct periodic seminar and workshop on the topic. Particularly, the respondents may learn and follow positive meanings to control the consequences of COVID-19.

References

1. Bacow, L. 2020. COVID-19 – Moving classes online, other updates. [Community Message]. Harvard University, June17. https://www.harvard.edu/covid-19-moving-classes-online-other-updates [Google Scholar].
2. Blumenstyk, G. 2020. "Why Coronavirus Looks like a 'Black Swan' Moment for Higher Ed." *Chronicle of Higher Education*. Accessed 10 June 2020. https://www.chronicle.com/article/Why-Coronavirus-Looks-Like-a/248219?cid=cp275
3. Lederman, D. 2020. "Preparing for a Fall without In-person Classes." *Inside Higher Ed*. Accessed 17June2020.https://www.insidehighered.com/digital-learning/article/2020/04/01/preparing-quietly-fall-semester-without-person-instruction
4. Michael, P. A., and Murphy. 2020. "COVID-19 and Emergency eLearning: Consequences of the Securitization of Higher Education for Post-pandemic Pedagogydoi:10.1080/ 13523260.2020.1761749.
5. Oman News Agency. 2020. May 7. https://omannews.gov.om/NewsDescription/ArtMID/392/ArticleID/12656/HMs-Attention-A-Major-Factor-of-Success-in-Addressing-Pandemic-Impacts- Health-Minister
6. S.Q.U. Portal. 2019. June 30. Accessed 6 October 2020. https://www.squ.edu.om/Portals/0/DNNGallery/uploads/2019/6/30/pdf
7. Times of Oman. 2020. April 14. https://t.timesofoman.com/2020/04/15/school-must-go-on-e-learn ing-during-the-time-of-covid-19/

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 756-761 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Trend Analysis of Temperature and Precipitation over Beed District of Marathwada Region, Maharashtra Using RClimDEX Model

Sujeet Deshmukh[1], D. Ushasri[2], Dhanaji Sawant[1] and Dhiraj Gardi[3]
[1]*College of Agriculture, Pune, MPKV, Rahuri, Maharashtra*
[2]*Krishi Vigyan Kendra, Malyal, Mahabubabad, Maharashtra*
[3]*College of Agriculture, Paniv, Maharashtra*

Abstract

The objective of this study is to assess the change trends of daily temperature extremes and precipitation in Beed district, Maharashtra during the period between 1981 and – 2010. The annual rainfall is highly variable, ranging from less than approximately 700 mm–800 mm and its distribution is unevenly spread between all the tahsils locations. Climate change threatens to increase air temperatures and evapotranspiration, increase the risk of heat waves associated with drought. Beed was particularly affected by warm extremes than cold extremes based on daytime indices. Precipitation indices do not illustrate statistically significant trends across the whole district. The annual trends of decadal precipitation events showed that there is >= 1mm rainfall and simple daily intensity index (SDII) has significant trend all over Beed district. From 1981 to 2010 cold days and nights has decreased, while over the same period the incident of extreme hot days and nights has increased. The temperature extremes show patterns consistent with warming over most of the analysed indices. The overall study over Beed district shows that decrease in rainfall trend.

Key words : *Extremes, index, variability, precipitation and temperature.*

Introduction

Considering knowledge of past climates to qualify the nature of existing changes has become a concern of growing importance during the last decades. As the science of climate change proceed, detection and attribution studies ventured into more sophisticated statistical analyses that examined complex patterns of climate change. The anthropogenic cause of current climate change has been identified by researchers and is a widely acknowledged issue in the political sphere during the last decades. The different emissions of greenhouse gases linked mainly with industrial production increase the global mean temperature via the greenhouse effect, affect the whole Earth system (Lavinia, 2011). These changes imply risks for human lives as well as natural ecosystems. In different parts of the world, climates are characterized by their variability which affects many sectors. Study and understanding of changes in extreme precipitation events is of great importance because of their large impact on society and ecosystems compared to changes in mean precipitation (Hartmann et al., 2013). The present study was planned in order to analyse the trends and variability in the extreme ends of the daily minimum and maximum temperature and rainfall distribution over the state and to strategize the resilient resource management for climate change effect mitigation in agriculture.

Materials and Methods

Location and Extent : Marathwada is located in the middle and south eastern portion of Maharashtra State. Godawari river basin is covered in northern part of Marathwada region and southern part of Marathwada region is covered by Krishna river basin. Marathwada region lies between 17° 35' to 20 ° 41' North Latitude and 70° 40' to 78° 16' East Longitude.

Aurangabad District is located mainly in the Godavari River Basin. It is located between latitude 18° 59' 31.2432'' N and longitude 75° 46' 34.0968'' E

The RClimDex model is developed and maintained by Xuebin Zhang and Feng Yang. It was designed to provide a user friendly interface to compute indices of climate extremes. It computes all 27 core indices recommended by the CCl/CLIVAR Expert Team for Climate Change Detection Monitoring and Indices (ETCCDMI) as well as some other temperature and precipitation indices with user defined thresholds.

Installation and running of R : R is a language and environment for statistical computing and graphics. It is a GNU implementation of the S language developed by John Chambers and colleagues at Bell Laboratories (formerly AT & T, now Lucent Technologies). S-plus provides a commercial implementation of the S language

How to install R : RClimDex requires the base package of R and graphic user interface. The installation of R

Table-1 : Summary information of the used precipitation Indices.

Index	Descriptive Name	Definition	Units
PRCPTOT	wet day precipitation	annual total precipitation from wet days	mm
SDII	simple daily intensity index	average precipitation on wet days	mm/d
CDD	consecutive dry days	maximum number of consecutive dry days	days
CWD	consecutive wet days	maximum number of consecutive wet days	days
R10mm	heavy precipitation days	annual count of days when RR >= 10	days
R20mm	very heavy precipitation days	annual count of days when RR >= 20	days
Rnnmmb	number of days above nn mm	Annual count of days when PRCP >=nn mm, nn is user defined threshold	days
R95p	very wet day precipitation	annual total precipitation when RR > 95th percentile of daily rainfall	mm
R99p	extremely wet day precipitation	annual total precipitation when RR > 99th percentile of daily rainfall	mm
RX1day	maximum 1-day precipitation	annual maximum 1-day precipitation	mm
RX5day	maximum 5-day precipitation	annual maximum consecutive 5-day precipitation	mm

A wet day is defined when RR >= 1 mm and a dry day when RR< 1 mm. All indices are calculated annually from January to December; In this study nn is 25mm; RR is the Daily Rainfall Rate.

Table-2 : Summary information of the used Temperature Indices.

Index	Descriptive Name	Definition	Units
SU25	hot days	annual count when TX > 25°C	days
FD10	frost days	annual count when TN < 0°C	days
ID20	cold days	annual count when TX < 20°C	days
DTR	diurnal temperature range	monthly mean difference between TX and TN	°C
TR20	warm nights	annual count when TN > 20°C	days
TXx	hottest day	monthly highest TX	°C
TNx	hottest night	monthly highest TN	°C
TXn	coolest day	monthly lowest TX	°C
TNn	coolest night	monthly lowest TN	°C
SU40	Hot days	annual count when TX > 25°C	%
TX10p	cool day frequency	percentage of days when TX < 10th percentile of 1981-2010	%
TN90p	hot night frequency	percentage of days when TN > 90th percentile of 1981-2010	%
TX90p	hot day frequency	percentage of days when TX > 90th percentile of 1981-2010	%
WSDI	warm spell	Annual count of days with at least 6 consecutive days when TX > 90th percentile of 1981-2010	days
CSDI	cold spell	annual count of days with at least 6 consecutive days when TN < 10th percentile of 1981-2010	days
GSL	growing season length	annual count between first span of at least 6 days with TG > 5°C after winter and first span after summer of 6 days with TG < 5°C	days

TX is the daily maximum temperature; TN is daily minimum temperature; TG is daily mean temperature.

Table-3 :

Indicators (units)	Indices	R^2 (Linear trend)	p–Value	Slope estimate	Slope error
Frost days (days)	FD0	NaN	NaN	0	0
Cold days (days)	FD10	0	0.938	0.022	0.28
Ice days (days)	ID0	NaN	NaN	0	0
Ice days (days) < 20°C	ID20	0	0.911	-0.001	0.01
Summer days (days)	SU25	4.5	0.262	0.105	0.092
Very hot days (days)	SU40	0.1	0.853	0.072	0.385
Hot nights (days) > 20°C	TR20	27.5	0.003	-2.16	0.666
Tropical nights (days)	TR35	NaN	NaN	0	0

involves a very simple procedure. 1) Connect to the R project website at http://www.r-project.org, 2) Follow the links to download the most recent version of R for your computer operating system from any mirror site of CRAN.

For Microsoft Windows (95, 98, 2000, XP, 07 and 10), download the Windows setup program. Run that program and R will be automatically installed in your computer, with a short cut to R on your desktop. The TclTk is included in the default installation of R 1.9.0 or

Table-4 : Decadal trends of the extreme indices of Air temperature during 1981-2010 of Beed district.

District	Indices	Years														
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Beed	FD0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FD10	13	16	1	20	15	7	43	8	9	0	4	11	12	4	11
	ID0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ID20	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0
	SU25	365	365	359	358	360	359	362	353	349	350	363	361	361	360	361
	SU40	57	11	42	41	37	33	42	26	16	5	58	60	30	18	26
	TMAXmean	34.18	33.09	32.85	32.15	32.96	33.11	32.92	31.83	31.27	30.96	33.96	33.55	32.47	32	33.38
	TMINmean	20.78	19.33	19.93	19.09	19.4	19.11	18.69	19.62	19.02	19.7	20.03	19.75	19.7	19.46	19.99
	TR20	260	204	204	192	207	185	211	193	186	208	214	213	213	199	217
	TR35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table-4 : Contd....

District	Indices	Years														
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Beed	FD0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FD10	5	3	0	1	18	2	9	12	1	11	64	7	6	8	14
	ID0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ID20	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
	SU25	366	363	360	362	365	360	365	355	354	364	361	361	364	363	364
	SU40	39	26	73	59	43	31	56	22	27	54	29	26	10	70	24
	TMAXmean	33.5	32.11	34.19	34.67	33.49	32.71	34.48	31.99	32.24	34.43	33.31	32.46	32.4	34.58	33.26
	TMINmean	20.35	19.31	19.8	19.56	19.01	19.81	18.85	19.55	19.94	19.03	16.46	19.14	18.27	17.7	17.08
	TR20	220	191	203	177	202	231	163	227	200	213	132	198	181	81	96
	TR35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

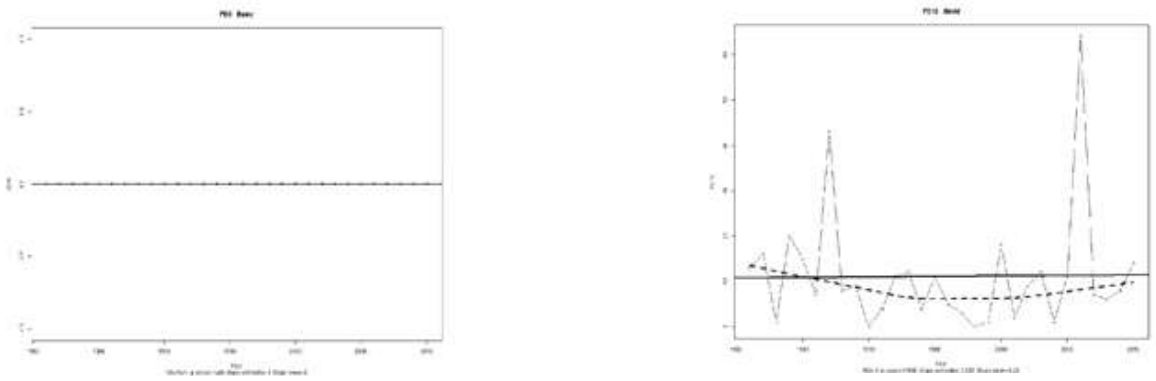


Fig.-1 : Trend analysis of temperature indices of (FD0) and (FD10) in Beed district.

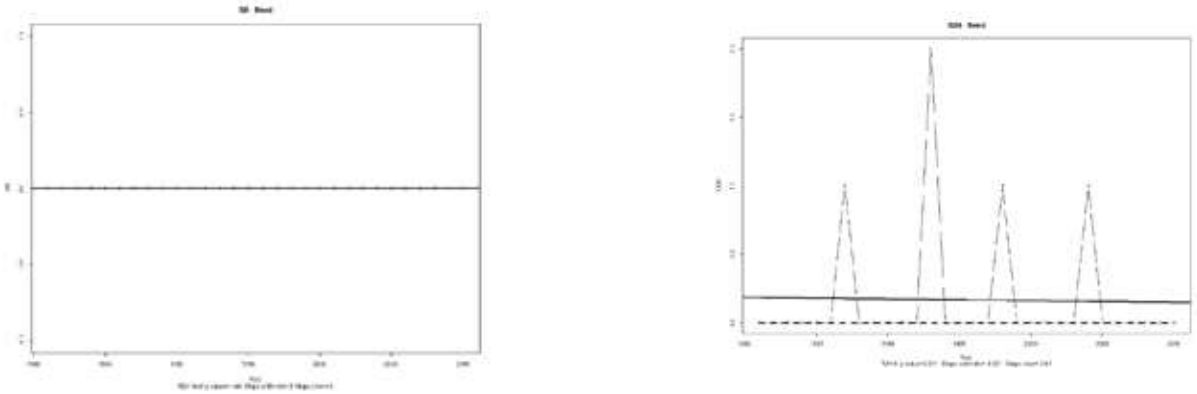


Fig.-2 : Trend analysis of temperature indices of (ID0) and (ID20) in Beed district.

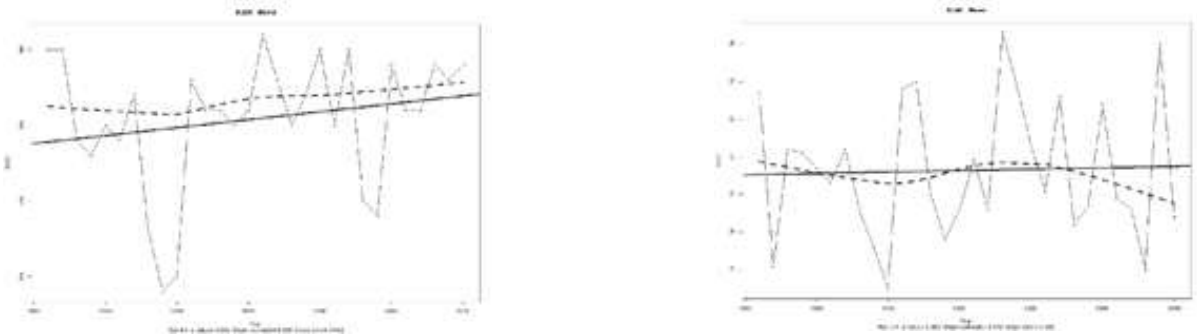


Fig.-3 : Trend analysis of temperature indices of (SU25) and (SU40) in Beed district.

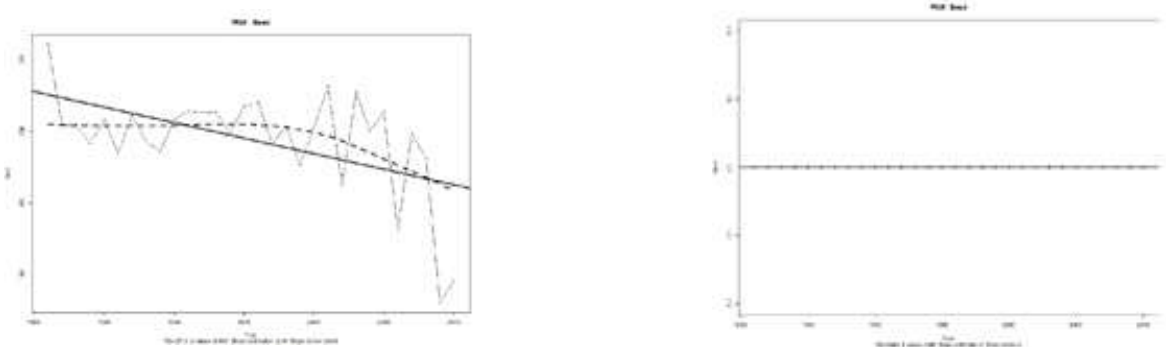


Fig.-4 : Trend analysis of temperature indices of (TR20) and (TR35) in Beed district.

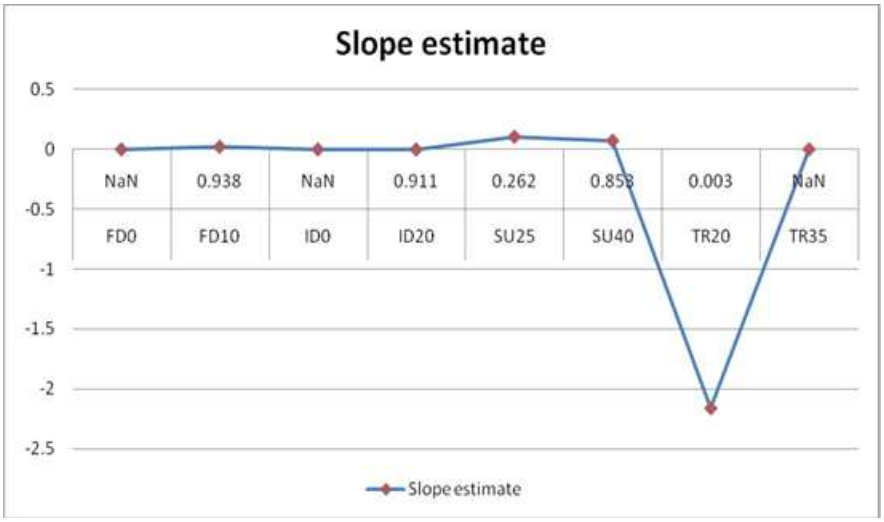


Fig.-5 : Graph showing slope estimate and p-value of Beed district.

later versions. It may need to be installed separately if you are running an earlier version of R.

How to run R : Under the Windows environment, double click the R icon on your desktop, or launch it through Windows "start" menu. This usually gets you into the R user interface. For some computers, you may need to first setup an environment variable called "HOME". See R for Windows FAQ for details if you have any problems. Under a unix environment, just run R to give you the R console. Exit from R by entering q in the R console under both Windows and unix. Under Windows, you may also click "File" menu and then "Exit".

Results and Discussion

The slope of the linear trend illustrates the change in variable over long term given period. Overall result of trend analysis was represented in the following table 3 and depicted in fig.-5

The trend of the temperature indices represents there is decreasing, and negative trend of Ice days (ID20) i.e -0.001 and Hot nights (TR20) i.e -2.16. Other three indices (FU10) is 0.022, (SU25) is 0.105 and (SU40) is 0.072 shows increasing and positive trend which illustrate overall rising of temperature in the Beed district.

Decadal trends of Diurnal Temperature Range (DTR) during 1981-2010 of Beed district : The decadal trends of Diurnal Temperature Range (DTR) Tmax and Tmin during the year 1981-1990 were found to be in between 1.9^0C to 30.2^0C in Beed district. Whereas, the decadal trends of Diurnal Temperature Range (DTR) Tmax and Tmin during the year 1991-2000 were found between 2.4^0C to 24.9^0C. The same pattern was reported in the year 2001-2010 the Diurnal Temperature Range (DTR) Tmax and Tmin index were in 3^0C to 33.4^0C of Beed district.

Result and trend annual analysis of Precipitation for the Beed district : Results after analysis of decadal precipitation events from 1981-1990 shows that, there was significant change and increasing in precipitation in year 1981, 1983, 1984, 1986 and 1990 while in other decades it shows decreasing trend in the Beed district.

Results after analysis of decadal precipitation events from 1991-2000 shows that, there was significant change and increasing in precipitation in year 1992, 1993, 1996, 1999 and 2000 while in other decades it shows decreasing trend in the Beed district.

Results after analysis of decadal precipitation events from 2000-2010 shows that, there was significant change and increasing in precipitation in year 2002, 2005, 2006 and 2008 while in other decades it shows decreasing trend in the Beed district.

References

1. Arora, M., Goel, N.K. and Singh, P. (2005). Evaluation of temperature trends over India Evaluation de tendances de température en Inde. *Hydrological Sciences Journal*, 50(1): 37–41.
2. Carlos Antonio (2014) Recent Changes in Temperature And Precipitation Extremes In An Ecological Reserve In Federal District, Brazil. *Revista Brasileira de Meteorologia,* Volume : 29, Page: 13-20.
3. Chaudhary, J.L. and Sastri, A.S.R.A.S. (1999). Regional climate and climatic swings with special reference to production of rice and water resource potential in Chhattisgarh region of central India. *Tropical ecology*, 40 (1): 137-144.
4. Fatemeh Rahimzadeh, Ahmad Asgari and Ebrahim Fattahi (2005) Variability of extreme temperature and precipitation in Iran during recent decades. *International Journal of Climatology.* 29: 329–343
5. Hartmann (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third

Assessment Report of the *Intergovernmental Panel on Climate Change*. Cambridge University Press.

6. Joshi, U. R. and Rajeevan, M. 2006. Trends in Precipitation Extremes over India. Research Report No.3/2006, National Climate Centre, India Meteorological Department, Pune, 27.
7. Lobell, D.B. and Duffy, P.B. (2007). Climate change uncertainty for daily minimum and maximum temperatures: A model inter-comparison. *Geophysical research letters*, 34:1-5.
8. Rai, S. K. and Chaudhary, J. L. (1998). Trends and periodicity of temperature anomaly of Raipur district for crop planning-A statistical approach, *Indian J. Environmental sciences*, 2(2): 73-81.
9. Sarju K. Baidya, Mandal Shreshta and Muhammad Shaikh (2008) Trends in Daily climate extremes of Temperature and Precipitation in Nepal, *Journal of Hydrology and Meteorology.* vol.5, No.1, p: 38-51.
10. Vincent, L.A. and Mekis, Eva. (2006). Changes in Daily and Extreme Temperature and Precipitation Indices for Canada over the Twentieth Century. *Atmosphere- Ocean*, 44: 177-193.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 762-767 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Trend Analysis of Temperature and Precipitation over Osmanabad District of Marathwada Region, Maharashtra Using RClimDEX Model

Sujeet Deshmukh[1], D. Ushasri[2] and Vishal Wale[1]
[1]*College of Agriculture, Pune, MPKV, Rahuri, Maharashtra*
[2]*Krishi Vigyan Kendra, Malyal, Mahabubabad, Maharashtra*

Abstract

The motive of this study is to assess the change and fluctuations in trends of daily temperature extremes and precipitation in Beed district, Maharashtra during the period between 1981 and 2010. The annual rainfall is highly variable, ranging from less than approximately 600 mm–700 mm and its distribution is unequally spread between all the tahsils locations. Environmental change takes steps to increment air temperatures and evapotranspiration, increment the gamble of heat waves related with dry spell. Osmanabad was especially impacted by warm limits than cold limits in view of daytime files. Precipitation do not recoards measurably huge patterns across the entire locality. From 1981 to 2010 cold days and nights has diminished, while over similar period the episode of extreme warm days and evenings has expanded. The temperature limits show designs predictable with warming over a large portion of the dissected records. The general concentrate over Osmanabad region shows that decline in precipitation pattern.

Key words : *Extremes, Index, variability, precipitation and temperature.*

Introduction

Study and understanding of changes in extreme precipitation events is of great importance because of their large impact on society and ecosystems. As the science of climate change proceed, detection and attribution studies ventured into more sophisticated statistical analyses that examined complex patterns of climate change. The anthropogenic cause of current climate change has been identified by researchers and is a widely acknowledged issue in the political sphere during the last decades. The different emissions of greenhouse gases linked mainly with industrial production increase the global mean temperature via the greenhouse effect, affect the whole Earth system. These changes imply risks for human lives as well as natural ecosystems. In different parts of the world, climates are characterized by their variability which affects many sectors. Study and understanding of changes in extreme precipitation events is of great importance because of their large impact on society and ecosystems compared to changes in mean precipitation. The present study was planned in order to analyse the trends and variability in the extreme ends of the daily minimum and maximum temperature and rainfall distribution over the state and to strategize the resilient resource management for climate change effect mitigation in agriculture.

Material and Methods

Location and Extent : Marathwada is located in the middle and south eastern portion of Maharashtra State. Godawari river basin is covered in northern part of Marathwada region and southern part of Marathwada region is covered by Krishna river basin. Marathwada region lies between 17o 35' to 20 o 41' North Latitude and 70 o 40' to 78 o 16' East Longitude.

Osmanabad district in Marathwada region lies on the Deccan plateau, about 600 m above sea level. Parts of the sina, Manjira and Terna River flow through the district. The district is located on the south side of the Marathwada region between latitude 17.35 to 18.40 degrees north, and latitude 75.16 to 76.40 degrees east.

The RClimDex model is developed and maintained by Xuebin Zhang and Feng Yang. It was designed to provide a user friendly interface to compute indices of climate extremes. It computes all 27 core indices recommended by the CCl/CLIVAR Expert Team for Climate Change Detection Monitoring and Indices (ETCCDMI) as well as some other temperature and precipitation indices with user defined thresholds.

Installation and running of R : R is a language and environment for statistical computing and graphics. It is a GNU implementation of the S language developed by John Chambers and colleagues at Bell Laboratories (formerly AT & T, now Lucent Technologies). S-plus provides a commercial implementation of the S language

How to install R : RClimDex requires the base package of R and graphic user interface. The installation of R involves a very simple procedure. 1) Connect to the R project website at http://www.r-project.org, 2) Follow the links to download the most recent version of R for your computer operating system from any mirror site of CRAN.

Table-1 : Summary information of the used precipitation Indices.

Index	Descriptive Name	Definition	Units
PRCPTOT	wet day precipitation	annual total precipitation from wet days	mm
SDII	simple daily intensity index	average precipitation on wet days	mm/d
CDD	consecutive dry days	maximum number of consecutive dry days	days
CWD	consecutive wet days	maximum number of consecutive wet days	days
R10mm	heavy precipitation days	annual count of days when RR >= 10	days
R20mm	very heavy precipitation days	annual count of days when RR >= 20	days
Rnnmmb	number of days above nn mm	Annual count of days when PRCP >=nn mm, nn is user defined threshold	days
R95p	very wet day precipitation	annual total precipitation when RR > 95th percentile of daily rainfall	mm
R99p	extremely wet day precipitation	annual total precipitation when RR > 99th percentile of daily rainfall	mm
RX1day	maximum 1-day precipitation	annual maximum 1-day precipitation	mm
RX5day	maximum 5-day precipitation	annual maximum consecutive 5-day precipitation	mm

A wet day is defined when RR >= 1 mm and a dry day when RR< 1 mm. All indices are calculated annually from January to December; In this study nn is 25mm; RR is the Daily Rainfall Rate.

Table-2 : Summary information of the used Temperature Indices.

Index	Descriptive Name	Definition	Units
SU25	hot days	annual count when TX > 25°C	days
FD10	frost days	annual count when TN < 0°C	days
ID20	cold days	annual count when TX < 20°C	days
DTR	diurnal temperature range	monthly mean difference between TX and TN	°C
TR20	warm nights	annual count when TN > 20°C	days
TXx	hottest day	monthly highest TX	°C
TNx	hottest night	monthly highest TN	°C
TXn	coolest day	monthly lowest TX	°C
TNn	coolest night	monthly lowest TN	°C
SU40	Hot days	annual count when TX > 25°C	%
TX10p	cool day frequency	percentage of days when TX < 10th percentile of 1981-2010	%
TN90p	hot night frequency	percentage of days when TN > 90th percentile of 1981-2010	%
TX90p	hot day frequency	percentage of days when TX > 90th percentile of 1981-2010	%
WSDI	warm spell	Annual count of days with at least 6 consecutive days when TX > 90th percentile of 1981-2010	days
CSDI	cold spell	annual count of days with at least 6 consecutive days when TN < 10th percentile of 1981-2010	days
GSL	growing season length	annual count between first span of at least 6 days with TG > 5°C after winter and first span after summer of 6 days with TG < 5°C	days

TX is the daily maximum temperature; TN is daily minimum temperature; TG is daily mean temperature.

Table-3 : Result and trend analysis of temperature indices in Osmanabad district.

Indicators (units)	Indices	R^2 (Linear trend)	p–Value	Slope estimate	Slope error
Frost days (days)	FD0	NaN	NaN	0	0
Cold days (days)	FD10	53.4	0	0.646	0.114
Ice days (days)	ID0	NaN	NaN	0	0
Ice days (days)<20°C	ID20	1	0.592	0.004	0.007
Summer days (days)	SU25	0	0.903	0.01	0.083
Very hot days (days)	SU40	0.7	0.663	-0.094	0.213
Hot nights (days) > 20°C	TR20	60.2	0	-5.231	0.805
Tropical nights (days)	TR35	NaN	NaN	0	0

For Microsoft Windows (95, 98, 2000, XP, 07 and 10), download the Windows setup program. Run that program and R will be automatically installed in your computer, with a short cut to R on your desktop. The TclTk is included in the default installation of R 1.9.0 or later versions. It may need to be installed separately if you are running an earlier version of R.

How to run R : Under the Windows environment, double

Table-4 : Decadal trends of the extreme indices of Air temperature during 1981-2010 of Osmanabad district.

District	Indices	Years														
		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Osmanabad	FD0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FD10	4	0	4	1	0	1	1	1	0	0	1	1	1	0	0
	ID0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ID20	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	SU25	352	363	357	362	362	363	363	362	357	360	363	364	360	356	360
	SU40	13	0	22	26	10	37	37	31	27	15	37	37	31	27	15
	TMAXmean	31.56	31.99	31.85	31.97	32.08	33.06	33.17	32.64	32.37	32.84	33.06	33.15	32.64	32.39	32.82
	TMINmean	19.48	19.73	19.43	19.7	19.58	19.67	19.75	19.91	19.88	19.98	19.65	19.71	19.92	19.89	19.97
	TR20	202	195	207	178	183	203	176	218	217	221	175	175	218	216	221
	TR35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

District	Indices	Years														
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Osmanabad	FD0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FD10	0	1	1	4	5	0	8	1	17	16	18	26	21	17	16
	ID0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ID20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	SU25	361	361	361	362	360	362	361	364	365	361	362	365	362	361	346
	SU40	15	17	31	23	22	20	20	33	15	20	23	11	6	14	35
	TMAXmean	32.84	32.52	32.83	32.14	32.86	33.21	33.15	33	32.39	32.25	32.11	32.18	31.45	32.11	32.12
	TMINmean	19.97	19.67	19.26	17.68	17.77	17.84	16.16	18.15	17.06	16.73	17.7	17.14	16.84	16.71	16.96
	TR20	221	203	166	81	87	76	39	122	96	77	109	97	82	93	86
	TR35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

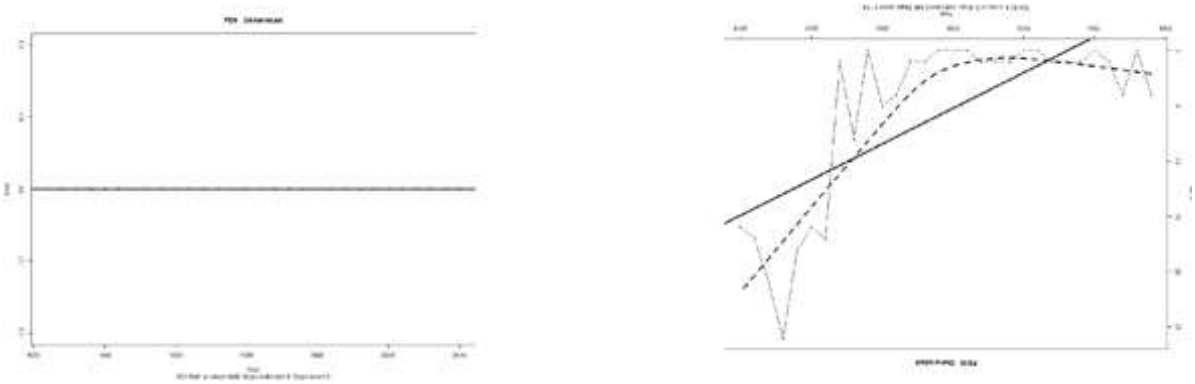


Fig.-1 : Trend analysis of temperature indices of (FD0) and (FD10) in Osmanabad district.

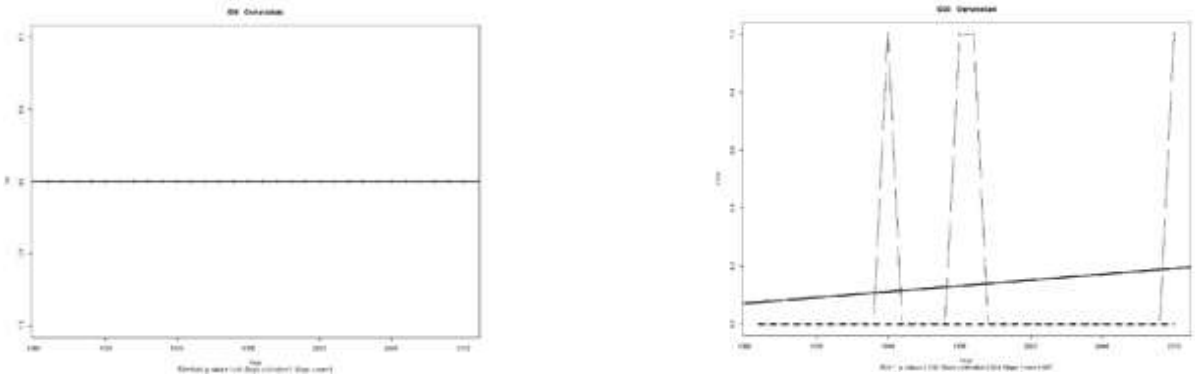


Fig.-2 : Trend analysis of temperature indices of (ID0) and (ID20) in Osmanabad district.

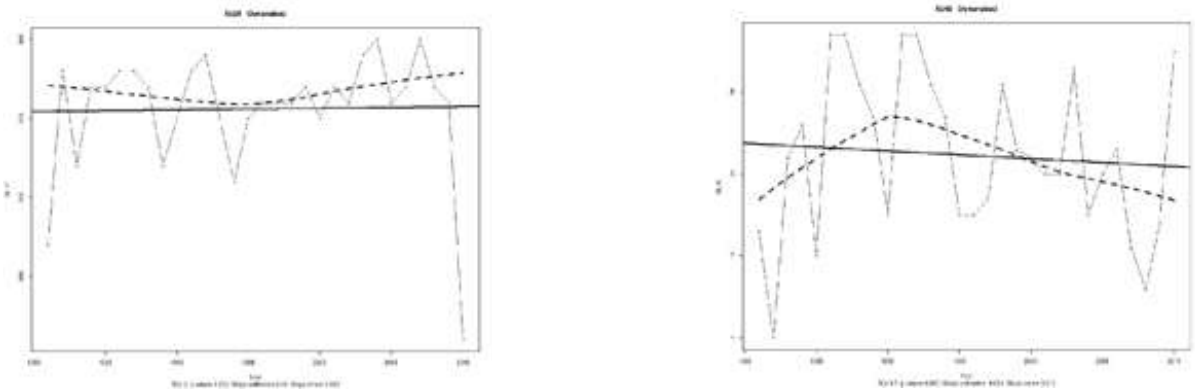


Fig.-3 : Trend analysis of temperature indices of (SU25) and (SU40) in Osmanabad district.

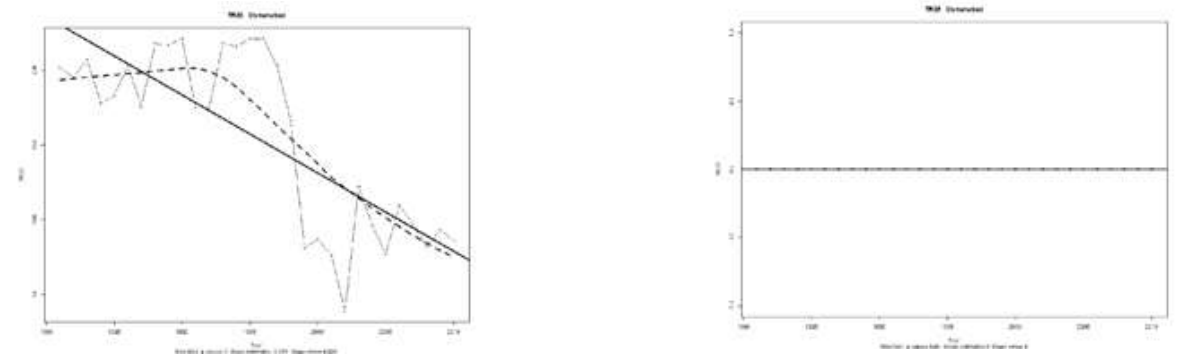


Fig.-4 : Trend analysis of temperature indices of (TR20) and (TR35) in Osmanabad district.

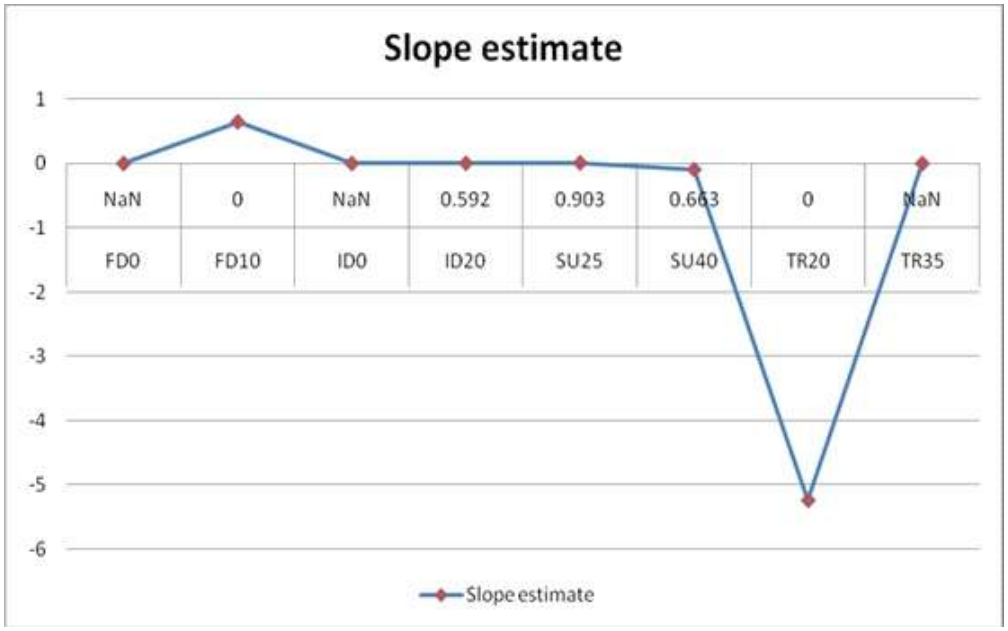


Fig.-5 : Graph showing slope estimate and p-value of Osmanabad district.

click the R icon on your desktop, or launch it through Windows "start" menu. This usually gets you into the R user interface. For some computers, you may need to first setup an environment variable called "HOME". See R for Windows FAQ for details if you have any problems. Under a unix environment, just run R to give you the R console. Exit from R by entering q in the R console under both Windows and unix. Under Windows, you may also click "File" menu and then "Exit".

Results and Discussion

The slope of the linear trend illustrates the change in variable over long term given period. Overall result of trend analysis was represented in the following table-3 and depicted in fig.-5

The trend of the temperature indices represents there is decreasing and negative trend of Very hot days (SU40) i.e -0.094 and Hot nights >20°C(TR20) i.e -5.231 while in other hand p-value of (SU25) is 0.903 and (SU40) is 0.663 shows the increasing and positive trend which illustrate overall rising of temperature in the Osmanabad district.

Decadal trends of Diurnal Temperature Range (DTR) during 1981-2010 of Osmanabad district : The decadal trends of Diurnal Temperature Range (DTR) Tmax and Tmin during the year 1981-1990 found in between 2.9°C to 22.8°C however, the the decadal trends of Diurnal Temperature Range (DTR) Tmax and Tmin during the year 1991-2000 were 3.8°C to 14.2°C and the decadal trends of Diurnal Temperature Range (DTR) Tmax and Tmin during the year 2001-2010 are in between 2.2°C to 27.8°C in Osmanabad district.

Result and trend annual analysis of Precipitation for the Osmanabad district : Results after analysing the decadal precipitation events from 1981-1990 shows that, there was significant change and increasing in precipitation in year 1982, 1985, 1986, 1987 and 1989 while in other decades it shows decreasing trend in the Osmanabad district.

Results after analysing the decadal precipitation events from 1991-2000 shows that, there was significant change and increasing in precipitation in year 1991, 1992, 1995, 1996 and 2000 while in other decades it shows decreasing trend in the Osmanabad district.

Results after analysing the decadal precipitation events from 2000-2010 shows that, there was significant change and increasing in precipitation during the year 2002, 2004, 2006, 2008 and 2009 while in other decades it shows decreasing trend in the Osmanabad district.

References

1. Chaudhary, J.L. and Sastri, A.S.R.A.S. (1999). Regional climate and climatic swings with special reference to production of rice and water resource potential in Chhattisgarh region of central India. *Tropical ecology*, 40 (1): 137-144.
2. Chaudhary, J.L. (1999). Temporal variation of rainfall and rainy days with reference to production of rice in Chhattisgarh region of central. India *J. Environment and Pollution*, 3(3&4): 127-130
3. Joshi, U. R. and Rajeevan, M. 2006. Trends in Precipitation Extremes over India.
4. Research Report No.3/2006, National Climate Centre, India Meteorological Department, Pune, 27.
5. Kumar, V., Jain, S.K. and Singh, Y. (2010). Analysis of

long-term rainfall trends in India. *Hydrological Science Journal*, 55(4): 484-496.

6. Oza, M. and. Kishtawal, C.M (2014). Trends in Rainfall and Temperature Patterns over North East India. *Earth Science*, 7: 90-105.
7. Lobell, D. B. and Duffy, P. B. (2007). Climate change uncertainty for daily minimum and maximum temperatures: A model inter-comparison. *Geophysical research letters*, 34:1-5.
8. Pant, G. B. and Hingane, L. S., (1988). Climatic changes in and around the Rajasthan desert during the 20th century. *International journal of Climatology*, 8: 391–401.
9. Ramakrishana,Y. S. (2013). Heat and cold waves, their effect on agriculture and allied sectors. In : Agrometeorological aspects of extreme weather events. (Eds. Rao, V.U.M.., Rao, A.V.M.S., Kumar, P.V., Bapuji Rao, B. and Sastry, P.S.N.). Central Research Institute for Dryland Agriculture, Hyderabad, pp.1133-137
10. Sharma, M. A., and Singh, J. B. (2010). Use of Probability Distribution in Rainfall Analysis. *New York Science Journal*, 3(9): 40–49.
11. Shrestha, A.B., Bajracharya, S.R., Sharma, A.R., Duo, C. and Kulkarnid, A. (2016). Observed trends and changes in daily temperature and precipitation extremes over the Koshi river basin 1975-2010. *International Journal of Climatology.* DOI: 10.1002/joc.4761.
12. Pant, G. B. and Hingane, L. S., (1988). Climatic changes in and around the Rajasthan desert during the 20th century. *International journal of Climatology*, 8:391–401.
13. Ramakrishana,Y. S. (2013). Heat and cold waves, their effect on agriculture and allied sectors. In : Agrometeorological aspects of extreme weather events. (Eds. Rao, V.U.M.., Rao, A.V.M.S., Kumar, P.V., Bapuji Rao, B. and Sastry, P.S.N.). Central Research Institute for Dryland Agriculture, Hyderabad, pp.1133-137.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 768-771 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

A Study of Seed Characterization of Okra {*Abelmoschus esculentus* (L.) Moench} Genotypes

Sunil Kumar, S.K. Dhankhar, Monika Yadav*, Archana Brar and Amit Kumar
Department of Vegetable Science, CCS Haryana Agricultural University, Hisar-125004
**Corresponding Authour Email : monikayadav31101996@gmail.com*

Abstract

The present study entitled "Characterization of okra [*Abelmoschus esculentus* (L.) Moench.]" was carried out at the Research farm of Department of Vegetable Science, CCS HAU, Hisar during spring summer season of the year 2012 on the basis of morphological descriptors with the objective to identify key diagnostic characters of the genotypes. Observations were recorded for six seed characters. Analysis of variance studies indicated significant differences among all the genotypes for all the characters under study. The genotype Hisar Naveen was found as superior with high mean values for seed size and test weight. The seed size and test weight was recorded maximum in HBT-71. Seed characters like Seed size, seed colour, seed shape and seed hairiness were also found key characters to differentiate the okra genotypes and will be helpful for seed agencies and in seed testing laboratories. Genotype HBT-42 based on seed characters having path of seed size (small), seed shape (round) with absent seed hairiness.

Key words *: Okra, variability, characterization.*

Introduction

Okra {*Abelmoschus esculentus* (L.) Moench} is a member of family *Malvaceae* having somatic chromosome number 2n=130. It is an important vegetable crop, which is primarily grown for tender fruits in both spring summer and rainy seasons throughout India. The green tender fruits of okra are rich in calcium (Ca), phosphorus (P), magnesium (Mg), iron (Fe), vitamin A and C and also good source of carbohydrate, protein and other mineral matters (Aykroyd, 1963). Okra is also a good source of mucilage which is renewable and inexpensive source of biodegradable material, and has potential for use as food, non-food products, and medicine (Kumar *et al*. 2010). India is the second largest producer of okra after China, where it has been cultivating for more than a century. In India, it is mainly grown in states like Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, Haryana, Punjab and occupies an area of 4.98 lakh hectare with an average production and productivity of 5.75 mt and 11.75 t/ha, respectively. In Haryana, Okra occupies an area of 18,200 hectare with a total production of 0.145 mt (Anonymous, 2011). However, the productivity (7.96t/ha) is far behind the national average. Plant variety is considered as primary input of modern crop production. Therefore, unless the farmer gets seed of improved varieties to grow, the investment on secondary inputs like fertilizer, irrigation, plant protection measures etc. will not be meaningful. That's why the continued effort on the development of high yielding and resistance to biotic and abiotic stresses varieties is keystone to enhance the productivity of crop plants. Characterization of available germplasm for morphological and agronomical characters is an important activity to make easy for the research workers to utilize the germplasm in breeding programmed (De Vicente *et al*. 2005). Characterization is used to distinguish the genotypes on the basis of their highly heritable characters, which helps in selecting the most suitable genotypes as per the need of the user. However, as the recent definition of IBPGR, characterization consists of recording those traits that are highly heritable and can be easily seen by the eyes and equally expressed in all environmental conditions. It provides information on diversity within and between crop collections/germplasm and make possible for the identification of unique accession(s) essential to promote better utilization for crop improvement for development of variety (s) or hybridization programme. It is conducted with diligence in fields following adequate cultural and plant protection measures. For each accession, several morphological characters are recorded using descriptors. Descriptors of genotype of the crop species is needed for identification of variety, verify the purity of variety, establishing the distinctness of the new genotypes from the existing varieties and documentation of genetic resources. Prasad and Sharma (2012) assessed seeds of okra cultivars having moisture content in the range of 8.13 to 12.27% (DWB) for dimensional, gravimetric and frictional properties. Seed size of variety Arka Anamika was largest and KS-442 had smallest size of seed. The properties such as sphericity, porosity, aspect ratio, angle of repose and coefficient of static friction differ significantly and dependent on genotype, which has paved the way for dimensional quality characterization through image

analysis of selected seeds of okra cultivars. Accordingly the dominating similar prominent physical characters formed separate place as coherent clusters.

Materials and Methods

The present research experiment for recording the morphological characters was carried out at the Vegetable Research Farm, Department of Vegetable Science, CCS Haryana Agricultural University, Hisar During rainy season of 2012. Observations of laboratory parameters (seed characters) were carried out in Seed Quality Laboratory, Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar in winter season, 2012.

Seeds of twenty okra genotypes were sown at spacing of 60cm between row to row and 30cm between plant to plant in Randomized Block Design (RBD) with three replications. Each genotype was grown in a plot of four rows accommodating thirty plants per replication. Two to three seeds per hill were sown and later thinned to retain one plant per hill. The recommended package and practices of the crop was followed to raise healthy crop. Observation of seed parameters of each genotype were taken in the laboratory in Completely Randomized Block Design with three replications.

Laboratory parameters (Seed Characters)

Seed shape : One hundred seeds of each genotype were randomly observed from its seed lot and their shape was observed visually under microscope stated as round and flat shape.

Seed colour : One hundred seeds of each genotype were collected randomly from its seed lot and their colour was observed visually with the help of microscope and classified as green or brown seed.

Seed size : On the basis of test weight of seeds, size of seed was categorized as small (>55g), medium (55-60.0g) and large size seed (<60.0g).

Test weight (g) : One thousand seeds from the ten fully matured brown colored fruits, which were harvested from thirty randomly selected competitive plants of each genotype, were taken. Weight of seeds was taken in gram.

Seed density (g/cc) : Seed density was recorded using a cylinder of 10 ml. Three gram seed of each genotype was added in 5ml water level and rise in water level in cylinder and replacement value is noticed and considered as seed density (g/cc).

Seed hairiness : One hundred seeds of each genotype were collected randomly from its seed lot and hairiness on seed was observed visually with the help of microscope, which were categorized as absent or present of hair on seed.

Statistical analysis

Analysis of variance (Randomized block design) : The analysis of variance of the observed data for different characters of okra crop planted with three replications in Randomized Block Design was carried out on the basis of the model described by Panse and Sukhatme (1967). The statistical model is given below :

$$Y_{ij} = \mu + g_i + r_j + e_{ij}$$

Where, Y_{ij} = An observation on the i^{th} genotype in j^{th} replication

μ = General mean

g_i = Effect of i^{th} genotype

r_j = Effect of r^{th} replication

e_{ij} = Random error (uncontrolled variation) associated with i^{th} genotype in j^{th} replication.

The assumptions of the model are :

(i) All the observations are independent

(ii) Error involved in the population is normally and independently distributed with mean zero and variance ^{2}.

(iii) The different effects in the model are additive in nature.

Analysis of variance

Source of variation	Degree of freedom	Mean square (MS)	Expected mean square (EMS)
Replications	(r-1)	MS_r	^2_e g ^2_r
Genotypes	(g-l)	MS_g	^2_e r ^2_g
Error	(r-l) (g-l)	MS_e	^2_e

Where, r = Number of replication

g = Number of genotype

MS_r = Mean square due to replication

MS_g = Mean square due to genotypes

MS_e = Mean square due to error

^2_e = Variance due to error

^2_g = Variance due to genotypes

^2_r = Variance due to replications

Significance of replication mean square and genotype mean square were tested against error mean square. The standard error of means (SEm), standard error of difference of mean (SEd), critical difference (CD) for a particular level of significance and per cent coefficient of variation (CV%) were estimated as stated below :

$$SEm\ (\pm) = \sqrt{\frac{\text{Error means squares } (MS_e)}{\text{Number of replications (r)}}}$$

Table-1 : Classification of okra genotypes on the basis of seed shape.

Category	Genotypes	Number of genotypes
Round	HBT-1-1, HBT-6, HBT-17, HBT-19-1, HBT-42, HBT-49-1, HBT-51-1-1, HBT-70-1, HBT-71, BB-1, Hisar Naveen and Hisar Unnat	12
Flat	HBT-12, HBT-34, HBT-36, HBT-36-1, HBT-50, HRB-105-2-2, HBTC-6-7-1 and HB-25-2	8

Table-2 : Classification of okra genotypes on the basis seed colour.

Category	Genotypes	Number of genotypes
Green	HBT-6, HBT-12, HBT-17, HBT-19-1, HBT-34, , HBT-42, HBT-49-1, HBT-50, HBT-51-1-1, HBT-70-1, HBT-71, HBTC-6-7-1, HRB-105-2-2, HB-25-2, BB-1and Hisar Unnat	16
Brown	HBT-1-1, HBT-36, HBT-36-1 and Hisar Naveen	4

Table-3 : Classification of okra genotypes on the basis seed size.

Category	Genotypes	Number of genotypes
Small (< 55 g)	HBT-42,	1
Medium (55-60 g)	HBT-12,HBT-50,HBT-36,HBT-36-1,HBT-51-1-1and HBTC-6-7-1,	6
Bold (> 60 g)	HBT-1-1,HBT-6,HBT-17,HBT-19-1,HBT-34,HBT-49-1, HBT-70-1,HBT-71,HRB-105-2-2, HB-25-2, BB-1,Hisar Naveen and Hisar Unnat	13

Table-4 : Classification of okra genotypes on the basis of hairiness on seed.

Category	Genotypes	Number of genotypes
Present	HBT-12, HBT-17, HBT-49-1, HBT-51-1-1, HBT-71 and BB-1	6
Absent	HBT-1-1, HBT-6, HBT-19-1, HBT-34, HBT-36, HBT-36-1, HBT-42, HBT-50, HBT-70-1, HRB-105-2-2, HBTC-6-7-1, HB-25-2, Hisar Naveen and Hisar Unnat	14

Table-5 : Analysis of variance for different characters in okra.

Sr. No.	Degree of freedom	Mean Sum of Squares			SE (m) ±	CV (%)	CD (P=0.5)
		Replication	Genotype	Error			
	Character	3	20	38			
1.	Seed size	0.053	4.467	3.474	0.175	6.388	0.502
2.	Test weight	36.543	676.152	659.570	2.405	6.762	6.913
3.	Seed density	32.766**	3.661	4.660	0.123	2.717	0.355

Table-6 : Mean performance of okra genotypes for different characters.

Sr. No.	Genotype	Seed size (mm)	Test weight (g)	Seed Density
1.	HBT-1-1	5.06	64.20	7.90
2.	HBT-6	4.50	62.00	7.66
3.	HBT-12	4.56	60.00	7.93
4.	HBT-17	4.66	60.50	8.06
5.	HBT-19-1	4.80	65.10	7.56
6.	HBT-34	4.63	62.60	7.96
7.	HBT-36	4.36	58.50	7.83
8.	HBT-36-1	4.70	59.00	7.83
9.	HBT-42	4.46	54.90	7.86
10.	HBT-49-1	5.13	62.60	8.23
11.	HBT-50	4.76	55.40	7.83
12.	HBT-51-1-1	5.00	56.70	8.10
13.	HB-25-2	4.53	61.60	8.03
14.	HBT-70-1	5.16	63.70	7.80
15.	HBT-71	5.30	66.30	8.10
16.	HBTC-6-7-1	4.56	60.00	7.80
17.	HRB-105-2	4.53	64.90	8.10
18.	BB-1	4.73	64.20	7.70
19.	Hisar Naveen	4.83	65.10	7.56
20.	Hisar Unnat	4.60	64.20	8.00

$$SEd\ (\pm) = \sqrt{\frac{2MSe}{r}}$$

CD at 5% = SEd × *t* at error degree of freedom (P= 0.05)

$$CV\ \% = \frac{\sqrt{MS_e}}{\text{General mean}} \quad 100$$

Results and Discussion

Seeds of all genotypes were evaluated in laboratory for their shape and were classified in two categories i.e. round and flat. Twelve genotypes had seeds of round shape, whereas, eight genotypes exhibited flat shape. The classification of genotypes has been presented in Table-1. Subramaniam and Ramakrishnam (1978) found that seed shape is helpful in characterizing rice cultivars. On the basis of seed shape varietal identification was carried out by Kumar (2000) in cotton hybrids and pallares *et al*, (2004) in foxtail. Seeds of all genotypes were observed visually for their and stated as brown and green colour seed. Out of twenty genotypes, brown colour of seed was noticed in four genotypes, whereas, green colour of seed was found in sixteen genotypes. The classification of genotypes has been presented in Table-2. Chauhan (2003) studied on thirty genotypes of fenugreek on the basis of seed colour and found wide diversity in seed colour. Taking into account seed size, genotypes were grouped into three classes i.e., small, medium and bold size seed. One genotype (HBT-42) was found with small seed size, six genotypes were of medium size and thirteen genotypes had bold seed size. The classification of genotypes has been presented in Table-3. With respect to presence of hairs on seeds of different genotypes, only six genotypes exhibited hairiness on their seeds, while other genotypes had no hairiness on their seeds. The classification of genotypes has been presented in 4.4. With respect to presence of hairs on seeds surface of different genotypes, only six genotypes exhibited hairiness on their seeds, while other genotypes had no hairs on their seeds. Mean performance of test weight ranged from 54.90 to 66.30 g and grouping of seed size is done on the basis of test weight. Only one genotype (HBT-42) had seeds of small size (< 55 g), six had medium ((55-60 g) and rest of the thirteen genotypes had bold (> 60 g) seed size. Seed density ranged from 7.56 to 8.23g/cc.

Conclusions

On the basis of seed shape the genotypes were categorized as round (twelve genotypes) and flat (eight genotypes). On the basis of seed colour the genotypes were grouped into two categories *viz,* green (sixteen genotypes) and brown (four genotypes). On the basis of seed hairiness the genotypes were grouped into two states i.e. present (six genotypes) and absent (fourteen genotypes). It can, therefore, conclude from the present study that all the twenty genotypes could be differentiated from each other on the basis of seed (laboratory) parameters.

Refrences

1. Aykroyd, WR., (1963). Nutritive value of Indian foods and planning of satisfactory diets, ICMR *Special Report Series*, No. 42.
2. Chauhan, P., (2003). Characterization and vigour assessment studies in fenugreek. Ph.D. Thesis. Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar, Haryana.
3. De Vicente, M.C., Guzman, F.A., Engels, J., and Rao, V.R. (2005). Genetic characterization and its use in decision making for the conservation of crop germplasm: The Role of Biotechnology. *Villa Gualino, Turin, Italy,* (5-7): 63.
4. Kumar, S., Dagnoko, S., Haogui, A., Rat Nadass, A., Pasternak, D., and Kouame, C., (2010). Okra (*Abelmoschus spp.)* in West and Central Africa: Potential and progress on its improvement. *African J. of Agric. Research.* 5(25): 3590-3598
5. Kumar, S.E. (2000). Studies on varietal identification in hybrids, parents and varieties of cotton. *Seed Tech. News*, 30(1): 14.
6. Pallares, I.N., Ferrari, L., Postulka, E.B. and Ritta, M.N., (2004). Identification of cultivars of foxtail millet from morphological and biochemical traits of their seed. *Seed Science and Tech*, 32(1): 187-196.
6. Prasad, K., and Sharma, R.K., (2012) Characterization of okra seeds of promising genotypes on the basis of physical properties. *Indian J. of Agri. Res.,* 46(3): 199-207
7. Sivasubramaniam, S., and Ramakrishnan, V., (1978). Identification of rice varieties by laboratory techniques. *Seed Research*, 6(1): 71-86.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 772-775 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Field Screening of *Vigna radiata* (L.) Wilczek Genotypes against Mungbean Yellow Mosaic Virus

Sunny Thakur[1*], Stuti Sharma[1], Shraddha Tomar[1], Priya Tiwari[1], Nidhi Pathak[1] and Shailja Goswami[1] and R. Shiv Ramakrishnan[2]

[1]*Department of Plant Breeding and Genetics, JNKVV, Jabalpur, M.P.*

[2]*Department of Plant Physiology, JNKVV, Jabalpur. M.P.*

**Corresponding Author Email : sunnythakur@jnkvv.org*

Abstract

Mungbean Yellow Mosaic Virus (MYMV) is one of the most destructive mungbean infections, spread by the whitefly (*Bemisia tabaci*). By screening 50 different genotypes, the current study attempted to uncover long-term MYMV tolerant lines. The experiment was carried out in the summer of 2022. In the field, the infector row method was employed, with 10 test rows alternated with spreader rows (Urdi Local). Based on the Percent Disease Incidence (PDI) values, the categorization was done on a 1–9 scale. The fifty genotypes were examined and categorized as 21 resistant, eight moderately resistant, six moderately susceptible, nine susceptible, and six highly susceptible. These genotypes can be used as parents in future breeding studies and to verify the molecular marker, which may be used in conjunction with marker-assisted selection (MAS) to develop YMV resistant mungbean breeding lines.

Key words : *Mungbean yellow mosaic virus, disease, germplasm, screening, resistance.*

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is a short-duration legume crop grown on 7 million hectares primarily in Asia and progressively spreading to other world regions. The entire mungbean area in India is around 3.04 million ha, with a production of 1.3 million tons and average productivity of 441 kg/ha (1). Mungbean has a yield potential of 2.5–3.0 t/ha. However, its average productivity is astonishingly low at 0.5 t/ha. Low productivity is caused by abiotic and biotic restrictions, inadequate crop management methods, and a lack of quality seeds of better varieties available to farmers. Green gram production is limited mostly due to low genetic yield potentiality, indeterminate growth habit, canopy architecture, low partitioning efficiency, cultivation on marginal land (2) and biotic and abiotic stressors (3).

Mungbean yellow mosaic virus and urdbean leaf curl virus are important biotic stressors. The mungbean yellow mosaic virus, a destructive virus of the *Geminiviridae*, has long been a major concern to legume crops, causing catastrophic losses in mungbean yields. MYMV disease incidence ranged from 4% to 40%, depending on crop variety and area (4). MYMV prevalence in farmer fields in the Indian subcontinent can reach 100%, resulting in significant yield losses (5).

The most successful and cost-efficient technique for combating MYMV is the development of resistant cultivars. In an intensive production system, host plant resistance provides an alternate approach for overcoming insect pests. To safeguard the environment, it is vital to identify resistant/moderately resistant genotypes to reduce insect and disease populations and production costs. Previously, researchers used scale-based screening on disease incidence and severity to identify resistance in mungbean germplasm against MYMV. Given the crop's economic importance, the current study has been proposed to identify resistant genotypes against major viral infections in green gram.

Materials and Methods

The field screening experiment was carried out at the Seed Breeding Farm, Department of Plant Breeding and Genetics, JNKVV, Jabalpur, during the summer season of 2022. The experimental materials included 50 genotypes and four checks (Table-2). The experiment was set up in an augmented design with a 4 m row length, having row to row and plant to plant spacing of 30 cm and 10cm, respectively. The infector row approach was used in the field, with 10 test rows alternating with spreader row (6) of the susceptible cultivar urdi local to assess MYMV infection. General cultural practices were followed, except for avoiding using insecticide treatments to encourage the population of whiteflies to contract the natural disease. The following formula calculated the percent disease incidence :

$$\text{Percent Disease Incidence (PDI)} = \frac{\text{Number of infected plants in a raw}}{\text{Total number of plants in row}}$$

Table-1 : Classification based on 1-9 scale for scoring of yellow mosaic disease adopted by Singh et al. (1988).

Scales	Percentage of plant foliage affected	Reaction
1	Mottling of leaves covering 0.1 to 5.0 per cent of leaf area	R
3	Mottling of leaves covering 5.1 to 10 per cent of leaf area	MR
5	Mottling and yellow discoloration of 10.1 to 25.0 per cent of leaf area	MS
7	Mottling and yellow discoloration of 25.0 to 50.0 per cent of leaf area	S
9	Severe yellow mottling on more than 50.0 per cent and up to 100 per cent of the leaf area	HS

Table-2 : Disease scoring of genotypes based on 1-9 scale for score.

S. No.	Genotype Name	Disease Reaction	Score	S. No.	Genotype Name	Disease Reaction	Score
1.	Virat (Check)	R	1	26	Satya	MR	3
2.	Shikha (Check)	R	1	27	Unnati	MR	3
3.	MH 421 (Check)	R	1	28	IPM 312-86K-1	R	1
4.	Urdi local (Susceptible check)	HS	9	29	DGG-1	R	1
5.	AKM 12-10	HS	9	30	TKMC-2-2-1	R	1
6.	SKUA-M-1046	S	7	31	MH 911	MR	3
7.	MH 309	MS	5	32	KM 2328	R	1
8.	COGG 912	S	7	33	MH 810	S	7
9.	GM-04-02	HS	9	34	KM 2342	R	1
10.	SM-11-75	MS	5	35	K 851	MS	5
11.	AKM10-7	S	7	36	RMG 1082	HS	9
12.	GM 08-06	S	7	37	DGG-4	R	1
13.	SGC 20	MS	5	38	PM-11-20	HS	9
14.	MH 934	S	7	39	PUSA 1471	S	7
15.	TBM-45	S	7	40	PUSA 1472	S	7
16.	IPM 312-19	R	1	41	IGKM-05-26-07	HS	9
17.	ML 512	R	1	42	AKM 10-13	MS	5
18.	Mung local nasurullaganj	MR	3	43	NDMK 14-24	R	1
19.	TBM-36	R	1	44	COGG-11-02	R	1
20.	CM-11-02	R	1	45	RMG-1030	R	1
21.	DGG-6	MR	3	46	PUSA 1471	MR	3
22.	ML 1299	MR	3	47	NVL 825	R	1
23.	VGG 04-11	R	1	48	ML 1907	R	1
24.	ML 2333	R	1	49	DGG-5	MS	5
25.	RMG 1004	R	1	50	TM 96-2	MR	3

Based on the scale used by Singh *et al.* (1988), the classification was performed in 1–9 scales. (Table-1)

Results and Discussion

Establishing effective breeding techniques necessitates breeders' understanding of resistance gene inheritance and gene function. This study aimed to investigate MYMV resistance in several mungbean genotypes. MYMV screening revealed a considerable variance in genotypes in terms of disease response. The fifty genotypes were divided into five groups based on the observed disease reaction.

Virat, Shikha, MH 421, IPM 312-19, ML 512, TBM-36, CM-11-02, VGG 04-11, ML 2333, RMG 1004, IPM 312-86K-1, DGG-1, TKMC-2-2-1, KM 2342, KM 2328, DGG-4, NDMK 14-24, COGG-11-02, RMG-1030, NVL 825, ML 1907 were among the 21 resistant genotype. Mung local nasurullaganj, DGG-6, ML 1299, Satya, Unnati, MH 911, PUSA 1471, TM 96-2 are moderately resistant varieties. MH 309, SM-11-75, SGC 20, K 851, AKM 10-13, and DGG-5 are moderately susceptible genotypes. Nine susceptible genotypes were SKUA-M-1046, COGG 912, AKM10-7, GM 08-06, MH 934, TBM-45, MH 810, PUSA 1471, PUSA 1472 and the remaining six genotypes viz., Urdi local, AKM 12-10, GM-04-02, RMG 1082, PM-11-20, IGKM-05-26-07 displayed highly susceptible reaction. Similar screening methods were employed by (8) to screen 120 germplasm lines under field condition, (9) calculated Percent Disease Incidence (PDI) and observed the differential response against MYMV, while (10) relied on disease severity index. PDI and mean disease severity index (DSI) together was employed by (11) to evaluate 35 genotypes. Similar techniques and results are observed in the studies of (12) and (13).

Breeding for resistant cultivars is an effective

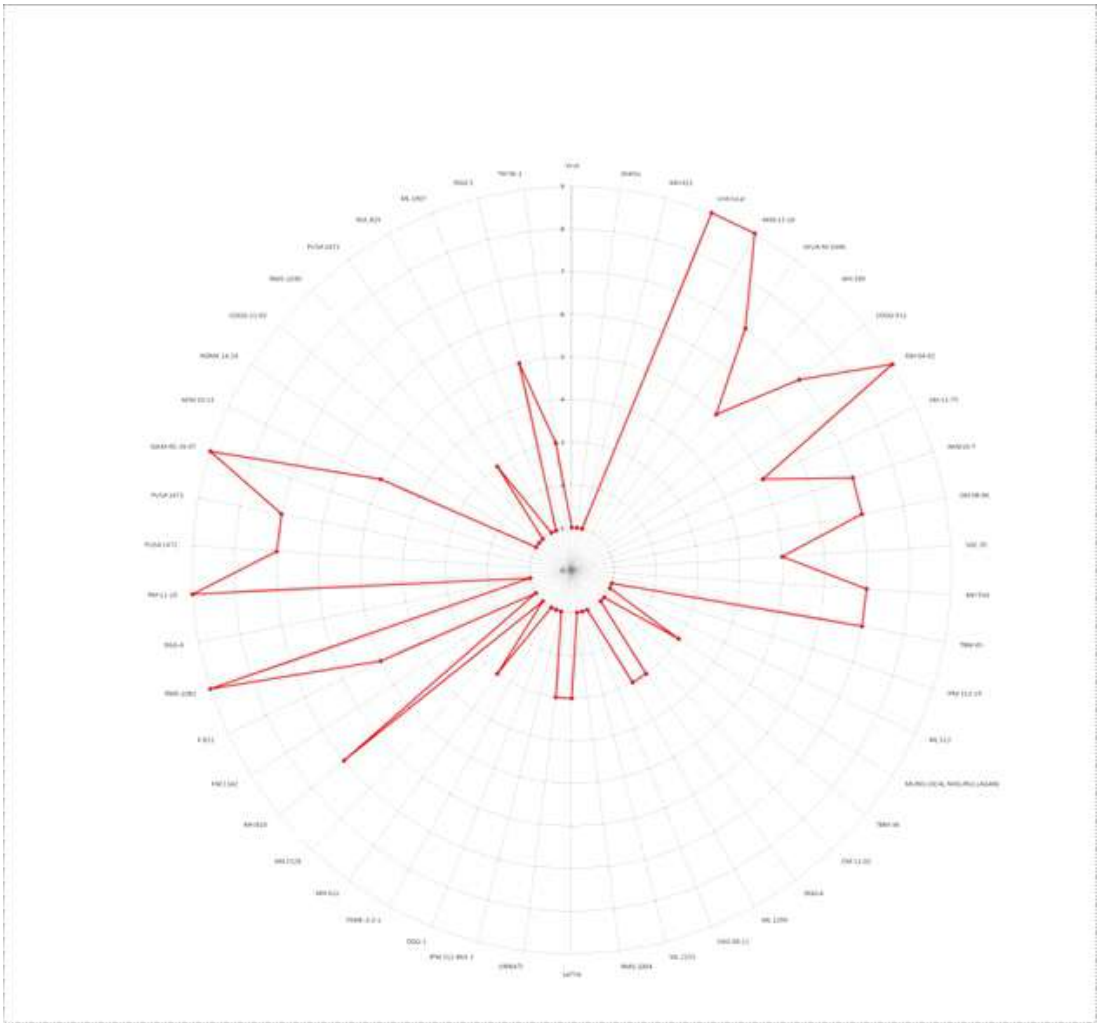


Figure-1 : Radar graph showing disease score of various genotypes.

technique for managing MYMV disease and preventing virus proliferation. However, because of the recessive nature of controlling the resistance mechanism in mungbean, breeding for disease resistance is problematic (14). These genotypes have the potential to be employed as parents in future breeding projects and validate the molecular marker, which can be aided by marker-assisted selection (MAS) for the improvement of YMV resistant mungbean breeding lines.

Acknowledgement

I am expressing my regards to Dr. Stuti Sharma for her guidance in preparing the manuscript and research. Assistance of Priya Tiwari, Shraddha Tomar, Shailja Goswami and Dr. Nidhi Pathak with data collection, data analysis, data interpretation and drafting of manuscript was commendable. I am thankful to all of the authors for their insightful comments, ongoing attention, encouragement, enlightening counsel, and gracious assistance in carrying out the necessary experiment.

References

1. Directorate of Economics and Statistics. (2019). Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture ad Farmers Welfare, Government of India, New Delhi.
2. Pathak, N., Singh, M.N., Mishra, M.K. and Saroj, S.K. (2013). Nature of gene action for yield and it's components in mungbean (*Vigna radiata*). *Indian Journal of Agricultural Sciences.* 85(4): 504-508.
3. Tiwari, P., Sharma, S. and Thakur, S. (2021). Diversity analysis of mungbean (*Vigna radiata* L.) Germplasm under different season. *The Pharma Innovation Journal,* 11(1): 52-57.
4. Bashir, M., Jamali, A.R., Ahmed, Z. (2006). Genetic resistance in mungbean and mashbean germplasm against mungbean yellow mosaic begomovirus. *Mycopathology.* 4(2): 1-4.
5. Green, S.K., Kim, D.H., Ingal, B.T., Maxwell, D. (2002). Mungbean yellow mosaic virus in the AVRDC Mungbean Improvement Program. *Workshop on Mungbean*. 159-173.

6. Sai, C. B., Nagarajan, P., Raveendran, M., Rabindran, R., Kannan Bapu, J. R. and Senthil, N. (2017). Understanding the inheritance of mungbean yellow mosaic virus (MYMV) resistance in mungbean (*Vigna radiata* L. Wilczek). *Mol. Breed.* 37: 63.
7. Singh, G., Kapoor, S. and Singh, K. (1988). Multiple disease resistance in mungbean with special emphasis on *Mungbean yellow mosaic virus.* In S. Shanmugasundaram (Ed.). *Proceedings of the Second International Symposium on Mungbean Vegetable Research and Development Centre.* 290–296.
8. Mohan, S., Sheeba, A., Murugan, E. and Ibrahim, S.M. (2014). Screening of mungbean germplasm for resistance to mungbean yellow mosaic virus under natural condition. *Indian Journal of Science and Technology*, 7(7): 891–896.
9. Bhanu, A.N., Singh, M.N. and Srivastava, K. (2017). Screening mungbean [Vigna radiata (L.) Wilczek] genotypes for mungbean yellow mosaic virus resistance under natural condition. *Adv Plants Agric Res*. 7(6): 00276.
10. Nadeya, K., Koul, V., Shankar, U., Ganai, S.A., Sharma, S. and Norboo, T. (2017). Screening of mungbean (*Vigna radiata* (L.) Wilczek) varieties against whitefly (*Bemisia tabaci* Genn.) and mungbean yellow mosaic virus (MYMV). *Int. J. Curr. Microbiol. App. Sci*. 6(8): 129-132.
11. Dharajiya, T., Ravindrababu, Y. and Pagi., N.K. (2018). Screening of mungbean [*Vigna radiata* (L.) Wilczek] genotypes for resistance against mungbean yellow mosaic virus (MYMV) under field condition. *Int. J. Curr. Microbiol. App. Sci.* 7(05): 3472-3483.
12. Nainu, A.J. and Murugan S. (2020). Screening of mungbean [*Vigna radiata* (l.) Wilczek] genotypes under field condition for resistance against mungbean yellow mosaic virus (MYMV). *Plant Archives.* 20(2): 6867-6871.
13. Bhaskar, A.V. (2021). Resistance to mungbean yellow mosaic virus disease in greengram. *The Pharma Innovation Journal*. 10(12): 1449-1452.
14. Shukla, G.P. and Pandya, B.P. (1985). Resistant to yellow mosaic in greengram. *SABRAO J*. 17: 165.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 776-780 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Farm Power Availability among All Agro-Climatic Zones in Uttar Pradesh-A Comparative Study

Tarun Kumar Maheshwari[1], Vipin Kumar Verma[2] and Pankaj Kumar[3]
[1]*Farm Machinery and Power Engineering, CAET, Etawah, U.P.*
[2]*College of Agricultural Engineering and Technology, Etawah, U.P.*
Email : maheshwari_tk@yahoo.com

Abstract

The gross area of the Uttar Pradesh is 24.2 million hectare, out of which 16.68 million hectare is the net sown area. The average size holding per farmer was only 0.83 ha. The small tractor i.e. power tillers, tractor prime mover, combine harvesters, diesel engines, electric pump sets, draught animals, agricultural workers are being considered as mobile power on which production and productivity of food grains depend. The power availability from different farm power sources i.e. agricultural worker, draught animal, power tiller, electric motor and diesel engine was determined by taking an average power of these sources 0.05, 0.38, 5.60, 3.70 and 5.60 kW respectively. But, available tractor power was calculated by taking an average power of 13.4, 18.7, 26.1, 33.6 and 41.0 kW for the power range of less than 14.9, 15.7-22.4, 23.1-29.8, 30.6-37.3 and greater than 38.0 kW respectively. The 15, 10, 6, 15 and 15 years respectively was considered as the average life of tractor, power tiller, combine harvester, electric motor and diesel engine. The level of mechanization i.e. total power availability on Indian farm was estimated by dividing sum of total power from all sources by total cultivated land of 140 million ha. For completion of timely farm operations, there is need to increase agricultural power acquirable from the present level of 1.75 kW per hectare to 4 kW per hectare by 2030. By 2030, in Uttar Pradesh, it is hope that about 70 per cent of unit farm operations i.e. tillage, sowing/planting, irrigation and threshing for all main crops will be fully mechanized and other unit operations for various crops will be mechanized up to 24–29 per cent. All 75-districts of UP may be stratified into 9-agro climatic zones strata, each zone consisting of many districts. The Uttar Pradesh is covered by into 9-agro climatic zones, 1. Bhabar and Tarai Zone 2. Western Plain Zone 3. Mid Western Plain Zone 4. South Western Semi-Arid Zone 5. Central Zone 6. Bundelkhand Zone 7. North Eastern Plain Zone 8. Eastern Plain Zone 9. Vindhyan Zone. Finally primary data was collected from all 9-agro-climatic zones for agricultural mechanization status i.e. 600 farmers and 40 farmers in each selected district in each agro-climatic zone as per the prepared proforma. In this present study, quantification of farm power availability was determined in all 9-agro climatic zones of Uttar Pradesh. The average value of farm power during 2018-19 in Central Zone, Eastern Plain Zone, South Western Semi-Arid Zone, Bundelkhand Zone, Bhabhar and Tarai Zone, Mid-Western Plain Zone, North Eastern Plain Zone, Vindhyan Zone, and Western Plain Zone were 2.18, 2.93, 3.41, 1.61, 3.70, 3.47, 2.53, 2.37 and 5.38 kW/ha respectively and was found 3.06 kW/ha in Uttar Pradesh which was 34.6% higher than country farm power availability. The farm power was highest in Western Plain Zone andwas lowest in Bundelkhand Zone. The highest and lowest value of farm power were 5.36 kW/ha and 1.61 kW/ha respectively.

Key words : *Farm power availability, agro-climatic zones, uttar pradesh, mobile power.*

Introduction

Uttar Pradesh is situated in northern India. The population of the state was about 200 million as per census of 2011, which accounted for 16.49 percent of the total population of India which comprises 77.73 percent lived in rural areas followed by 22.27 percent in urban areas (DPR, 15 January, 2018 Punjab *et al.*). The percentage of rural population of U.P. was higher than national figure of 68.84 percent (Ramendu Roy and Hasib Ahmad, 2015). The gross area of the Uttar Pradesh is 24.2 million hectare, out of which 16.68 million hectare is the net sown area. In Uttar Pradesh, the cropping intensity was about 153 percent as per 2011 census (Maheshwari and Tripathi, 2019). The small and marginal farmers community is dominated in UP. The average size holding per farmer was only 0.83 ha (Gaiagift, 2021). The average size per marginal farmer was about 0.40 hectare. The net sown area of Uttar Pradesh was calculated i.e. 11 percent of total area of India, which is approximately 20 % of the total food grain yield of the nation and contributes more than about 41 million tonnes of total food grain (Maheshwari and Dwivedi, 2020). The main cereal crops in the state are rice, wheat, groundnut, sugarcane, rapeseed, vegetables, fruits, bajra, maize, jower and barley. The UP produces 37.90% of Wheat, 22.83% of India's Paddy, 34% of Groundnut, 21% of Sugarcane, 17.5% of Rape-seed, 16% of Vegetables and 8% of Fruits, 3.57%, 2.68 %, 0.69% and 0.64% of bajra, maize, jowar and barley respectively. In India, Uttar Pradesh is the highest potato producer and is providing 43% of the total production. In U.P., the major pulses crop are the gram, urd, arhar and moong and had

Table-1 : Level of mechanization for major crops in India.

Major crops	Seedbed preparation	Mechanization levels for field operations, %		Harvesting and Threshing
		Sowing/ Planting/ Transplanting	Weeding and Intercultural and Plant protection	
Rice	70	20	30	60
Wheat	70	60	50	70
Maize	60	40	30	30
Sorghum and Millets	50	30	15	10
Pulses	50	40	20	25
Oilseed	50	40	20	25
Cotton	50	30	25	0
Sugarcane	55	10	20	10

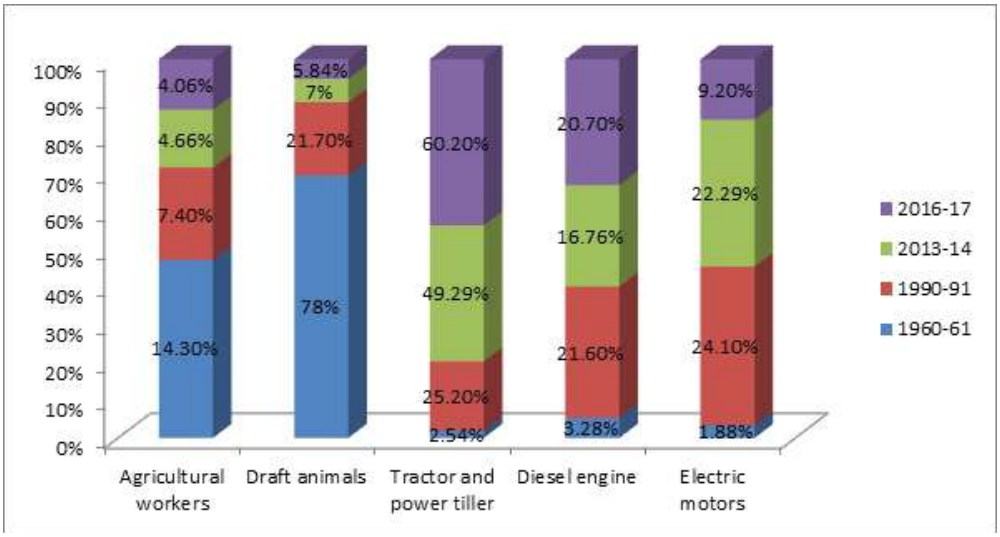


Fig.-1 : Share of different power sources in total power availability.

covered largest share i.e. about 2.4% after that about 2.1%, about 1.30% and about 0.30% of urd, lentil and moong respectively. The state is covered by four divisions i.e. Eastern (24 districts), Western (29 districts), Central (15 districts) and Bumdelkhand (7 districts). In UP state have 75 districts, 327 tehsils, 822 blocks and 107452 villages at present. The Uttar Pradesh is covered by into 9-agro climatic zones, 1. Bhabar and Tarai Zone 2. Western Plain Zone 3. Mid Western Plain Zone 4. South Western Semi-Arid Zone 5. Central Zone 6. Bundelkhand Zone 7. North Eastern Plain Zone 8. Eastern Plain Zone 9. Vindhyan Zone. The population density of UP state was about 830 persons in each kilometer square. The main cereal crops in the UP state are rice, wheat, bajra, barley and maize. Hence, Uttar Pradesh agriculture sector play a vital role in national economy. It is necessary to adopt area specific strategies for improving the agricultural sector growth in the states like UP for achieving the desired agriculture growth in India.

In Uttar Pradesh, during the year 2001, the farm power availability was 1.75 kilowatt per hectare. Although, the state should take more and more power farming in well timed and precisely to obtain agricultural work at minimum amount and obtaining highest use work efficiencies in pricey inputs and also to conserve available resources because it is highly populated, The important issues in the region is to economize water needed for various crops combining heterogeneity of crops helping to water resources and also use precision land leveling and efficient irrigation equipment. For completion of timely farm operations, there is need to increase agricultural power acquirable from the present level of 1.75 kW per hectare to 4 kW per hectare by 2030. Uttar Pradesh, it is hope that about 70 per cent of unit farm operations i.e. tillage, sowing/planting, irrigation and threshing for all main crops will be fully mechanized and other unit operations for various crops will be mechanized up to 24–29 per cent. As per the latest report sale of tractors was maximum in UP i.e. about 134719 tractors was sold in UP in 2018-19 and about 58 tractors were available per 1000 hectare of land area in 2018-19. The total mechanization levels were calculated by taking an

average of weighted mechanization levels operation wise and crop wise. The assessment of levels of farm mechanization for major cereals, pulses, oilseeds, millets and cash crops are shown in table-1. From the table-1, it is cleared that the seedbed preparation operation is highly mechanized i.e. more than 50% for major crops whereas harvesting and threshing operation is the lowest mechanized i.e. lower than 30% for major crops except for wheat and rice crops. The level of mechanization is higher in wheat and rice crops as compared to other crops in seedbed preparation. But mechanization level for wheat crop is the highest i.e. 60%in sowing operation. The planting/transplanting operation for sugarcane and rice crops has only 10 and 20% the mechanization levels respectively. However harvesting and threshing operations have more than 60% the mechanization levels in case of rice and wheat crops. The overall levels of farm mechanization was 45, 63, 40, 26, 34, 34, 26 and 24%, respectively for rice, wheat, maize, sorghum and millets, pulses, oilseeds, cotton and sugarcane crops. In India, overall farm mechanization level is 40%, which is lower than other developing countries such as Brazil - 75% and China - 59.5% (Fang, 2017).

The massively increase farm output in agriculture, farm mechanization is the process of using agricultural machinery up to great extent. Agricultural mechanization draws a major controversy in modern time that it is often considered only as the application of mechanical power technology especially tractors in agriculture field. But, the three main levels i.e. human power, animal power and mechanical power technologies within each level of mechanization technology need consideration with varying degrees of structure (Rijk, 1989), on the basis of accuracy, costs, effectiveness and capacity to do work (Morris, 1985). Further technology of agricultural mechanization varies from crop to crop and location to location. Hence the mechanization inputs quality, labor productivity and finally land may differ considerably (Gifford & Rijk, 1980). Thus, the quantification of level of mechanization for each crop production requires mechanization planning. It is very much important to identify the variables, which are having highly significance towards the mechanization, once the quantification of mechanization is done. This would help in monitoring the mechanization status in the specific region in combination along with other agronomic mechanization indicators. In this present study, quantification of level of mechanization i.e. farm power was determined for all 9-agro climatic zones of Uttar Pradesh. The different sources of power available on the Indian farm for doing various mobile and stationary operations are mobile power viz. human (men, women, children), Draught animals (bullocks, buffaloes, camels, horses and ponies, mules and donkeys), tractors, power tillers and self-propelled machines (combines, dozers, reapers, sprayers etc.); and stationary power i.e. diesel/oil engines (for pump sets, threshers, sprayers and other stationary operations) and electric motors (for pump sets, threshers, sprayers and other stationary operations). The share of different power sources in total power availability during different period is given in fig.-1.

Almasi *et al.* (2000) found a main problem in assess a mechanization parameter depend on the ratio of mechanical tractor field power to gross field power is that it never exhibit the actual use situation while unit agricultural power might be discuss as indicator of strength power present, it may not be totally necessarily utilized to the agriculture sector which may be based upon present of diesel as well as electric power and proper load in agriculture. For convey of farm and non-farm things, the most of the agricultural grower in undeveloped nations take different range tractor as per determined power availability i.e. level of mechanization with the help of following formula :

$$\text{Farm Power i.e. level of mechanization} = \frac{\text{Total Power}}{\text{Cultivated Area}}$$

The total available tractors power in kW = Mean PTO power of one tractor in kW x total number of field working tractors.

Total real power of tractors = Total PTO power of working tractors x coefficient (0.75).

Cattle energy (kWh) = Total existing cattle power x Annual functional hours.

Annual functional hours = Number of working days x Mean working hours during a day.

Total existing cattle power (kW) = Power produced by each cattle x Number of cattle.

Human energy (kWh) = Total exiting agricultural workers x Annual functional hours

Annual functional hours : Total agricultural workers x Mean functional hours during a day

Total exiting human hours (kW) : Produced power of each human x Number of humans

Materials and Methods

An appropriate sampling design for selection of sample for primary data collection with respect to agricultural mechanization status in all 9-agro-climatic zones of UP state, was stratified multistage sampling treating group of agro-climatic zone as strata, district as first stage, and block as second stage, village as third stage and farmers as ultimate stage units. All 75-districts of UP may be stratified into 9-agro climatic zones strata, each zone

Table-2 : Average values of Farm Power in different Agro-Climatic Zones of Uttar Pradesh.

Sl. No.	Agro-climatic Zones	Average Values of Farm Power (kW/ha)
1.	Central Zone	2.18
2.	Eastern Plain Zone	2.93
3.	South Western Semi-Arid Zone	3.41
4.	Bundelkhand Zone	1.61
5.	Bhabhar and Tarai Zone	3.70
6.	Mid-Western Plain Zone	3.47
7.	North Eastern Plain Zone	2.53
8.	Vindhyan Zone	2.37
9.	Western Plain Zone	5.38

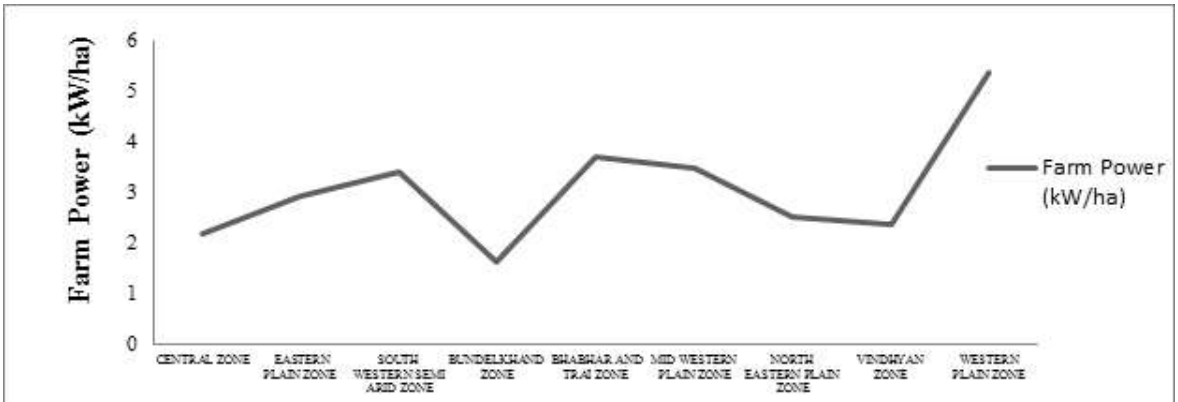


Fig. -2:Variation of Farm Power in different Agro-Cimatic Zones of UP

consisting of many districts. Agro-climatic zone districts criteria was based on neighborhood (geographical proximity) i.e. each agro-climatic zone at least one district was selected. From each district at least one block was selected by simple random sampling without replacement (SRSWOR). Within each selected district, block was sub-stratified into urban and rural. From each block i.e. urban/rural, few villages were selected by SRSWOR in proportion to the total no. of villages in the block. All the selected villages shall be completely enumerated for preparation of sampling frame i.e. listing of farmers involved in mechanization. The cost and time were the constraint then list of farmers involved in mechanization was prepared in consultation with deputy director agriculture (extension) of each district staff, those were fully engaged in particular block and have information of each block primary as well as secondary data along with headman knowledgeable person of the village. The total no. of farmers involved in mechanization in the villages shall be grouped into three categories i.e. (i) farmers having implements and supply the implements to other farmers on custom hiring, (ii) farmers having implements and do not supply the implements to other farmers on custom hiring and (iii) farmers not having implements and use them on custom hiring. Five farmers out of total no. of farmers shall be selected from each of the three groups by simple random sampling without replacement. Finally primary data on agricultural mechanization status was collected from 15 districts of all 9-agro-climatic zones i.e. 600 farmers and 40 farmers in each selected district in each agro-climatic zone as per the prepared proforma.

Level of mechanization (power availability) : Farm power is an essential input in agricultural production system to operate different types of equipment for timely field completion of agricultural works to increase productivity and maintain sustainability of farm. The mobile power is used for different field jobs like land preparation, sowing, weeding, spraying, and harvesting etc., whereas stationary power is used for lifting water, operating irrigation equipment, threshing, cleaning and grading of agricultural produce. The main sources of mobile power are human, draught animal, tractors, power tiller and self-propelled machines (combines, dozers, reapers, sprayers and etc.) where as the source of stationary power is oil engines and electric motors. The power availability was evaluated using formula given by Equation.

Power availability (hp/ha) = Total Power/Net Cultivated Area,

Where, Total power = Total mobile power + Total stationary power

Results and Discussion

Farm Power : The variation of farm power in different agro-climatic zones is given in figure 2. From the figure 2, it is much cleared that out of 9-agro-climatic zones, farm power was highest in Western Plain Zone and was lowest in Bundelkhand Zone. The highest and lowest value of farm power were 5.36 kW/ha and 1.61 kW/ha respectively. The average value of farm power in 2018-19 financial year in Uttar Pradesh was found 3.06 kW/ha. The average values of all 9-agro-climatic zones farm power are given in table-2.

Conclusions

The farm power availability of all 9-agro-agro climatic zones i.e. Central Zone, Eastern Plain Zone, South Western Semi-Arid Zone, Bundelkhand Zone, Bhabhar and Tarai Zone, Mid-Western Plain Zone and North Eastern Plain Zone were 2.18, 2.93, 3.41, 1.61, 3.70, 3.47, 2.53, 2.37 and 5.38 respectively. The average value of farm power in 2018-19 financial year in Uttar Pradesh was found 3.06 kW/ha, which 34.6% higher than country farm power availability.

References

1. Almasi, M., S. Kiani, and N. Louimi. 2000. Principles of Agricultural Mechanization. Ma'soumeh (PBUH) Publication. Ghom, Iran. PP. 19-40.
2. A Regional Proposal under NAFCC (2018): On Climate Resilience Building among Farmers through Crop Residue Management (For Punjab, Haryana, UP and Rajsthan State)
3. Fang, C. (2017). Development of agricultural mechanization in China. https://forum2017.iamo.de/microsites/forum2017.iamo.de/fileadmin/presentations/B5_Fang. pdf accessed on 09.03.2018
4. Gaiagift.net (2021): Annual rainfall of Uttar Pradesh
5. Gifford, R. C., and A. G. Rijik. (1980). Guidelines for Agricultural mechanization strategy in development. Economic and Social Commission for Asia and the Pacific (ESCAP), Regional Network for Agricultural machinery.
6. Morris, J., (1985). The economics of small farm mechanization. In 'Small Farm Mechanization for Developing Countries' (eds P. Crossley and Kilgour), pp. 171-184, John Wiley and Sons: New York.
7. Prof. Ramendu Roy and Hasib Ahmad (2015): State Agricultural Profile of Uttar Pradesh, Agro Economic research Centre, University of Allahabad, Allahabad: 211002.
8. Rijk, A. G., (1989). Agricultural mechanization policy and strategy-the case of Thailand. Asian Productivity Organization, Tokyo, Japan.
9. Tarun Kumar Maheshwari and Utkarsh Dwivedi (2020): Determination of Agricultural Mechanization Parameters for Western zone of Uttar Pradesh, Plant Archives Vol. 20, Special Issue (AIAAS-2020), 2020 pp. 276-28.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 781-784 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Variability Study in Pod Characters and Germination Parameters in *Pterocarpus marsupium* among Different Provenances of Odisha

T.L. Mohanty[1], P. Mallick[1], H. Nayak[1], M.C. Behera[1], S.G. Nair[1], B. Parimanik[2] and S. Behera[3]

[1]*College of Forestry, OUAT, Bhubaneswar*

[2]*KVK, Boudh, OUAT, Bhubaneswar*

[3] *AICRP on Agroforestry, OUAT, Bhubaneswar*

Abstract

A good seed source is needed for better establishment of plantation and to get higher return in short period. Selection of provenance helps in increasing the productivity for a particular species and site. Seed source showing higher may be selected as a good seed seed source for production of quality plnting material. The present investigation entitled "Provenance variation study of *Pterocarpus marsupium* in Odisha" was undertaken during the year 2019-2020 in the College of Forestry, Odisha University of Agriculture and Technology, Bhubaneswar, to find out the best provenance. In this experiment we evaluated seed (morphometric traits) and germination characteristics of bijasal, which was collected from 7 regions of Odisha. In the entire process of investigation it was found that there was significant variation in 100 seed weight, seed moisture content, germination parameters and nursery parameters, whereas seed length and seed diameter found to have no significant relationship between them. Pod width varied between 4.60 cm to 5.10 cm in M4 and M-3 respectively. Pod length varied between 5.93 cm to 5.3 cm with maximum for PM-3 and the minimum for PM-6. The 100 seed weight found to be maximum in PM-5 (68.19g) and the minimum for PM-7 (48.39g). The range of moisture content was between 9.13% to 19.20% with maximum for PM-2 and minimum for PM-1. All the seed parameters' are found to be positively correlated with each other. Among germination parameters germination percentage (53%), germination value (6.36) and mean germination time (20.24days) was found maximum in seed source PM-3, whereas PM-1 displayed high germination energy (33.33%). The seed source PM-5 recorded minimum value for Germination percentage (29.66%), Germination value (2.00). The provenance PM-6 displayed minimum germination energy (17.0%) and Provenance PM-7 recorded minimum value for mean germination time (13.55). PM-3 was found to be a superior provenance with respect to morphological and germination parameters.

Key words : *Provenance, seed, morhometric trais, germination parameters.*

Introduction

Pterocarpus marsupium roxb. belongs to family Fabaceae commonly known as 'bijasal' is a tall deciduous tree with spreading branches, large and round crown, stout and straight cylindrical clean bole. It is a deciduous tree with height reaches up to 30 meters. It is especially common in Madhya Pradesh, Maharashtra (Chandrapur and Bhandara), Andhra Pradesh, Odisha, West Bengal, Kerala, Tamil Nadu and Karnataka but absent in Assam. Major associates of bijasal are *Shore arobusta, Adina cordifolia* and *Mallo tusphilippensis*. Minor associates are *Cassia fistula*, *Terminalia alata*, *Acacia catechu*, *Dalbergia sissoo* and *Schleichera oleosa*.

The tree is commonly harvested for medicinal purposes as well as provides food and range of commodities. It is famous for its high-quality durable timber for furniture making. The heartwood of this tree is golden yellow. Heartwood is antibiotic and hypoglycemics in nature and is practiced to control blood sugar. It is grown as a shade tree in coffee plantation and is often cultivated as a multipurpose tree in home garden and as a component of agro forestry system in India and Sri Lanka. Commercial gum of importance obtained from the tree is known as kino gum which is used to treat diarrhoea. The powder or the decoction made from the bark is also used for treatment of diarrhoea, bleeding and gout. Decoction made from bark is medicinally used for diabetic patients and it also controls acidity being astringent in nature. The herbal tea made from bark of *Pterocarpus marsupium* is used in toothache, and intestinal parasites. The plant produces good quality leaf fodder and is used as manure in areca nut plantations.

Pterocarpus marsupium is heavily exploited for its timber, resin and medicinal bark. Its population is declining in India. The tree almost reaches the criteria for "vulnerable' 'but is currently listed as 'near threatened' in the IUCN red list of threatened species. Mainly found in moist or dry, mixed deciduous forests in hilly areas at elevations up to 1200m. *Pterocarpus marsupium* has been used in ayurveda, unani and homoeopathic medicine since long. Due to its vulnerability, existing pockets of *Pterocarpus marsupium* have to be identified, protected and conserved.

The use of the proper seed source is considered by many tree breeders to obtain large genetic gains in tree

Table-1 : Pod characters among different provenances.

Accession no.	Pod diameter (cm)	Pod length (cm)	100 Pod weight (gm)	Moisture content (%)
PM-1	4.73	5.57	55.85	9.13
PM-2	4.73	5.40	63.14	19.20
PM-3	5.10	5.93	63.68	13.37
PM-4	4.60	5.33	62.28	15.23
PM-5	5.00	5.90	68.19	15.27
PM-6	4.63	5.30	51.44	11.67
PM-7	4.80	5.40	48.39	10.90
SE	0.23	0.24	1.22	0.89
C.D .%	NS	NS	3.69	2.72
C.V.%	8.29	7.44	3.57	11.45

Table-2 : Germination parameters among different provenances of *Pterocarpus marsupium.*

Accession no.	Germination Percent (%)	Germination energy (%)	Germination value (%)	Mean germination time (days)	Seed vigour index
PM-1	48.66	33.33	5.34	17.80	1907.47
PM-2	43.0	19.0	4.18	17.28	1493.82
PM-3	53.0	31.0	6.36	20.24	2626.68
PM-4	38.33	26.33	3.33	19.63	810.29
PM-5	29.66	19.33	2.0	14.96	464.48
PM-6	37.0	17.0	3.08	15.48	695.6
PM-7	34.66	21.33	2.72	13.55	701.86
SE	1.72	1.85	0.29	0.80	123.86
C.D.5%	5.22	5.62	0.90	2.42	375.67
C.V%	7.34	13.44	13.41	8.15	17.30

improvement programme compared to other breeding methods (Zobel and Talbert, 1984). The importance of seed source contributing genetic variation in temperate trees in its place of origin than the individual tree differences is quite large compared to individual tree differences as reported by (Wright, 1976). The present study "Provenance variation study of *Pterocarpus marsupium* Roxb. in Odisha" was carried to assess the variations in seed characters and germination parameters among different provenances of *Pterocarpus marsupium.*

Materials and Methods

The present experiment "was conducted during 2019-20 in the nursery of College of Forestry, OUAT, Bhubaneswar, Odisha. The experimental field is located at 21^0 03' N Latitude and 86 ^{0}16' E Longitude with an average altitude of 25 meter above M.S.L.

The meteorological data between July'19 to June'20 was recorded at Meteorological Observatory of Odisha University of Agriculture and Technology, Bhubaneswar. The climatic parameters during study period were as follows with temperature ranged between minimum of 15.6^0c to maximum of 37.2^0c, relative humidity ranged between 72% to 91%, total rainfall during was 1488 mm with maximum of 398mm and 19 rainy days in the month of August'19 and bright sunshine hour varied from 3.5 to 5 hrs in the active growth period from july'19 to sept'19.

The mature and dried pods of *Pterocarpus marsupium* having brown colour were collected from selected plus trees during April-May 2019. The tree wise pods are spread separately on the floor under the shade for one week and stored in air tight plastic containers. The seeds collected from the seven seed sources in month of April were measured for seed characters. The experiment consisted of 7 provenances as treatments with 3 replication laid in CRD design in the nursery. Seeds were sown in polythene bags using complete randomized design with 3 replications. All the nursery operations like weeding, irrigation, fertilization, watering and intercultural operations were done in the field. Seeds collected from different regions of Odisha are treated as treatments as PM-1-Jamtalia (Sundergarh), PM-2-Beldungiri (Mayurbhanj), PM-3-Podapadar (Koraput), PM-4-Bargarh (sundargarh), PM-5-Sunki (Koraput), PM—6-Narayanpatna (Koraput), PM-7–Pithapata (Mayurbhanj). Seeds were soaked with cold

water for 24 hours before sowing in polypot. Daily recording of data on germination was taken up to 28 days to calculate different germination parameters. The following seed characters were studied sed length, seed diameter, 100 seed weight and seed moisture content. The germination parameters like germination (%), germination value, peak value, mean daily germination, germination energy, mean germination time (Czabatore, 1962) and seed vigour index (Zhu and Hong, 2008) were calculated.

The measurements of different parameters were used for analysis of variance (ANOVA) to understand the significance of differences among treatments. Critical difference (CD), Coefficient of variance (CV%), standard error and phenotypic correlation.

Results and Discussion

The results obtained from the present investigation are presented in Table 1 and 2 as follows :

Morphometric variation in pod characters

Pod diameter : Pod diameter did not show significant differences among different provenances. It ranged between 4.6 cm to 5.1 cm for provenances PM-4 and PM-3 respectively.

Pod length : Pod length was found non-significant with respect to the seeds collected from different seed sources. Seed length was recorded to be varied between 5.30 cm and 5.93 cm in provenances PM-6 and PM-3 respectively.

Pod Weight : 100 seed weight differed significantly among different provenances. The maximum seed weight was observed in PM-5 (68.19g) and the minimum for PM–7 (48.39g) which was statically at par with PM- 6 (51.43 g).

Pod Moisture Content : The moisture content of pod differed significantly among different provenances. The range of moisture content was recorded between 9.13%and 19.20%. Maximum moisture content was found in PM-2 (19.20%) while the minimum value was recorded for PM-1(9.13%) which was statistically at par with PM-7(10.90%) and PM-6 (11.67%).

Significant difference was not found in pod length and pod width among different provenances whereas other seed characters showed showed significant difference. Pod length was recorded to be ranging between 5.30cm and 5.93 cm, with maximum for PM-3 (5.93 cm) and the minimum for PM-6 (5.30 cm). Pod diameter ranged between 4.60cm to 5.10cm for seed sources PM-4 and PM-3 respectively.. Pod weight was found to vary between 48.39g and 68.19g, whereas the maximum pod weight (68.19g) was found in PM-5 and the minimum (48.39g) in PM–7. The range of moisture content was recorded between 9.13%and 19.20%. Minimum value was recorded for PM-1(9.13%) and maximum was for PM-2 (19.20%). Sreekumar and Gunaga (2017) reported significant differences in seed traits like seed length, seed weight, seed volume and seed density except seed width in *Calophyllum inophyllum* L. among 15 seed sources in a study conducted at Gujarat. Seed vigour determines the quality of planting material by assessing the performance during germination and emergence of the seedling. Seed vigour index was found to vary from 464.48 in PM-5 to 2626.68 in provenance PM-3.

Germination parameters of different provenances of *Pterocarpus marsupium*

Germination percent : The maximum germination percent (53.0%) was observed in PM-3, which was statistically at par with PM-1(48.66%). The minimum germination percent (29.66%) was recorded in PM-5.

Germination energy (%) : Germination energy ranged between 17.0% and 33.33% with maximum for PM-1(33.33%), which was found at par with PM-3 (31.0%). In contrast to it, the minimum value was recorded in PM-6 (17.0%).

Germination value : The maximum germination value of 6.36 was found in PM- 3, whereas the minimum value of 2.00 for PM- 5.

Mean germination time : Mean germination time was found to be varying between 13.55 and 20.24. The highest mean germination time was recorded in PM-3(20.24) which was at par with PM-4 (19.63), while the minimum germination time of 13.55 was found in PM-7.

Seed vigour index : The highest seed vigor index (2626.68) was found in provenance PM-3, while the lowest seed vigor index (464.48) was recorded in PM-5.

There was significant variation in germination percent, germination energy, mean germination time and germination value among different provenances. Significant variation observed with respect to pod germination percent of *Pterocarpus marsupium* seeds of different provenances. The significantly highest germination percent (53.0%) was observed in PM-3. However, the lowest germination percent (29.66%) was recorded in PM-5.The findings are consistent with the studies done by Das (2015) in *Aquilaria agallocha*, Luna *et al*. (2004) in *Albizia lebbek*. There was significantly different germination energy among different sources. Germination energy ranged between 17.0% and 33.33% with maximum for PM-1and the minimum estimate was recorded in PM-6.The present finding is consistent with the findings of Thapliyal, Singh *et al*. (2014) in *Abies pindrow*,

Wani and Wani *et al*. (2013) in *Madhuca indica* Gmel. and Ginwal & Mohit *et al*. (2000) in *Acacia nilotica*. According to the data, there was significantly different germination value estimated among different provenances. The maximum germination Value of 6.36 was found in seed source of PM- 3, whereas the minimum value of 2.0for PM-5. The present findings have been similar to findings of Loha*et al.* (2006) in *Cordia africana* Lam., Singh and Bhat(2008) in *Dalbergia sissoo*, Airi*et al.* (2009) in *Hoppophae salicifolia* and Luna *et al*. (2004) in *Albizia lebbek*. Data indicated that the estimates on mean germination time differed significantly with respect to the seeds collected from different provenances. Mean germination time was found to be varying between 13.55and 20.24. PM-3 source witnessed significantly highest estimate of 20.24 and the minimum germination time of 13.55 was found in PM-7. Similar type of findings has been reported by Wani and Wani (2013) in *Madhuca indica*.

There was significant variation observed in morphometric traits of pod like hundred pod weight and pod moisture content except for pod length and pod diameter. The maximum pod diameter (5.10 cm) and pod length (5.93cm) was found in PM-3 and seed vigour index was found to be maximum in PM-3 (2626.68). There was significant difference in germination parameters among different provenances. Germination percentage (53.0%), Germination value (6.36) and mean germination time (20.24 days) were found maximum in provenance.

Conclusions

PM-3 was found to be a superior provenance with respect to seed vigour index and could be recommended for collection of seeds for production of quality planting material.

References

1. Airi S, Bhatt ID and Rawat RS.2009.Variation in seed germination of *Hippophae salicifolia* with different pre-soaking treatments. *Journal of Forestry Research*, 20: 27-30.
2. Czabator, F.J. 1962. Germination value : An index combining speed and completeness of Pine seed germination. Forest Science. 8, 386-396.
3. Das N, 2015. The effect of different pre sowing treatment of on the germination of *Aquilaria agallocha* and *Shorea robusta* seeds in the nursery, *Indian Forester*, 141(3): 285-292.
4. GeraM, GinwalHS .2000. Genetic variation in seed germination and growth performanceof12 *Acacianilotica* provenances inIndia. *Journal of Tropical Forest Science*, 12(2): 286-297.
5. Ginwal HS, Gera M. 2000. Genetic variation in seed germination and growth performance of 12 Acacia nilotica provenances in India. *Journal of Tropical Forest Science*, 12(2): 286-297.
7. Luna RK and Nautiyal S. 2006. Seed source variation in Black Siris (*Albizia lebbek* Benth.), *Indian Forester,* 132(4): 149-155.
8. Loha A, Tigabu M, Teketay D.2006.Provenance variation in seed morphometric traits, germination, and seedling growth of *Cordia africana* Lam. *New Forests*, 32: 71-86.
9. Singh B and Bhatt BP. 2008. Provenance variation in pod, seed, seedling traits of *Dalbergia sissoo* ROXB., Central Himalaya, India. *Tropical Agricultural Research and Extension*, 11.
10. Sreekumar R and Gunaga R. 2017. Variation in fruit and seed traits among different seed sources of *Calophyllum inophyllum* collected from coastal regions of Konkan, India. *International journal of current Microbiology and Applied Sciences*, 6(12): 441-448.
11. Thapliyal M, Singh VRR. 2014.Variation in germination and seedling growth of abiespindrow Spach. (Royle) in Garhwal region of Uttarakhand, India. Nusantara *Bioscience*, 6(2): 125-128.
12. Wani MS and Wani AM.2013.Genetic variability and Association analysis in Madhuca indica Gmel,*Indian Forester,* 139(8): 692-698.
13. Wright JW. 1976. Introduction to Forest Genetics. Acad. Press. 436p
14. Zobel B and Talbert J. 1984. Applied forest tree improvement. *John Wiley and Sons,* New York.505
15. Zhu S Y and Hong D L. 2008. Comparison between two hybrid cultivars of indica rice in sseed vigour and biochemical traits after aging, *Chinese journal of Eco-Agriculture,* 16(2): 396-400.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 785-788 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Temporal Study of Area, Production and Productivity of Coffee in Kodagu District and Karnataka State

Thanuja P.[1*], G.L. Meena[1], Satish Kumar Yadav[3] and Babita Kumari[4]

[1]*Department of Agricultural Economics and Management, MPUAT, Udaipur-313001, India*

[2]*Division of Agricultural Statistics, ISRI, New Delhi*

[3]*Department of Agricultural Economics, SKRAU, Bikaner, Rajasthan*

**Corresponding Author Email : thanujapnt@gmail.com*

Abstract

Coffee is known as sage's milk and brown gold conquered third position among most transacted good in international market. India is the one of the most leading producer of coffee. Karnataka stands first in Area and production of coffee with having Kodagu District as the "coffee cup of India". The present study completely depended on secondary data collected from 2000-01 to 2019-20 and aimed to estimate compound growth rate in area and production of coffee in kodagu district as well as Karnataka state. Compound growth rate and Cuddy-della valle instability index was used for the study. The study revealed that the growth rate over years for both area and production under Kodagu district and Karnataka state was very less showing very less increase in both parameters. It may be due to the long life span of coffee plant. Instability in production and area of the state as a whole was highest compared to instability in area and production of Kodagu district.

Introduction

The coffee plant is a woody perennial evergreen dicotyledonous that belongs to the Rubiaceae family. As it grows to a relatively large height, it is more accurately described as a coffee tree. The two main species of cultivated coffee are Arabica coffee (*Coffea Arabica)* accounts for 75-80 percent of the world's production, and Robusta coffee (*Coffea canephora*) accounts for about 20 percent and differs from the Arabica coffees in terms of taste and beans are more robust.

The Arabs were the first to cultivate and also to trade coffee. Arabica coffee was introduced to India sometime during 1600 A.D. by a Muslim pilgrim; Baba Budan, raised seedlings on his hermitage on the hills near Chikmagalur of Karnataka.

Coffee, nicknamed as "Islamic milk" and "sage's milk", it is also used as an important therapeutic agent to stimulate heart and respiratory systems and as a diuretic. Coffee conquered the third most popular drink after water and wine. Coffee is now regarded as one of the main commodities of international trade. Today, coffee is a single largest commodity entering the international trade next to petroleum and petroleum products in the world.

There are about 125 countries that consume coffee and about 50 per cent of them produce coffee. The toppest coffee producing countries and their contribution is as fallows Brazil (33.16%), Vietnam (15.06%), Indonesia (11.60%), Colombia (10.39%), Mexico (4.73%), India (4.5%), Ethiopia (3.96%), Guatemala (3.3%), Honduras (2.90%), Uganda (2.83%) and others (7.57%) (International coffee organisation, 2011-12).

Indian coffee is known for the world's best shade-grown 'mild' coffees (COFFEE BOARD). Indian coffee industry earns a foreign exchange to the tune of about Rs.4000 Crore per annum. Coffee is cultivated predominantly in three states of India, namely, Karnataka, Tamilnadu and Kerala. Karnataka has a pride place in the production of coffee, accounting for 71.03 per cent of India's total production. Kerala, Tamil Nadu and non-traditional areas, account for 20.46, 6.68 and 1.83 per cent of country's total production respectively.

In Karnataka, coffee cultivation is confined to three districts, namely Kodagu, Chikmagalur and Hassan. These districts respectively account for 45.66, 38.99 and 15.45 per cent of the area, and 54.06, 34.10 and 11.84 per cent of the production of coffee in the state. With that Kodagu stands first in coffee production. It referred to as the 'Coffee Cup of India'.

Research Methodology

Present study is based on analysis of secondary data on Area, Production and productivity of coffee for the year from 2000-2019, at the district level (Kodagu) and state level (Karnataka). The data for the study has collected from various issues of 'Coffee Statistics' published by Coffee Board of India, Bangalore, and Indiastat.com. Analytical methods used for the study is discussed as follows:

Estimation of Growth Rates : The growth rates in area, production and productivity were studied estimating

Table-1 : Growth Area, production and productivity of coffee in Kodagu district and Karnataka state.

	Kodagu District			Karnataka		
	Area	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
R^2	0.72	0.34	0.50	0.80	0.28	0.50
CGR	1.52	0.77	-0.75	1.04	0.74	-0.3

Table-2 : Instability index of Area, production and productivity of coffee in Kodagu district and Karnataka state.

	Kodagu District			Karnataka		
	Area	**Production**	**Productivity**	**Area**	**Production**	**Productivity**
S.D.	9844.23	8918.94	106.52	15135.76	17276.82	80.89
AM	99243.65	111505.00	1130.48	224283.15	210899.00	942.69
IIN	5.25	6.50	6.66	3.02	6.95	6.07

compound growth rates at different periods. Compound growth rate of various categories were worked out on the basis of log-linear regression equations.

$$Y= ab^t u_t$$

Where,

Y= Area/ production / productivity of coffee.

a = intercept

t = Time in years

U_t = Error term.

b = growth rate over a time period i.e. 'r' and b=(r+1)

Where,

r=Compound growth rate.

$Y= a(r+1)^t u_t$

On making log transformation of this equation:

Log $Y=\log a+ \log (r+1)^t+ \log u^t$

Compound growth rate 'r' = (Antilog of b-1) x 100

Instability analysis : The instability index is a simple analytical technique for determining fluctuations or instability in time-series data. It was calculated as follows:

(i) Estimate the parameters of a log-linear trend line for the variable (Yt) for which instability is to be estimated.

(ii) If the estimated parameter will be statistically significant, then the instability index

(IIN) is defined as (by Cuddy-Della Valle)

$$IIN = CV \times \sqrt{1 - R^2}$$

Where CV= coefficient of variation for the time-series calculated as

$$CV = (SD \quad Mean) \times 100$$

Where, S.D. = standard deviation

(iii) If the estimated parameter in the regression equation in step (i) was found insignificant or R^2 <0, then the CV itself was the instability index.

Results and Discussion

Growth rate of Area production and productivity are presented in the table-1. It shows that the growth rate in area was positive for both in kodagu district (1.52) and Karnataka state (1.04). This showed that in comparison to the state, higher growth rate was taken place in area in Kodagu district under coffee plantation but no major difference was observed. This was due to perennial nature of the crop, once area occupied under coffee plantation has to be maintained for longer period of time. (Approximately 30 year of economic life span).

The analysis of coffee plantation in respect of production for the Kodagu district and karnataka state shows that the compound growth rate was positive in production of coffee for both Kodagu district and state as whole. But, the compound growth rate was revealed very low (0.77 % and 0.74% respectively) at both level, it was due to that there was a great fluctuation in production of coffee in Kodagu district during the period of 2000-01 to 2003-04. Thus, a great fluctuation was seen in production of coffee at state level.

In relation to productivity of coffee (kg/ha), the negative compound growth rate was estimated for both Kodagu district and state level. It was -0.75 % and -0.3% respectively. The analysis showed that productivity of coffee in Kodagu district and in Karnataka state has been widely fluctuating from 1022 kg per hectare in 2001-02 for Kodagu district and from 810 Kg/ha in 2001-02 for state level. In comparison to the karnataka state the higher productivity was recorded for Kodagu district during the entire period (from 2000-01 to 2019-20) more fluctuations was seen in productivity for karnataka state against the Kodagu district. The reason of less productivity and higher fluctuation was mainly due to climate change and higher age group of plants.

Thus, from the above discussion it can be revealed that compound growth rate in respect of area and production for Kodagu district as well as for karnataka

Table-3 : Area production and productivity of Coffee under Kodagu District and Karnataka State. (2000-01 to 2013-14).

Sl. No	Kodagu			Karnataka		
	Area (ha)	Production (MT)	Productivity (kg/ha)	Area (ha)	Production (MT)	Productivity (ha)
2000-01	81350	105885	1301.598	198750	210950	1061.384
2001-02	82350	111750	1357.013	200975	215350	1071.526
2002-03	82350	104820	1272.86	203138	191300	941.7243
2003-04	81900	92900	1134.31	203682	185550	910.9789
2004-05	87224	106825	1224.72	208552	210825	1010.899
2005-06	100079	105050	1049.671	222017	196275	884.0539
2006-07	101229	107500	1061.949	226316	196275	867.2608
2007-08	103325	105700	1022.986	225458	191575	849.7148
2008-09	103325	108395	1049.068	226900	183860	810.3129
2009-10	103580	111235	1073.904	227340	205700	904.8122
2010-11	103580	110230	1064.202	227750	213780	938.6608
2011-12	105380	115025	1091.526	229658	223425	972.8596
2012-13	104890	119190	1136.333	230333	230225	999.5311
2013-14	105427	111860	1061.019	213386	211100	989.287
2014-15	104922	1,22,120	1163.91	230434	2,33,230	1012.13
2015-16	104922	137,300	1308.59	230434	251,520	1091.51
2016-17	107089	1,19,860	1119.26	244785	2,21,745	905.88
2017-18	107089	1,16,550	1088.35	244785	2,22,300	908.14
2018-19	107296	1,10,730	1032.00	245288	2,19,550	895.07
2019-20	107566	1,07,175	996.37	245682	2,03,445	828.08

state as whole was recorded positive. But, in case of productivity the negative compound growth rate was noticed with higher fluctuating trend all the period of time. The success of failure of any improvement in the art of agriculture is measured by the resultant increase or decrease in the productivity (sonal gajbhiye et.,al). More fluctuation was noticed in productivity in comparison to area and production and hence less improvement.

Instability in Coffee : Instability measures the extent of variability of time series data. The cuddy della vella instability index was calculated and results were presented in the table 2. Instability index value below 15 denotes low instability, instability index between 15-30 denoted medium instability index and above 30 maximum instability.

Table-2 reveals that of area in kodagu district (5.25%) was higher than the CV of Karntaka state (3.02%). It reveals that though the instability was very less in area of coffee both in state and district, the instability was found to be high in Kodagu District compared to Karnataka state. It may be due to the stable contribution to an area of coffee by the other coffee cultivating districts of the state which contributed to the average area of the coffee in the state.

Production : The instability in Production of coffee was found to be more in Karnataka (6.5%) than in Kodagu district (6.95%). Instability in production in state reveals that total production of coffee as a whole was more instable.

Productivity : From table-2 it revealed that instability in productivity in Karnataka state was (6.6%) and in Kodagu state (6.07%).

Conclusions

Area and production of coffee in Karnataka and kodagu district reported higher and positive while CGR of productivity was negative, showing the decreasing productivity of coffee in study area. This decreased productivity denoted that coffee has reported less improvement over the time in Karnataka. This might be because of failure of rainfall, pest problem and lower management due to unavailability of labour force.

Instability in both production and productivity of coffee under state as a whole was found lowest it might because the coffee is a long duration crop and frequent change in area and hence production was not handy.

References

1. Ashalatha, (2000). “Export trade performance of Indian cashew”. *M.Sc. (Agri) Thesis, Uni. Agric. Sci.,* Bangalore.
2. Ashoka, N., Naik, B.K., Kulkarni, V.S. (2013). “Analysis of trends and instability in area, production and productivity of Indian coffee”. *International journal of Commerce and Business management*, 6(1): 103-107.
3. Dass, S.R., Vashist, A.K. and Singh, C. (1985). “Quantum,

Unit Value and Export Value of Coffee Exports". *Agril. Situ. Ind*, 39(10): 751-755.

4. Fialor, S., .1985, An analysis of the production pattern and marketing of cocoa in Ghana. *M.Sc. (Agri) Thesis, Uni. Agric. Sci.,* Bangalore.
5. Prakash, T.N., (1986). "A Study on Supply Response, Market Margins and Growth Rates of Indian Coffee". *M.Sc. (Agri.) Thesis, Univ. Agric. Sci.,* Bangalore.
6. Gairhe Samaya and Reddy S Vijayachandra, (2012). "Scenario of Coffee in India- An Overview". *Research Journal of Agricultural Sciences*, 3(1): 259-261.
7. Gajbhiye Sonal, Wankhade. R.n. and Kakde s.j., (2010). "Growth and instability of chickpea production in Vidarbha region of Maharasthra". *International Journal of Commerce and Business Management*, 3(2): 172-174
8. Gemtessa, K., (1991). "An analysis of the structure of Ethiopian coffee exports". *M.Sc. (Agri.) Thesis, Univ. Agric. Sci.*, Bangalore.
9. Indira, M., (1988). "An econometric analysis of coffee marketing in India". *Ph.D. Thesis, Institute for Social and Economic Change,* Bangalore.
10. Jeromi, P. D. and Ramanathan, A., (1993). "World market and India: An analysis of growth and instability". *Ind. J. Agric. Econ.,* 48(1): 88-97.
11. Misra, S. R., (1990). "Domestic consumption of tea in India 1961 to 1985". *Ind. Econ. J.,* 37 (3) : 42-52.
12. Ramchandra, V.A., (2006). Production and marketing of sapota in Northern Karnataka-An economic analysis. *M.Sc. (Agri.) Thesis, Uni. Agric. Sci.,* Dharwad (India).
13. Sharma, Amod and Kalita, D.C., 2008, Trends of area, production and productivity of major fruit crops in Jammu and Kashmir. *Agric. Situ. in Ind.*, 66(1): 15-17.
14. Singh, J. P., (1993). "Green revolution versus instability in food grain production in India". *Agribusiness*, 9(5) : 418-493.
15. Smita Shindgikar and Patil, M.T., (2006). Trends in exports of grapes from India. *Agric. Situ.* India, 63(8): 473-478.
16. Veena, U.M., (1992). "An Econometric Analysis of Indian Coffee Exports". *M.Sc. (Agri.) Thesis, Univ. Agric. Sci.,* Bangalore.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 789-792 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Non-Genetic Factors on Production Performance of *Pandharpuri* Buffalo Maintained at Organized Dairy Farm

U.S. Gaikwad*, V.R. Dhangada, M.G. Mote, S.A. Dhage and R.B. Shende
Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722 (MS)
**Corresponding Author Email : ulhasgaikwad7@gmail.com*

Abstract

The data pertaining to the production traits of *Pandharpuri* buffalo was collected from *Pandharpuri* Buffalo Improvement Project, Zonal Agriculture Research Station (ZARS), Shenda park, Kolhapur. A total of 355 records of 100 *Pandharpuri* buffaloes spread over a period from 1992 to 2020 were utilized to study the effect of period of calving, season of calving and lactation order on different production traits viz. TLMY, 305 DMY, LL, PMY and MY/LL. The Least squares mean for the LMY, 305 DMY, LL, PMY and MY/LL were analysed by least square method as described by Harvey (1990) The overall least square mean recorded for lactation milk yield (LMY), 305 days milk yield (305 DMY), lactation length (LL), peak milk yield (PMY) and milk yield per lactation length (MY/LL) were 1421.56 ± 27.56 kg, 1590.79 ± 39.28 kg, 282.41 ± 3.03 days, 6.942 ± 0.11 kg and 4.944 ± 0.07 kg respectively. The period of calving shows the significant effect on 305 DMY, LL. The season of calving had the significant effect on LMY, LL, PMY and MY/LL whereas shows non-significant effect on 305 DMY. The lactation order had non-significant effect on all the production traits except PMY and MY/LL.

Key words : *Pandharpuri buffalo, production traits, Non Genetic factor, reproduction traits.*

Introduction

As per the report unveiled by Department of Animal Husbandry and Dairying in 2019, there was an increase of 4.6% with total number of livestock population of 535.78 million in India over 2012 livestock census. The total buffaloes in the country are 109.85 million showing an increase of about 1.0% over previous census. The total milch animals (in milk and dry) in cows and buffaloes is 125.34 million, an increase of 6.0% over the previous census (20th livestock census). *Pandharpuri* buffalo is a water buffalo breed originated in Pandharpur tahasil of Solapur distict of Maharashtra also called as “Black Gold” of Maharashtra. It is native to town Pandharpur in Solapur, Kolhapur, Sangli and Satara districts of Maharashtra (M.H.). These breeds are hardy in nature and can produce 6-7 litres of milk even in adverse conditions. The drying off of an animal is important because udder needed rest prior to parturition. For the resuscitation of tissue secreting milk and preparation of udder for next lactation for optimal milk production performance dry period is important. The profit and success of Indian dairy sector is highly dependent on the production and reproduction efficiency of dairy animals. So, as to enhance the production performance of dairy animals, it is necessary to develop an understanding of the factors affecting production traits. Various non-genetic factors such as period of calving, season of calving and lactation order had effect on production and reproduction performances. Therefore, it is necessity to investigate and understand the effect of non-genetic factors on production performances to make improvement in management practices.

Materials and Methods

Source of data : The data comprising of 355 calving records of *Pandharpuri* buffalo spread over a period from January 1992 to May, 2020 were collected from the *Pandharpuri* Buffalo Improvement Project, Zonal Agricultural Research Station, Shenda Park, Kolhapur for the present investigation.

Location and climate : Zonal Agricultural Research Station (ZARS), Shenda Park, Kolhapur is located in South- West of Maharashtra state. It comes under the sub- montane zone of Maharashtra state and is situated at an elevation of 561 meters above the mean sea level on the 16^0 721’ North latitude and 74^0 2413’ East longitude. The maximum and minimum temperatures recorded were 30.4^{0}C and 17^{0}C, respectively.

History of herd and breeding programme : The Indian Council of Agricultural Research, New Delhi has sanctioned Network Project on *Pandharpuri* Buffalo Improvement in the IX five-year plan and started on 29/03/2001. An elite herd of 50 *Pandharpuri* buffaloes are being reared at Zonal Agricultural Research Station, Shenda Park, Kolhapur, Mashrashtra (India). Breeding bulls are produced from elite buffaloes and are reared on the farm. Breeding bulls reared are trained for semen donation and quality semen is freezed in the semen freezing laboratory established at Zonal Agricultural Research Station, Shenda Park, Kolhapur (Maharashtra

State) under Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar.

Classification of the data : The buffaloes calved during the entire period were divided into four periods as P_1 (1992-1999), P2 (2000-2008), P3 (2008-2015) and P_4 (?2015). Similarly, on the basis of season of calving data were grouped for rainy (June- September), winter (October-January), summer season (February-May) and coded as S_1, S_2 and S_3 respectively. Also, data were grouped on the basis of lactation order from 1 to 4 and coded as L_1 to L_4. The buffalo having four and above lactation were considered under group 4 and coded as L_4.

Least square analysis : The influence of various non-genetic factors on different traits except age at first calving were studied by least square analysis of variance by using the technique described by Harvey (1990). The two different models were constructed and used to study the effect of period of calving, season of calving and lactation order on different traits under study.

Model-I : The following model was used to study the effect of period of calving, season of calving and lactation order on all the production and reproduction traits except age at first calving.

$$Y_{ijkl} = \mu + P_i + S_j + L_k + e_{ijkl}$$

Where,

Y_{ijkl} = Observation on l^{th} parameter belonging to i^{th} period of calving, j^{th} season of calving, and k^{th} lactation order

μ = Overall mean

P_i = Effect of i^{th} period of calving (i = 1, 2, 3 and 4)

S_j = Effect of j^{th} season of calving (j = 1, 2 and 3)

L_k = Effect of k^{th} lactation order (k = 1, 2, 3 and 4)

e_{ijk} = Random error, NID with mean and variance (0, ^{2})

Model-II : The effect of season of calving and period of calving on age at first calving was studied by using following model.

$$Y_{ijk} = \mu + P_i + S_j + e_{ijk}$$

Where,

Y_{ijk} = Observation on k^{th} parameter belonging to i^{th} period of calving of j^{th} and season of calving.

μ = Overall mean

P_i = Effect of i^{th} period of calving (i = 1, 2, 3 and 4)

S_j = Effect of j^{th} season of calving (j = 1, 2 and 3)

e_{ijk} = Random error, NID with mean and variance (0, ^{2})

Duncan's Multiple Range Test (DMRT) : Duncan's multiple range test as modified by Kramer (1957) was used to make pair wise comparison among the least squares means within the different groups with the use of inverse elements and root mean squares for error. Whenever, the effects found significant. If the values are greater than ^{2}e, Z (P,ne) then the difference are considered to be significant.

$$(\bar{Y}i \quad \bar{Y}j) \quad \sqrt{\frac{2}{Cii \quad Cjj \quad 2Cij}}$$

If the value was greater $^2e, Z(P, ne)$ than then difference was considered to be significant.

Where,

$\bar{Y}i \quad \bar{Y}j$ = Mean difference between two subclasses

Cii = Corresponding diagonal element of i^{th} subclass

Cjj=Corresponding diagonal element of j^{th} subclass

Cij=Corresponding off-diagonal element of ij^{th} subclass

Z (p,ne)=Significant (P < 0.05 and P > 0.01) Studentized Range Value in Duncan's Table at number of higher mean in range chosen (p) and error degree of freedom (ne).

Results and Discussion

Least squares mean of various production traits is showed in table-2. The overall least squares mean for LMY, 305 DMY, LL, PMY and MY/LLwere 1421.56 ± 27.56 Kg, 1590.71 ± 39.29 kg, 282.41 3.02 days, 6.94 0.10 kg and 4.944 ± 0.07 kg respectively. The period of calving had significant effect on all the production traits. The buffaloes calved during P_2 had significantly highest LMY followed by buffaloes calved in P_1, P_4 and lowest in P_3. There was highly significant difference in LMY of buffaloes calved during different periods. These results were in complaince with Thiruvenkadan (2014), Verma (2016), Jakhar (2017) and Rathod (2017) in Murrah buffalo, Dangar (2018) in Jaffarabadi buffalo. Non-significant effect of period of calving on LMY was mentioned by Singh (2011), Gupta (2012) in Murrah buffalo. The significantly highest 305 days milk yield was obtained from the buffaloes calved during period P_2, The difference in 305 DMY during P_4, P_3 and P_1 were at par with each other. The significant effect of period of calving on 305 days milk yield was also commented by Suresh (2013), Naval *et al.* (2015), Jakhar *et al.* (2016), Rathod *et al.* (2017) and Verma *et al.* (2016) in Murrah buffaloes and Panicker et al. (2016) in Nagpuri buffaloes. However, non-significant effect of period of calving on 305 DMY was remarked by Chakraborty *et al.* (2010), Thiruvenkadan *et al.* (2014) in Murrah buffalo. lactation length (days) was highest in

Table-1 : Least square analysis of variance (Mean sum of square) for non-genetic factors affecting various production traits.

Source of Variation	LMY	305 DMY	LL	PMY	MY/LL
Period of Calving	1285255.96***	594815.71*	8223.33*	23.03***	9.49***
Season of Calving	1260026.36***	96591.69^{NS}	7579.65*	5.23*	7.23***
Lactation Order	267581.68^{NS}	279753.70^{NS}	521.35^{NS}	7.50*	2.43^{NS}
Error	193302.216	150826.17	2325.65	2.79	1.37

* P < 0.05; ** p < 0.01 NS = Non-Significant

Table-2 : Least squares mean for different production traits of *Pandharpuri* buffalo.

Effect	Traits				
	TLMY	305 DMY	LL	PMY	MY/LL
Overall Mean (μ)	1421.56 ± 27.56 (355)	1590.71 ± 39.29 (151)	282.41 ± 3.02 (355)	6.94 ± 0.10 (355)	4.95 ± 0.07 (355)
Period of Calving (Years)					
P_1 (1992-1999)	1424.24^{b} ± 47.80 (94)	1502.356^{b} ± 58.15 (51)	293.73^{a} ± 5.24 (94)	6.67^{b} ± 0.18 (355)	4.82^{bc} ± 0.13 (355)
P_2 (2000-2007)	1572.62^{a} ± 47.59 (91)	1746.16^{a} ± 53.26 (55)	288.17^{a} ± 5.22 (91)	7.70^{a} ± 0.18 (91)	5.33^{a} ± 0.13 (91)
P_3 (2008-2015)	1300.59^{b} ± 42.26 (119)	1528.88^{ab} ± 69.94 (32)	277.92^{ab} ± 4.64 (119)	6.75^{b} ± 0.16 (119)	4.61^{c} ± 0.11 (119)
P_4 (2015)	1388.80^{b} ± 63.04 (51)	1585.80^{b} ± 111.37 (13)	269.83^{b} ± 6.92 (51)	6.64^{b} ± 0.24 (51)	5.02^{ab} ± 0.17 (51)
Season of Calving					
S_1 (Rainy)	1378.02^{b} ± 51.71 (76)	1568.38± 66.81 (37)	278.24^{ab} ± 5.67 (76)	7.18 ± 0.11 (76)	4.89^{b} ± 0.14 (76)
S_2 (Winter)	1333.62^{b} ± 32.31 (207)	1558.11 ± 49.23 (78)	276.05^{b} ± 3.54 (207)	6.74 ± 0.12 (207)	4.71^{b} ± 0.09 (207)
S3 (Summer)	1553.04^{a} ± 52.34 (72)	1645.10 ± 68.90 (36)	292.95^{a} ± 5.74 (72)	6.90 ± 0.11 (72)	5.23^{a} ± 0.14 (72)
Lactation Order					
L_1	1370.41 ± 47.03 (96)	1508.71 ± 70.94 (39)	279.59 ± 5.16 (96)	6.56^{b} ± 0.18 (96)	4.84 ± 0.13 (96)
L_2	1497.83 ± 49.93 (82)	1706.40 ± 67.55 (38)	282.88 ± 5.48 (82)	7.26^{a} ± 0.19 (82)	5.20 ± 0.13 (82)
L_3	1424.13 ± 57.46 (62)	1601.11 ± 73.41 (30)	285.83 ± 6.30 (62)	6.95^{ab} ± 0.22 (62)	4.89 ± 0.15 (62)
L_4	1393.87 ± 44.34 (115)	1546.97 ± 62.67 (44)	281.37 ± 4.86 (115)	7.00^{ab} ± 0.17 (115)	4.86 ± 0.12 (115)

Similar superscripts within the column does not differ significantly. Figure in parenthesis indicate number of observations.

buffaloes calved during period P_1 followed by P_2, P_3 and lowest in P_4. The significant effect of period of calving on lactation length was also detected by Kushwaha *et al.* (2013) in Bhadawari buffalo, Pandey *et al.* (2015) in Murrah buffalo and Sawaliya *et al.* (2016) in Jaffarabadi buffalo. However non-significant effect was spotted by Thiruvenkadan et al. (2014) and Jakhar *et al.* (2016) in Murrah buffaloes and Rathod *et al.* (2017) in Surti buffalo. The PMY of buffaloes calved during period P_2 was higher than those calved in P_3, P_1 and P_4. Similar results were stated by Suresh (2013) in Murrah buffalo and Sawaliya *et al* (2016) in Jaffarabadi buffalo. However, non-significant effect of period of calving on PMY were remarked by Kundu *et al.* (2003) in Murrah and Das *et al.* (2015) in Swamp buffaloes. The MY/LL in buffaloes calved during P_2 was higher than buffaloes calved in P_4, P_1 and P_3. The findings of this research fortified the findings of Thiruvenkadan (2011) and Jakhar *et al.* (2017) in Murrah buffaloes.

The season of calving had significant effect on all the production traits except 305 DMY. The significantly highest LMY were observed in buffaloes calved during season summer season followed rainy and lowest in winter season. These results were in conformity with Kushwaha (2013) in Bhadawari buffaloes and Verma (2016), Jakhar (2017) in Murrah buffaloes. However, present results were incongruence with Singh (2011), Gupta (2012), Thiruvenkadan (2014) and Rathod (2017) reported in Murrah buffaloes and Dangar *et al.* (2018) in Jaffarabadi buffaloes. The highest lactation length was perceived in buffaloes calved during summer season followed by rainy and lowest in winter season. These results were in consistent with Naval *et al.* (2015) and Jakhar *et al.* (2016) in Murrah buffaloes. In *Pandharpuri* buffalo, the highest PMY was observed in buffaloes calved during rainy season followed by summer season and lowest in winter season. These results were in obedience with Thiruvenkadan *et al.* (2014) and Kaur *et al.* (2020) in Murrah. Whereas, non-significant effect of season of calving was noted by Kundu *et al.* (2003) and Jakhar *et al.* (2016) in Murrah buffalo and Sawaliya *et al.* (2016). MY/LL (kg) was higher in buffaloes calved during season summer season followed by rainy season and winter season. These results were similar to Thiruvenkadan (2011) in Murrah buffaloes.

The lactation order had non-significant effect on all the production traits except peak milk yield and MY/LL. The significantly highest PMY was observed during L_2 followed by L_4, L_3 and lowest in L_1 lactation. Similar results were perceived by Thiruvenkadan *et al.* (2014) and

Jakhar *et al.* (2016) in Murrah buffalo, Das *et al*. (2015) in Swamp buffalo and Sawaliya *et al.* (2016) in Jaffarabadi buffalo. The LSM of MY/LL (kg) was higher in buffaloes calved during lactation order L_2 followed by L_3, L_4 and lowest L_1. These results incongruence with the findings of Thiruvenkadan (2011) and Jakhar *et al.* (2017) in Murrah buffaloes, Ibrahim *et al.* (2012) in Egyptian buffaloes and Panicker *et al.* (2016) in Nagpuri buffaloes.

Conclusions

The overall least square mean for lactation milk yield (LMY), 305 days milk yield (305 DMY), lactation length (LL), peak milk yield (PMY) and milk yield per lactation length (MY/LL) were 1421.56 ± 27.56 kg, 1590.79 ± 39.28 kg, 282.41 ± 3.03 days, 6.942 ± 0.11 kg and 4.944 ± 0.07 kg respectively. The period of calving shows the significant effect on 305 DMY and LL. The season of calving had the significant effect on LMY, LL, PMY and MY/LL. Whereas, season of calving shows non-significant effect on 305 DMY. The lactation order had non-significant effect on all the production traits except PMY and MY/LL. It might be indicate that *Pandharpuri* buffalo breed is well adopted to Kolhapur district and their production performance can not be affected by most of the non-genetic (Climatic) factor. Further, it is recommended that this study must be correlated with larger data size for valid conclusion.

References

1. Chakraborty, D., Dhaka, S.S. and Pander, B.L. 2010. Prediction of lactation milk yield from test day records in Murrah buffaloes. *Ind J Anim Sci*.; 80(3): 244–245.
2. Dangar, N. S., Pawar, V.D., Ramani, U. V., Pandya, G. M., Kharadi, V. B. and Brahmkshtri, B, P. 2018. Non-genetics factors affecting age at first calving in Surti buffaloes. *International journal of Livestock Research*. Vol. 08(01): 43-49.
3. Das, A., Das, D., Goswami, R. N., Bhuyan, D. and Sinha, S. 2015. Effects of non-genetic factors on lactation milk yield and peak yield of Swamp buffalo and their repeatability. *Indian J. Anim. Res*., 49:418-419.
4. Gupta, J. P., Sachdeva, G.K., Gandhi, R.S. and Chakravarty and A.K. 2012. Non- genetic factors influencing growth and production performance in Murrah buffaloes. *Ind. J. Dairy Sci.* 65(3): 32-35.
5. Harvey W.R. (1990) Least-squares analysis of data with unequal subclass numbers. ARS H-4, U.S.D.A, Washington.
6. Ibrahim, M. A. M. 2012. Effect of enrollment in milk recording systems on improving milk production in Egyptian buffalo. *J. Animal and Poultry Prod., Mansoura Univ*., Vol.3 (1): 39–46.
7. Jakhar, V., Vinayak, A.K. and Singh, K.P.2016. Genetic evaluation of performance attributes in Murrah buffaloes. Haryana Vet; 55(1): 66–69.
8. Jakhar, V., Vinayak, A.K. and Singh, K.P. 2017. Effect of Non-genetic Factors on Performance Traits of Murrah Buffaloes: Review. International Journal of Current Microbiology and Applied Sciences 6(11): 4248-4255.
9. Kaur, R., Malhotra, P., Kashyap, N., Dash, S.K. and Kaur, S. 2020. Analysis of different non-genetic factors affecting production performance of Murrah buffaloes. *Ind J of Anim Res*., Vol. 54, Issue (4): 517-519.
10. Kramer, C.Y. 1957. Extension of multiple range tests to group correlated adjusted mean. Biometrics, 13(1): 13-18.
11. Kushwaha, P., Singh, S., Das, S., Maity, B., Singh, K. K. and J. Jayasankar. 2013. Production and reproductive performance of Bhadawari buffaloes in Uttar Pradesh, India. *Journal of Buffalo Science.* (2): 72-77.
12. Kundu, S., Pandey, R.S. and Singh, S.K. 2003. Non- genetic factors affecting some reproductive traits in Murrah buffaloes. *Indian J. Anim. Scie. Buffalo Bulletin.* Vol. 33 No. 3.
13. Nawal, K. P. and Raman Narang. 2015. Effect of non-genetic factors on persistency and milk production traits in Murrah buffaloes. *J. Anim. Res*., Vol. 5(3): 493-495.
14. Pandey, H., Tomar, A.K.S., Upadhyay and D. 2015. Effect of environmental factors on first lactation milk yield in Murrah buffaloes. *Buffalo Bulletin*, 34(4): 459-464.
15. Panicker, V.C., Sirothia, A.R. and Upadhyay, S.R. 2016. Production performance of Nagpuri buffalo under field condition. *Buffalo Bulletin*. Vol. 35 No. 4: 715-722.
16. Rathod, A.S., Vaidya, M.S. and Ali, S.S. 2017. Genetic Studies of Productive and Reproductive Attributes of Surti Buffalo in Maharashtra. *International journal of livestock research*. Vol. 8(08): 309-314.
17. Sawaliya, B. D. and Ahlawat, A. R. 2016. Non-genetic factors affecting economic traits in Jaffarabadi Buffalo at organized farm. *IJSAR*, 3(2): 69-76.
18. Singh, T. P., Singh, R. and Singh, G. 2011. Performance of production traits in Nili-Ravi buffaloes. *Ind J Anim Sci*.; 81(12): 1231–1238.
19. Sturges, H. 1926. The choice of class interval. Journal of American statistical association. Volume 21. 65-66.
20. Suresh, B. 2013. Production performance of Murrah buffalo at organized dairy farm production system in west Godavari district of Andhra- Pradesh. *Indian Journal of Applied Research,* Volume 3, Issue (8): 674-675.
21. Thiruvenkadan, A. K. 2011. Performance of Murrah buffaloes at coastal region of Tamil Nadu, India. *Indian Journal of Animal Sciences* 81 (10): 1080–1083.
22. Thiruvenkadan, A. K., Paneer Selvam S., Maruli, N., Selvam, S. and Ramesh Sarvanakumar. 2014. Milk production and reproductive performance of Murrah buffaloes of Tamil Nadu, India. *Buffalo Bulletin* 33(3): 291-300.
23. Verma, M. K., Sachdeva, G. K., Yadav, A. K., Gautam, S., Ali, M.M. and Santosh Kumar. 2017. Effect of genetic and non-genetic factors on milk yield and milk constituents in Murrah buffalo. *Indian J. Anim. Res*., 51(2): 2017: 387-390.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 793-796 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Bio-Chemical Study on Kashi Pragati of Okra Cultivar in Respect with Organics and Biofertilizers

Umakant Singh[1], Amit Kumar Pandey[2]*, Birendra Prasad[1], Santosh Kumar[2], Manoj Kumar[2], Ashutosh Singh[2] and Ashwini Choudhary

[1]*Regional Research Station, Agwanpur, Saharsa, Bihar, India*

[2]*Mandan Bharti Agriculture College, Agwanpur, Saharsa, Bihar, India*

**Corresponding Author Email : amitpandeybau@gmail.com*

Abstract

During the last era in India, the use of chemical fertilizer has increased tremendously. The excessive use of these chemicals leads to the degradation of soil quality, health as well as nutritional status. The experiment was conducted during July to December during two consecutive year 2018-19 in a factorial randomized block design with three replication with 16 treatments of organic manure and biofertilizer. Finding showed that in the various treatments, the organic and biofertilizer combination, 1/3 N through FYM +1/3 N through vermicompost + 1/3 N through neem cake with azotobacter and PSM had a significant effect on fruit quality characteristic and maximum total soluble solid (2.15° Brix), total sugar (2.83 mg/100g), ascorbic acid (14.00%) protein (15.10%), calcium (66.75 mg/100g) and magnesium (48.76 mg/100g) were recorded in these treatment.

Key words : *Okra, Manures, Biofertilizers, Quality*

Introduction

Okra is one of the most important vegetable crop growth in tropical and sub-tropical region and is said to be native of South Africa and Asia (Miglani *et al.,* 2017). In India it is cultivated almost in all states throughout the year and consumed by bulk of the people. Major okra growing states in India are Uttar Pradesh, Bihar and Orissa (Lakra *et al.,* 2017). The okra is also known as lady's finger or locally known as bhendi [*Abelmoschus esculentus* (L.) Moench] is one of the most important rainy and summer season vegetable crop, belongs to the family Malvaceae. It is commonly used for its tender parts. The dried stems and roots of okra used for clarification of sugar juice in gur or jaggery manufacture in India (Meena and Meena, 2018). Fully ripen fruits stem containing crude fiber are used in paper industries. Because of its richness in nutrition, taste, medicinal and industrial value okra is one of the most popular vegetables in all section of peoples. It can be grown in both the *rabi* and *kharif* season. All parts of okra like fresh leaves, buds, flowers, pods, stems and seeds can be used for different purpose and hence it is a multipurpose crop in term of its use (Singh and Ram, 2018). High iodine content of fruit helps to control gaiter. Okra is said to be very useful against genitourinary disorder, spermatoorrhoea and chronic dysentery (Bano *et al.,* 2018). The oil is used in soap and cosmetic industry while protein is used for fortified food preparation. The crushed seed is fed to cattle for higher milk production and the fiber is utilized in Jute textile. Okra fruit contains 89.6 g moisture, 6.4 g carbohydrate, 1.9 g protein, 0.2 g fat, 0.07 mg thiamine, 13 g vitamin C, 0.1 mg riboflavin, 66 mg calcium and 1.5 mg iron per 100 g of okra fruit (Dhaliwal, 2012).

In Bihar, the mixed farming system with livestock raising is an integral part of crop production. Farm yard manure is rich in nutrients basically using cow dung, cow urine, waste straw and other dairy waste. It is not only provided nutrients to the plant but also improves soil structure, besides improving the fertilizer use efficiency and microbial population in soil (Beno *et al.,* 2018). Vermicompost is a slow nutrient releasing organic manure which have most of the macro as well as micro nutrients in chelated forms and fulfil the nutrient requirement of plant for longer period (Meena *et al.,* 2019). Biofertilizers like azotobacter and PSB liberate growth promoting substances and vitamins and help to maintain soil fertility. Indiscriminate use of inorganic fertilizer has resulted in decreased nutrient uptake, poor quality of vegetables and deterioration of soil health. Okra produces fruit for a long times and need balanced and sufficient supply of nutrient for better quality the objective of this experiment is to develop a module for the organic production of okra.

Materials and Methods

Description of study site : The experiment was carried out a t Regional Research Station, Agwanpur, Saharsa, Bihar India located at 41 meter above mean sea level with coordinates of 25°52"50' N latitude and 86°48"62' E longitude. The experiment site's soil has pH 7.44, electrical conductivity 0.42 dSm^{-1}, with clay loam texture, low organic carbon (4.68 g kg^{-1}), and medium N, P, K and

Table-1 : Treatment details.

Treatment symbol	Details
T_1	75% N through FYM + 25% N through vermicompost + no biofertilizer
T_2	75% N through FYM + 25% N through vermicompost + azotobacter
T_3	75% N through FYM + 25% N through vermicompost + PSB
T_4	75% N through FYM + 25% N through vermicompost + azotobacter +PSB
T_5	50% N through FYM + 50% N through vermicompost + no biofertilizer
T_6	50% N through FYM + 50% N through vermicompost + azotobacter
T_7	50% N through FYM + 50% N through vermicompost + PSB
T_8	50% N through FYM + 50% N through vermicompost + azotobacter +PSB
T_9	25% N through FYM + 75% N through vermicompost + no biofertilizer
T_{10}	25% N through FYM + 75% N through vermicompost + azotobacter
T_{11}	25% N through FYM + 75% N through vermicompost + PSB
T_{12}	25% N through FYM + 75% N through vermicompost + azotobacter +PSB
T_{13}	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + no biofertilizer
T_{14}	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + azotobacter
T_{15}	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + PSB
T_{16}	1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + azotobacter +PSB

low in Zn & B (219 kg ha^{-1}, 17.50 kg ha^{-1}, 101 kg ha^{-1}, 0.72 mg kg^{-1} Zn and 0.48 mg kg^{-1} B), respectively. During the crop growing season the total rainfall was 1110 mm. The maximum and minimum temperature fluctuated from 30.8 to 42 ^oC while the minimum temperature fluctuated from 12.5 to 25 ^oC.

Experimental design : the field experiment has been conducted for two consecutive year between 2018 and 2019 to investigate the effect of additing different types of organic manure in different proportion with or without biofertilizer on biochemical composition of okra. The factorial randomized block design was used for the layout of experiment. There were 16 treatment combination with tree replications. The experiment was consisted for four levels of organic manure *viz*., FYM, vermicompost and neem cake and four levels of biofertilizer viz., azotobacter and PSB. Okra variety "Kashi Pragati" was sown at 50 x 45 cm^2 in a row to row and plant to plant spacing on 17th July, 2018. With a seed rate of 10 kg ha^{-1}. Total practicing were seven in number which measure in kg. Standard cultural practices recommended for okra was followed uniformity for all the experiment plots. FYM and vermicompost were applied after final land preparation. Microbial inoculant was applied through inoculation in two ways i.e. with seed and with organic manure.

Quality Characteristics

Total sugar : In a test tube, 5 mil of diluted juice extract and 4 ml of concentration HCl were added to it and kept it for 15 minutes at 68 ^oC in a boiling water bath. After cooling the test tube the acidity was neutralized by adding anhydrous sodium carbonate till the effectiveness stopped. The final volume was set at 50 ml with distilled water and using starch as indicator, the liberated iodine was titrated with a 0.01 N sodium thiosulphate solution. The disappearance of blue colour and the appearance of a milky white colour was the end point. A blank was also run simultaneously. The result were calculated using the following formula and expressed in per cent.

% Total sugar = Fehling's solution factor x 100 x dilution x volume of sample used x 1000

Ascorbic acid content : Ascorbic acid was determined following the method of Mukherjee and Choudhuri (1983). Fresh fruit and leaves (0.25 g) were homogenized with 6% trichloroacetic acid and 4 ml of supernatant was mixed with 2 ml denitrophenol hydrazine. One drop of 10% thiourea was added for 15 minutes and subsequently cooled then 80% H_2SO_4 (5 ml) was added.

Protein content : It was calculated by multiplying nitrogen per cent in fruit by the factor 6.25 as suggested by Gupta *et al.* (1972).

Total soluble salts : Total soluble sugar was measured by a manual hand Refrectometer. Calcium and magnesium content was determined by adopting standard procedures.

Results and Discussion

It was found that the various quality parameters viz., TSS, total sugar, crude protein, ascorbic acid, Ca and Mg content of fruit varied significantly due to various integrated nutrient management practices (table-1). The highest TSS (2.15^o brix) was recorded under the treatment

Table-2 : Effect of organic manures and biofertilizers on quality traits in okra.

Treatment	TSS (°Brix)	Ascorbic acid (mg/100g)	Crude protein (%)
T_1	1.75	12.39	12.89
T_2	1.76	13.43	13.43
T_3	1.77	13.29	13.29
T_4	17.78	13.55	13.55
T_5	1.79	13.59	13.59
T_6	1.80	13.73	13.78
T_7	1.81	13.62	13.62
T_8	1.82	13.82	13.82
T_9	1.89	14.08	14.08
T_{10}	1.90	14.16	14.16
T_{11}	1.90	14.10	14.10
T_{12}	1.91	14.19	14.19
T_{13}	1.93	14.28	14.28
T_{14}	1.97	14.73	14.73
T_{15}	2.04	14.34	14.34
T_{16}	2.15	14.00	15.10

receiving 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + azotobacter and PSB. However minimum TSS (1.75^o brix) was noted in the treatment 75% N through FYM + 25% N through vermicompost without azotobacter and PSB. The presence of minerals and antioxidants i.e. protein, phenol, carotenoid and ascorbic acid other than some osmoprotectant in addition to phytohormones such as indole-3-acetic acid might be the reason for the enhanced total soluble solids content (Abdallal, 2013).

Similar finding were also reported by Amiry *et al.* (2018). Singh and Ram (2018) reported that okra plants fertilized with FYM, vermicompost, neem cake with azotobacter and VAM performed best in terms of TSS. The effect of organic manure and biofertilizer upon fruit quality characteristics like total sugar was recorded significant. The highest total sugar (2.83%) was recorded in the treatment receiving 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + azotobacter and PSB. The overall significant trend was a follow $T_{16}>T_{15}>T_{14}>T_{13}>T_{12}$. Similar finding were also observed by Choudhary *et al.,* 2022; Hemalatha *et al.,* 2018 and Oyediran *et al.,* 2018. The present investigation revealed that ascorbic acid content in okra varied significantly with treatment. It varied from 12.39 mg/100 g to 14.00 mg/100 g under different treatment combination. Maximum ascorbic acid content was found in treatment receiving 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N /through neem cake integrated with azotobacter and PSB.

This could be explained on the basis of better availability of desired and required nutrients in root zone resulting from its solubilization caused by the organic acids produced from the decomposition of organic manure. The synthesis of ascorbic acid is closely associated with carbohydrate metabolism. Similar finding of increased ascorbic acid content of okra fruits with combined application of organic manure and biofertilizer were also reported by Mishra *et al.,* 2019 and Meena *et al.,* 2019.

The data pertaining in table-1 showed that protein of okra fruit ranged from 12.89 to 15.10 percent. The highest protein content of okra fruit (14.00%) was recorded in the treatment receiving 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + azotobacter and PSB. Application of organic sources of nitrogen might have increased the protein content of the okra fruit (Wagh *et al.,* 2014). The nutrient contained in FYM, vermicompost, neem cake in combination with azotobacter + PSB would have helped in enhancing the protein synthesis and helped in its effective storage in okra fruit. Similar results were reported in okra by Katharine *et al.,* 2016 and Kadam *et al.* (2017). Gayathri and Krishnavei (2015) reported that enhancement of protein content in okra with the application of organic manure and biofertilizer might be due to the availability of nitrogen leading to balanced C:N ratio enhancing the vegetative growth resulting in the higher photosynthetic activity. Data on Ca and Mg revealed that the treatments receiving 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake + azotobacter and PSB recorded higher nutritional value in okra in terms of Ca and Mg. Similar finding was also reported by Amiry *et al.,* 2018. Application of organic manure and biofertilizer had considerable impact on the quality features of okra. Because organic manure contains important nutrients in conveniently accessible form, they promote plant growth by giving vital nutrients to plant physiological activities. The application of organic manure improved the soil physico-chemical characteristics, enzymatic activity, hormone stimulation, microbial population. The increase in fruit quality could be attributed to a better supply of micronutrients.

Conclusions

From the present study it is clearly evident that application of 1/3 N through FYM +1/3 N through vermicompost + 1/3 N through neem cake either alone or in combination with azotobacter and PSB performs better than other treatments with respect to quality parameters of okra. Azotobacter inoculated with PSB proved its superiority in respect to quality traits of the plant.

References

1. Abdallal, M.M. (2013). The potential of *Moringa oleifera* extract as a biostimulant in enhancing the growth, biochemical and hormonal contents in rocket (*Eruca vesicaria* subsp. Sativa) plants. *International Journal of Plant Physiology and Biochemistry* ***5***(3): 42-49.
2. Amiry, Mohammad Nader; Anjanappa, M.; Ibaad, M.H.; Indiresh, K.M.; Patil, S.V.; Kumar, Anil S. and Ajaneya Reddy, B. (2018). Influence of integrated nutrient management on soil nutrient status, nutrient uptake and quality of okra (*Abelmoschus esculentus* L. Moench) cv. Arka Anamika under drip irrigation. *International Journal of Pure and Applied Bioscience* 6(1): 170-174.
3. Bano, Rukshana; Soni, A. K.; Singh, Jai; Singh, S.P. and Mahawar, Arun Kumar (2018). Efficacy of organic manures and bio-fertilizers on yield attributes and yield of okra var. Chameli. *International Journal of Current Microbiology and Applied Science* 7(9): 3668-3675.
4. Choudhary, Ramesh Chand; Bairwa, H.L.; Kumar, Uttam; Javed, Talha; Asad, Muhammad; Lal, Kanhaiya; Mahawer, L.N.; Sharma, S. K.; Singh, Pushpendra; Hassan, Mohamed M.; Abo-Shosha, Ali A.; Rajagopal, Rajinikanth and Abdelsalam, Nader R. (2022). Influence of organic manures on soil nutrient content, microbial population, yield and quality parameters of pomegranate (*Punica granatum* L.) cv. Bhagwa. *PLoS One* 17(4): 1-15.
5. Dhaliwal, M.S. (2012). Hand book of vegetable crops. Kalyani Publisher 2nd edition 226-235.
6. Gayathri, K. and Krishnavei, K. (2015). Effect of organic manures and inorganic fertilizers on certain quality parameters of okra [*Abelmoschus esculentus* L. Moench] cv. Arka Anamika. *Advance Research Journal of Crop Improvement* 6(2): 116-118.
7. Gupta, S. B.; Pathak, R. K.; Bhan, S. and Singh, A. (1972). Effect of NPK on yield, nutrient uptake and quality of toria. *Indian Journal of Agronomy* 17 (1): 88-91.
8. Hemalatha, M.; Selvi, D. and Vasanthi, D. (2018). Integrated plant nutrients supply and foliar nutrition on yield and quality of okra [Abelmoschus esculents (L.) Moench] hybrid COBhH-4 in Alfisols of Tamirabarani Command Area. *Madras Agriculture Journal* 105 (10-12): 517-523.
9. Kadam, D.; Kasture, M.; Dodake, S.; Dhopavkar, R. and Dademal, A. (2017). Effect of boron and Konkan Annapurna briquettes on yield, nitrogen use efficiency and nutrient uptake by okra (Abelmoschus esculents (L.). *International Journal of Chemical studies* 5(3): 214-217.
10. Katharine, S.P.; Mariappan, G.; Radhika, K. and Hemalatha, S. (2016). Influence of amino acid formulation on okra and brinjal. *Asian Journal of Soil Science* 11(1): 115-119.
11. Lakra, Reena; Swaroop, Narendra and Thomas, Tarence (2017). Effect of Different Levels of NPK and Vermicompost on Physico-Chemical Properties of Soil, Growth and Yield of Okra [*Abelmoschus esculentus* L.] var. Rohini. *International Journal of Current Microbiology and Applied Science* 6(7): 1398-1406.
12. Meena, D.C. and Meena, M.L. (2018). Effect of Integrated Nutrient Management on Growth Parameters of Okra [*Abelmoschus esculents* (L.) Moench]. *Chemical Science Review and Letters* 7(26): 582-585.
13. Meena, D.C.; Meena, M.L. and Kumar, Sanjay (2019). Influence of organic manures and biofertilizers on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench). *Annals of Plant and Soil Research* 21(2): 130-134.
14. Miglani, Abhinav; Gandhi, Navdeep; Singh, Navjot and Kaur, Jasreen (2017). Influence of different organic manures on growth and yield of okra. *International Journal of Advance Research in Science and Engineering* 6(1) 868-892.
15. Mishra, B.; Sahu, G.S.; Tripathy, P.; Mohanty, S. and Pradhan, S. (2019). Effect of organic and inorganic fertilizers on growth, yield and quality of okra under integrated nutrient management. *International Journal of Current Microbiology and Applied Sciences* 8(8): 66-73.
16. Mukherjee, S.P. and Choudhuri, M.A. (1983). Implications of water stress-induced changes in the levels of endogenous ascorbic acid and hydrogen peroxide in Vigna seedlings. *Physiologia Plantarum* 58(2): 166-170.
17. Oyediran, Oke Kingsley; Aseri, Gajender Kumar and Jain, Neelam (2018). Bio-filmed Bio-fertilizers and Organic Manure Application for Reducing Chemical Fertilizer in Sustainable Okra production. *International Journal of Agriculture Research* 13(2): 80-86.
18. Singh, Smriti and Ram, R. B. (2018). Biochemical study on kashi pragati of okra cultivar in respect with organic, inorganic and bio fertilizers. *Current Journal of Applied Science and Technology* 27(5): 1-5.
19. Singh, Smriti and Ram, R.B. (2018). Effect of organic, inorganic and bio-fertilizer on yielding and fruiting traits of okra [*Abelmoschus esculents* (L.) Moench]. *Journal of Pharmacognosy and Phytochemistry* 7(5): 90-93.
20. Wagh, S.S.; Laharia, G.S.; Iratkar, A.G. and Gajare, A.S. (2014). Effect of INM on nutrient uptake, yield and quality of okra [*Abelmoschus esculentus* L. Moench]. *An Asian Journal of Soil Science* 9(1): 21-24.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 797-800 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Organic Manures and Biofertilizers on Nutrient Concentration of Okra (*Abelmoschus esculentus* (L.) Moench)

Umakant Singh[1], Amit Kumar Pandey[2]*, Birendra Prasad[1], Santosh Kumar[2], Manoj Kumar[2], Ashutosh Singh[2] and Ashwini Choudhary

[1]*Regional Research Station, Agwanpur, Saharsa, Bihar, India*

[2]*Mandan Bharti Agriculture College, Agwanpur, Saharsa, Bihar, India*

**Corresponding Author Email : amitpandeybau@gmail.com*

Abstract

The present experiment was conducted at Regional Research Station, Agwanpur, Saharsa, Bihar, India during *Kharif*, 2018. To evaluate the impact of organic manure (farm yard manure, vermicompost and neem cake) and biofertilizer (Azotobacter, PSB and PSB + Azotobacter) on nutrient composition and its uptake of okra fruit. N, P and K content and its uptake by okra were found significantly affected due to 1/3 N through FYM + 1/3 N through vermicompost and 1/3 N through neem cake. Among different biofertilizer combined use of Azotobacter + PSB recorded significantly higher nutrient concentration and uptake by plants. Whereas superior values regarding the uptake of nutrients observed in the treatment receiving combination of FYM, vermicompost, neem cake and Azotobacter + PSB. The experiment was laid down in factorial randomized block design with sixteen treatments replicated thrice.

Key words : *Okra, organic manures, biofertilizer, nutrient uptake.*

Introduction

Okra (*Abelmoschus esculentus* L. Moench) belongs to malvaceae family commonly known as Bhindi and Lady's finger is a popular vegetable crop grown round the year and fetches premium price in the market (Mishra *et al.*, 2019). It is an annual vegetable crop grown in tropical and sub-tropical parts of the world mainly for its tender green fruit used as vegetables (Akhila *et al.,* 2019) while the roots and stems are used for preparing 'gur' or brown sugar (Chauhan, 1972). Okra is rich in vitamins, calcium, potassium and other nutrients. It is said to be very useful against genito-urinary disorder spermatoorrhoea and chronic dysentery (Yadav *et al.,* 2006). Due to its high iodine content, consumption of okra is good for the control goitre. Okra fruits contain 89.6 g moisture, 6.1 g carbohydrate, 1.9 g protein, 0.2 g fat, 0.07 mg thiamine, 13 g vitamin C, 0.1 mg riboflavin, 66 mg calcium and 1.5 mg iron per 100 g of okra (Dhaliwal, 2012).

The modern agricultural farming practices, along with irrational use of chemical inputs over the past four decades have resulted in not only loss of natural habitat balance and soil health but have also caused many hazards like soil erosion, ill effect on environment, reduced food quality and increased the cost of cultivation, rendering the farmer poorer year by year (Ram *et al.,* 2011). The continuous use of chemical fertilizers resulted in the decline in organic matter content of the agricultural soil leading to depletion of beneficial microorganism which in turn reduced the soil productivity. The agricultural land is diminishing exorbitantly and there is no scope for further expansion in area. Hence to meet the increasing demand, the crop production has to be increased per unit area of land (Baliah and Muthulakshmi, 2017). The demand of chemical fertilizers is keep on increasing widening the gap between the demand and supply such a gap would be difficult to bridge in the wake of the energy crises. Therefore the strategies for improving agricultural production should consider supplementing nutrients through microbial processes. This can be accomplished through the application of organic fertilizer (Meena and Meena, 2018). Organic farming a new agricultural production system involves locally and naturally available organic materials or agro inputs to meet the production system without endangering our precious natural resources. It is an ecological production management system that promotes and enhance biodiversity, biological cycles and soil biological activities (Kumar *et al.,* 2017). Organic manures generally improve the soil physical, chemical and biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop production. Biofertilizers are carried based preparation containing live cells of efficient strains of beneficial microorganism in a viable stale intended for seed, soil or root application with the objective of increasing the numbers of such microorganisms and accelerating certain microbial process to augment the extent of availability of nutrients in a farm which can be easily assimilated by the plants. Azotobacter, phosphorus solubilizing bacteria (PSB) contribute to the enhancement

Table-1 : Initial properties of experimental soil.

Sl. No.	Parameters	Value
1.	Soil pH (1:2 Soil : Water)	7.46
2.	Electrical Conductivity	0.43
3.	Organic Carbon (g kg^{-1})	4.60
4.	Available Nitrogen (kg ha^{-1})	224
5.	Available P_2O_5 (kg ha^{-1})	20.55
6.	Available K_2O (kg ha^{-1})	101
7.	Available Zn (mg kg^{-1})	0.76
8.	Available B (mg kg^{-1})	0.52

of nitrogen fixation and phosphate solubilization. The organic manure like vermicompost, FYM and neem cake with Azotobacter and PSB will further contribute to enhancement of N and P content. Hence, combination of organic manure and microbial inoculants provides an ideal nutrition strategies for the okra plant which is economical as well as ecological efficient.

Materials and Methods

A field experiment was conducted during the *kharif* season in light textured sandy soil of Regional Research Station, Agwanpur, Saharsa with four levels of organic manures and four levels of biofertilizer in factorial randomized block design with three replication. The experiment site was located in between 25°52"50' N latitude and 86°48"62' E longitude in agro-climatic zone-II of Bihar having hot moist sub-humid climate. Okra variety Kashi Pragati was sown at 50 x 45 cm^2 row to row and plant to plant spacing on17th July, 2018 with a seed rate of 10 kg. The recommended dose of fertilizers 120: 60: 40 N : P: K, respectively were applied in the form of organic sources viz., vermicompost, FYM, neem cake either alone or in combination with biofertilizers. The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were prepared according to layout. The seeds were soaked overnight and sown in the field directly, light irrigation was given just sowing of seeds. All the cultural practices were followed regularly during crop growth and observation were recorded on yield. Fruits from all treatments and replication were collected in separate paper bags for analysis. The collected samples were initially washed with tap water and then with 0.2 per cent detergent, 0.1 N HCl to remove the dust and again washed with distilled water, they were wiped with bottling paper and air dried for 2 days later over dried at 60 °C for 48 hours to a constant weight. The dried material is grounded into fine powder. The powdered samples were analyzed for N, P, K following the standard procedure at soil testing laboratory of Mandan Bharti Agriculture College, Agwanpur, Saharsa. Nitrogen in plant samples was determined by employing KELPLUS digestion and distillation system. Plant material of 1.0 g was digested with Conc. H_2SO_4. After digestion the resultant clear aliquot was transferred into distillation tube and distilled with 10 ml of 40 per cent sodium hydroxide. Thus ammonia liberated was absorbed in 4 per cent boric acid. The absorbed ammonia was titrated with 0.1 N H_2SO_4 in the presence of mixed indicator (Subbiah and Asija, 1956). One gram of dried and powdered plant material was digested in 10 ml of di-acid mixture HNO_3 and $HClO_4$ in 9:4 ratio. The extract was finally made up to 100 ml with distilled water and filtered through Whatman No. 1 filter paper. This solution can be used for the estimation of phosphorus and potassium. Phosphorus in the plant material was determined by Vanado-molybdo phosphoric yellow colour method with the help of spectrophotometer (Jackson, 1973). Potassium was determined by direct feeding of the extract to the flame photometer (Jackson, 1967). The data on these parameters were subjected to statistical analysis to draw logical conclusion.

Results and Discussion

Effect of Organic Manure : In this present study, the nutrient content of okra differ significantly due to the application of organic manure and biofertilizers (Table-3). Nitrogen content varied from 0.167 to 0.267 present under different organic manure levels. Highest N content (0.267%) was recorded in the treatment receiving 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake whereas minimum nitrogen concentration was recorded in the treatment 75% N through FYM + 25% N through vermicompost. The increased N content could be due to prolonged availability of nitrogen to the plant. This is a consonance with the finding of (Akhila *et al.,* 2019). The phosphorus content of okra differ significantly due to application of vermicompost, FYM and neem cake. The maximum phosphorus content was registered in the treatment having 1/3 N through FYM + 1/3N through vermicompost and 1/3 N through neem cake. Maximum P-concentration in this treatment may be due to solubilizing action of organic and released during the decomposition of organic manure which accelerate the mineralization of native as well as applied phosphorus (Mishra *et al.,* 2020). There was a significant differences found among the various treatments of organic manure like FYM, vermicompost and neem cake with respect to potassium concentration in okra fruit. The highest content of K was found in the plots treated with 1/3 of N through FYM + 1/3 of N through vermicompost and 1/3 N through neem cake. Potassium likely to be maintained in exchangeable form in the soil treated with organic manure which in turn might have restricted the K^+ ions getting fixed by inorganic clay particles in soil, increased the concentration of K (Prabu *et al.,* 2002). The better supply of nutrients have helped in

Table-2 : Chemical composition of organic manures used for the experiment.

Organic Manure	Nutrient Content									
	Organic carbon (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
FYM	10.22	0.68	0.32	0.73	0.72	0.18	114.42	62.24	15.30	2.40
Vermicompost	17.85	2.48	0.89	1.67	0.82	0.17	162.15	71.50	22.00	3.72
Neem cake		5.2	1.1	1.4	1.2	0.75	506.20	65.12	42.37	7.36

Table-3 : Effect of organic manures and biofertilizer on nutrient content in okra at harvest.

Treatments	N Content (%)	P Content (%)	K Content (%)
A. Organic Manures			
1. 75% N through FYM + 25% N through vermicompost	0.157	0.678	1.090
2. 50% N through FYM + 50% N through vermicompost	0.209	0.711	1.225
3. 25% N through FYM + 75% N through vermicompost	0.250	0.713	1.379
4. 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	0.267	0.731	1.549
CD (p = 0.05)	0.30	0.006	0.045
B. Biofertilizers			
1. No biofertilizer	0.132	0.687	1.144
2. Azotobacter	0.243	0.710	1.325
3. PSB	0.229	0.730	1.284
4. PSB + Azotobacter	0.277	0.749	1.491
CD (p = 0.05)	0.030	0.007	0.045

Table-4 : Effect of organic manure and biofertilizer on nutrient uptake by okra fruit at harvest.

Treatments	N-Uptake (kg ha^{-1})	P-Uptake (kg ha^{-1})	K-Uptake (kg ha^{-1})
A. Organic Manures			
1. 75% N through FYM + 25% N through vermicompost	13.68	55.83	89.36
2. 50% N through FYM + 50% N through vermicompost	25.38	83.69	146.30
3. 25% N through FYM + 75% N through vermicompost	32.26	96.48	183.08
4. 1/3 N through FYM + 1/3 N through vermicompost + 1/3 N through neem cake	38.93	107.90	222.92
CD (p = 0.05)	1.53	0.86	6.84
B. Biofertilizers			
1. No biofertilizer	13.46	66.30	112.32
2. Azotobacter	30.57	87.42	165.80
3. PSB	28.95	88.36	158.58
4. PSB + Azotobacter	38.27	101.91	204.93
CD (p = 0.05)	1.53	0.86	6.84

better absorption and utilization of all plant nutrients. Similar observations were also reported by Sharma *et al.* (2014) and Yadav *et al* (2016). Similar trends were also observed in case of N, P and K uptake of okra fruits.

Effect of Biofertilizer : The combined application of azotobacter and PSB could bring significant differences on nutrient concentration by okra (Table-3&4). The highest N, P and K content 0.277, 0.749 and 1.491 per cent, respectively were observed in azotobacter + PSB. Similarly the maximum uptake of N, P and K 38.27, 101.91 and 204.93 kg ha^{-1}, respectively were recorded in the azotobacter + PSB treatment. The increased concentration and uptake of N, P and K by okra in azotobacter + PSB treatment might be due to the additive effect of biofertilizers which might have provided better soil condition inclusive of improved soil fertility, nitrogen fixation, phosphate solubilization, enhanced the activities of other microbes and also released of growth stimulants. Active and rapid multiplication of microorganism in rhizosphere creating a favourable condition of nutrient availability and secretion of hormones like IAA, cytokinin and gibberellin (Manohar and Bahadur, 2001). Similar observations were also reported by Bamboriya *et al.* (2018), Mishra *et al.* (2020) and Akhila *et al.* (2019). Further, this is clearly indicated that a synergistic

indication between organic manure and biofertilizer which have resulted in enhanced yield and uptake of nutrients.

Conclusions

Application of FYM, vermicompost and neem cake appeared best in respect of yield sustainability, nutrient concentration and uptake of okra over other treatments. Azotobacter inoculated with PSB proved its superiority in respect of nutrient content and uptake of the plants.

References

1. Akhila, N.; Kumari, Anitha D.; Nayak, Hanuman M. and Vijaya, D. (2019). Impact of organic manures and biofertilizers on available NPK in soils and nutrient composition of okra fruit. *International Journal of Current Microbiology and Applied Sciences* 8(5): 622-631.
2. Baliah, T. N. and Muthulakshmi, P. (2017). Effect of microbially enhanced vermicompost on the growth and biochemical characteristics of okra (*Abelmoschus esculentus* (L.) Moench). *Advances in Plants and Agricultural Research* 6(5): 147-152.
3. Bamboriya, Jitendra Singh; Naga, S.R.; Sharma, S.R.; Choudhary, M.R. and Bamboriya, S.D. (2018). Productivity, quality and profitability of okra (*Abelmoschus esculentus*) as influenced by organic manures and biofertilizers. *International Journal of Bio-resource and Stress Management* 9(4): 506-509.
4. Chauhan, D.V.S. (1972). Vegetable production in India. (3rd edition) Ram Prasad and Sons, Agra.
5. Dhaliwal, M.S. (2012). Handbook of vegetable crops, Kalyani Publishers. 2nd edition 216-235.
6. Jackson, M.L. (1967). Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 205.
7. Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall Inc. Englewood Cliffs, New Jersey, USA.
8. Kumar, Vikash; Saikia, Jumi and Barik, Nishant (2017). Influence of organic, inorganic and biofertilizers on growth, yield, quality and economics of okra [*Abelmoschus esculentus* (L.) Moench] under Assam condition. *International Journal of Current Microbiology and Applied Sciences* 6(12): 2565-2569.
9. Manohar, R.K. and Bahadur, A. (2001). Response of okra to biofertilizers. *Vegetable Science* 28(2): 197-198.
10. Meena, D.C. and Meena, M.L. (2018). Effect of integrated nutrient management on growth parameters of okra (*Abelmoschus esculentus* (L.) Moench*). Chemical Science Review and Letters* 7(26): 582-585.
11. Mishra, B.; Sahu, G.S.; Tripathy, P.; Mohanty, S. and Pradhan, B. (2020). Impact of organic and inorganic fertilizers on growth, yield, nutrient uptake and soil fertility in okra (*Abelmoschus esculentus* (L.) Moench) cv. Pusa A-4. *The Pharma Innovation International Journal* 9(7): 210-213.
12. Mishra, B.; Sahu, G.S.; Tripathy, P.; Mohanty, S. and Pradhan, S. (2019). Effect of organic and inorganic fertilizers on growth, yield and quality of okra under integrated nutrient management. *International Journal of Current Microbiology and Applied Sciences* 8(8): 66-73.
13. Prabu, T.; Narwadkar, P.R.; Sajindranath, A.K. and Rathod, N.G. (2002). Effect of integrated nutrient managementon growth and yield of coriander (*Coriandrum sativum* L.). *South Indian Horticulture* 50(4-6): 680-684.
14. Ram, Moola; Davari, Mohammadreza and Sharma, S. N. (2011). Organic farming of rice (*Oryza sativa* L.) – wheat (*Triticum aestivum* L.) cropping system-a review. *International Journal of Agronomy and Plant Production* 2(3): 114-134.
15. Sharma, D.P.; Prajapati, Jagat Lal and Tiwari, Akhilesh (2014). Effect of NPK, vermicompost and vermiwash on growth and yield of okra. *International Journal of Basic and Applied Agricultural Research* 12(1): 5-8.
16. Subbiah, B.V. and Asija, C.L. (1956). A rapid procedure for the determination of available nitrogen in soils. *Current Sci.* 25: 259-262.
17. Yadav, J.R.; Shekhavat, A.K.S.; Ramadhar, Singh S.P. and Singh, B. (2006). Yield and chemical composition response of integrated nutrient management in okra (*Abelmoschus esculentus* (L.) Moench). *Progressive Agriculture* 6(2): 157-159.
18. Yadav, S.C.; Yadav, G. Gupta, G.; Prasad, V.M. and Bairwa, M. (2016). Effect on integrated nutrient management on quality and economics of okra (*Abelmoschus esculentus* (L.) Moench). *International Journal of Farm Sciences* 6(3): 233-237.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 801-804 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Forward and Backward Linkages Followed by the Farmers in Redgram Based Farming System

Ashok Kumar Melkeri[1*], S.K. Meti[1], S.B. Goudappa[1] and Suresh S. Patil[2]

Department of Agricultural Extension Education, University of Agricultural Sciences, Raichur, Karnataka

[2]College of Agriculture, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka

Abstract

The study was conducted to know the forward and backward linkages followed by the farmers in redgram based farming system in Kalaburagi district of North Eastern Karnataka. Kalaburagi district was purposively selected because the district is the pulse bowl of the state with highest area. The study was conducted in eight villages selected from four talukas of Kalaburagi district which included 30 farmers from each selected villages thus making a sample of 240 farmers using random sampling method. Ex-post-facto research design was employed for conducting study. Data was collected by using a detailed interview schedule employing personal interview method and analysed using mean, standard deviation, frequency and percentage. The major findings of the backward linkages in farming activities revealed that, 30.41, 36.25, 88.33 and cent per cent of the farmers had received information regarding land preparation, water management, nutrient management and plant protection chemicals from fellow farmer and input dealer. With respect to input purchase 38.33 and 24.16 per cent of the farmers purchased seed and seed treatment materials from KSDA. About 47.91 per cent of the farmers purchased organic manures *i.e.,* farm yard manure and vermi-compost from others/self. Large majority 95.00, 35.83, 100.00 and 21.66 per cent of the farmers purchased chemical fertilizer, growth regulators, plant protection chemicals and pheromone traps from the input dealers. In case of financial assistance 30.00 per cent of the farmers for input purchase took financial assistance from co-operative banks. Majority 72.08, 100.00, 86.25 and 93.33 per cent of the farmers for labour payment, storage and harvesting took financial assistance from others/self. The major findings from forward linkages revealed that 30.00, 26.66, 19.58, 10.00, 50.41 and 75.83 per cent of farmers received information from fellow farmer regarding grading the produce, packing, processing, storage, transportation and market price of the redgram.

Key words : *Backward linkage, forward linkage, farming activities, input purchase, financial assistance.*

Introduction

Redgram (*Cajanus cajan* (L) mill. sp.) is commonly known as arhar, pigeonpea, tur, togari, gango pea and no eye pea. It is an important and old crop of the country. It is the second most important pulse crop only after chickpea. Redgram is an important pulse crop grown in the tropics and subtropics. It finds important place in farming systems adopted by small holding peasants in large number of developing countries. Redgram is considered to be origin of peninsular India. It is a short annual crop in India and as a perennial in many other countries, where pods are harvested at regular interval. The crop has deep root system and hence highly drought tolerant. It is a protein rich staple food contains about 22.30 per cent protein, which is almost three times that of cereals. Redgram supplies a major share of protein, requirement of vegetarian population of the country. Redgram is mainly consumed in the form of split pulse as Dal, which is an essential supplement of cereal based diet (Nene and Sheila, 1990, Tuwafe *et al*., 1993).

India is the largest producer, consumer and importer of redgram in the world. India occupies 79.00 per cent of world redgram area and accounts for 67.00 per cent of world production of redgram. In India, redgram occupies an area of 4.44 million hectares and production of about 4.28 million tonnes, having a productivity of 967 kg/ha (INDIASTAT, 2017). It is mainly grown in Maharashtra, Karnataka, Madhya Pradesh, Telangana, Uttar Pradesh and Andhra Pradesh. Maharashtra (1.24 million hectares) is the leading producer of redgram followed by Madhya Pradesh (0.64 million hectares). In Karnataka, redgram is largely grown in northern parts, especially in Kalaburagi district and is called as pulse bowl of Karnataka. 'Kalaburagi Tur Dal' received Geographical Indication (GI) Tag (No. 593) from government of India during the year 2019. The state occupies an area of about 8.85 lakh hectares with the production of 7.62 lakh tonnes, having an average productivity of 861 kg/ha (INDIASTAT, 2017). Kalaburagi has an area of about 3.28 lakh hectares with production of 3.77 lakh tonnes and a productivity of 1209 kg/ha (Anonymous, 2017). Hence, it is evident that redgram crop command greater importance for attaining a better position in the world market, which would in turn contribute to our national income. At the same time, there is a need to concentrate on backward and forward linkage followed by the farmers in redgram based farming system. Backward linkage is operationally defined as the contacts

of the farmers with the agencies/institutes/individuals in supporting farm production activities in redgram. A list of organizations/institutes/individuals providing information, input purchase and financial assistance for crop production was prepared in consultation with the experts and farmers in crop production. A semi-structured interview schedule was developed by incorporating the factors enlisted which was used to obtain the responses of farmers. Forward linkage is operationally defined as contacts of farmers with agencies / organizations / individuals involved in supporting post production activities in redgram. A list of organizations / institutes / individuals providing information regarding post-harvest activities was prepared in consultation with the experts and farmers in crop production. A semi-structured interview schedule was developed by incorporating the factors enlisted which was used to obtain the responses of farmers. The procedure followed by jadhav (2009) was used with suitable modification. The tabulation of responses was carried out based on frequency and percentage.

Materials and Methods

The research study was conducted in Kalaburagi district of Karnataka state during the year 2018-19. Kalaburagi district was purposively selected because the district is the pulse bowl of the state with highest area. Out of seven talukas from the Kalaburagi district four talukas were selected purposively based on highest area under redgram cultivation. The talukas selected for the study were Aland, Chittapur, Jewargi and Kalaburagi. A list of villages where redgram is grown as principal crop is prepared in consultation with the officials of Department of Agriculture. Two villages from each talukas were selected based on maximum area under redgram cultivation. The villages selected for the study were Madan Hipperga and Narona from Aland taluka, Kalgi and Dandothi from Chittapur taluka, Yedrami and Nelogi from Jewargi taluka and Kamalapur and Srinivas Saradagi from Kalaburagi taluka. Thus a total of eight villages were selected from four talukas. Considering all the farmers in the selected villages, the criteria for selection of farmer as a respondent is that, he should successfully cultivate redgram crop. Along with redgram one or the other intercrops and enterprises like dairy (minimum two milch animals), sheep/goat farming (minimum of four sheep's/goat/unit), poultry rearing *etc*. From the each selected village, a separate list of redgram based farmers was prepared in consultation with officials of Department of Agriculture. From the list prepared, 30 farmers were selected randomly by using simple random sampling technique. Thus, the study sample comprised of 240 respondents. Ex-post-facto research design was employed for conducting study. Data was collected by using a detailed interview schedule employing personal interview method. The responses were scored, quantified, categorized and tabulated using frequency, percentage, mean and standard deviation.

Results and Discussion

Backward linkages followed by the farmers in redgram based farming system for source on farming activities, input purchase and financial assistance : Backward linkages followed by the farmers in redgram based farming system are grouped into three sources like farming activities, input purchase and financial assistance. Based on the frequencies each linkage was converted in percentage and presented in Table-1.

With respect to farming activities over one third (30.41%) of the farmers had received information regarding land preparation from fellow farmers followed by 17.50 per cent from UASR Scientist. Regarding water management, over one third (36.25%) of the farmers received information from fellow farmer followed by 15.41 per cent from UASR Scientists. Majority (88.33%) of the farmers had received information regarding nutrient management from input dealers followed by (47.91%) from KSDA. Cent per cent of the farmers had received information regarding plant protection chemicals from input dealers followed by 47.91 per cent from fellow farmer. This was observed due to the fact that farmers had linkage to a satisfactory level with KSDA, UASR Scientists and input dealer. As the study area comes under the jurisdiction of KSDA. The KSDA is the organization which provides technical guidance to the farmers regarding redgram based farming activities. The UAS, Raichur is imparting knowledge by conducting trainings, demonstrations, group meetings, individual contacts and visits to farmer's field to motivate them to adopt the redgram based farming system. Input dealers also play a major role in the plant protection chemicals many of the farmers if there is any incidence of pest or disease attack most of farmers go to input dealers and ask the control measures for that pest or disease and suggested sprayings are being taken by the farmers. Fellow farmers/neighbours are always considered as reliable source for information as they are in contact with each other in their day to day activities and also they are the easy source of information for the farmers.

Regarding input purchase over one third (38.33 %) of the farmers had purchased the seeds from KSDA followed by 19.16 per cent from input dealers. About 24.16 per cent of the farmers purchased the seed treatment materials from KSDA followed by 19.16 per cent from UASR scientist. Less than half 47.91 per cent of the farmers purchased organic manures *i.e.,* farm yard

Table-1: Backward linkages followed by the farmers in redgram based farming system for source on farming activities, input purchase and financial assistance. (n=240)

Sl. No.	Purpose	UASR Scientist		KSDA		Fellow Farmer		Input Dealer		Grower Association	
I.	**Source on farming activities**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1.	Land preparation	42	17.50	21	8.75	73	30.41	0	0.00	0	0.00
2.	Water management	37	15.41	18	7.50	87	36.25	0	0.00	0	0.00
3.	Nutrient Management*	88	36.66	115	47.91	108	45.00	212	88.33	0	0.00
4.	Plant protection chemicals*	47	19.58	55	22.91	115	47.91	240	100.00	0	0.00
II	**Input Purchase**	**UASR Scientist**		**KSDA**		**Fellow Farmer**		**Input Dealer**		**Own**	
		F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1.	Seeds	37	15.41	92	38.33	23	9.58	46	19.16	42	17.50
2.	Seed treatment chemicals	46	19.16	58	24.16	5	2.08	0	0.00	12	5.00
3.	Organic manures	17	7.08	33	13.75	38	15.83	0	0.00	115	47.91
4.	Chemical fertilizer (NPK & Micro-nutrients)*	18	7.50	63	26.25	0	0.00	228	95.00	0	0.00
5.	Growth regulators	5	2.08	15	6.25	0	0.00	86	35.83	0	0.00
6.	Plant protection chemicals*	16	6.66	43	17.91	0	0.00	240	100.00	0	0.00
7.	Pheromone traps	0	0.00	0	0.00	23	9.58	52	21.66	0	0.00
III	**Financial Assistance**	**Nationalised Banks**		**Co-operative Banks**		**Fellow farmer**		**SHGs**		**Own**	
		F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
1.	Input purchase	58	24.16	72	30.00	34	14.16	44	18.33	32	13.33
2.	Labour payment	0	0.00	0	0.00	29	12.08	38	15.83	173	72.08
3.	Storage	0	0.00	0	0.00	0	0.00	0	0.00	240	100.00
4.	Harvesting	0	0.00	0	0.00	15	6.25	18	7.50	207	86.25

F= Frequency, %= Percentage, * = Multiple responses UASR= University of Agricultural Sciences, Raichur
KSDA= Karnataka State Department of Agriculture SHGs= Self Help Groups

manure and vermi-compost from others/self. Majority (95.00 %) of the farmers purchased chemical fertilizer was obtained from input dealers. About 35.83 per cent of the farmers purchased growth regulators from input dealers. Cent per cent of the farmers purchased plant protection chemicals from input dealers. Whereas 21.66 per cent of the farmers purchased pheromone traps from input dealers. The probable reason for the above result indicates that seeds and seed treatment materials purchased from KSDA are of good quality once pest and disease resistant varieties to some extent. Nearly half of the farmers used organic manures *i.e.,* FYM/vermi-compost are being prepared in their own field to some extent some of the farmers are being brought from other farmers also. Majority of the farmers had purchased chemical fertilizers, plant protection chemicals and growth regulators from input dealers as they were in contact to nearby input dealers for fertilizers and chemicals most of the time.

In case of financial assistant less than half (30.00 %) of the farmers for input purchase took financial assistance from co-operative banks followed by 24.16 per cent from nationalized banks. Majority (72.08 %) of the farmers for labour payment took financial assistance from others/self, followed by 15.83 per cent from SHGs. Cent per cent of the farmers took financial assistance from self and used their own houses for storage purpose. Majority (86.25 %) of the farmers for harvesting took financial assistance from others/self, followed by 7.50 per cent from SHGs. The probable reason for the above result indicates that the farmers took financial assistance for input purchase from co-operative banks and nationalized banks as they have a wide network at grass root levels and are in vicinity of villages. Moreover, the interest rates of banks are very low as compared to other sources of finance but majority of the farmers did not take financial assistance for labour payment, storage and harvesting from co-operative banks and nationalized banks either they used their own money or from others because most of the farmers were educated up to high school level followed by illiterates and they were unaware about the subsidies which government is providing to the farmers and also majority of them were medium annual income category. The findings get support from the studies of Jadhav (2009).

Forward linkages followed by the farmers in redgram based farming system with respect to source of information on harvesting and marketing : The data presented in the Table 2 revealed that 30.00 per cent of the farmers received information from fellow farmer regarding grading the produce followed by 15.83 per cent from KSDA. With respect to packing 26.66 per cent of the farmers received information regarding packing from

Table-2 : Forward linkages followed by the farmers in redgram based farming system with respect to source of information on harvesting and marketing. (n=240)

Sl. No.	Purpose	Local traders		Commission agents		Co-operative society		APMC		UASR Scientist		KSDA		Fellow Farmer	
		F	%	F	%	F	%	F	%	F	%	F	%	F	%
1.	Grading	0	0.00	0	0.00	33	13.75	16	6.66	27	11.25	38	15.83	72	30.00
2.	Packing	0	0.00	0	0.00	31	12.91	26	10.83	0	0.00	0	0.00	64	26.66
3.	Processing	0	0.00	0	0.00	12	5.00	18	7.50	22	9.16	25	10.41	47	19.58
4.	Storage	0	0.00	0	0.00	28	11.66	15	6.25	0	0.00	0	0.00	24	10.00
5.	Transportation*	32	13.33	38	15.83	33	13.75	16	6.66	0	0.00	0	0.00	121	50.41
6.	Price*	53	22.08	58	24.16	35	14.58	125	52.08	0	0.00	0	0.00	182	75.83

F= Frequency, %=Per cent, *= Multiple responses APMC= Agriculture Produce and Marketing Committee
UASR= University of Agricultural Sciences, Raichur KSDA= Karnataka State Department of Agriculture

fellow farmer followed by 12.91 per cent from co-operative society. With regard to processing 19.58 per cent of the farmers received information regarding processing from fellow farmer followed by 10.41 per cent from KSDA. In case of storage 11.66 per cent of the farmers received information regarding storage from APMC followed by 10.00 per cent from fellow farmer. Half of the farmers (50.41 %) of the farmers received information regarding transportation from fellow farmer followed by 15.83 per cent from commission agents. Majority (75.83 %) of the farmers received the information regarding price from fellow farmer followed by 52.08 per cent from APMC. The probable reason for the above results indicates that, fellow farmers and co-operative society were most credible source of information to the farmers. KSDA and UASR, Scientists were next most important source of information to the farmers. The little per cent of farmers had contacted to obtain information regarding grading and processing. Whereas, very few per cent of farmers obtained information from APMC, commission agents and local traders regarding post-harvest activities. The APMC is at district level which becomes difficult for the farmers to contact frequently and obtain the information regarding post-harvest activities. The results are in close agreement with the findings of Jadhav (2009).

Conclusions

It can be concluded that majority of the farmers had not adopted forward linkages i.e., post-harvest activities and marketing behaviour such as grading, packing and processing of redgram. Because the farmers are in hurry to sell their produce due to economic compulsion, the policy makers and other agencies have to come forward to finance the growers in advance. So that purpose the farmers sell their produce after the harvest of the redgram crop they are not adopting the post-harvest activities in redgram. Hence we have to create awareness among the redgram based farmers regarding the importance of post-harvest activities and marketing behaviour for getting higher income through intensive extension activities.

References

1. Anonymous., 2017, Final estimates of area, production and productivity of important agricultural crops in Karnataka. *Directorate of Economics and Statistics.* Report, Bengaluru.
2. Avinash., 2017, An analysis of technological gap of ginger cultivation by the farmers in Bidar district of Karnataka. *M.Sc. Thesis, Univ. Agric. Sci.* Raichur.
3. Jadhav, B.A., 2009, Technological gap in adoption of recommended practices of mango cultivation. M.Sc. Thesis, Univ. Agric. Sci. Dharwad.
4. Lekhanath, T., 2016, A Study on technological gap and marketing behaviour of pomegranate growers in Koppal district of Karnataka. *M.Sc. Thesis, Univ. Agric. Sci.* Raichur (India).
5. Mohanakumar, V., 2016, Adoption of post-harvest management practices in pigeonpea crop for sustainable income. *Int. J. Sci. and Nature,* 7 (3): 492-495.
6. Nene, Y. L. and Sheila, V. K., 1990, Pigeonpea geography and importance, in Nene, Y. L., Susan, D., Hall and Sheila, V. K., the pigeonpea. *CAB international ICRISAT*, India. 1-13.
7. Sidram, 2015, A study on knowledge, perception and utilization pattern of organic inputs by the farmers in Karnataka state. *Ph.D. Thesis, Univ. Agric. Sci.* Dharwad (India).
8. Tuwafe, S., Silim, S.N. and Singh, L., 1993, ICRISAT/AFDB Pigeonpea importance project in Easter and Southern Africa. In: *Pigeonpea Newslett,* 12: 5-6.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 805-811 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Agroforestry Systems and there Importance in Agriculture : A Review

Devi Lal Dhaker[1], L.R. Yadav[1], Govardhan Lal Kumhar[2], Rayapati Karthik[3], Shivam Maurya[4] Rajendra Bairwa[5] and Dalip[6]

[1]*Department of Agronomy, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan*
[2]*Dept. of Genetics & Plant Breeding, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan*
[3]*Department of Agronomy, Prof. Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad*
[4]*Department of Plant Pathology, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan*
[5]*Department of Soil Science, Dr Rajendra Prasad Central Agriculture, Pusa, Samastipur, Bihar*
[6]*Dept. of Genetics & Plant Breeding, Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan*

Abstract

World has progressed so much since last century thanks to advanced technologies with the help of which we are able to find solutions within no time. Still improvement in farmer's income is not upto the mark because of change in environmental conditions, soil properties and research gaps. Modern agriculture management practices shall improve the production by taking environmental sustainability into account. Agroforestry is one of the few practices which improve farmer's income in a sustainable manner. Agroforestry is an age old practice yet a dynamic ecologically based natural resources management system that combines the crops and trees, diversifies the agricultural landscape. This system sustains production for increased social, economic and environmental benefits for land users at all levels.. The benefit derivable from the interface between forest trees and agricultural crops is vast which include the optimal use of land for both agricultural and forestry production on a sustainable basis including the improvement of the quality of soil. This is in addition to the socio-economic benefits that are accruable from agroforestry. Indeed the advantage of agroforestry is all encompassing and germane to a sustainable production system and livelihood. This paper highlighted Agroforestry practices and in sustainable land use systems.

Key words : *Carbon sequestration, agroforestry, plantation, climate change, sustainability.*

Introduction

In India, the organized research was initiated in early 1970s through industry participation in plantation of commercial tree species through Indian Council of Agricultural Research (ICAR) institutes. As follow-up, the All India Coordinated Research Project (AICRP) on agroforestry and National Research Centre for Agroforestry were established in 1983 and 1988, respectively by the ICAR. Presently, there are 37 Centre's of the AICRP on Agroforestry located in State Agricultural Universities, ICAR institute and ICFRE institutes working in network mode for conducting research work in different agro-climatic zones. Since then several agroforestry models/technologies has been developed for different agro-climatic regions. Agroforestry systems can be considered by several workers across the globe as a better climate change mitigation option than ocean, and other terrestrial options, because agroforestry provides ecosystem services such as carbon sequestration, biodiversity conservation, water quality enhancement and land degradation. Agroforestry was included in global programme such as reduced emissions from forest degradation and deforestation (REDD) related to climate change mitigation and adaptation.

In simplest language, agroforestry is the cultivation of trees with non-tree crops or livestock on the same plot of land. The crops can be cultivated in the same plot at the same time, in rotation, or even in separate plots when elements from one are used to benefit the other. This simplistic description, however, ignores the integrated ideas connected with agroforestry, which make this land management system probably the most self-sustaining and environmentally sound of any agricultural system. As a result, a second definition of agroforestry is the integration of trees, plants, and animals in sustainable, long-term systems. Agroforestry can be considered more as an approach than as a single, finished technology. Although several finished systems have been devised and tested, such technology may require adjustment for particular situations. The flexibility of the agroforestry approach is one of its advantages. Agroforestry has traditionally been a way of life and livelihood in India for centuries. The origin of agroforestry practices in India i.e. growing trees with food crops, grasses and other components is believed to have started during Vedic era, though agroforestry as a science evolved in recent years. The long history and diversity of agroforestry system and practice in the country have been widely reviewed (Tejwani, 1994; Pathak *et al.*, 2000; Sharda *et al.,* 2001; Prasad and Dhyani, 2010; Kumar *et al.*, 2012.) India has announced the landmark National Agroforestry Policy

2014 that will mainstream the growing of trees on farms to meet a wide range of developmental and environmental goals. For planning and implementation the Policy has recommended developing sound database and information system on agroforestry. However, at present unlike forest cover and area under crops, exact estimates for area under agroforestry is not available. The accurate assessment of area under agroforestry is being estimated by Central Agroforestry Research Institute, Jhansi using geospatial technologies in different agro-climatic zones. As per preliminary estimate, it has been estimated that area under agroforestry is 17.45 million ha in the country.

Contribution of Agroforestry in Indian Economy : Agroforestry contributes both tangible and intangible benefits to the Indian economy. On the one hand, it has aided in the restoration of degraded fields, while on the other, it has enhanced farm productivity. Agroforestry currently meets nearly half of the demand for fuel wood, 2/3 of the demand for small timber, 70-80% of wood for plywood, 60% of raw material for paper pulp, and 9-11% of the green fodder requirement of livestock, in addition to meeting the subsistence needs of households for food, fruit, fibre, medicine, and so on. Agroforestry is also playing the greatest role in maintaining the resource base and increasing overall productivity in the rainfed areas in general and the arid and semi-arid regions in particular. Industries have taken up poplar, *Eucalyptus*, bamboos, *Acacia, Casuarina*, *Ailanthus* and teak for commercial agroforestry due to their great market potential. Genetically improved clonal planting stock of eucalypts, poplars and acacias has transformed the productivity and profitability of plantations. Average yields from such clonal plantations are 20 to 25 times higher compared to the average productivity of forests in India. Almost 50 million plants of improved Eucalyptus are being planted every year (Dhyani *et al.,* 2015). In fact, agroforestry has high potential for simultaneously satisfying three important objectives *viz.*, protecting and stabilizing the ecosystems; producing a high level of output of economic goods; and improving income and basic materials to rural population. Besides, agroforestry is capable of conserving natural resources under different agro-climatic regions and is the only option to increase the forest/tree cover from present less than 25 to 33 per cent in the country.

Components of an Agroforestry System

Land : Agroforestry is not a balcony or greenhouse system of pots. It is a method of managing property for the benefit of the landowner, the environment, and the long-term well-being of society. While this is applicable to all landholdings, it is especially significant in hillside farming, where agriculture can result in rapid soil loss. If the farmer owns the property, he or she has a vested interest in thinking conservatively about how to keep the land in good shape for a long time. Unfortunately, farmers who rent land may be less interested in the long-term benefits of agroforestry, and may even be concerned that making changes may result in higher rent or the lease being terminated.

Trees : In agroforestry, particular attention is placed on multiple purpose trees or perennial shrubs. The most important of these trees are the legumes because of their ability to fix nitrogen and thus make it available to other plants. The roles of trees on the small farm may include the following :

(1) Sources of fruits, nuts, edible leaves, and other food.

(2) Sources of construction material, posts, lumber, branches for use as wattle (a fabrication of poles interwoven with slender branches etc.) and thatching.

(3) Sources of non-edible materials including sap, resins, tannins, insecticides, and medicinal compounds.

(4) Sources of fuel.

(5) Beautification.

(6) Shade, Soil conservation, especially on hillsides.

(7) Improvement of soil fertility.

In order to plan for the use of trees in agroforestry systems, considerable knowledge of their properties is necessary. Desirable information for each species includes its benefits, adaptability to local conditions (climate, soil, and stresses), the size and form of the canopy and root system, and suitability for various agroforestry practices. Some of the most common uses of trees in agroforestry systems are :

(1) Individual trees in home gardens, around houses, paths, and public places.

(2) Dispersed trees in cropland and pastures.

(3) Rows of trees with crops between (alley cropping).

(4) Strips of vegetation along contours or waterways.

(5) Living fences and borderlines, boundaries.

(6) Windbreaks.

Agroforestry Systems :

Range and Classification of Agroforestry : The range and classification of agroforestry practices are the following.

Agro silvicultural : Agrosilviculture was aptly regarded as a variant of taungya to be practiced outside of forest reserve (Nwoboshi, 1982). It envisages multiple land use

Table-1 : Trees or Large Shrubs with Edible Products for Agroforestry Systems.

Species	Common Name	Edibility	Principle Uses
Anacardium occidentale	Cashew	flowers, seeds, fruit	garden, fence, pasture
Annona muricata	Soursop	flowers, fruit	garden, fence, pasture
Borassus aethiopum	Borassus palm	multiple food uses	garden, pasture
Cajanus cajan	Pigeon Pea	seed, leaves	hills, nitrogen fixation, fuel, hedgerows
Carica papaya	Papaya	flowers, fruit	garden, quick shade
Cnidoscolus aconitifolius	Chaya	Leaves	rapid hedge
Cocos nucifera	Coconut	multiple food uses	pasture, roadside, construction
Coffea arabica	Coffee	seeds (bean)	hedges, hills, fuel
Gliricidia sepium	Mother of Cacao	Flowers	living fence, feed, fuel
Leucaena leucocephala	Leucaena, Ipil Ipil	leaves, young pods	hills, alley cropping, nitrogen fixation, fuel
Manihot esculenta	Cassava	roots, leaves	rapid hedge
Moringa oleifera	Moringa, Drumstick	leaves, flowers, pods	fence, garden
Psidium guajava	Guava	flowers, fruit	pasture, fuel
Sauropus androgynus	Katuk	Leaves	hedge, alley cropping
Theobroma cacao	Cacao	pulp, seeds	understory tree, pasture
Yucca guatemalensis	Izote	Flowers	Hedge
Ziziphus mauritiana	Jujube	flowers, fruit	erosion control, fuel

Table-2 : Principle Trees for Agroforestry Systems (Especially For Hillsides).

Species	Common Name	Principal Uses
Bursera simaruba	Gumbo limbo	living fences, fuel, forage
Calliandra calothyrsus	Calliandra	vegetation strips, fallows, windbreaks, fuel
Erythrina berteroana	Pito	living fences, forage, rapid cover, nitrogen fixing
Faidherbia albida	Apple-ring acacia	terraces, dispersed trees, forage, nitrogen fixing
Gliricidia sepium	Mother of Cacao	living fences, forage, fuel, hardwood
Leucaena leucocephala	Leucaena, Ipil Ipil	alley cropping, soil conservation, food, nitrogen fixing, fuel, forage
Moringa oleifera	Moringa, Drumstick	living fences, rapid cover
Senna siamea	Siamese senna	terraces, fuel, nitrogen fixing
Sesbania grandiflora	Agati	rapid cover, forage, nitrogen fixing
Sesbania sesban	Sesban	planting stakes, quick cover, nitrogen fixing

involving arable and tree crops, but the emphasis here is shifted to the agricultural crops which are of dominant interest. Indeed, agrosilviculture could be likened to shifting cultivation (Nwoboshi, 1982) except that the fallow vegetation is planted with economic trees whose gestation period is equivalent to the fallow period.

Silvo-pastoral : These are mostly trees with pastures and livestock. It is essentially the practice of animal production along with trees and pastures.

Mixed farming : Mixed farming system practiced by majority of the farming communities indicated the existence of traditional agroforestry system common in the semi-arid zones of Nigeria (Oboho, 1989). Integration of trees into farming system and subsequent modification of the system could be easy with earlier understanding of the importance of trees in the farming system. Similarly, the practice of animal production could make the intensification of fodder bank system an easily acceptable agroforestry model. With soil fertility, maintenance as the major problem of practical ways of applying various specialized knowledge and skills to the development of rural production systems. It evolves energy between agricultural production and forestry that is beneficial for increased food production, sustainable wood production and improvement of the quality of the soil. This is a win-win situation. The advantages of Agroforestry are quite quantum. Agroforestry, among other benefits strive to optimize the use of land for agricultural production on a sustainable basis and at the same time meeting other needs from forestry.

Shifting cultivation : Shifting cultivation was the farming system widely embraced by peasants in the tropics in the past (Greenland, 1974). This form of farming is no longer common, because rapid population growth

Table-3 : Examples of Successful Uses of Trees on Small Farms (Not Necessarily With Other Crops).

Location	System	Tree Crop	Benefits
Central America	Living fence	*Erythrina, Yucca, Gliricidia*	food, feed
Tropics	Windbreaks	*Casuarina*	Fuel
Central Africa	Dispersed trees	*Faidherbia albida*	fuel, feed, erosion control
Niger	Improved fallows	*Leucaena, Sesbania*	soil fertility restoration
India	Earthworks	*Dalbergia, Pongamia, Prosopis,*	food, soil conservation
Tropical Africa	Gully Protection	*Tamarix*	food, soil conservation

Table-4 : Examples of Successful Agroforestry Systems of Trees and Crops.

Location	System	Tree Crop	Benefits	Understory Crops
Costa Rica	dispersed trees	*Cordia alliodora*	lumber, shade, nutrients	coffee
Costa Rica	dispersed trees	*Erythrina* spp.	nitrogen, fuel, shade, nutrients	coffee
Puerto Rico	dispersed trees	*Inga* spp.	shade, nitrogen, fuel, wood	coffee, bananas, root crops
El Salvador	dispersed trees	*Inga* spp.	fuel, nitrogen, shade	coffee, cacao
Central America	dispersed trees	leguminous trees	lumber, fuel, shade, nitrogen	grains, pasture
Malaysia	dispersed trees	dwarf coconut	food, lumber	cacao
Tropics	dispersed trees	Coconut	food, feed	pasture
Mexico	dispersed trees	*Brosimum* spp.	food, lumber	many crops, pasture
Haiti	home garden	Mango	fruit	Rice
Sri Lanka	mixed perennials	various fruit trees	fruit, other products	spices, vegetables
Philippines	home garden	various fruit trees	fruits, edible leaves	many vegetables
West Africa	home garden	fruit trees	fruits	vegetables
Ivory Coast	mixed perennials	cacao, bananas	food	yams
Puerto Rico	mixed perennials	oranges, avocados, bananas	food, nutrients	coffee, root crops
Tropics	alley crop	*Leucaena leucocephala*	erosion control, fuel, nitrogen, nutrients	annuals, grasses
Nigeria	alley crop	*Gliricidia sepium*	erosion control, fuel, nitrogen, nutrients	root crops, grains
Rwanda	vegetative strips	*Grevillea, Albizia,* and *Leucaena* spp.	timber, fuel, forage	

has increased food demand tremendously to the level that fallow periods had to be reduced and the forestry sector had to give way gradually to agricultural needs. This has led to un-precedented deforestation, lowering of soil productivity, loss of biodiversity, increased soil erosion and weed infestation, and consequently lowered crop yield (Okigbo, 1984a). Unfortunately, the continued relying on expanding cultivated areas has not been able to contribute substantially to resolving the food crisis, because not all the available land is equally productive (Okigbo, 1984b). It is not even economical on the long run. Utilization levels of land and water resources are close to maximum potentials and future growth will be possible only through better management of a fixed resource base (Banuri and Holmberg, 1992).

Different role of Agroforestry systems

Role of Agroforestry in Nutritional and Food Security : The modern production systems have negatively impacted the nutrient balance as well as soil fertility and farmers are not applying fertilizers according to recommended doses which results in imbalance between nutrient supply and crop demand (Karthik *et al.,* 2021). The country's food production has increased many folds since independence but recent improvements in food supply have been insufficient to fulfill the nutritional needs of the common person in an ever increasing population of the country. Agroforestry with appropriate tree- crop / legume combination is one option in this regard. The different agroforestry systems provide the desired diversification options to increase the food security and act as a insurance against the low production during drought and other stress conditions.

Agroforestry also provides nutritional security because of diverse production systems which include fruit, vegetables, legumes, oilseed crops, medicinal and aromatic plants in addition to normal food crops grown by the farmers. With the rapid growth of urbanization and economic growth in the country, farming community have witnessed unprecedented opportunities for moving beyond subsistence farming to supplying products needed by urban population. Agroforestry products such

as timber, fruit, food, fiber, fodder, medicine and others are progressively meeting the subsistence needs of households and providing the platform for greater and sustained productivity. Thus, agroforestry systems offer opportunities to farmers for diversifying their income and to increase farm production. Research results from different agroclimatic regions of the country show that financial returns generated from agroforestry systems vary greatly but are generally much higher than returns from continuous unfertilized food crops. The higher returns associated with agroforestry can translate into improved household nutrition and health, particularly when women control the income. Agroforestry has proven as an important tool for crop diversification. By virtue of diversity of the components of the agroforestry systems like fruits, vegetables, nutritional security to the communities could be ensured. In agroforestry, the potentially higher productivity could be due to the capture of more growth resources e.g. light or water or due to improved soil fertility. The best example is of poplar (*Populus deltoides*) - a popular species in agroforestry system in the Upper Indo-Gangetic region. Poplar was a best choice as it was fast growing, compatible with wheat and other crops and has industrial use. Therefore, poplar (*Populus* spp.) based agroforestry in northern India made rapid strides. Woodlots of other fast growing trees such as *Eucalyptus* spp., *Leucaena leucocephala, Casuarina equisetifolia, Acacia mangium, Acacia auriculiformis*, *Ailanthus*, teak and *Melia dubia* are also becoming increasingly popular among the farmers in several parts of the country due to their great market potential.

Importance of Agroforestry for Fodder Production : Trees and shrubs often contribute substantial amount of leaf fodder in arid, semi-arid and hill regions during lean period through lopping/pruning of trees, popularly known as top feed. The leaf fodder yield depends on species, initial age, lopping intensity and interval as well as agroclimatic conditions. Silvipastoral system is the most appropriate land use system for degraded lands. The top feeds are also considered very important in vegetation stabilization and sustained productivity of rangelands (Dhyani, 2003). They also play an important role as windbreaks and by providing shade for the grazing animal. The important ones are *Prosopis cineraria, Albizia lebbeck. Acacia* spp., *Leucaena leucocephala, Dalbergia sissoo, Ailanthus excelsa, Azadirachta indica, Acacia leucopholea* etc. for the arid and semi –arid region and *Grewia optiva, Morus alba, Celtis australis, Albizia, Oaks, Ficus* etc. for the hilly regions. Bamikole *et al.* (2003) reported that feed intake, weight gain, digestibility and nutrient utilization can be enhanced by feeding *Ficus religiosa* in mixture with *Panicum maximum*, and it can be used in diet mixtures up to 75% of drymatter fed. Dagar *et al.* (2001) found the most suitable species for problematic soils *i.e.,* silvipastoral system on alkali soils *Prosopis juliflora*, *Acacia nilotica* and *Tamarix articulata* are the most promising trees and *Leptochloa fusca*, *Chloris gayana* and *Brachiaria mutica* most suitable grasses. *Leptochloa fusca* in association with *Prosopis juliflora* produced 46.5 tha-1 green fodders over a period of four years without applying any amendments and fertilizer.

Conservation of Bio-diversity through Agroforestry : Through an integrated conservation development approach, agroforestry advances contribute to biodiversity conservation. Forest degradation has resulted in massive losses in biodiversity, which can be preserved through agroforestry by using a conservation-by-use strategy. The creation or improvement of new types or populations will be aided by biodiversity. It will also aid in increasing the availability of improved planting material, which is critical for increasing farm productivity and production. Swaminathan (1983) has pointed out that biodiversity is the feed stock for a climate resilient agriculture. Agroforestry with components like trees, agricultural crops, grasses, livestock, etc. provides all kinds of life support system. Trees in agro ecosystems in Rajasthan and Uttarakhand have been found to support threatened cavity nesting birds and offer forage and habitat to many species of birds. Traditional agroforestry systems are excellent examples of agro-biodiversity conservation. The best examples are the tropical home gardens of Western ghats (India) and north-eastern hill region. Nonetheless, agroforestry may not avert all species losses, but with divergent life forms such as trees, agricultural crops, grasses, livestock, etc., it may act as an effective buffer to prevent such losses, especially in the smallholder land use systems where there are a variety of species than in the larger ones.

Role of Agroforestry in Carbon Sequestration : The emphasis of land use systems that have higher carbon content than existing plant community can help achieve net gains in carbon, specifically and significant increases in carbon storage can be achieved by moving from lower biomass land uses e.g. grasslands, crop fallows etc to tree based systems such as forests, plantation forests and agroforestry (Karthik et al., 2020). Agroforestry is a major carbon sequestration strategy as it is having large C storage potential in its multiple plant species and soil as well as its usefulness in agricultural lands and in reforestation. Agroforestry can also have an indirect benefit on C sequestration when it helps to decrease pressure on natural forests, which are the largest sinks of terrestrial C. Another indirect avenue of C sequestration is through the use of agroforestry technologies for soil conservation, which could enhance C storage in trees and soils. For enhancing the C sequestration potential of

agroforestry systems practices such as conservation of biomass and soil carbon in existing sinks; improved lopping and harvesting practices; improved efficiency of wood processing; fire protection and more effective use of burning in both forest and agricultural systems; increased use of biofuels; increased conversion of wood biomass into durable wood products are advocated to be exploited to their maximum potential. Agroforestry thus contributes to the resilience of agriculture by adaptation and mitigation of climate change effects. In India, evidence is now emerging that agroforestry systems are promising land use system to increase and conserve aboveground and soil carbon stocks to mitigate climate change (Dhyani *et al.,* 2009). Earlier average sequestration potential in agroforestry in India has been estimated to be 25 t C/ha over 96 Mha (Sathaye and Ravindranath, 1998).

Problems in Agroforestry Sector : During last more than three decades, many agroforestry technologies have been developed and demonstrated by various research organizations. However, most of them have not reached to farmer's field for want of awareness, inadequate infrastructure and lack of policy support which is why desired impact has not been observed in terms of adoption of technology. The major reason for this is that agroforestry sector is disadvantaged by adverse policies, legal constraints and lack of coordination between the government sectors to which it contributes *viz.*, agriculture, forestry, rural development, environment and trade. Absence of appropriate policy and institutional arrangement to provide farmers with clear incentives to plant and protect trees that contribute to both ecosystem function and rural livelihoods is a great hurdle. Existing rules and regulations are greatest obstacles in felling, transport and marketing of agroforestry products and they vary from state to state. Agroforestry has to be declared at par with agriculture in availing credit and other subsidies by poor farmers (Dhyani *et al.,* 2009). The agroforestry technologies have been successful in the areas where farmer's got incentive in terms of quality planting material and assured market for example in case of Poplar, *Leucaena* and *Eucalyptus.* Availability of quality planting material of trees is one of the major concerns and need to be addressed urgently.

Policy related to Agroforestry : In India, agroforestry has been receiving greater attention by researchers, policy-makers and others for its perceived ability to contribute significantly to economic growth, poverty alleviation and environmental quality. Agroforestry is now recognized as an important part of the 'evergreen revolution' movement in the country. India launched National Agroforestry Policy (http://www.indiaenvironmentportal.org.in/content/389156/ national-agroforestry-policy-2014/) in 2014 and became the first country in the world to have a National Agroforestry Policy (http://ccafs.cgiar.org/publications/ indias-new-national agroforestry-policy). The policy is not only seen as crucial to India's ambitious goal of achieving 33 per cent tree cover but also to mitigate GHG emissions from agriculture sector. After launching the NAP in 2014, considerable progress has been made in terms of putting it into practice. Department of Agriculture Cooperation and Farmers Welfare (DAC and FW) under the Ministry of Agriculture and Farmers Welfare (MOA and FW) is also playing a significant role in the promotion of agroforestry. It has taken a policy decision to include trees in all its programmes, and this will significantly increase tree-planting on farms, especially under schemes funded by the National Mission on Sustainable Agriculture (NMSA). This has so far approved the funding for 80,000 ha of new agroforestry projects (pers. comm.). Efforts are on to issue guidelines on the production and supply of high-quality planting material and accreditation of nurseries producing MPTS planting material.

Advantages of Agroforestry : It should be noted that the attempts being made under agroforestry are to optimize the use of land for agricultural production on a sustainable basis at the same time meeting other needs from forestry (Fagbemi, 2002). Nitrogen-fixing and non-nitrogen-fixing trees persist well in agroforestry with annual crops, presents a farming system in which arable crop yields could be enhanced. The tree rooting system brings about stability that can lead to soil conservation. What is needed would be mutual interaction and proper management techniques that would reduce the adverse effects that may result when trees are integrated into agro-ecosystem (Connor, 1983).

(1) Consistent restoration of the fertility status of the soil through the recycled litter deposition and nitrogen fixing mechanism of trees

(2) A variety of products, firewood, poles, woodcraft, fodder, medicinal herbs and food for livestock and man respectively

(3) Prevention of wind and water erosion by trees acting as wind break and intercepting the raindrop impact on the soil respectively

(4) Improving the micro-climate effect of the immediate and adjourning environment

(5) Restoration of water table to an absorbable level for crops use

(6) Increased income opportunities

(7) Increased economic stability

(8) Reduce cost for establishing plantation

(9) Increased ability to manage for sustained yield

Conclusions

There is a need to utilize the all resources efficiently in a sustainable manner to enhance the agricultural production which ultimately benefits the farmers. Climate change is the major issue which needs to be given immediate attention and many governments as well as organizations are turning blind eye to climate change although it is ruthlessly affecting the food production and human health. These issues could be solved with the help of agroforestry system where the natural resources such as land, water, and vegetation occupy center-stage for the welfare and development of people. Agroforestry options may provide a means for diversifying production systems and enhancing the sustainability of smallholder farming systems and it often produce crops of higher value than mono crops. Thus, diversifying the production system to include a significant tree component may buffer against income risks associated with climatic variability. Agroforestry enhance the uptake of CO_2 or reduce its emission and has the potential to remove a significant amount of CO_2 from the atmosphere, if the trees are harvested, accompanied by replanting of same and/or other area, and sequestered carbon is locked through non-destructive use of such wood. Now it has been proved that agroforestry system are promising land use system to increase aboveground and soil C stock to mitigate greenhouse gas emissions.

References

1. Bamikole, M.A., Babayemi, O.J, Arigbede, O.M and Ikhatua, U.J. (2003). Nutritive value of *Ficus religiosa* in West African dwarf goats. *Animal Feed Science and Technology* 105(1-4): 71-79.
2. Banuri, I. and Holmberg, J. (1992). Governance for sustainable development: A Southern Perspective. Islamabad and London. P. 50
3. Connor, B.J. (1983). Plant stress factors and their influence on production of agroforestry plant association. In: Plant Research and Agroforestry, ICRAF, Nairobi, pp. 401-426.
4. Dagar, J.C., Sharma, H.B. and Shukla, Y.K. (2001). Raised and sunken bed technique for agroforestry on alkali soils of Northwest India. *Land Degradation and Development* 12(2): 107-118.
5. Dhyani, S.K., Handa, A.K .and Uma. (2015). Agroforestry research in India: Present Status and Future Perspective. In: SK Dhyani, Newaj R, Alam B and Dev I. Eds. Organized Agroforestry Research in India: Present Status and Way Forward. Boitech Book Publisher, Delhi
6. Dhyani, S.K., Kareemulla, K., Ajit. and Handa. (2009). Agroforestry potential and scope for development across agro-climatic zones in India. *Indian Journal Forestry* 32(2): 181-190.
7. Dhyani, S.K. (2003). Role of watershed management in improving forage production. In R.C. Jakhmola and R.K. Jain (Eds.), Sustainable Animal Production. *Pointer Publisher* Jaipur, India. p 173-207.
8. Fagbemi, T. (2002). Investment opportunities in renewable resources industry-forestry. 1st Edn., Belodan Press, Nigeria.
9. Greenland, D.S. (1974). Evaluation and development of different types of shifting cultivation: In Shifting Cultivation and Soil Conservation in Africa. SIDA/FAO Soils Bull. 24: 5-13.
10. Karthik, R., Dhaker, D., Raising, L.P. (2021). Performance of Cereals under Need based Nitrogen Management Strategies: A Review. *Agricultural Reviews.*
11. Karthik, R., Reddy, N.P., Bhavana and B. Rajitha, G. 2020. Role of Agroforestry in Climate Change Mitigation through Carbon Sequestration. In book: Advances in agronomy (12:01-21) Publisher: Akinik. https://doi.org/10.22271/ed.book.833.
12. Kumar, B.M., Singh, A.K. and Dhyani, S.K. (2012). South Asian Agroforestry: Traditions, Transformations, and Prospects. In book: Agroforestry : The Future of Global Landuse (pp. 359-389). Publisher: Springer
13. Nwoboshi, L.C. (1982). Tropical silviculture-principles and techniques. Ibadan University Press. P. 333.
14. Oboho, E.G (1989). Important forest products in the semi-arid area of Sokoto State. In Forest resources development and the sourcing of local raw materials in Nigeria. Proceedings of the 19th Annual Conference of the Forestry Association of Nigerian. Eds: J.A Okojie and P.C Obiaga. pp. 33-38.
15. Okigbo, B.N. (1984a). Improved permanent production systems as an alternative to shifting cultivation. FAO, Rome, Italy 53:1-100.
16. Okigbo, B.N. (1984b). Cropping systems and rotations development from improving shifting cultivation and related intermittant production systems in tropical Africa. FAO, Rome, Italy 50: 121-140.
17. Pathak, P.S., Pateria, N.M. and Solanki, K.R. (2000). Agroforestry systems in India: a diagnosis and design approach. National Research Centre for Agroforestry. ICAR. pp 166.
18. Prasad, R. and Dhyani, S.K. (2010). Review of agroforestry contributions and problems in arid eco-system for livelihood support in India. *Journal Soil and Water Conservation* 9(4): 277-87.
19. Sathaye, J.A. and Ravindranath, N.H. (1998). Climate change mitigation in the energy and forestry sectors of developing countries. *Annual Review of Energy and Environment.* 23: 387-437.
20. Sharda, V.N., Dhyani, S.K. and Sharma, A.R. (2001). Role of Agroforestry in Disaster Management. Submitted to Chairman, HPC (DM Plan), DOA and C, GoI, New Delhi.
21. Swaminathan, M.S. 1983). Genetic conservation: microbes to man. Presidential address to the 15th international Congress on Genetics. In: Genetics: new frontiers, vol. 1. *Oxford and IBH Publishing Co.,* New Delhi, India
22. Tejwani, K.G. (1994). Agroforestry in India. *Oxford and IBH Publ. Co. Pvt. Ltd.,* New Delhi, 233p.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 812-815 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Three-Dimensional (3D) Printing–A Future Boom to Food Industry

P. Geetha
Department of Food Science and Nutrition, Centre for Post Harvest Technology,
Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore-641003

Three-dimensional printing, more formally known as additive manufacturing (AM) or rapid prototyping, has been around for decades. The first working 3D printer, "Stereolithography Apparatus," was created in 1984 by Chuck W. Hull of 3D Systems Corp (Bogue, 2013). The 3D printer works in a very similar way to the standard inkjet printer. However, instead of printing layers of ink on paper, a 3D printer uses materials to build a three-dimensional object (Berman, 2012). Many in the industry use the terms 3D printing and additive manufacturing interchangeably. Additive manufacturing (AM) is the broader and more all-inclusive term. Additive manufacturing refers to the technology of producing a final three-dimensional product by depositing thin layers of material upon each other (Wohlers and Gorne, 2014). Most commercial 3D printers use a computer-aided (CAD) design to translate the design into a three-dimensional object. The design is then used by the 3D printer to deposit the layers of material (Chua *et al.* 2010).

3D printing technology is maturing and has worked its way into several markets. Maturing technology is helping the next generation of users adopt 3D printing. In the early days, technology was costly and not feasible for the general market. Today, 3D printing is re-emerging, and it is now one of the hottest and exciting advancements in the design and marketing world.

There are different technologies in 3D printing :

Selective Laser Sintering (SLS)

Fused Filament Fabrication (FFF)

Stereolithography (SLA)

Digital Light Projection or Digital Light Processing (DLP)

Each 3D printing technology has its strengths and equipment and is suitable for different applications.

3D Printing and the Food Industry : 3D printing of food is being developed by squeezing out food materials, layer by layer, into three-dimensional objects. A large variety of food items are appropriate candidates, such as chocolate and candy, and flat foods such as crackers, pasta, and pizza (Wong, 2014; Chew, 2017). 3D food printing or culinary printing manufactures food products with customization in shape, color, flavors, textures, and nutrition. 3D food printing is being considered in the food sector due to its multiple advantages such as personalized nutrition, customized food designs, simplifying the supply chain, and broadening of the available food material. 3D food printing has excellent advantages in low volume food fabrication of customized items in food services. 3D technology printers help in the formation of the 3D shape and deliver the food with a visual aesthetic and, most importantly, good taste (Liu *et al.,* 2017).

The printing precision of 3D food printed object is influenced by several factors. The shape of the 3D model, slicing parameters, the flow performance of ingredients, and the post-treatment effect structure accuracy and shape stability of printed food. Other critical factors for the structure accuracy of printed food objects are the properties of food ingredients, such as rheological properties, thermal properties, and chemical properties (Liu et al., 2017). Printer's characteristics, such as height, nozzle diameter, printing rate, nozzle movement rate, layer thickness, are also critical for the quality of resulting printed food (Hao *et al.,* 2010).

Finally, the printing precision can be affected by the deformation caused by the post-treatment, such as drying and baking (Liu *et al.,* 2017). The design of the 3D model is an important factor that can determine or influence the stability and precision of final printed objects. Food Printing Emerging Technologies 3D printers manufacture and create food utilizing lasers, powdery materials, and nozzles. The applied technologies are related to the properties of the edible materials that are printed (Godoi *et al.* 2016). Some printers use thermal energy from the laser, hot air, and heating elements to sinter or melt the powder. Others use ink-jet type printing head to spray solvent or binder. For liquids, chocolate, orpaste technologies such as hot-melt extrusion, also called Fused Deposition Modeling (FDM) is used. The material is heated above its melting point, and it solidifies quickly after extrusion and welds to the previous layers. This technology is used to create personalized 3D chocolate products (Hao *et al.* 2010; Causer, 2009). This technology can also be used at room temperature for soft materials extrusion using materials such as dough, meat, paste, processed cheese, and puree (Godoi *et al.* 2016). The technology provides an engineering solution for

digitalized food design and nutrition control. Lille *et al.* (2018) investigated the applicability of extrusion-based 3D food printing technology for food pastes made of protein, starch, and fiber-rich materials. The advantages of food printers using this technology are compact size, low maintenance cost, and easily interchangeable print heads. Sun et al. (2018) provides a comprehensive analysis of how to apply this technology to innovate food texture and taste. Severini *et al.* (2016) evaluated variables affecting the printability of cereal-based products and identified additive layer deposition technology as the one that obtained the proper structures. Finally, Dankar *et al.* (2018) focus in-depth on optimizing extrusion-based food printing, which supports the widest array of food and maintains numerous shapes and textures. PancakeBot is an example of a printer that uses this technology to create pancakes by automatically dispensing batter directly onto a griddle. Users can make their pancake designs or select from layouts included in the software or browse through an online community that is updated with new designs every week (Pankace Bot.com, 2019).

For powders like sugar with low melting points, Selective Laser Sintering (SLS) technology is used, which can generate food containing multiple layers with each layer having different food components (Godoi *et al.* 2016). A related technology in this category is Selective Hot Air. Sintering and Melting (SHASAM). This food printing technology uses a beam of hot air to fuse sugar powders and print 3D food items (Godoi *et al.* 2016). Food printers in this category can build complex food items in a short time without post-curing. CandyFab built several printers capable of sintering and melting a bed of sugar and sugar-based product. TNO's Food Jetting printer applies the laser to sinter sugars and sugar-based powders. For liquid-based and powder-based materials, Binder Jetting printers can create complex 3D food fabrication with varying textures .In this technology, each powder layer is distributed evenly across the fabrication platform. The liquid binder sprays and binds consecutive powder layers (Sachs *et al.* 1990). Post-processing may be required to remove moisture or improve strength. The food printer designed based on Binder Jetting technology offers advantages such as faster fabrication and low maintenance costs. The disadvantages are rough surface finish, high machine cost, and limited materials. Sugar Lab is an example of a printer that uses sugar and different binders to fabricate cakes for special events (Yang *et al.* 2001). Another technology used for 3D food printing is inkjet printing (Kruth *et al.* 2007). This technology uses liquid-based and low viscosity materials such as paste or puree. Other materials that are commonly used are chocolate, liquid dough, cheese, jams, and gels. The food printer designed based on inkjet printing dispense a stream of droplets from the syringe-type print head in a drop-on-demand way to create edible food products such as cookies, cakes, or pastries. The technology is used only for surface filling or image decoration. The advantages of food printers using this technology are fast fabrication, high resolution, and accuracy, and multiple material choices and colors. The cutting-edge printer uses fresh ingredients loaded into stainless steel capsules to make foods like pizza, brownie, and stuffed pasta. The printer has different types of nozzles and allows printing with almost any food material from mashed potatoes to chocolate. The printer creates fascinating food designs and customizes and balances dishes toamaze customers. The machine is also an Internet of Things (IoT) appliance. It can be connected to the internet, and recipes and designs can be uploaded from anywhere.

Recently developed food products using 3D technology

Food Product	Printing Method
3D-printed cereal-snack bar	Extrusion
3D-printed buckwheat dough with yellow flesh peach, enriched with complex coacervates microcapsules	
Button mushroom	
Cookies	
Cookies with microalgae	
Emulsion with whey protein isolate and soy oil	
Gels based on xanthan/ konjac gums	
Grinding and milling fractions of rice husk with the addition of guar gum	
Mixture of 50% native wheat starch + 40% maltodextrin + 10% palm oil powder	Selective laser sintering
Powdered milk	Extrusion - cold
Potato starch	Extrusion - hot
Tomato paste (Acceptance study)	Extrusion

Source : Rodica-Anita Varvara et al., (2021)

Advantages of Food Printing : The potential benefits of 3D printing technology applied to the food sector are numerous. Technology fundamentally changes food preparation and manufacturing.

It saves time and energy.

It helps in creates unique food formulation and niche product in the market with dense nutritive value.

It gives variety of foods by changing its colour, shape and design.

It can reduce the usage of chemical additives to the greater extent.

It can eliminate the food wastage which is the major problem in India.

It reduces the potential health risks associated with human exposure to radiation like microwaves.

Capacities of Food Printing : 3D food printing is now becoming more of a reality. The technology is changing how the food industry operates. The technology is transforming the consumer experience, the way that foods are created with more complex and original shapes and innovative recopies. It offers more customization to better adapt to a diversity of diets. In addition to endless possibilities, 3D printed foods may bring about many positive implications, including eliminating malnutrition, improving food scarcity, creating new value chains, etc. The critical motivators for 3D food printing are ondemand production, customization, and geometric complexity (Lipton et al., 2015).3D food printing can enable precise control of people's diets by digitizing and personalizing the nutrition and energy requirements of a person according to one's physical and nutrition status (Severini & Derossi, 2016). Food printers provide a platform for those experimenting with food forms and flavors to achieve intricate and fantastic food designs that cannot be produced by ordinary people (Sun *et al.* 2015a). Non-traditional food materials such as high fiber plant-based materials, animal-based by-products, and insects can be used by these printers to create a variety of foods (Severini & Derossi, 2016; Payne *et al.,* 2016).3D food printing can alter or broaden existing food value chains.Another benefit of food printing is its potential to simplify and facilitate food distribution into hard to-reach locations.

Food Printing Market Size and Forecast : 3D food printing is evolving quickly, and its market is expected to expand at a compound annual growth rate of 50 percent during the period 2017-2024 and is expected to reach $400 million by 2024 (Kenneth Research, 2019). Prominent factors driving the market include growing demand for customized food and increasing demand from healthcare applications. North America (United States, Canada) accounted for about 36 percent of the global 3D food printing market, followed by Europe 31 percent and the Asia Pacific at 22 percent.

Applications : 3D food printing has the potential to revolutionize food innovation and protection through better creativity, personalized and digitized nutrition, and broadened sources of food materials. They are opening the new doors for the customization of the food products with the delivery of a potent mix of the right nutrients. It can be applied in Military and space foods which require correct nutrients in right quantities; geriatric foods which smooth in texture, which could be easy to chew.

Conclusions

Today, food printing is no longer an idea but a reality. It can revolutionize food innovation and production through customizability, better creativity, and sustainability. It could eliminate the entire process, from grocery shopping to preparing the ingredients and cooking. Currently, 3D food printing is being applied in food areas such as military food, space food, elderly food, and sweets food. Several factors are enhancing the popularity of the food printing industry. The influential Millennial demographic has focused so much on food as a critical part of their social, political, and economic consciousness. Their focus on fresh, personalized, and made-to-order foods has been a game-changing development for the food industry. Food printers, though advantageous, are still an emerging technology that must overcome several challenges, including cost, speed, and ease-of-use. However, 3D printers are getting better every year, and the price is falling owing to the increasing adoption and technological developments. The future of 3D food printing is bright, as there is no limit to the scope and the future of the 3D culinary printing industry.

References

1. Berman, Barry. (2012). 3D Printing: The New Industrial Revolution. *Business Horizons* 55(21). 55-162.
2. Bogue, Robert. (2013). 3D Printing: The Dawn of a New Era in Manufacturing? *Assembly Automation* 33(4), 307-311.
3. Causer, C. (2009). They've got a golden ticket. *Potentials, IEEE,* 28 (4). 42-44.
4. Chew, C. (2017). Did BeeHex Just Hit 'Print' to Make Pizza at Home-Huff Post.
5. Chua, C.K., Leong, K.F., and Lim, C.S. (2010). Rapid Prototyping: Principles and Applications, *World Scientific Publishing Company,* 3rd Ed., 2010.
6. Dankar, I., Haddarah, A., Omar, F. E. L., Sepulcre, F., & Pujolà, M. (2018). 3D Printing technology: The new era for food customization and elaboration. *Trends in Food Science & Technology,* Volume 75,. May. PP 231– 242.
7. Godoi, F. C., Prakash, S., and Bhandari, B. R. (2016). "3d printing technologies applied for food design: Status and prospects," *Journal of Food Engineering,* vol. 179, pp. 44-54, 2016.
8. Hao, L., Mellor, S., Seaman, O. Henderson, J., Sewell, N., Sloan, M. (2010). Material characterization and process development for chocolate additive layer manufacturing. *Virtual and Physical Prototyping,* 5(2), pp. 57-64.
9. Kruth, J., Levy, G., Klocke, F. (2007). Consolidation phenomena in laser and powder-bed based layered manufacturing. CIRP Annals-Manufacturing Technology. 56(2). 730-759. Lansard, M. (2020). Food 3D printing: 10 food 3D printers available in 2020. February 6. Online: https://www.aniwaa.com/buyers-guide/3d-printers/food-3dprinters/.

10. Lille, M., Nurmela, A., Nordlund, E., Metsä-Kortelainen, S., and Sozer, N. (2018). Applicability of protein and fiber-rich food materials in extrusion-based 3D printing. *Journal of Food Engineering. March.* Volume 220. PP 20-27.
11. Lipton, J., Cutler, M., Nigl, F., Cohen, D., and Lipson, H. (2015). Additive manufacturing for the food industry. *Trends in Food Science & Technology*. 43. PP 114-123.
12. Liu, Z., Zhang, M., Bhandari, B., and Wang, Y. (2017). 3D printing: Printing precision and application in the food sector. *Trends in Food Science & Technology.* November. 69, Part A, PP 83-94 .
13. PancakeBot (2019). Website. Retrieved from: http://www.pancakebot.com/home.
14. Payne, C. L., Dobermann, D., Forkes, A., House, J., Josephs, J., McBride, A., Müller, A., Quilliam, R.S., & Soares, S. (2016). Insects as food and feed: European perspectives on recent research and future priorities. *Journal of Insects as Food and Feed,* 2, pp. 269-276.
15. Rodica-Anita Varvara, Katalin Szabo, Dan Cristian Vodnar (2021)3D Food Printing: Principles of Obtaining Digitally-Designed Nourishment,Nutrients 2021, 13, 3617. https://doi.org/10.3390/nu13103617.
16. Sachs, E., Cima, M., Cornie, J. (1990). Three-dimensional printing: rapid tooling and prototypes directly from a CAD model. CIRP Annals-Manufacturing Technology, No 39. 201-204.
17. Severini, C., and Derossi, A. (2016). Could the 3D Printing Technology be a Useful Strategy to Obtain Customized Nutrition? *Journal of Clinical Gastroenterology,* 50. S175-S178.
18. Severini, C., Derossi, A., and Azzollini D. (2016). Variables affecting the printability of foods: Preliminary tests on cereal-based products. Innovative Food Science & Emerging Technologies. December. Volume 38, Part A, PP 281-291.
19. Sun, J., Zhou, W., Yan L., Huang, D., and Lin, L. (2018). Extrusion-based food printing for digitalized food design and nutrition control. *Journal of Food Engineering.* March. Volume 220, PP 1-11.
20. Wohlers, T., Gorne, T. (2014). History of Additive Manufacturing. Wohlers Report. Wohlers Associates, Inc. Online: http://www.wohlersassociates.com/history2014.pdf.
21. Wong, V. (2014). A Guide to All the Food That's Fit to 3D Print (So Far). Bloomberg, January 28. Online: https://www.bloomberg.com/news/articles/2014-01-28/all-the-food-thats-fit-to-3d-print-from-chocolates-to-pizza.
22. Yang, J., Wu, L., and Liu, J. (2001). Rapid prototyping and fabrication method for 3-D food objects. U.S. Patent, No 6280785. Yang, F., Zhang, M., and Bhandari, B. (2017). Recent Development in 3D Food Printing. *Critical Reviews in Food Science and Nutrition,* October 57(14). PP 3145-3153.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 816-820 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Soil Moisture Management to Increase Leaf Yield in Mulberry, Morus alba L. and Silk Cocoon Production in Southern Dry Climatic Zones of Tamil Nadu

A. Mahimasanthi[1*] S. Rajaram[2], Babulal[3] and Pankaj Tiwari[3]

[1]*Research Extension Centre, CSRTI, CSB, Samayanallur, Tamil Nadu-625402, India*

[3]*Central Sericultural Research and Training Institute, Central Silk Board, Mysuru-570008, India.*

Abstract

The mulberry, *Morus alba* is grown as food crop for silkworm, *Bombyx mori* L. Occurrence of drought is very frequent in these areas. Due to prevailing dry conditions, irrigations given to mulberry gardens were insufficient to meet the water requirements of plants. Hot & dry winds removed moisture from the garden soil at faster rate and vigorous growth of plants were affected by less moisture in the soil. The situations necessitate increasing the moisture holding capacity of the soil to conserve water and minimize the amount of water loss from the soil through evaporation & seepage. The response of mulberry to soil moisture is well studied under irrigated conditions. A study was conducted in South Tamil Nadu in mulberry gardens to conserve the soil moisture in the mulberry garden with trenching & mulching, green manuring, windbreaks & shelterbelts, weed management, sub-soiling or hard pan breaking and rain water harvesting. The performances were compared with equal number of farmers' garden under traditional method of cultivation as control for two years. The study results revealed that the average leaf yield, dfls uptake, cocoon production and income ha^{-1} yr^{-1} in treated mulberry gardens recorded as 37.11MT; 2391 Nos.; 1850.61 kg and Rs.5,70,981.30/- respectively with improvement percentage of 78.15; 83.14; 87.47 and 97.83 over the control and the statistical analysis of difference in performances in respect of all parameters showed highly significant @ 5% CD level.

Key words *: water shortage, moisture conservation, leaf yield, cocoon production, sericulture income.*

Introduction

Tamil Nadu state in India is famous for traditional silk fabrics woven on handlooms. The state occupies 4th position in silk production in India with an average production of 2000 MT raw silk annually. The state continues to occupy the leading position in cocoon productivity @ >80 kg for 100 silkworm layings as against the national average of 60.24 kg (1). Presently 25237 farmers are doing sericulture in Tamil Nadu, cultivating mulberry in 49716.90 acres which gives employment opportunities to 2,32,850 persons (2).

The leaf of mulberry, *Morus alba* is the basic food of silkworm, *Bombyx mori* L. The role of leaf quality is very important in the success of silkworm rearing and cocoon production (3). Mulberry is grown as perennial crop under irrigated conditions and is to be irrigated throughout. Recently the production and productivity of silk is severely affected in the southern dry climatic zones of Tamil Nadu state due to acute water shortage. There is insufficient water in the perennial rivers in Southern Tamil Nadu. Rain is the main source of irrigation water. The state received 23-37% deficit rainfall in last two years (4). The deficit rain and excessive drawing of ground water caused lowering of water table level. The irrigations made to mulberry gardens were insufficient to meet the water requirements of plants, the hot dry wind removed moisture from the garden soil at faster rate and vigorous growth of plants were affected by less moisture in the soil (5). Low and erratic rainfall, high evaporation rate and limited water holding capacity of surface soils are the main constraints in agricultural production (6). Physiological activity of mulberry deteriorated when water is retained below field capacity (7). Marked variations in the photosynthetic rates and ribulose-1,5-bisphosphate carboxylase activity among the mulberry cultivars were recorded when subjected to water stress(8). Water stress conditions in plants induce loss of turgor and reduce cell expansion and growth of plants (9). The leaf turgor potential directly affects leaf enlargement, stomatal conductance and photosynthetic activity (10). Insufficient irrigation water availability for mulberry cultivation due to low rainfall or failure of monsoon or frequent droughts found to be the major limiting factor for the industry in Tamil Nadu (11). Hence it is very important to increase the moisture holding capacity of the soil and to conserve water. The amount of water loss from the soil through evaporation and seepage should be minimized. The response of mulberry to soil moisture is well studied under irrigated conditions. If the soil moisture in soil regime is increased it will increase the quality and quantity of leaf yield, which in turn increases the silkworm rearing capacity of the farmer and cocoon production (12). The quality leaves help in the production of good quality cocoons, increases the cocoon yield and fetches more prices in the market (13). Water-use efficiency (WUE) is considered an important determinant of yield under stress and even as a component of crop drought resistance (14). Moisture stress frequently

limited both the quality and yield of mulberry leaf (15). There is very high level of gap in adopting soil moisture conservation technologies and rain water harvesting technologies among the farmers of South India (13). Soil management practices have to be tailored to store and conserve as much rainfall as possible by reducing the runoff and increasing storage capacity of soil profile in farmers' fields. Hence this experiment is conducted in mulberry garden in southern dry zones of Tamil Nadu to study the of impact soil moisture management technologies in an integrated manner and its influence on leaf yield and cocoon production as farmers participatory research.

Materials and Methods

Field experiments were conducted as farmers participatory research at farmers' mulberry fields in Dindigul (10.35°N 77.95°E, 265 m altitude) and Tenkasi clusters (8.97°N 77.3°E, 143 m altitude) in South Tamil Nadu for two years 2017 & 2018. The average temperature, rainfall, and relative humidity during the different seasons for the study period were measured at a weather station close to the experimental site.

Experimental Gardens : Thirty mulberry gardens of four to five years old V1 plantations with the spacing of 5'+ 3' X 2' were selected for the study. The following recommended packages of practices were done. Leaves were harvested on seventieth day and subsequent pruning were done immediately. Gardens were ploughed to remove weeds and applied with of 10MT of organic manure in two split doses, followed by the application of NPK straight fertilisers five times a year in the ratio of 320:120:120 kg/ha intervals. Multi nutrient spray was sprayed on 35th day after pruning. Treatment (T_1) was done in fifteen fields. Soil moisture regime management technologies were done in an integrated manner apart from usual package of practices. Technologies such as Green manuring, Trenching & mulching, Windbreaks & shelterbelts, Weed management, Sub-soiling or hard pan breaking and Rain water harvesting were done in the fields for two years.

Soil moisture management technologies : In Fifteen mulberry garden following soil moisture management technologies were done as Treatment (T_1).

(i) Mulching : Crop residues like straw, shoots or stalk were placed on the soil surface in between mulberry rows as organic mulching.

(ii) Windbreaks and shelterbelts : Fast growing trees were planted as shelterbelts in rows across the direction of wind. Depending on gaps, certain amount of wind passed through the shelterbelts, while the rest deflected and crossed over the shelterbelts.

(iii) Weed management : Prompt weed control was done in the garden after every pruning by power weeder and hand weeding. A weed free environment was maintained throughout.

(iv) Sub-soiling/hard pan breaking : If subsoil was compacted, a tractor operated chisel plough or sub-soiler was used in paired row and wider spaced mulberry gardens for breaking the hard pan. In closer spaced gardens, hard pan was broken manually by deep digging and by making trenches.

(v) Green manuring : After pruning of mulberry, green manure plant, Dhaincha (*Sesbania aculeate)* plants seeds were sown @ 8kgs/ac between the mulberry rows as inter crop during the rainy season. The green manure crops were allowed to grow until flower initiation and ploughed in-situ. Before sowing the seeds were inoculated with Rhizobium culture to improve the root nodulation and nitrogen fixation. Green manuring were done twice in a year.

(vi) Rain water harvesting : The rainwater was collected and allowed to percolate down into the earth by making pits of 30cm^3 sizes in between rows. Water was stored during the rainy season and slowly percolated into soil.

Performances data were compared with equal number of farmers' fields under traditional method of cultivation as control (T_0) for two years.

Crop parameters studied : The average leaf yield, disease free layings uptake, rearing performance, quantity of cocoon produced and income generated by farmers' from sericulture were studied as parameters

Average leaf yield : Mulberry shoots were harvested on 70th day of pruning and weighed. In a year a garden was pruned for five times and the shoots with leaves were harvested for five times and weighed immediately. Total leaves harvested in a year were accounted for two years and taken average. Average leaf yield was calculated using the formula

Average leaf yield (MT/Ha) = Average weight of leaves harvested in a garden in a year/Acreage × 2.5

Disease free layings (DFLs) uptake : The harvested leaves were used for silkworms rearing. Number of disease free silkworm layings reared using the above leaves were considered as DFLs uptake. Annual average was accounted.

Disease free layings uptake (No) = Average number of silkworm eggs reared in a Year/acreage × 2.5

Cocoon production (Kg) : Total quantity of silkworm cocoons harvested by rearing above layings were accounted and annual average was calculated

Cocoon production (Kg) = Average quantity of cocoons produced in a year/acreage × 2.5

Rearing performance : Rearing performance was studied in terms of average cocoon yield for 100DFLs.

Average cocoon yield (Kg) = Total cocoon produced/Number of DFLs reared× 100

Farmers Income (Rs/ha/Annum) : This is calculated after marketing of cocoon using the formula :

Income (Rs ha^{-1} $yr^{-1)}$ = Total quantity of cocoons produced in one hectare × Average price of cocoon.

Data were computed and statistical analyses were done (16).

Results and Discussion

During the experimental periods, the meteorological data recorded maximum temperature of 37.6°C during May month and minimum temperature of 20.1°C during January month. The average annual rainfall of the region was about 846 mm with a share of 48% thro' the North East and 32% thro' the south west monsoon rains. Maximum rainfall was received from II fortnight of September to first fortnight of December. Of the total rainfall, 73% was received in less than100 days in these regions, highly uneven showers leading to dry condition in other periods. During monsoon period the underground water got recharged and utilised continuously in succeeding months. During summer months there was maximum utilisation and almost dried during post summer. This led to moisture stress to the plants during those periods.

Practising of soil moisture regime management techniques significantly increased the leaf yield in the mulberry garden. A total of 37.11t ha-1 yr-1 leaves were harvested from the treated fields (T_1) which was highly significant than T_0 @ 5% CD level. A total of 20.83t ha-1 yr-1 leaves were harvested from the control gardens (T_0) (Table.1). This is in accordance with the earlier studies of (12) where he stated that increasing soil water conservation and reducing evaporation increases leaf yield two to three times in mulberry.

This mulberry leaves were used to rear silkworms. From the treated plots (T_1), the farmer could rear 2391 disease free layings (dfls) per hectare per annum. From the control plots (T_0), the farmer could rear only 1306 disease free layings per hectare per annum. From the treated plots (T_1), the farmer could produce 1850.61kgs of silk cocoons per hectare per annum. From the control plots (T_0), the farmer could produce 1003.23kgs of silk cocoons per hectare per annum (Table-2). In both parameters T_1 was highly significant than T_0 @ 5% CD level. This is in conformity with earlier studies of (13) where reported that the adoption of integrated drought management technologies increased the soil moisture and fertility which in turn increases the quality and quantity of mulberry leaves which reflected in increase in cocoon productivity

The average cocoon productivity is 77.6kg/100 dfls for treated plots (T_1) and 75.3kg/100 dfls for control (T_0). The average price per one kg of cocoon in treated plots (T_1) was Rs.308/- and Rs.287/- in control plot (T_0). Though statistically non-significant, higher productivity and higher price attributed to the better quality of cocoon in T_1 compared to T_0. From the treated plots (T_1), the farmers could get an average income of Rs.5,70,981/- from silk cocoons harvested from a hectare per annum which was highly significant than T_0 @ 5% CD level**.** From the control plots (T_0), the farmer could earn Rs. 2,89,064/- from silk cocoons harvested per hectare per annum.

Incremental increase in all parameters studied might be due to the soil moisture management technologies adopted in the fields. Sub-soiling facilitated deep percolation of rainwater, supported vertical growth of mulberry roots, and increased the water storage in root zone which minimised the effects of moisture stress due to delayed irrigations and high atmospheric temperatures (17). Similar situation was recorded in the present fields also. Trenching loosened the soil, improved the water holding capacity of the soil and increased the water infiltration which helped in storage of rainwater. Mulching increased the organic content and ensured resistance against moisture stress. Stubble mulch cover on sandy soil reduced wind erosion, increased soil moisture storage by reduction in soil evaporation, improved dry aggregates stability and increased crop yields. Mulching reduced direct water loss through evaporation from the upper layers of the soil and established better conditions (18).

Green manuring, strengthened the mulberry plants resilience, increased fertility status, increased water holding capacity and reduced weeds growth. The incorporation of green manuring increased soil moisture contents in different soil depths. Green manure application had significant effects on available soil moisture and soil water infiltration rate (19, 20). Windbreaks and Shelterbelts reduced the wind speed, filtered desiccating dusty winds and protected the leaf quality. Wind breaks obstructed wind flow, reduced wind speed and protected soil while shelter-belts protected crops against wind & improved microclimate of the crops (21, 22).

Effective weed management eliminated the competition of weeds with crops for limited soil moisture and enhanced the availability of soil moisture to main

Table-1 : Leaf yield and silkworm rearing on treated (T_1) and control (T_0) fields (Mean of two years).

Field	Leaf yield (MT /ha/annum)		No. of DFLs reared (ha /annum)		Average yield/100 dfls (Kg)	
	T_1	T_0	T_1	T_0	T_1	T_0
F_1	48.125	20.000	3125	1250	75	80
F_2	57.500	29.375	3750	1875	80	70
F_3	38.750	15.312	2500	938	80	75
F_4	28.250	12.950	1800	780	80	80
F_5	28.025	23.750	1785	1500	80	75
F_6	28.025	27.500	1785	1750	80	80
F_7	29.375	26.225	1875	1665	80	80
F_8	48.125	15.312	3125	938	75	75
F_9	31.250	17.900	2000	1110	75	70
F_{10}	33.701	20.000	2163	1306	79	70
F_{11}	37.112	20.208	2423	1250	76	73
F_{12}	34.637	21.458	2363	1308	75	74
F_{13}	37.085	19.690	2525	1275	75	75
F_{14}	39.362	21.982	2253	1335	79	76
F_{15}	37.365	20.825	2405	1305	75	77
Mean	37.112	20.832	2391	1306	77.60	75.3

Table-2 : Cocoon production and income generated from treated (T_1) & control (T_0) fields (Mean of two years).

Field	Cocoon prdn. (Kg)		Cocoon price/kg (Rs.)		Income generated (Rs.)	
	T_1	T_0	T_1	T_0	T_1	T_0
F_1	2343.70	1000.00	350.00	300	820300	300000
F_2	3000.00	1312.50	290.00	300	870000	393750
F_3	2000.00	703.30	300.00	275	600000	193359
F_4	1440.00	624.00	300.00	300	432000	187800
F_5	1428.00	1125.00	305.00	300	435530	337500
F_6	1428.00	1400.00	300.00	275	428400	385000
F_7	1500.00	1332.00	305.00	300	457500	399600
F_8	2343.70	703.13	315.00	260	738280	184812
F_9	1500.00	777.00	315.00	290	472500	225830
F_{10}	1709.00	875.00	300.00	270	512740	236250
F_{11}	1841.38	1065.73	304.00	290	559770	309060
F_{12}	1771.60	990.00	306.00	297	541960	294730
F_{13}	1893.75	1040.73	308.00	287	583260	298688
F_{14}	1777.50	1025.00	310.00	277	551000	283790
F_{15}	1782.50	1075.00	315.00	284	561478	305800
Mean	1850.61	1003.23	308.20	287.00	570981	289064

crop. Weed control improved crop productivity and imparted more stability to crop production. Rain water harvested by impounding the rainwater in the garden, micro catchments, runoff collection pits, farm ponds and bore well recharging helped in water storage. This reduced runoff and at the same time, water was concentrated in furrows causing better water availability to roots (23). From all these it is assured that practising of soil moisture regime management techniques improved the conditions of the soil, increased the water holding capacity and soil moisture regimes of the soil.

The study results revealed that the average leaf yield, dfls uptake, cocoon production and income/ ha/ annum from soil moisture regime management practised fields [T_1] vs. control (T_0) was recorded as 37.11 & 20.83 MT; 2391 & 1306 Nos.; 1850.61 & 1003.23 kg and Rs.5,70,981.30 and Rs. 2,89,064.70 respectively with improvement percentage of 78.15; 83.14; 87.47 and 97.53 over the control and the statistical analysis of difference in performances in respect of all parameters showed highly significant @ 5% CD level.

The impact of soil moisture management technologies execution, increased mulberry leaf yield (78.1%), dfls uptake (83.14%), cocoon production (87.47%) and income (97.53%) ha^{-1} yr-1 at farmers' level over the control which is statistically highly significant @ CD 5% level. For the efficient utilization and better cropping one has to overcome the physical disadvantage and to retain their advantage by water conservation technique by the effective measures to increase moisture availability to the crop production and for better crop production and soil erosion control. Hence it is recommended to practice the soil moisture conservation technologies in an integrated manner to double the income in southern dry zones.

References

1. Note on Sericulture (2020) *http://www.csb.gov.in/*
2. DOS., (2020) *https://tnsericulture.gov.in/*
3. Dandin S. B., Jayaswal J. and Giridhar K. (2001). Hand book of Sericulture technologies. *Central silk board*, Bangalore, 287p.
4. IMD. (2014). Drought Monitoring. http*://www.imdagrimet.gov.in/fap*
5. Mahimasanthi A., Daniel A.G.K. and Sivaprasad V. (2016). Extent of adoption of drought management technologies in mulberry sericulture in southern dry zone of Tamil Nadu. *Int. J. Trop. Agric.,* 34: 95-102.
6. Bhan S. (1997) Soil and water conservation practical for sustainable agriculture in rainfed areas with particular reference to northern alluvial plains zone of India. *Bhagirath* XXXXV p. 55-65.
7. Misra A.K., Ghosh M.K. and. Bindroo B.B. (2012). Water deficit condition and its impact on mulberry plant (*Morus* spp.) in relation to its growth and physiological parameters. *J. Crop Weed.,* 8 (2): 143-145.
8. Chaitanya V., Jutur P., Sundar D. and Reddy A.R. (2003). Water stress effects on photosynthesis in different mulberry cultivars. Plant Growth Regul., 40(1): 75-80.
9. Siddique B.M.R., Hamid A. and Islam M.S. (2000). Drought stress effect on water relation of *Wheat. Bot. Bull. Acad.*, 41: 35-39.
10. Ashraf M.Y., Azmi A.R., Khan A.H. and Ala S.A. (1994). Effect of water stress on total phenol, peroxidase activity and chlorophyll content in wheat (*Triticum aestivum* L.). *Acta physiol plant.*, 16: 185-91.
11. Rajaram S., Benchamin K.V. and Qadri S.M.H (2006). Impact of drought on sericulture. *Ind Silk.*, 45 (8) : 10-12.
12. Benjamin K.V., Nizamuddin S, Sabitha M.G. and Ghosh A. (1997). Mulberry cultivation technique under water stress condition. *Ind Silk.,* 36(3): 12-18.
13. Mahimasanthi A., Rajaram S., Daniel A.G.K., Vidunmala M., Vedavyasa K., Morrison M. N. and Sivaprasad V. (2018) Bridging of gaps in adoption of drought management technologies in mulberry cultivation in drought prone areas of South India. *Sericologia* 58(1): 55-63
14. Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures in Agricultural Research, 2ndEdn., *John Wiley and Sons*, New York.pp. 680.
15. A. (2009). Effective use of water (EUW) and not water-use efficiency (WUE) is the target of crop yield improvement under drought stress. *Field Crops Res.*, *112* (2-3) : 119-123.
16. Guha A, Sengupta D, Rasineni G.K. and Reddy A.R. (2010). An integrated diagnostic approach to understand drought tolerance in mulberry (*Morus indica* L.). *Flora*, *205*: 144–151.
17. Verma S., John M., Aqueel S. A. and Datta R.K. (1997) Subsoiler—an effective equipment for rain water harvesting and *in situ* moisture conservation. *Ind. Silk,* 36(3): 23-25.
18. Benites J and Castellanos A. (2003). Improving soil moisture with conservation agriculture.
19. Sajjad M.R., Subhani A., Rafique R., Hussain T., Naseem W., Bibi R. and Malik S.N. (2018). Green Manuring for Moisture Conservation and Wheat Yield Improvement in Rainfed Agriculture. *J. Nat. Sci. Res.*, 8 (9): 33-41.
20. Mosavi S B, A., A Jafarzadeh, M R Nishabouri, Ostan, V Feiziasl and E Karimi (2012). The effect of different green manure application in dry land conditions on some soil physical properties. *Intl. J. Agri. Crop Sci.*, *4* (17): 1233-1239.
21. David R., Tomas K., Josef K., Jan V. and Martin P. (2016). Effect of Windbreaks on Wind Speed Reduction and Soil Protection against Wind Erosion. *Soil & Water Res., 10*: 17221-45.
22. Singh R.J.D., Mandal B.N., Chand G.L., Alam N.M. and Sharma N.K. (2015). Efficient Soil and Water Management under Limited Water Supply Condition. In. *Integrated Soil and Water Resource Management for Livelihood and environmental Security.* Rajkhowa, D.J., Das, Anup, Ngachan, S.V.,Sikka, A.K. and Lyngdoh, M. (Eds.) pp 1-19. ICAR Research Complex for NEH Region, Umiam – 793 103, Meghalaya, India.
23. Singh S, Rao V.U.M. and Singh D. (1991) Microclimatic studies in summer moong (*Vigna radiata* L. Wilczek) and bare fields. *Mausam*, 42(3): 265-268.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 821-823 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Morphological Characterization of Chow-Chow [*Sechium edule* (Jacq.) Sw.] in North East India

M.M. Shulee Ariina*, Khamrang Mathukmi, Konjengbam Ramit Singh, Hau Ngaih Lian, M. Jangyukala and S. Kikatemjen Ozukum

Department of Horticulture, School of Agricultural Sciences and Rural Development, Nagaland University

Abstract

A total of twenty genotypes of chow-chow were collected from North eastern states of India. The genotypes were grown in Randomized Block Design at Horticulture research farm, SASRD, Medziphema to study both the quantitative and qualitative traits. Wide range of fruit colour was observed from pale while to dark green. A total of 15 genotypes were found without spines while the remaining was found with spines. The fruit length varied from G-4 with 6.95cm (collected from Ziro, Arunachal Pradesh) to G-15 with 20cm (Tamei, Manipur) with average length of 13.68cm. The maximum fruit diameter was recorded in G-9 (9.63 cm, collected from Nongpiur, East Khasi hills, Meghalaya) followed by G-4 while lowest was recorded in G-3 (6.23 cm, collected from Mao-gate, Manipur). Number of fruits per plant ranged between 5.91 in G-20 (collected from Makhan village Manipur) to 11.41 in G-14 and G-18 (collected from Namchi, Sikkim and Tening, Peren district, Nagaland) with average fruit per plant of 8.40. The average fruit weight varied from G-4 (64.33g) to G-15 (474.0g). The highest fruit yield per plant was recorded G-15 with 3.06 kg while lowest yield in G-4 with 0.62 kg. The average fruit yield per plant was 1.92 kg. Biochemical analysis of fruit revealed that higher TSS content was observed in G-10 (5.16%, collected from Makhel village, Manipur) while high level of Vit. C was observed in G-9 (22.10 mg $100g^{-1}$). Moisture was recorded highest in G-8 (94.18%), Mawkriah, East Khasi hills, Meghalaya) and Cabohydrate in G-15 (4.80%).

Key words : *Chow-chow, genotypes, qualitative, TSS and variation.*

Introduction

Chow-chow [*Sechium edule* (Jacq.) Sw.] also known as Chayote is an underutilized crop of family Cucurbitaceae, is native to Central America and humid tropical region of Mexico. In India, the crop was introduced by the Western Missionaries (Singh *et al.,* 2012) and nowadays it is widely distributed along the Himalayan states and adjoining areas of Myanmar, Bhutan and Nepal. Chow-chow is an herbaceous, monoecious, self-compatible, perennial vine with tuberous roots. In addition to the fruits; stems, tender leaves and tuberous roots are also eaten. It produces large number of fruits, which are single seeded and viviparous. The single seeded fruits are viviparous. It is very popular among the tribals of North-Eastern regions owing to its hardiness, profuse fruiting with minimum care and its multiple uses. It grows luxuriantly under high rainfall conditions. Considerable variations are found in chow-chow in respect of fruit size, shape, colour, presence of spines and nutritional composition of the fruits. It is unique among the cultivated cucurbits by bearing a single seeded fruit and exhibiting vivipary (Aung *et al.,* 1990). So far, it remained a neglected underutilized crop and few studies have been carried out. Therefore, an attempt has been made to collect and characterize chow-chow genotypes of the North-Eastern region.

Materials and Methods

A total of 20 genotypes of chow-chow were collected from different states of North-East India. The sprouted fruits of all genotypes were planted at Horticulture Research Farm, SASRD, Nagaland University, Medziphema during the rainy season of 2019-20 in Randomized Block Design. The sprouted fruits of each genotype were planted in hill at a spacing of 2 m row to row and 2 m within rows consisting 5 plants in each row. The plants were trained on trellis. The observation recorded for 14 quantitative traits and qualitative traits, viz. vine length, no. of fruits/plant, fruit length, fruit diameter, fruit weight, fruit yield per plant, spine, spine distribution, fruit colour, fruit shape, TSS, Vit. C, moisture and carbohydrate. Mean data of quality and quantitative characters were subjected to statistical analysis.

Results and Discussion

The qualitative and quantitative traits are presented in Table-1. A range of fruit colour was observed such as dark green, light green, yellow, light yellow, cream and white as seen in Fig-1.

As far as spine is concerned, 15 genotypes were found without spine and remaining had spines from soft to hard. The fruit length varied from G-4 with 6.95cm (collected from Ziro, Arunachal Pradesh) to G-15 with

Fig.-1 : Major group of Chow-chow based on spine, spine distribution, fruit colour and fruit shape.

Table-1 : Quantitative and qualitative characters of Chow-chow.

	Vine length	No. of fruits/ plant	Fruit length	Fruit diameter	Fruit weight	Fruit yield/ plant	Spine	Spine Distribu-tion	Fruit colour	Fruit shape	TSS	Vit. C	Moisture	Carbo-hydrate
G-1	283.66	10.83	10.98	7.60	101.33	1.12	A	Nil	LG	R	5.00	14.40	91.23	4.23
G-2	343.83	7.58	16.20	6.90	307.00	2.34	A	Nil	PY	O	5.08	16.81	90.96	4.28
G-3	270.83	6.66	12.86	6.23	217.00	1.47	P	H	G	P	4.55	12.61	93.11	4.25
G-4	197.66	9.58	6.95	9.33	64.33	0.62	A	Nil	G	O	4.65	16.78	92.50	4.67
G-5	243.16	8.25	17.00	8.86	224.16	1.88	A	Nil	PY	R	5.15	17.25	91.85	4.44
G-6	194.66	8.83	12.06	8.70	124.00	1.14	A	Nil	G	P	5.06	16.91	93.41	4.52
G-7	274.16	9.25	12.58	8.86	253.83	2.37	A	Nil	G	P	5.05	16.55	90.70	4.40
G-8	343.16	6.33	18.63	8.80	465.83	3.01	A	Nil	PY	P	4.25	12.48	94.18	4.19
G-9	258.00	8.25	15.95	8.40	293.16	2.46	A	Nil	G	P	4.26	22.10	91.13	4.43
G-10	299.16	8.50	11.26	9.63	240.50	2.04	A	Nil	DG	O	5.16	18.85	91.15	4.22
G-11	300.66	10.08	11.83	9.30	215.00	2.18	P	H	DG	R	5.15	17.18	90.96	4.50
G-12	346.33	7.00	15.55	7.13	345.33	2.47	P	M	G	P	4.28	17.35	93.45	4.78
G-13	180.66	6.25	14.78	6.86	253.83	1.61	A	Nil	G	P	4.36	21.80	92.41	4.38
G-14	278.83	11.41	10.51	8.40	153.16	1.81	P	L	DG	O	4.50	21.61	92.63	4.19
G-15	220.16	6.33	20.00	8.40	474.00	3.06	A	Nil	PY	P	4.76	19.36	93.33	4.80
G-16	235.33	8.25	13.83	7.00	201.16	1.69	A	Nil	LG	O	4.83	10.23	91.43	4.66
G-17	183.66	11.00	10.48	6.93	166.00	1.90	A	Nil	G	O	4.68	19.25	93.30	4.42
G-18	244.00	11.41	14.08	8.26	171.16	2.01	A	Nil	G	O	4.11	17.73	92.28	4.71
G-19	232.50	6.25	14.86	7.73	269.00	1.72	A	Nil	G	O	5.06	18.33	91.85	4.41
G-20	188.66	5.91	13.30	7.05	250.16	1.54	P	H	G	P	4.86	19.36	91.23	4.39
Mean	255.95	8.40	13.68	8.02	239.50	1.92					4.74	17.35	92.15	4.44
Range	180.66-346.33	5.91-11.41	6.95-20.00	6.23—9.63	64.33-474.00	0.62-3.06					4.11-5.16	10.23-22.1	90.7-94.18	4.19-4.8
C.D. 5%	11.79	0.82	1.58	1.77	10.81	0.16					0.08	0.25	0.50	0.02

20cm (Tamei, Manipur) with average length of 13.68cm. The maximum fruit diameter was recorded in G-9 (9.63 cm, collected from Nongpiur, East Khasi hills, Meghalaya) followed by G-4 while lowest was recorded in G-3 (6.23 cm, collected from Mao-gate, Manipur). Number of fruits per plant ranged between 5.91 in G-20 (collected from Makhan village Manipur) to 11.41 in G-14 and G-18 (collected from Namchi, Sikkim and Tening, Peren district, Nagaland) with average fruit per plant of 8.40. The average fruit weight varied from G-4 (64.33g) to G-15 (474.0g). The highest fruit yield per plant was recorded G-15 with 3.06 kg while lowest yield in G-4 with 0.62 kg. The average fruit yield per plant was 1.92 kg. Biochemical analysis of fruit revealed that higher TSS content was observed in G-10 (5.16%, collected from Makhel village, Manipur) while high level of Vit. C was observed in G-9 (22.10 mg $100g^{-1}$). Moisture was recorded highest in G-8 (94.18%), Mawkriah, East Khasi hills, Meghalaya) and Cabohydrate in G-15 (4.80%).

Considerable variations were found in respect of various fruit characteristics like number of fruits per plant, size, shape, weight, diameter and colour as well as presence of spine and other biochemical traits in the present study. Similar variation is observed in some of the earlier reports on indigenous chow-chow collections (Sanwal *et al.,* 2008, Sanwal *et al.,* 2010, Mishra & Das 2015, Kim *et al.,* 2016 and Verma *et al.,* 2017).

References

1. Aung, L.H., Ball, A. and Kushad, M. 1990. Developmental and nutritional aspects of chayote (*Sechium edule*). *Economic Botany.* 44(2): 157–164.
2. Kim, C.H., Son, D., Seong, K.C., Kim, S.C., Lim, C.K. and Song, E.Y. 2016. Introducing the new crop vegetable chayote [*Sechium edule* (Jacq.) Swartz.] into Korea for climate change. *Acta Horticulturae.* 1127. ISHS. DOI 10.17660.
3. Mishra, L.K. and Das, P. 2015. Nutritional Evaluation of Squash (*Sechium edule*) Germplasms collected from Garo Hills of Meghalaya – NE India. *International Journal of Agriculture, Environment and Biotechnology.* 8(4): 971-975.
4. Sanwal, S. K., Singh, S. K., Singh, P. K. and Misra, A. K. 2010. Characterization of Chow-Chow (*Sechium edule*) Germplasm of North-eastern Region of India for Economic Traits. *Indian Journal of Plant Genetic Resources.* 23(1): 19-21.
5. Sanwal, S.K., Yadav, R.K., Singh, P.K. and Rai, N. 2008. Variability and genetic diversity studies in indigenous chow-chow genotypes of northeast India. *Indian Journal of Horticulture.* 65(2): 167-170.
6. Singh, B. K., Pathak, K. A. and Ngachan, S.V. 2012. Exploring underutilized chow–chow in Mizoram. *Indian Horticulture.* 57(5): 3–5.
7. Verma, V. K., Pandey, A., Jha, A. K. and Ngachan, S. V. 2017. Genetic characterization of chayote [*Sechium edule* (Jacq.) Swartz.] landraces of North Eastern Hills of India and conservation measure. *Physiology and Molecular Biology of Plants.* 23(4): 911–924.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 824-830 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Economic of Rose Crop in Chittorgarh District of Rajasthan

Narender Sevta*, Hari Singh and Giridhari Lal Meena
Department of Agricultural Economics and Management, RCA, MPUAT, Udaipur
**Corresponding author*

Abstract

Rose is one of the most important flower crop in horticulture. It is a popular crop for both domestic and commercial cut flower. Rose also has medicinal value. Essential oil, vitamin A, B, E, and K, potassium and iron form the key medicinal components. Out of 13 tehsils in Chittorgarh, two tehsil namely Dungla and Bhadaser were selected based on the maximum area under rose crop. Five villages were selected randomly from two selected tehsil and 60 farmers were chosen at randomly and data was collected for the rose crop year 2020-21. The overall cost of cultivation of rose crop in Chittorgarh district was found ₹ 132239.46 per hectare in which the total variable cost and total fixed cost were ₹ 109660.99 and ₹ 22578.47 per hectare. The percentage share of variable cost and fixed cost were 82.93 per cent and 17.07 per cent in total cost. The share of human labour (44.54 per cent) was found higher than other cost. The amortised establishment cost was ₹ 13509.26 per hectare. The gross return and net return was ₹ 323087.35 and ?190874.90 per hectare, respectively. The total production was found 72.53 quintal per hectare in which fresh flower production was 66.02 quintal and dry flower production was 6.51 quintal per hectare. The cost of production ₹ 1824.25 per quintal of rose flower. The farm business income and farm labour income were found ₹ 266388.91 and ₹ 232835.40per hectare. The farm investment income was ₹ 281099.85 per hectare. The return per rupee ratio was found 2.44.

Key word : *Rose crop, cost of cultivation, gross return, net return, cost of production, farm business, farm labour income, farm investment income, return per rupee.*

Introduction

Rose is one of the most important flower crop in horticulture. Rose is a woody perennial flowering plant of the genus Rosa, in the family Rosaceae. It is a popular crop for both domestic and commercial cut flower. Generally, it is used as a decorative in households and public garden. Rose also has medicinal value. The medicinal parts of the plant are the flower, petals, rose hips, root, root bark and essential oil. Essential oil, vitamin A, B, E, and K, potassium and iron form the key medicinal components. The extract of rose plant especially acts as antidepressant, antiseptic, anti-inflammatory, digestive stimulant, kidney tonic and menstrual regulator (Nanda and Das, 2015)

Rose is the most preferred flower in the international market. India has high potential for export of cut flower. India ranks 1st in area and production of cut roses and export only 0.20 to 0.40 percentage of global export trade. Top most cut roses producing countries in the world are India, China, Ecuador, Colombia, Kenya and Netherland, etc. More than 45 per cent area of world undercut rose is in India. In India, major cut flower producing states are West Bengal, Karnataka, Gujarat, Chhattisgarh, Maharashtra, Uttar Pradesh, Tamil Nadu, Madhya Pradesh and Andhra Pradesh. During 2013-2015, export of cut roses has increased but price of export cut flower decreased. The export of cut roses from India has declined in the countries like Australia and Japan and increased in Singapore, New Zealand and Malaysia. Increase in price of cut roses was relatively more in USA, Saudi Arabia, Australia and Netherland (Bhagat, *et al.,* 2019). According to Agricultural and Processed Food Products Export Development Authority (APEDA), area of floriculture production in India was 305 thousand hectares in 2019-20. . The Production of flowers in India was 2301 thousand tonnes loose flowers and 762 thousand tonnes cut flowers in 2019-20. The country has exported 15,695.31 MT of floriculture products to the world for the worth of ?575.98 Crores/77.84 USD Millions in 2020-21. USA, Netherland, UAE, UK, and Germany are major importing countries of Indian floriculture during the 2020-21(Source – APEDA).

According to ICAR-Directorate of Floriculture Research Annual Report 2017- 18, the traditional flowers are grown in an area of 3.09 lakh hectare and producing 22.46 lakh tonnes of loose flower and 4.84 lakh tones of cut flowers (National Horticulture Board 2016).

India also has significant proportion of trade in potted flowering plants, ornamentals foliage plants for landscaping, turf grasses, cut foliage, dry flowers, specialty flowers, annual flower seeds and fillers. The knowledge of cost of cultivation and returns from rose cultivation is very useful for the cultivators to adjust and coordinate the available resources in a profitable manner.

The Government of India has identified floriculture as a sunrise industry and has high export-oriented status. Owing to steady increase in demand of flower, floriculture has become one of the important commercial trades in agriculture.

Objective : To work out the cost, return and profitability of rose cultivation

Materials and Methods

In southern Rajasthan, Chittorgarh district has been purposively selected on the basis of higher area and production under rose cultivation. Out of 13 tehsils of Chittorgarh, Dungla and Bhadeser tehsils, were selected on basis of maximum area under rose cultivation. A random sample of 60 rose farmers was taken from selected two tehsils. Out of 60 rose farmers, 30 rose farmers of Dungla tehsil and 30rose farmers of Bhadaser tehsil were selected. 15 rose farmers of Dungla tehsil were selected from each village namely-Chikarda and Ghodakhera and 10 rose farmers of Bhadesar tehsil were selected from each village namely- Kuharon Ki Dhani, Baliyo Ki Dhani and Shankhlo Ki Dhani. Further rose farmer were divided in to three category on the basis of land holding namely- small (< 0.5 Ha), medium (0.5-1.00 Ha) and large (>1.00 Ha). Village wise and category wise detail of selected rose farmers are given in the table-1. Tabular and statistical analysis was done for estimating cost of cultivation, cost of production and profitability of rose cultivation.

Data type used : primary.

Cost of cultivation : For analyzing the cost of cultivation, the variable cost items and fixed cost items was considered. The variable cost included the farm expenditure on human labour, bullock labour, machine labour, fertilizer, manure, plant protection, irrigation, interest on working capital, manure, plant protection chemical etc. The fixed cost was calculated by adding the depreciation charges, rental value of owned land, annual amortised establishment cost, land revenue and interest on fixed capital etc. The annual amortised establishment was estimated by using establishment cost to spread it over the entire life period of rose crop. The total cost of production was calculated by adding all the expenditures on variable inputs and fixed inputs.

The cost of cultivation was calculated by using simple mathematical analysis and this included Cost A, Cost B, Cost C :

Establishment cost :

Land preparation (ploughing + layout) (₹)

Cost of digging trenches (₹)

Cost of digging pit (₹)

Cost of plant (₹)

Cost of planting (₹)

Other cost (₹)

Annual amortised establishment cost–

$$A = P \frac{i(1 \quad i)n}{(1 \quad i)n \quad 1}$$

A = annual amortised establishment cost

P = present establishment cost

n = economical life of rose garden

i = interest rate at 12 per cent

Cost item :

1. Value of hired human labour (₹)
2. Value of bullock labour (₹)
3. Value of machine labour (₹)
4. Value of fertilizer (₹)
5. Value of manure (₹)
6. Value of plant protection (₹)
7. Value of Irrigation (₹)
8. Land revenue and taxes (₹)
9. Incidental charge (₹)
10. Interest on working capital (₹)
11. Depreciation on working capital (₹)

Cost-A (item 1 to 11)

12. Rental value of owned land / land rent of leased in land (₹)
13. Interest on fix capital (₹)
14. Amortised establishment cost (₹)

Cost-B (cost A + item 12+13+14)

15. Imputed family labour (₹)

Cost-C (cost B + item 15)

Income measure : To analyse the returns from the rose cultivation following concepts were used.

1. Gross income = Q_m x P_m

Where Q_m = quantity of main product

P_m = price of main product

There was no by- product of rose.

2. Farm business income = Gross income – Cost A.
3. Farm labour income = Gross income – Cost B.
4. Net income = Gross income – Cost C.

5. Farm investment income = Farm Business Income – Imputed Value of Family Labour.

Cost of production : Cost of production was calculated by following formula-

Cost of production (per quintal)

$$\frac{\text{Total cost of cultivation}}{\text{Yield in quintal per hectare}}$$

Profit analysis : The profit is the difference between total revenue and total cost incurred. Thus, net profit for any farm business can be written as :

$$\text{Net profit} = TR - TC$$

Where,

TR = Total Revenue

TC = Total Cost

Results and Discussion

Input use in rose cultivation : In Chittorgarh district overall use of rose planting material was found 3981.36 plants per hectare. The use of planting material was found maximum for large size farm group and minimum for small size farm group. The overall use of FYM was found 14.41 tonnes per hectare of rose cultivation. It was found maximum for small size farm (18.40 tonnes/ha) and minimum for large size farm (12.22 tonnes/ha). The use of fertilizers was found maximum in case of large size farm group (188.14 Kg/ha) and minimum in case of small size farm group (135.55 Kg/ha). Overall use of fertilizer per hectare was 149.65 kg. It showed scare availability of FYM for large size farmer so high use of fertilizer per hectare. The overall use of human labour was 168.27 man-days per hectare for rose cultivation in which family labour was119.56 man-days and hired labour was 48.71 man-days per hectare. The use of human labour for rose cultivation was recorded highest for small size farm (173.68 man-days/ ha) and lowest for large size farm (154.44 man-days/ ha). It was observed that use of family labour was highest for small size farm (125.95 man-days/ ha) and lowest for large size farm (101.67 man-days/ha) whereas use of hired human labour was found highest for large size farm (52.78 man-days/ ha) and lowest for small size farm (47.73 man-days/ha). It showed a decreasing trend with increases in size of land holding in respect of use of family labour and an increasing trend with increases of land holding in respect of use of hired human labour per hectare.

The use of machine labour was observed highest for large size group and lowest for small size group for rose cultivation. Overall use of machine labour was 37.42 hours/ ha for rose cultivation. The use of plant protection chemical was found maximum for small size group (4.57 liter/ ha) and Minimum for large size group (2.02 liter/ ha). Overall use of plant protection chemical for per hectare of rose cultivation was 3.44 liter/ ha. The electricity consumption for irrigation in rose cultivation per hectare was found maximum in case of small size farm and minimum in case of large size farm. Overall electricity consumption for irrigation in rose cultivation per hectare was 722.63 unit/ha.

Cost of cultivation of rose in Chittorgarh district : The overall cost of rose cultivation in Chittorgarh district of Rajasthan was ₹ 132239.46 in which the total fixed cost and the total variable cost was ₹ 22578.74 and ?109660.99 which accounted for 17.07 and 82.93 per cent of total cost of cultivation respectively.

The overall percentage share in total cost per hectare was highest for human labour cost (44.54 per cent) followed by total value of owned land, amortised establishment cost, FYM, interest on working capital, machine labour, irrigation charges, plant protection cost, depreciation charges, fertilizer cost, interest on fixed cost which accounted for 13.61 per cent, 10.22 per cent, 6.48 per cent, 6.09 per cent, 4.66 per cent, 4.64 per cent, 3.38 per cent, 2.11 per cent, 1.84 per cent, 1.35 per cent per hectare respectively.

The total cost of rose cultivation was recorded higher in case of small size group i.e. ₹ 140612.58 than overall cost of cultivation (₹ 132239.46). In case of medium and large size group, the cost of rose cultivation was estimated ₹ 131054.25 and ₹ 120731.03 respectively. On all three size group, highest percentage share in total cost was accounted for human labour cost which was 43.23 per cent, 43.34 per cent, 44.77 per cent per hectare on small, medium and large size group respectively. The reason behind high human labour cost was due to picking rose flower required more human labour in rose cultivation.

The amortised establishment cost was higher in case large size group i.e. ₹ 14906.26 than overall amortised establishment cost (₹ 13509.26). It was ₹ 13113.02 and ₹ 13435.73 on small and medium size group respectively. Percentage share of amortised establishment cost in total cost was 9.33 per cent, 10.25 per cent, 12.35 per cent and 10.22 per cent per hectare on small, medium, large and overall size group respectively.

The cost of FYM was recorded highest on small size group i.e. ₹ 11040.00 and lowest on large size group i.e. ₹ 6622.22. On medium and overall size group, it was ₹ 7942.86 and ?8563.07 respectively. On small, medium, large and overall size group, the share of FYM cost was recorded 7.85 per cent, 6.06 per cent, 5.49 per cent and

Table-1 : Village wise and category wise number of selected farmers.

Size of group	Number of farmers					Total
	Dungla		Bhadesar			
	Chikarda	Ghodakhera	Kuharon ki dhani	Baliyo ki dhani	Shankhlo ki dhani	
Small (<0.5 Ha)	3	3	5	3	1	15
Medium (0.5-1.0 Ha)	10	8	5	6	8	37
Large (1.0Ha)	2	4	0	1	1	8
Total	15	15	10	10	10	60

Table-2 : Utilization of farm input in physical quantity in rose cultivation Chittorgarh.

Input	Small	Medium	Large	Overall
Planting material (no./ha)	3874.88	3947.65	4121.55	3981.36
FYM (tonnes/ha)	18.40	13.24	12.22	14.41
Fertilizers (Kg/ha)	135.55	142.74	188.14	149.65
Plant protection (liter/ha)	4.57	3.25	2.02	3.44
Human labour (man days /ha)	173.68	162.28	154.44	168.27
(i) Family labour	125.95	113.33	101.67	119.56
(ii) Hired labour	47.73	48.95	52.78	48.71
Machine labour (hr/ha)	35.33	37.00	39.89	37.42
Electricity consumption for irrigation (unit/ha)	889.41	674.79	624.96	722.63

Table-3 : Cost of cultivation of rose crop in Chittorgarh district. (₹/Ha)

Input	Small	Medium	Large	Overall
Amortised establishment cost	13113.02 (9.33)	13435.73 (10.25)	14906.26 (12.35)	13509.26 (10.22)
FYM	11040.00 (7.85)	7942.86 (6.06)	6622.22 (5.49)	8563.07 (6.48)
Fertilizers	2209.52 (1.57)	2322.22 (1.77)	3066.67 (2.54)	2438.84 (1.84)
Plant protection	5946.67 (4.23)	4228.57 (3.23)	2627.78 (2.18)	4471.34 (3.38)
Human labour	60790.00 (43.23)	56800.00 (43.34)	54055.56 (44.77)	58894.57 (44.54)
(i) Family labour	44083.33	39666.67	35583.33	41845.83
(ii) Hired labour	16706.67	17133.33	18472.22	17048.74
Machine labour	6067.67 (4.32)	6161.90 (4.70)	6371.55 (5.28)	6162.80 (4.66)
Electricity charges for irrigation	7560.00 (5.38)	5735.71 (4.38)	5300.00 (4.39)	6140.95 (4.64)
Interest on working capital	8588.56 (6.11)	8020.40 (6.12)	7076.16 (5.86)	8052.28 (6.09)
Total variable cost	117188.15 (83.34)	108951.37 (83.13)	97383.62 (80.66)	109660.99 (82.93)
Total value of owned land	18000 (12.80)	18000 (13.73)	18000 (14.91)	18000 (13.61)
Depreciation charges	3689.87 (2.62)	2326.76 (1.78)	3382.11 (2.80)	2790.66 (2.11)
Land revenue	0 (0)	0 (0)	0 (0)	0 (0)
Interest on fixed capital	1734.56 (1.23)	1776.12 (1.36)	1965.12 (1.63)	1787.80 (1.35)
Total fixed cost	23424.43 (16.66)	22102.89 (16.87)	23347.41 (19.34)	22578.47 (17.07)
Total cost	140612.58 (100)	131054.25 (100)	120731.03 (100)	132239.46 (100)

6.48 per cent per hectare respectively. Due to less availability of FYM to large farms group, the cost of FYM was found minimum on large size group.

The overall cost of fertilizer was ₹ 2438.84 per hectare. The cost of fertilizer was ₹ 2209.52, ₹ 2322.22 and ₹ 3066.77 on small, medium and large size group respectively which accounted for 1.57 per cent, 1.77 per cent and 2.54 per cent per hectare respectively. The cost of plant protection was recorded higher on small size group i.e. ₹ 5946.67 than overall plant protection cost per hectare. On medium and large size group, it was ₹ 4228.57 and ₹ 2627.78 respectively which accounted for 1.77 per cent and 2.54 per cent per hectare respectively.

The cost of human labour was recorded higher on small size group i.e. ₹ 60790.00 than overall human labour cost (₹ 58894.57). The human labour cost was found ₹ 56800 and ₹ 54055.56 on medium and large size group respectively. The family labour cost was estimated higher on small size group i.e. ₹ 44083.33 than other size group because most of family member of small size farm was engaged in their farm work. The cost of family labour was ₹ 39666.67, ₹ 35583.33 and ₹ 41845.83 on medium, large and overall size group per hectare respectively. The cost of hired human labour was higher in case of large size farms i.e. ₹ 18472.22 and lower in case of small size

Table-4 : Cost and return from rose production in Chittorgarh district.

S.N.	Particulars	Small N = 15	Medium N = 37	Large N = 8	Overall N = 60
1.	Cost of cultivation (₹/ha)	140612.58	131054.25	120731.03	132239.46
2.	Gross return (₹/ha)	343106.67	315295.24	322488.89	323087.35
3.	Net return (₹/ha)	202494.09	184240.98	201757.86	190847.90
4.	Total production	74.08	71.23	76.37	72.53
	(a) fresh flower (quintal per ha)	67.83	64.73	69.17	66.02
	(b) Dry flower (quintal per ha) (1 Qt = 10 bag)	6.25	6.50	7.20	6.51
5.	Cost of production (₹/quintal)	1898.03	1839.94	1580.94	1824.25

Table-5 : Cost of cultivation of rose crop according to cost concepts in Chittorgarh district. (₹/ha)

S.N.	Particulars	Small	Medium	Large	Overall
1.	Total variable cost	117188.15 (83.34)	108951.15 (83.13)	97383.62 (80.66)	109660.99 (82.92)
2.	Total fixed cost	23424.43 (16.65)	22102.89 (16.86)	23347.41 (19.33)	22578.47 (17.07)
3.	Cost A	66305.09 (44.15)	53759.06 (41.02)	52069.38 (43.12)	56698.44 (42.87)
4.	Cost B	100945.91 (71.79)	86970.92 (66.36)	85147.69 (70.52)	90251.96 (68.24)
5.	Cost C	140612.58 (100)	131054.25 (100)	120731.03 (100)	132239.46 (100)

Table-6 : Economics of rose crop in Chittorgarh district. (₹/ha)

S.N.	Particulars	Small	Medium	Large	Overall
1.	Cost of cultivation	140612.58	131054.25	120731.03	132239.46
2.	Gross income	343106.67	315295.24	322488.89	323087.35
3.	Farm business income	276801.58	261536.17	270419.51	266388.91
4.	Farm labour income	242160.76	228324.32	237341.19	232835.40
5.	Net income	202494.09	184240.98	201757.86	190847.90
6.	Farm investment income	303440.00	271211.90	286905.56	281099.85
7.	Return per rupee	2.44	2.40	2.67	2.44

farm i.e. ₹ 16706.67 than overall hired human labour cost (₹ 17048.74).

The overall machine labour cost was estimated? 6162.80. The machine labour cost was higher on large size farms and lower on small size farms. It was ₹ 6067.67, ₹ 6160.90 and ₹ 6371.55 on small, medium and large size farms respectively. The irrigation charge was recorded higher in case of small size group (₹ 7560.00) and lower in case of large size group (₹ 5300). The overall irrigation cost was recorded ₹ 6140.95.

The overall interest on working capital was ₹ 8052.28. On small, medium and large size group, interest on working capital was ₹ 8588.56, ₹ 8020.40 and ₹ 7076.16 which accounted for 6.11 per cent, 6.12 per cent and 5.86 per cent respectively. The overall interest on fixed capital was ₹ 1787.80. It was estimated ₹ 1734.56, 1776.12 and ₹ 1962.12 on small, medium and large size group respectively. The rental value of owned land was same for all three category i.e.18000 per hectare. It was differ in term of percentage i.e. 12.80 per cent, 13.73 per cent, 14.91 per cent and 13.61 per cent on small, medium, large and overall size group respectively.

The total cost of cultivation of rose crop was ₹ 120731.03 per hectare on large size group. In case of medium size group, total cost of rose cultivation was ₹ 131054.25 per hectare. On small size group, the cost of rose cultivation was higher i.e. ₹ 140612.58 per hectare than overall cost of cultivation (₹ 132239.46).

Economics of rose cultivation : In Chittorgarh district, the overall gross return and net return was found ₹ 323087.35 per hectare and ₹ 190847.90 per hectare respectively. The gross return was recorded highest on small size group i.e. ₹ 343106.67 per hectare followed by ₹ 322488.89 per hectare on large size group then ₹ 31529.24 per hectare on medium size group. The net return was ₹ 202494.09 per hectare, ₹ 184240.98 per hectare and ₹ 201757.86 per hectare on small, medium and large size group respectively.

Overall total production of rose flower was 72.53 quintal per hectare in which the production of fresh flower and dry flower was 66.02 quintal and 6.51 quintal per hectare respectively. The total rose production per hectare was recorded highest in case of large size group (76.37 quintal) and lowest in case of medium size group (71.23 quintal). On small size group, the total rose production was 74.08 quintal per hectare. The production

of fresh rose flower was recorded 67.83 quintal, 64.73 quintal and 69.17 quintal per hectare on small, medium and large size group respectively. The dry flower production per hectare was higher on large size group (7.20 quintal) followed by medium size (6.50 quintal) then small size group (6.25 quintal).

The cost of rose flower production was found higher on small size group i.e. ₹ 1898.03 per quintal than overall cost of rose flower production (₹ 1824.25). The cost of rose flower production was recorded ₹ 1839.94 per hectare and ₹ 1580.94 per hectare on medium size and large size group respectively.

Cost group : The overall cost A and cost B were accounted 42.87 per cent and 68.24 per cent of cost C in Chittorgarh district respectively. On small size group, the cost A and cost B were found 44.15 per cent and 71.79 per cent of cost C. The cost A and cost B were accounted 41.02 per cent and 66.36 per cent of total cost on medium size group respectively. On large size group, cost A and cost B were 43.12 per cent and 70.52 per cent respectively.

Income measure of rose crop in Chittorgarh District : The overall gross income of rose cultivation was estimated ₹ 323087.35 per hectare in Chittorgarh district of Rajasthan. The overall farm business income and the overall farm labour income was ₹ 266388.91 and ₹ 232835.40 per hectare for rose cultivation respectively. The overall net income and overall farm business income over cost C was ₹ 190847.90 and ₹ 281099.85 per hectare respectively.

As shown in the table 6 per hectare gross income of rose crop in Chittorgarh district were ₹ 343106.67, ₹ 315295.24 and ₹ 322488.89 on small, medium and large size group respectively. The farm business income of rose cultivation was higher on small size group (₹ 276801.58) and lower on medium size group (₹ 261536.17). It was ₹ 270419.54 on large size farm per hectare. The farm labour income was also higher on small size group (₹ 242160.76) and lower on medium size group (₹ 228324.32) than overall farm labour income (₹ 232835.40). It was ₹ 237341.19 hectare on large size group.

In Chittorgarh district, the net income of rose crop per hectare over cost C was estimated higher in case of small size group i.e. ₹ 202494.09 followed by large size farm group (₹ 201757.86) then medium size farm group (₹ 184240.98). The farm investment income per hectare over cost C was estimated highest on small size group (₹ 303440.00) and lower on medium size group (₹ 271211.90) than overall farm investment income (₹ 281099.85). On large size group, it was ₹ 286905.56 per hectare.

The ratio of return per rupee was found highest in case of large size group i.e. 2.67 and lowest in case of medium size farm group i.e. 2.40 than overall ratio of return per rupee (2.44). The ratio was estimated 2.44 in case of small size group.

The cost of cultivation varied from ₹ 120731.03 to ₹ 140612.58 per hectare of rose in Chittorgarh district. The cost of cultivation was found higher on small size group (₹ 140612.58) and lower on large size group (₹ 120731.03) than overall cost of cultivation (₹ 132239.46).

Conclusions

The following conclusions were drawn from the study : The results shown that the cost of cultivation of rose crop in Chittorgarh district was ₹ 140612.58, ₹ 131054.25 and ₹ 120731.03 on small, medium and large size groups, respectively. The overall cost of cultivation of rose crop was ₹ 132239.46 per hectare in which total variable cost and fixed cost was ₹ 109660.99 and ₹ 22578.47 per hectare, respectively. The share of variable cost was 82.93 per cent of total cost while share of fixed cost was 17.07 per cent. The human labour (44.54%) accounted for highest percentage in overall cost followed by total value of owned land, annual amortised establishment cost, FYM, interest on working capital, machine labour cost, plant protection cost, depreciation charge, fertilizer cost and interest on fixed capital which accounted for 13.61 per cent, 10.22 per cent, 6.48 per cent, 6.09 per cent, 4.66 per cent, 3.38 per cent, 2.11 per cent, 1.84 per cent and 1.35 per cent, respectively.

Overall gross income of rose crop during 2020-21 was found to be ₹ 323087.35 per hectare in Chittorgarh district. The net return over cost C was estimated of ₹ 190847.90 per hectare. The overall production of flower was 72.53 quintal per hectare out of which fresh flower production was 66.02 quintal per hectare and dry flower production was 6.51 quintal per hectare. Total production was highest on large size farm (76.37 quintal per hectare). The cost of rose production was estimated of ₹ 1898.03, ₹ 1839.94 and ₹ 1580.94 per quintal on small, medium and large size farm, respectively. The overall cost of rose production was ₹ 1824.25 per quintal.

The overall farm business income and farm labour income in Chittorgarh district was estimated ₹ 266388.91 and ₹ 232835.40 per hectare. The farm business income and farm labour income was found higher in case of small size farm. The overall farm investment income was? 281099.85 per hectare. It was higher on small size farm. The return per rupee ratio was found 2.44, 2.40 and 2.67 on small,

medium and large size farm, respectively. The overall return per rupee ratio was 2.44.

Suggestion

Lack of awareness, scientific knowledge about cultivation and use of improved technology are main problem in study area. Thus, the main focus should be given on improve awareness level and use of proper techniques in rose cultivation by demonstration trails though concerred extension education workers and KVK so that the rose farmer can use proper input and get maximum benefit.

References

1. Agricultural Statistics at a glance, year 2018-19. Department of Agriculture, Government of Rajasthan (2018-19).
2. Bhagat, A.A., Badgujar, C.D., Bhosale, S.S. and Supe, V.S., 2019. An economics analysis for export of fresh cut rose flowers from India. *World*, *6*(2): 291-298.
3. Das, P. and Nanda, S., 2015. Medicinal Efficacy of Rose Plant: A Mini Review. *PharmaTutor*, *3*(10): 23-26.
4. Haque, M.A., Miah, M.M., Hossain, S. and Alam, M. 2013. Profitability of Rose Cultivation in Some Selected Areas of Jessore District. *Bangladesh Journal of Agricultural Research*, *38*(1): 165-174.
5. http://apeda.gov.in/apedawebsite/SubHead_Products/Floriculture.htm
6. http://nhb.gov.in/
7. Makadia, J.J., Patel, K.S. and Ahir, N.J., 2012. Economics of production of the rose cut flowers in south Gujarat. *International Research Journal of Agricultural Economics and Statistics*, *3*(1): 111-114.
8. Thulasiram, R. and Sivaraj, P. 2020. An Economic Analysis of Production and Marketing of Jasmine in Madurai District of Tamil Nadu. *International Journal of Farm Sciences*, *10*(2): 60-67.
9. Sharma, M., Thakur, R. and Mehta, P., 2014. Economic feasibility analysis of major flower crops in Himachal Pradesh state of India. *International Journal of Advanced Research in Management and Social Sciences*, *3*(9): 4-40.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 831-835 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

To study the seasonal incidence of insect pests on brinjal crop under organic farming

Pradeep Kumar Gautam, Hemant Swami, Lekha, Gaurang Chhangani, Mahaveer Meena, Piyush Sharma and Mahendra Yadav

Department of Entomology, RCA, MPUAT, Udaipur, Rajasthan

Email : pradeepgautam57259@gmail.com

Abstract

An experiment was conducted at the Organic farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) during *kharif* 2021. The population of aphid, jassid, whitefly and shoot and fruit borer (BSFB). The infestation of aphid on brinjal was initiated in the 36th standard meteorological week and reached the peak with 14.90 aphids/5 plants during 41th standard meteorological week. The pest showed positive significant correlation with mean temperature (r = 491*) while negative non-significant correlation with mean relative humidity (r = -0.07) and rainfall (r = -0.394). The infestation of jassid on brinjal initiated in the 37th standard meteorological week and reached the peak with 13 jassids/5 plants during 41th standard meteorological week. The pest showed positive non-significant correlation with mean temperature (r = 0.411) while negative non-significant correlation with mean relative humidity (r = -0.153) and rainfall (r = -0.414). The infestation of whitefly on brinjal initiated in the 36th standard meteorological week and reached the peak with 14.52 whiteflies/5 plants during 41th standard meteorological week. The pest showed positive significant correlation with mean temperature (r = 0.484*) while negative non-significant correlation with mean relative humidity (r = -0.07) and rainfall (r = -0.393). The infestation of BSFB on shoot of brinjal initiated in the 36th SWM, which gradually increased and reached the peak with a mean of 35.54 % in 41th SMW. The shoot damage had a negative non-significant correlation with rainfall (r = -0.423) and mean relative humidity (r = -0.319) whereas positive non-significant correlation with mean temperature (r = 0.281). The infestation of shoot and fruit borer on fruits initiated in the 41th SWM which gradually increased and reached to its peak with a mean of 32.98 % on number and 31.98 % on weight basis in the 46th SWM. The fruit damage had a positive non-significant correlation with mean relative humidity (r = 0.378 & 0.309) and rainfall (r = 0.174 & 0.189) whereas negative non-significant correlation with mean temperature (r = -0.104 & -0.04) on number basis and weight basis.

Key words : *Brinjal, aphids, jassids, whiteflies, shoot and fruit borer, correlation, standard meteorological week (SMW).*

Introduction

Brinjal or eggplant *Solanum melongena* (Linn.), member of Solanaceae family is native of India. It is one of the most important vegetable grown in Asia. In India the total area under brinjal cultivation is 749.5 thousand hectares with an annual production of 12873 thousand metric tonnes (Anonymous, 2020-21). It is rich in nutrient, vitamins, minerals, and dietary fiber and on average 100 g edible portion of brinjal provides 40 g carbohydrate, 1.40 g proteins, 0.30 g mineral and vitamins (Aycord, 1983). Brinjal production is severely constrained by several insect pests, including shoot and fruit borer, (*Leucinodes orbonalis* Guenee); leafhopper, *Empoasca devastance*; whitefly, (*Bemisia tabaci* Gennadius); and aphid (*Aphis gossypi* Glover); Shoot and fruit borer, (*L. orbonalis* Guenee) BSFB is one of the most destructive pest of brinjal as it can lead yield loss as high as 20-89 per cent from various part of country (Raju *et al.,* 2007).

The young caterpillars of BSFB damage the crop by boring into tender shoots near the growing point and then move into flower buds and fruits, when available. A single caterpillar can destroy as many as 4-6 fruits making them unfit for human consumption and marketing. Both nymphs and adults of leaf hopper suck the sap from the lower surface of leaf through their piercing and sucking mouth parts. While sucking the plant sap, they also inject toxic saliva into the plant tissues, which leads to yellowing. When several insects suck the sap from the same leaf, yellow spots appear on the leaves, followed by crinkling, curling, bronzing and drying, termed as hopper burn. It also acts a vector of yellow mosaic virus. Among the sucking pest complex thrips prefer to feed mostly on foliage, sometimes on fruit exhibit silvery feeding scars on the lower leaf surfaces, especially along the mid- rib and veins. In severe infestations, the leaves turn yellow or brown and dry on the lower leaf surfaces whereas aphid severe infestation leads to curling and deformation of leaves.

For the successful management of pests and for the quality production of brinjal, it is mandatary to understand the seasonal incidence of major insect pests therefore, studies were carried out to find out the correlation between the pest population and weather parameters, so that the pest could be managed at the right time.

Materials and Methods

The experimental field to study the seasonal incidence of major insect pests infesting brinjal was laid out in plots measuring 5 m x 3 m and replicated thrice. Five plants per plot were selected randomly and tagged to record weekly observations of major insect pests throughout the experimental period. The data obtained were correlated to the abiotic factors of the environment and coefficient of correlation was worked out.

Major sucking insect pests Jassids, aphid and whiteflies : The population of jassids, aphids and whiteflies were recorded from the three leaves (upper, middle and lower) of the five tagged plants in each replication. The population was estimated by gently holding the leaf between two halves of a petri plate (10 cm diameter) and the adults and nymphs within the petri plate were counted. The nymphal population was counted with the help of magnifying lens and the data were expressed as numbers per three leaves.

Incidence of BSFB, *Leucinodes orbonalis* (Guen.) : The study on the seasonal incidence of *Leucinodes orbonalis* infesting brinjal was carried out in uniform size plots each measuring 5.0 m x 3.0 m and replicated thrice as shown in Fig-1. The seedlings of brinjal variety "Ajmeri" were transplanted in the first week of August, 2021 with row to row and plant to plant spacing of 60 cm x 45 cm, respectively.

Observations : Observations on the population of shoot and fruit borer were recorded from five randomly selected plants from each plot at weekly intervals during morning hours between 6.30 A.M. to 9.30 A.M. Population of shoot and fruit borer was counted visually on these plants for each plot. Wherever necessary the shoot/ fruits were split open to note the pinkish coloured larvae. The incidence of shoot and fruit borer was expressed by using the following equation

Shoot infestation on number basis (%)

$$= \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \quad 100$$

Fruit infestation on number basis (%)

$$= \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \quad 100$$

Fruit infestation on weight basis (%)

$$= \frac{\text{Number of infested fruits}}{\text{Total weight of fruits}} \quad 100$$

Statistical analysis : Population data of pest was subjected to statistical analysis to find out the simple correlation with abiotic factors using by the Karl Pearson formula for correlation coefficient.

$$r_{xy} \quad \frac{XY \quad \frac{(X)(X)}{n}}{X^2 \quad \frac{(X)^2}{n} \qquad Y^2 \quad \frac{(Y)^2}{n}}$$

Where,

$r_{xy=}$ Simple correlation coefficient

Y= Variable i.e. Mean number of insect pests

X= Variable i.e. abiotic component

n= Number of observations

Results and Discussion

It is desirable to understand the entire details of abiotic characteristics of environment of the insect pests before carrying out the management. With this view, the quantitative estimation of population buildup of major insect pests of brinjal was carried out in relation to abiotic factors, such as temperature, relative humidity and rainfall under the prevailing agro-climatic conditions. According to the data depicted in fig.-1 and Table-1, it is observed that the incidence of aphid commenced in the 1st week of September (36th standard meteorological week) with mean population of 3.52 aphids /5 plants and reached its peak of 14.90 aphids/5 plants during 2nd week of October (41th standard meteorological week). In the present investigation the pest showed significant positive correlation with mean atmospheric temperature (r = 491*) and non-significant negative correlation with mean relative humidity (r = -0.07) and rainfall (r = -0.394). It indicates that rise in temperature favoured the population buildup of aphid while relative humidity and rainfall adversely affected their population. Similar results were also reported by Singh *et al.* (2005), Nonita *et al.* (2006) and Chandrakumar *et al.* (2008).

According to the fig.-1 enumerated in Table-1 observed the incidence of jassid commenced in the 2nd week of September (37th standard meteorological week) with mean population of 1.64 jassid /5 plants and reached its peak of 13 jassids/5 plants during 2nd week of October (41 standard meteorological week). In the present study the jassid showed a positive non-significant correlation with mean temperature (r = 0.411) and negative non-significant correlation with relative humidity (r = -0.153) and rainfall (r = -0.414). It indicates that the abiotic factors did not significantly influence the jassid population. Results were also reported by Kumar *et al.* (2014) and Deole (2015).

According to the data recorded in fig.-1 and Table-1, the incidence of whitefly commenced in the first week of September (36th SMW) 3.26 whiteflies/5 plant and attained its peak with a mean of 14.52 whiteflies/5 plants

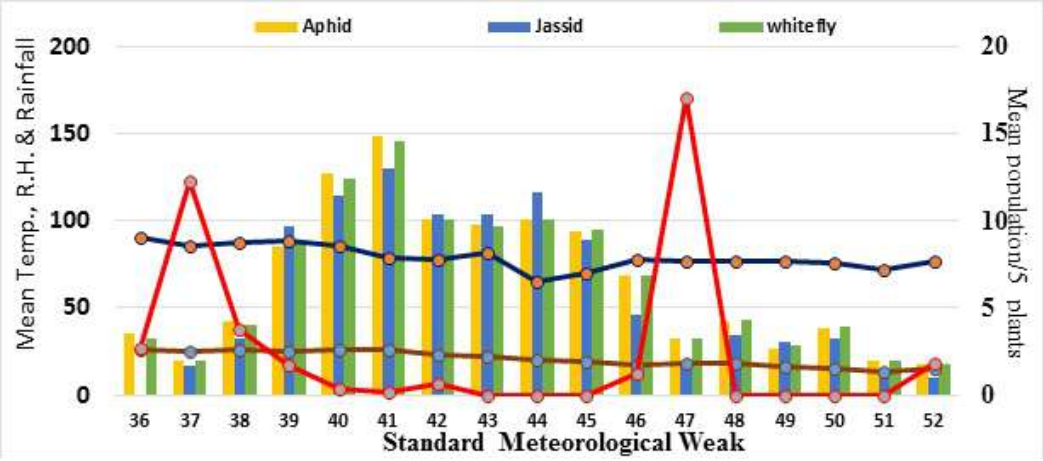


Fig.-1 : Influence of abiotic factors on the incidence of sucking insect pests of brinjal.

Table-1 : Influence of abiotic factors on the incidence of sucking insect pests in brinjal during *kharif* 2021.

Date	SMW.	Mean Atm. Temperature	Mean RH (%)	Total Rainfall (mm)	Mean population/5 plant		
					Aphid	Jassid	Whitefly
Sep. 3-9	36	26.20	90.50	27	3.52	-	3.26
Sep. 10-16	37	24.90	85.80	122.40	2.01	1.64	2.01
Sep. 17-23	38	25.60	87.50	37.80	4.20	3.21	4.02
Sep. 24-30	39	25.40	89	17.20	8.50	9.66	8.7
Oct. 1-7	40	25.80	85.20	3.30	12.70	11.47	12.38
Oct. 8-14	41	26.25	78.50	1.80	14.90	13	14.52
Oct. 15-21	42	22.95	78	6.60	10.10	10.37	10.05
Oct. 22-28	43	21.85	81.55	0	9.80	10.40	9.7
Oct. 29-Nov. 4	44	19.90	65.25	0	10.03	11.63	10.03
Nov. 5-11	45	19.05	70.40	0	9.43	8.90	9.45
Nov. 12-18	46	17.45	78	12	6.90	4.60	6.82
Nov. 19-25	47	18.70	76.80	170.80	3.20	1.77	3.24
Nov. 26. Dec. 2	48	18.65	76.35	0	4.20	3.40	4.35
Dec. 3-9	49	16.50	77.30	0	2.70	3	2.8
Dec. 10-16	50	15.75	75.60	0	3.84	3.27	3.95
Dec. 17-23	51	13.45	71.70	0	1.96	1.43	2.01
Dec. 24-31	52	15.75	76.90	18	1.80	1.02	1.75
Seasonal mean		20.83	79.08	24.52	6.45	6.17	6.41
Coefficient of correlation (r) for population and Mean Atm. Temperature					0.491	0.411	0.484
Coefficient of correlation (r) for population and Mean RH (%)					-0.069	-0.153	-0.07

during second week of October (41th SMW). The whitefly population showed a positive significant correlation with mean atmospheric temperature (r = 0.484*), negative non-significant correlation with mean relative humidity and (r = -0.07) and rainfall (r = -0.393). The present findings were also observed by Omparkash *et al*. (2013) and Mathur *et al.* (2012).

According to the data presented in fig.-2 and Table-2, it is observed that the incidence of brinjal shoot and fruit borer*, L. orbonalis* was persistent at all the growth stages of the crop. The infestation of shoot and fruit borer on shoots initiated with a mean of 4.25 per cent in the first week of September (36th SMW) during crop seasons reaching the peak 35.54 per cent in the second week of October (41thSMW) during *kharif* 2021. The shoot damage had a negative non-significant correlation with rainfall (r = -0.423) and mean relative humidity (r = -0.319) while positive non-significant correlation with mean temperature (r = 0.281). The infestation of *L. orbonalis* as the fruit borer initiated with a mean of 9.45 % on number and 8.35 % on weight basis in the second week of October (41th SMW) during crop seasons. The pest caused peak damage to the fruits (32.98 % on number and 31.98 % on weight basis) in the second week of November (46th SMW) during crop period. The fruit damage had a naegative non-significant correlation with mean temperature (r = -0.104 & -0.04) while positive non-significant correlation with rainfall (r = 0.174 & 0.189)

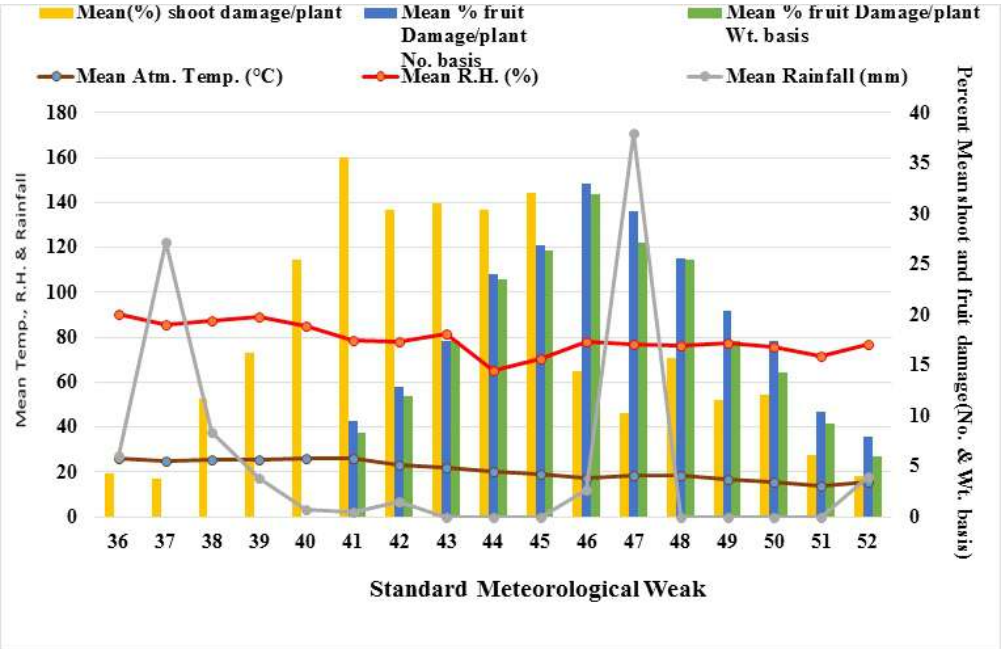


Fig.-2 : Influence of abiotic factors on the incidence of shoot and fruit borer insect pest of brinjal.

Table-2 : Influence of abiotic factors on the incidence of BSFB Leucinodes orbonalis (Guen.) in brinjal during *kharif* 2021.

Date	SMW.	Mean Atm. Temperature (C_0)	Mean RH (%)	Total Rainfall (mm)	Mean Shoot damage/ plant	Mean(%) shoot damage/ plant	Mean fruit Damage/ plant No. basis	(%)	Mean fruit Damage/ plant Wt. basis	(%)
Sep. 3-9	36	26.20	90.50	27.00	0.04	4.25	-	-	-	-
Sep. 10-16	37	24.90	85.80	122.40	0.03	3.8	-	-	-	-
Sep. 17-23	38	25.60	87.50	37.80	0.12	11.65	-	-	-	-
Sep. 24-30	39	25.40	89.00	17.20	0.16	16.24	-	-	-	-
Oct. 1-7	40	25.80	85.20	3.30	0.25	25.48	-	-	-	-
Oct. 8-14	41	26.25	78.50	1.80	0.36	35.54	0.09	9.45	0.08	8.35
Oct. 15-21	42	22.95	78.00	6.60	0.30	30.34	0.13	12.85	0.12	11.98
Oct. 22-28	43	21.85	81.55	0.00	0.31	31.05	0.17	17.34	0.17	17.40
Oct. 29-Nov.4	44	19.90	65.25	0.00	0.30	30.35	0.24	23.98	0.23	23.45
Nov. 5-11	45	19.05	70.40	0.00	0.32	32.05	0.27	26.84	0.26	26.37
Nov. 12-18	46	17.45	78.00	12.00	0.14	14.48	0.33	32.98	0.32	31.98
Nov. 19-25	47	18.70	76.80	170.80	0.10	10.27	0.29	30.25	0.27	27.19
Nov. 26-Dec.2	48	18.65	76.35	0.00	0.16	15.65	0.26	25.59	0.25	25.48
Dec. 3-9	49	16.50	77.30	0.00	0.11	11.54	0.19	20.41	0.17	17.35
Dec. 10-16	50	15.75	75.60	0.00	0.12	12.04	0.17	17.35	0.14	14.26
Dec. 17-23	51	13.45	71.70	0.00	0.06	6.12	0.10	10.38	0.09	9.17
Dec. 24-31	52	15.75	76.90	18.00	0.03	3.98	0.08	7.95	0.06	5.95
Seasonl incidence		20.83	79.08	24.52	0.17	17.36	0.14	13.85	0.13	12.88
Coefficient of correlation (r) for population and Mean Rainfall					-0.423		0.378		0.309	
Coefficient of correlation (r) for population and Mean Atm. Temperature					0.281		-0.104		-0.04	
Coefficient of correlation (r) for population and Mean RH (%)					-0.319		0.174		0.189	

and mean relative humidity (r = 0.378 & 0.309) on number basis and weight basis. The results of present study were supported by the findings of Patnaik (2000) and Muthukumar and Kalyanasundaram (2003).

Conclusions

During the season, the insect pest recorded on the brinjal were jassid, aphid, whitefly and shoot and fruit borer. Aphid incidence initiated with 3.52 aphids/5 plants in the 36th SMW and reached the peek with 14.90 aphids/5 plants during 41st SMW. Jassid incidence initiated (1.64 jassids/5 plants in the 37th SMW and reached the peak (13 jassids/5 plants was observed during 41st SMW. Whitefly incidence initiated (3.26 whiteflies/5 plants) in the 36th

SMW and reached the peak (14.52 whiteflies/5 plants) was observed during 41st SMW Shoot and fruit borer initiated with a mean of 4.25 % on shoot in the 36th (SMW) and reached the peak (35.54 %) during 41st SWM. Shoot and fruit borer initiated with a mean of 9.45 % on number and 8.35 % on weight basis on fruit in the 41st SMW and reached the peak (32.98 % on number and 31.98 % on weight basis) during 46th SMW. Aphid, jassid and whitefly showed positive correlation with mean temperature while negative correlation with mean relative humidity and rainfall. BSFB on shoot showed positive correlation with mean temperature while negative correlation with mean relative humidity and rainfall. BSFB on fruit showed a negative correlation with mean temperature whereas positive correlation with mean relative humidity and rainfall.

References

1. Anonymous, 2021. *Indian Horticulture Database*. National Horticulture Board. Ministry of Agriculture, Krishi Bhawan, Government of India, New Delhi
2. Aycord, W.R. 1983. The nutritional value of Indian food and planning of satisfactory diets I.C.M.R., Special Report Series No. 42.
3. Chandrakumar, HL., Kumar, CTA., Kumar, NG., Chakravarthy, AK. and Raju, TBP.2008. Seasonal occurrence of major insect pests and their natural enemies on brinjal, *Current Biotica* 2: 1.
4. Deole, S., 2015. Population dynamics of major insect pests of brinjal crop in summer season. *Journal of Hill Agriculture*, 6(2), pp.180-183.
5. Kumar, B., Singh, I.B., Verma, S. and Pal, M. 2014. Seasonal incidence and management of *Amrasca biguttula biguttula*, Ishida of brinjal. *Plant Archives* 4(2): 1151-1154.
6. Mathur, A., Singh, N.P., Meena, M. and Singh, S. 2012. Seasonal incidence and effect of abiotic factors on population dynamics of major insect pests on brinjal crops. *Journal of Environmental Research and Development*, 7: 431-435.
7. Muthukumar, M. and Kalyanasundaram, M. 2003. Influence of abiotic factors on the incidence of major insect pests in brinjal (*Solanum melongena* L.). *South Indian Horticulture*, 51: 214-218.
8. Nonita, M., Hemchandra, O., Bijaya, P. and Singh, T.K., 2006. Seasonal incidence and spatial distribution of the cotton aphid (*Aphis Gossypii* glover) and its coccinellid predators on brinjal. *Uttar Pradesh Journal of Zoology*, pp.265-270.
9. Omprakash, S., Raju, S.V.S. and Rajkumar, B.V. 2013. Influence of biotic and abiotic factors on the seasonal incidence of major sucking pests of brinjal. *Journal of Progressive Agriculture,* 4:87.
10. Patnaik, H.P., 2000. Flower and fruit infestation by brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. damage potential vs. weather. *Vegetable Science*, *27*(1), pp.82-83.
11. Raju, S.V.S., Bar, U.K., Uma, S. and Kumar, S. 2007. Scenario of infestation and management of eggplant shoot and fruit borer, *Leucinodes orbonalis* Guen. in India. *Resistant Pest Management*, Newsletters, 16: 14-16.
12. Singh, S., Kumar, A. and Awasthi, B.K. 2005. Study of sucking and leaf feeding insect in relation to weather parameters on the brinjal crop. *Vegetable science*, 32(2): 210-212.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 836-840 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Public Private Partnership (PPP)-An Emerging Tool for Economic Growth

Shwetha Shree B. and H. Basavaraja
Department of Agricultural Economics, College of Agriculture, UAS, Dharwad-580005, Karnataka

Introduction

The term public–private partnership describes a contractual agreement among public and private entities in the context of infrastructure and other services. Through PPP agreement, skills and assets of each sector are shared in delivering a service or a facility for the use of the general public. Public partners includes government entities like ministries, departments, municipalities, or state-owned enterprises like BHEL, HMT etc. Private partners includes local or international businesses or investors with technical or financial expertise relevant to the project. PPPs may also include Non-government organizations (NGOs) and/or Community-based organizations (CBOs) like SHG's, tribal groups etc.

The concept of Public Private Partnerships (PPPs) has emerged as a viable option for infrastructure development especially in the context of developing countries. The PPP's have large impact on the delivery of public infrastructure. As it is known, Infrastructure is recognized as one of the critical factors which determines a country's economic success. Currently, Public Private Partnership (PPP) is one of the best experimented strategies to achieve the specified goals within the time frame and modernize public services and infrastructure in agriculture, health, science and technology, education, infrastructure development and extension. Improvement in all these sectors help in overall development of the country.

Research issues and objectives : The paper aims at revealing the Macroeconomic benefits of PPP using three channels (objectives) through which these partnerships can potentially boost economic growth. First channel is PPP's accessing to different sectors resulting in sectorial development. The second channel focuses on infrastructure development through PPP. The third channel highlights employment generation through PPP.

Research Methodology

Data used for the study was collected from various published sources. Time series secondary data on sectorial development and investment in infrastructural PPP projects were collected for the period of 26 years (1991-92 to 2016-17) and on employment generation were collected for the period of 8 years (2007-08 to 2014-15) from annual reports and websites like indiastat.com.Simple tabular and Compound Growth Rate (CGR) analysis were used in the study. Tabular analysis is used for the presentation of some of the analyzed data. Appropriate percentages and averages were worked out and presented in the form of tables. Compound growth rate analysis indicates past performance. The analysis of growth is usually used in economic studies to find out the trend of a particular variable over a period of time. It clearly indicates the performance of the variable under consideration and hence it can be very well used for making policy decisions. The growth in the PPP projects, investment in Infrastructure were estimated using the exponential growth function of the form :

$$Y_t = ab^t u_t \quad \ldots.(1)$$

Where,

Y_t : Dependent variable for which growth rate was estimated

a : Intercept

b : Regression coefficient

t : Years which takes values, 1, 2, …,n

u_t : Disturbance term for the year t

The equation was transformed into log linear form for estimation purpose and was estimated using Ordinary Least Square (OLS) technique. The compound annual growth rate (g) in percentage was then computed from the relationship as

$$g = (\text{Antilog of } \ln b - 1) * 100$$

Results and Discussion

The empirical findings of the study and relevant discussion to the results have been presented under the following heads :

Sectorial development through PPPs : PPP's have ventured to different sector over the years and the number of PPP projects taken up in different sectors showed a positive growth which is presented in Table-1. PPPs in energy sector showed 34.89 per cent of growth per annum from 1991-92 to 2016-17. Similarly transportation sector showed 32.30 per cent growth. These two sectors are the most important sector which can dictate a countries economy because use of renewable energy, power

Table-1 : Growth trend of PPP projects in different sectors in India. (Number of project)

Financial Year	Transport	Energy	Social and Commercial Infrastructure	Water sanitation	Communication
1991-92	0	2	0	5	0
1992-93	0	0	0	6	0
1993-94	0	0	5	1	0
1994-95	0	0	0	2	0
1995-96	1	1	0	9	0
1996-97	2	3	0	8	0
1997-98	9	2	0	11	0
1998-99	13	0	0	3	0
1999-2000	9	3	0	13	0
2000-01	8	14	0	14	0
2001-02	27	3	0	7	0
2002-03	19	12	1	5	0
2003-04	19	18	0	8	0
2004-05	29	27	3	33	0
2005-06	81	25	7	25	0
2006-07	76	64	6	40	0
2007-08	64	108	27	62	0
2008-09	96	150	19	86	0
2009-10	139	149	19	102	0
2010-11	210	203	19	86	0
2011-12	235	247	20	100	6
2012-13	260	287	20	94	12
2013-14	351	405	30	211	11
2014-15	342	539	41	144	12
2015-16	680	480	34	162	12
2016-17	516	599	37	179	9
CGR (%)	32.30	34.89	19.13	20.43	10.00

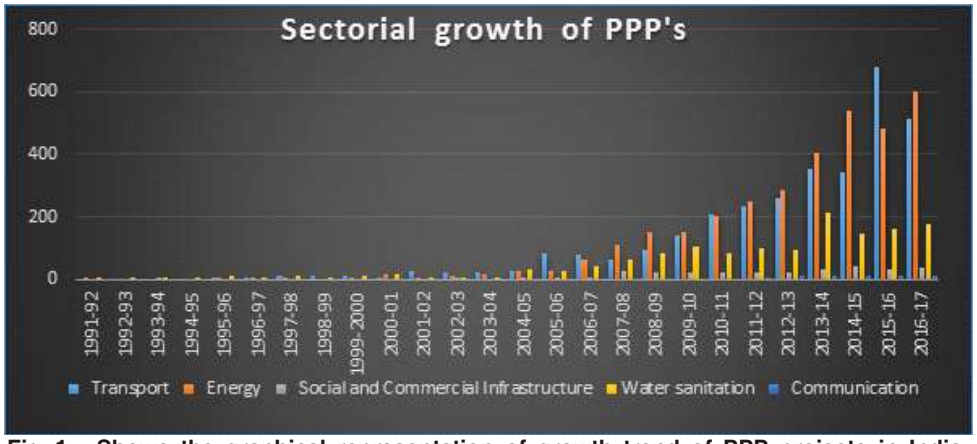


Fig.-1 : Shows the graphical representation of growth trend of PPP projects in India.

generation projects, construction of roads, railways, ports plays a crucial rolefor sustaining India's economic growth. Apart from these, PPP's are also rapidly growing in social and commercial infrastructure and water sanitation sectors at the rate of 19.13 per cent and 20.43 per cent respectively. A new sector to which the PPP's have recently entered is communication which is growing at a rate of 10 per cent per annum from 2011-12 (Fig.-1). The status of completed projects is presented in Table-2 which shows that around 693 projects worth of Rs.-1.61 lakh crore under different sectors have been successfully completed by the end of 2013 which highlights timely

Table-2 : Status of PPP Projects in Central and States/UTs Sectors. (As on March 31, 2013)

Sl. No.	Ministry / Sector	Completed Projects		Projects Under Implementation		Projects in Pipeline		Overall Status	
		No. of Projects	Projects Cost (Rs. in lakh crore)	No. of Projects	Projects Cost (Rs. in lakh crore)	No. of Projects	Projects Cost (Rs. in lakh crore)	No. of Projects	Projects Cost (Rs. in lakh crore)
(A) Central Sector									
1.	National Highways	75	0.314	161	1.554	18	0.253	254	2.122
2.	Major ports	29	0.129	29	0.056	20	0.174	78	0.389
3.	Railways	4	0.015	3	0.034	12	0.581	19	0.631
4.	Airports	3	0.058	2	0.252	15	0.236	20	0.548
	Total	111	0.518	195	1.926	65	1.245	371	3.690
(B) State Sector									
1	Roads	166	0.224	187	0.650	200	0.716	553	1.590
2.	Ports	28	0.331	18	0.284	39	0.406	85	1.021
3.	Urban infrastructure	179	0.075	144	0.474	420	2.571	743	3.122
4.	Power	26	0.365	121	1.134	42	0.348	189	1.849
5.	Railways	0	0	2	0.013	0	0	2	0.013
6.	Airports	0	0	1	0.001	22	0.144	23	0.145
7.	Other sectors	183	0.098	126	0.203	288	0.487	597	0.790
	Total (states/UTs sector)	582	1.096	599	2.763	1011	4.675	2192	8.534
Grand total		693	1.614	794	4.689	1076	5.921	2563	12.225

Table-3 : Growth trend of infrastructure projects in India. (Number of project)

Year	PPP and private infrastructure projects	Traditionally procured infrastructure projects	Total projects in infrastructure
1991-92	2	5	7
1992-93	0	6	6
1993-94	5	1	6
1994-95	0	2	2
1995-96	2	9	11
1996-97	5	8	13
1997-98	11	11	22
1998-99	13	3	16
1999-00	10	15	25
2000-01	21	15	36
2001-02	29	8	37
2002-03	30	8	38
2003-04	28	17	45
2004-05	47	45	92
2005-06	88	50	138
2006-07	88	99	187
2007-08	146	115	261
2008-09	124	237	361
2009-10	148	261	409
2010-11	223	295	518
2011-12	248	360	608
2012-13	287	386	673
2013-14	274	733	1007
2014-15	373	705	1078
2015-16	323	1045	1368
2016-17	315	1025	1340
Total	2840	5464	8304
CGR (%)	27.51	30.23	28.71

Table-4 : Growth of investment in infrastructure projects in India.

Financial Year	Number of Project	Total investment (in Rs. lakh Crore)
1991-92	7	0.084
1992-93	6	0.039
1993-94	6	0.117
1994-95	2	0.004
1995-96	11	0.064
1996-97	13	0.123
1997-98	22	0.111
1998-99	16	0.179
1999-2000	25	0.258
2000-01	36	0.170
1802001-02	37	0.312
2002-03	38	0.336
2003-04	45	0.647
2004-05	92	1.054
2005-06	138	1.166
2006-07	186	2.347
2007-08	261	3.287
2008-09	361	4.312
2009-10	409	4.213
2010-11	518	4.451
2011-12	608	7.502
2012-13	673	4.519
2013-14	1007	4.829
2014-15	1078	6.038
2015-16	1368	7.538
2016-17	1340	9.161
CGR (%)	28.71	28.57

Table-5 : State wise data on employment generated through PPP with special reference to North Eastern states of India. (Employment in number).

Year	Tripura	Arunachal Pradesh	Assam	Nagaland	Meghalaya	Sikkim	Manipur	Mizoram	Total
2007-08	2329	352	11528	2748	798	2099	575	1859	22288
2008-09	4590	626	13688	9992	178	1019	1100	4340	35533
2009-10	3867	256	12787	5780	614	401	909	4326	28940
2010-11	4315	463	10458	2468	989	1857	1427	1346	23323
2011-12	2744	923	13192	2604	243	2554	1504	866	24630
2012-13	1952	1528	11671	580	327	489	1782	1032	19361
2013-14	2053	582	12971	852	0	889	2166	1342	20855
2014-15	1976	250	16608	439	137	1921	191	0	21522
Total	23826	4980	102903	25463	3286	11229	9654	15111	196452

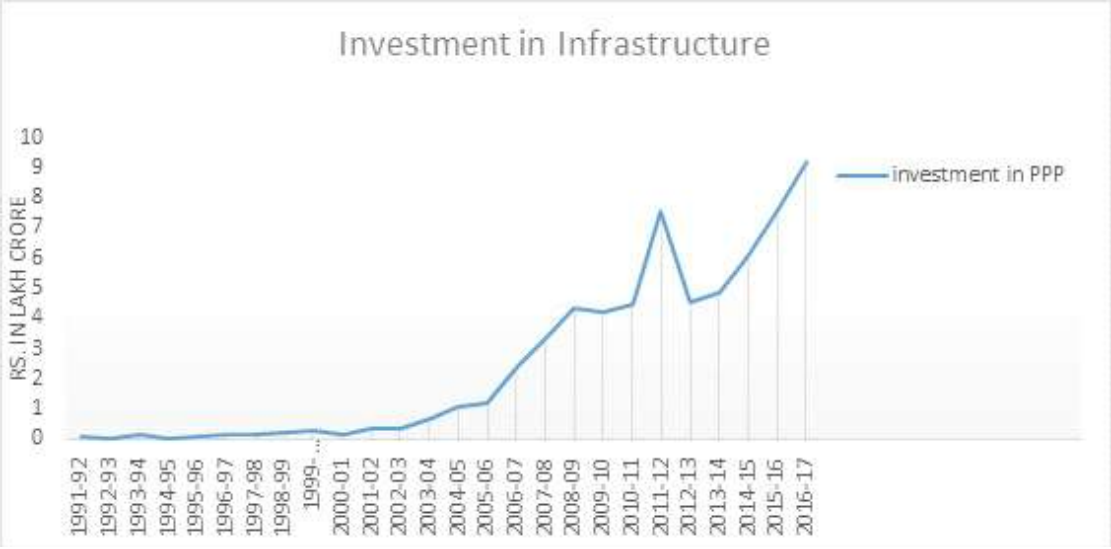


Fig.-2 : Growth of Investments in infrastructure in India Employment generation through PPP projects.

completion of projects and also strong capital accumulation in the form of infrastructure for the country. Total of 1824 projects have been awarded under PPP worth of Rs.24.9 lakh crore as on 2019.

Infrastructure development through PPP : Increased industrial activity, rapidly growing population pressure, and need of economic and social development have created a greater demand for better quality of roads, railways, airport, seaports, power supply, water and sanitation services. The existing infrastructure is under tremendous pressure due to this increase in demand. The findings showed that the PPP projects under infrastructure is growing at a rate of 27.51 per cent per annum, accordingly increasing Projects under infrastructure at a rate of 28.71 per cent from1991-92 to 2016-17 (Table-3). According to World Bank data on Private Participation in Infrastructure, the aggregate investment commitment in PPI projects was highest in India during 2008-12 (Fig.-2). Investment in infrastructure projects in India have showed a positive growth rate of 28.57 per cent (1991-92 to 2016-17). India remained the largest market for PPI in the developing world and attracted over 90 per cent of regional investment. Twelth Five Year Plan (2012-17) has projected an investment of Rs. 55.74 lakh crore in infrastructure, which is more than twice the investment of Rs. 24.24 lakh crore anticipated during the Eleventh Plan (2007-12).

Unemployment rate in India averaged to 7.31 per cent from 2018 until 2020 recording the highest rate, hence there is strong necessity to create employment. PPP is one of the solution to tackle the problem of unemployment. Due to unavailability of data in employment generation, the role of PPP in employment generation is restricted to North Eastern states of India from 2007-08 to 2014-15 only. But the available data have a significance role to play in the country. Around 1.96 lakh people were provided with employment under various PPP projects from 2007-2015 in seven sister states of North East India (Table-5). This shows the extent of PPP projects accessing to each state of the country. In the table-5, row total provides the data on employment generated every year in seven states of India and column total highlights the total employment generated from 2007-08 to 2014-15 in each state.

Conclusions and Policy implications : India's global competitiveness remains constrained and is adversely affected by lack of infrastructure, which is critical for improved productivity across all sectors of the economy. Poor infrastructure is also a major barrier to foreign direct investment (FDI). This is the time to give a way to PPP projects to play their key role in the country. The study has clearly revealed the prominence of PPP's in infrastructure development, sectorial development and employment generation and also these acts as a link to access other benefits like attract FDI, increasing global competitiveness, better living standards etc. This shows the clear vision through which PPPs, either as an infrastructure project or a public finance tool, can potentially bring macroeconomic benefits. Infrastructure development is a tool for the sustainable growth of India by making it globally competitive, enhancing the government profits and poverty alleviation. For the current declining Economic growth of the country, PPP is one of the solution to expand infrastructure facilities and other services as it helps in sectorial development, value for the money invested with innovated technologies and bridge the gap between need and availability of fund by private sector investment.

References

1. Anonymous, (2014). Compendium of PPP Projects in Infrastructure Report. Planning Commission, Government of India.
2. Minsoo Lee, Xuehui Han, Raymond Gaspar and Emmanuel Alano, (2018). Deriving macroeconomic benefits from public–private partnerships in developing Asia. ADB Economics Working Paper Series No. 551, 1-23
3. Samta Singh, (2017). Evolution and Need for PPP in India. Imperial Journal of Interdisciplinary Research (IJIR), 3(4), 2089-2094.
4. Wendrila Biswas, (2016). Public Private Partnership and Economic Growth with special reference to India – An overview. International Journal of Management, 7(3), 18-26.

www.indiastat.com
www.pppinindia.com

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 841-845 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Sowing Dates and Fodder Maize Genotypes have Promising Influence on Growth Parameters Studied Under Temperate Kashmir Conditions

Umer Rashid Bhat*[1]; Bilal Ahmad Lone[2], Zahoor Ahmad Dar[3], Mohd Aslam Dar[4], Tauseef Ahmad Bhat[1], Tanveer Ahmad Ahngar[1], Faisul ur Rasool[3], Fayaz Ahmad Bahar[3], Mohammad Anwar Bhat[1] and Iqra Mushtaq[1]

1Division of Agronomy, FOA, Wadura, Sopore, SKUAST-Kashmir, J&K, India
[2]Section of Agro-Meteorology, FOH, Shalimar, Srinagar, SKUAST-Kashmir, J&K, India
[3]Dryland Agriculture Research station, Budgam, SKUAST-Kashmir, J&K, India
[4]Division of Genetics and Plant Breeding, FOA, Wadura, Sopore, SKUAST-Kashmir, J&K, India

Abstract

A field experiment was carried out at Agronomy research farm, FoA, Wadura, Sopore, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during *kharif* 2019. The experiment comprised of two factors with four dates of sowing viz. 30th April, 10th May, 20th May and 30th May as main plot treatments and three genotypes viz. SFM-1, PMC-6 and J-1006 as sub-plot treatments laid in split plot experimental design replicated thrice with the aim to find out optimum sowing date and genotype with respect to growth parameters. Results of the experiment revealed that sowing on 30th April and 30th May reported significantly highest and lowest plant height, leaf area index, leaf stem ratio from 45 DAS up to harvest. Among genotypes, SFM-1 obtained higher plant height, leaf area index, leaf stem ratio from 15 DAS up to harvest than PMC-6 and J-1006 respectively. Experimental findings showed that significantly highest and lowest leaf number plant^{-1} obtained at knee high stage, tasseling, silking and at harvesting stage when crop was sown on 30th April and 30th May respectively. While as, SFM-1followed by PMC-6 reported higher leaves plant^{-1} at knee high stage, tasseling, silking and at harvesting stage among genotypes. Leaf area index at emergence were non-significant with respect to sowing dates and genotypes Plant population was statistically non-significant with regard to sowing dates and genotypes.

Key words *: Sowing dates, genotypes, growth parameters, Plant height, leaf area index.*

Introduction

Maize (*Zea mays L.*) is the third major cereal crop of the world and in India ranks third after wheat and rice. Maize is considered as extensive cereal crop primarily due to highest productivity among cereals and acquires wider adaptability in varied agroclimatic conditions hence, known as 'Queen of Cereals' [1]. In world around 190 million hectares of area with production of about 1438 million tonnes is under maize cultivation [2]. In India about 9.50 million hectares with annual production of 27.23 million tonnes and productivity of 2870 kg hectare^{-1} is under maize cultivation [3]. The area under fodder production in India is around 9.85 million hectares and accounts only 4 percent of cultivated area and production of about 462 million tonnes for green fodder and 394 million tonnes for dry fodder respectively [4.] In the union territory of Jammu and Kashmir maize is the second most important cereal crop after rice and is grown on an area of 0.31 miilion hectare with production of 0.51 million tonnes with an average productivity of 1650 kg ha^{-1} [3]. In union territory of Jammu and Kashmir, about 90.6% of the total area under maize is planted under rainfed conditions [5].

Maize (*Zea mays* L.) is considered as important double-purpose crop grown widely in *kharif* season used in human diet as grain as well as animal feed. Maize forage supplies large amounts of energy rich forage for dairy animal diets; free from anti nutritional factors so can be fed to cattle at any growth stage [6].The maize crop is having many desirable fodder qualities due to which it is preferred as compared to other cultivated non fodder crops viz; high productivity, high production potential, broader adaptability, rapid growing nature, succulence, palatability, free from toxicants, rich in protein and minerals and having high digestibility than non-legume fodder, body weight and milk quality increases in cattle [7]. Hence, it is widely known as ready-made fodder crop. Maize is highly nutritive, excellent, and sustainable fodder for livestock [8]. The green fodder of maize possesses lactogenic properties and therefore, suited for milch cattle [9].

There is modifying effect on the growth and development of maize plants with the environmental changes (sunshine, temperature) associated with different sowing dates. Growth and yield of maize is significantly affected by sowing dates. Greater the deviation from optimum date of sowing of each hybrid greater the reduction in yield [10]. One of the challenges for maize growers at present is to find the narrow interval between sowing earlier and sowing later [11]. Maize sown

Table-1 : Plant height (cm) of maize at 15 days interval as influenced by sowing dates and genotypes.

Treatments	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
			Dates of sowing			
30th April	6.51	25.62	100.99	185.22	249.87	284.70
10th May	6.56	29.90	95.43	176.79	242.54	274.77
20th May	6.73	35.03	91.29	171.50	236.91	268.72
30th May	6.92	38.73	85.46	164.87	228.42	260.68
SEm±	0.06	0.87	1.12	1.18	1.41	1.54
CD (P= 0.05)	0.20	3.02	3.87	4.08	4.79	5.23
			Genotypes			
SFM-1	6.79	34.04	95.43	177.91	242.47	275.75
PMC-6	6.68	31.75	92.74	173.36	238.60	271.28
J-1006	6.60	31.17	92.14	172.56	237.23	269.63
SEm±	0.03	0.20	0.53	0.82	0.92	1.01
CD (P= 0.05)	0.09	0.61	1.58	2.78	3.12	3.43

Table-2 : Leaf area index of maize at 15 days interval as influenced by sowing dates and genotypes.

Treatments	Emergence	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
				Dates of sowing			
30th April	0.16	0.37	1.34	3.73	5.65	6.31	6.43
10th May	0.17	0.39	1.41	3.57	5.34	6.01	6.11
20th May	0.18	0.40	1.51	3.37	5.09	5.87	5.94
30th May	0.18	0.42	1.57	3.29	4.82	5.37	5.42
SEm±	0.01	0.01	0.02	0.03	0.05	0.07	0.04
CD (P= 0.05)	NS	0.03	0.07	0.09	0.17	0.24	0.12
				Genotypes			
SFM-1	0.19	0.41	1.51	3.61	5.34	6.02	6.17
PMC-6	0.17	0.39	1.45	3.44	5.22	5.87	5.95
J-1006	0.16	0.38	1.42	3.37	5.12	5.77	5.89
SEm±	0.01	0.004	0.01	0.02	0.03	0.04	0.03
CD (P= 0.05)	NS	0.01	0.04	0.07	0.10	0.13	0.09

earlier performs better and yields more due to the fact that the vegetative phase of life cycle prevails in the cooler part of the season with less moisture stress [12]. Early sowing is beneficial compared to late sowing due to long growth span which allows more choice of hybrid maturities and more chances for re plant. In earlier sowing tasseling and silking period lies before to moisture stress risk and drought damage [13]. Harvesting is done earlier in the season when conditions are better which minimize time losses [14]. One of the advantages of early sowing is that female flowering happens before month of July which is the month of stress because of water deficiency. Late sowing adversely decline maize production viz; the effective growing season is shortened, crop photosynthesis is declines and crop is exposed to high risk lethal cold temperatures before grain maturation late in the season, insect and disease stress and moisture and heat stress during pollination. There is accelerated crop development in late sowings due to presence of increased temperatures during crop duration which decline assembled solar radiation causing reduction in biomass production [13]. Choosing of appropriate sowing date with a good variety guarantee higher maize production in addition to recommended agro management practices [15]. For achieving higher efficiency from available nutrients, water, and solar energy, selection of optimum sowing date for already existing varieties is unavoidable [16].

Material and Methods

The present investigation was carried at the Agronomy Research Farm, FoA, Wadura, Sopore, SKUAST-Kashmir during *kharif* 2019 that lies between 34° 21' N latitude and 74° 23' E longitude having an altitude of 1590 m above the mean sea level. The climate is temperate and continental type characterized by hot summers and severe winters with average annual precipitation is 812 mm (average of past thirty years) and more than 80 percent of precipitation occurs during December to April in the form of rains and snow received from western disturbances. The mean maximum and minimum temperatures during crop growth season were 33.34 °C and 6.81 °C respectively. The total precipitation amounted to 398.1 mm during crop growth season. The soil of the experimental site was silty clay loam in texture, with medium in available nitrogen, phosphorus and potassium

Table-3 : Leaf stem ratio of maize at 15 days interval as influenced by sowing dates and genotypes.

Treatments	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest
			Dates of sowing			
30th April	1.24	0.97	0.82	0.68	0.56	0.46
10th May	1.28	1.04	0.78	0.61	0.52	0.42
20th May	1.30	1.10	0.73	0.57	0.50	0.40
30th May	1.32	1.11	0.68	0.56	0.47	0.37
SEm±	0.01	0.01	0.01	0.01	0.01	0.004
CD (P= 0.05)	0.03	0.03	0.03	0.03	0.03	0.01
			Genotypes			
SFM-1	1.30	1.10	0.78	0.63	0.53	0.43
PMC-6	1.28	1.05	0.75	0.60	0.51	0.41
J-1006	1.27	1.03	0.74	0.59	0.51	0.41
SEm±	0.004	0.005	0.004	0.004	0.004	0.004
CD (P= 0.05)	0.01	0.02	0.01	0.01	0.01	0.01

Table-4 : Number of leaves plant^{-1} at phenological stages of maize and plant population (m^2) as influenced by sowing dates and genotypes

Treatments	Knee high stage	Taselling	Silking	Harvesting	Plant population
		Dates of sowing			
30th April	8.10	15.15	16.04	16.15	28.04
10th May	8.07	15.08	15.94	16.02	28.02
20th May	8.04	15.03	15.86	15.92	28.00
30th May	8.02	14.97	15.77	15.81	28.03
SEm±	0.005	0.01	0.02	0.02	0.14
CD (P= 0.05)	0.02	0.04	0.07	0.07	NS
		Genotypes			
SFM-1	8.07	15.09	15.94	16.02	28.01
PMC-6	8.05	15.05	15.89	15.96	28.02
J-1006	8.04	15.03	15.87	15.94	28.01
SEm±	0.004	0.01	0.01	0.01	0.05
CD (P= 0.05)	0.01	0.03	0.03	0.03	NS

and neutral pH. The experiment consisting of two factors viz., four sowing dates (30th April, 10th May, 20th May and 30th May) and three genotypes (SFM-1, PMC-6 and J-1006) laid out in split plot design (SPD) taking sowing dates as main plots treatments and genotypes as sub plot treatments with three replications. A fertiliser dose of 10 t ha^{-1} FYM, 120 kg ha^{-1} nitrogen, 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} was applied uniformly to each plot. For the purpose of recording data, five plants were randomly selected and tagged from every plot of each replication. Plant height was measured with the help of meter scale and converted in cm at 15 days interval from sowing up to harvest from base of plant to the apex of the flag leaf before tasselling and after tasselling up to base of tassel up to harvest.

Leaf area index : Leaves of the plants which were taken for leaf stem ratio were separated and then leaf area was measured by leaf area meter.

$$LAI = \frac{\text{Total leaf area (cm}^{1})}{\text{Ground area (cm}^{-2})}$$

For leaf stem ratio, plants were cut from base of plant and then leaves were separated from the stem from each plant. The leaves and stems from each plot were sun dried and weighed separately. Then there ratio was taken as leaf stem ratio.

$$\text{Leaf stem ratio} = \frac{\text{Dry weight of leaves}}{\text{Dry weight of stem}}$$

Five randomly selected plants were selected for counting number of leaves plant^{-1}. Number of green leaves considered as leaves plant^{-1} were taken at phenological stages *viz*., knee high stage, taselling stage, silking stage and harvesting.

Plant population was recorded at harvesting time by the quadrant in each plot at marked spots and the population was recorded in plants m^2.

Results and Discussion

Plant height : Results indicated that sowing on 30th April recorded significantly taller plants over other sowing dates at 45 DAS up to harvest. Whereas lower plant height was noticed on 30th May sowing date from 45 DAS upto harvest (Table-1). It can be explained that presences of favorable weather conditions and lengthy growth duration have supported profuse vegetative growth under this particular date of sowing. [17] have revealed that delayed sowing of maize significantly decreases plant height. [18] also reported that in early sowing plants remain tall compared to short plants remained in late sowing. SFM-1 recorded statistically significantly higher plant height among genotypes at 15 DAS up to harvest. The plant height among different varieties does not remain equal as plant height is a genetically controlled. The difference in plant height in genotypes is due to the variation in their genotypic make-up [19] and [20].

Leaf area index : Sowing date of 30th April and 30th May registered maximum and minimum leaf area index from 45 DAS up to harvest, however at emergence leaf area index was non-significant with respect to both sowing dates and genotypes (Table-2). The maximum leaf area index marked with 30th April sowing may be due to presence of more favorable weather for vegetative growth of the plants. Similar conclusions revealed by [21] that early sowing resulted in higher leaf area index. There is reduction in growing cycle with delayed sowing and which decreases leaf area index in maize and is according to the findings obtained by [22] and [23].

Among genotypes, SFM-1 recorded maximum leaf area index from 15 DAS up to harvest than rest of genotypes. The difference in leaf area index among genotypes might be due to variation in genetic make-up among the varieties which contributing factors for maximum vegetative growth with maximum leaf area under given set of climatic conditions to longer span of growth from sowing to harvesting. Similarly [24] and [25] reported that difference of leaf area index among varieties is due to variation in their genetic makeup.

Leaf stem ratio : Sowing date of 30th April and 30th May (Table-3) recorded highest and lowest leaf stem ratio at 45 DAS up to harvest respectively. Sowing on 30th April obtained higher leaf stem ratio than successive sowing dates mainly attributed due to more stem weight and lower leaf weight in comparison to rest sowing dates. [26] Confirmed that delayed sowing significantly decreased leaf stem ratio. SFM-1 obtained highest leaf stem ratio than PMC- 6 and J- 1006 in case of genotypes from 15 DAS and up to harvest compilation. This might be due to more ample growth, high leaf number, leaf area and stem diameter which had supported higher leaf stem ratio in SFM-1 .These findings are according with earlier findings depicted by [24] and [25].

Number of leaves plant^{-1} : Among sowing dates, sowing on 30th April was superior among sowing dates, recorded highest number of leaves plant^{-1} at all phenological stages taken, while as lowest leaves plant^{-1} obtained at 30th May sowing (Table 4). It might due to presence of ideal growth conditions under said sowing date. Leaf number plant^{-1} decreased with delayed sowing due to reduction in photoperiod, which leads to decrease leaf number plant^{-1}.The conclusions are similar as determined by [26] and [27]. Among genotypes, SFM-1 proved significantly superior, having higher number of leaves plant^{-1} at all phonological stages taken, followed by PMC- 6 and J-1006 respectively. Variation in leaf number plant^{-1} in according to dates of sowing and genotypes in sorghum were given by [28] and [29].

Plant population m^{-2} : Plant population m^{-2} was recorded at harvesting of the crop (Table 4). Results determined that both sowing dates and genotypes have non-significant effect on plant population m^{-2} recorded at harvesting. It might due to assured germination, sowing of seed manually by dibbling method at optimum soil moisture and presence of assured irrigation facilities throughout the crop growth period. [30] and [31] noticed no variation in plant population of maize in different sowing dates.

Conclusions

Growth parameters were promising and significantly higher when sowing was performed on 30th April with genotype SFM-1. Thus the results of the investigation lead to the conclusion that to obtain higher growth parameters of fodder maize under temperate Kashmir conditions, sowing should be carried around 30th April which is suitable sowing date and in combination with SFM-1 which is desirable genotype.

References

1. Choudhari, V.V. and Channappagouda, B.B. 2015. Effect of organics on morpho-physiological traits and grain yield of maize (*Zea mays* L.). *The Bioscan* 10 (1): 339-340.
2. Food and Agriculture Origanisation, 2019.
3. Directorate of Economics and Statistics. 2019
4. Directorate of Economics and Statistics. 2015
5. Directorate of Economics and Statistics. 2017.
6. Dahmardeh, M., Ghanbari, A., Syasar, B. and Ramroudi, M. 2009. Effect of intercropping maize with cowpea on green forage yield and quality evaluation. *Asian Journal of Plant Science* 8(3): 235-239.
7. Sattar, M. A., Haque, M. F., Rahman, M. M. 1994. Intercropping maize with broadcast rice at different row

spacing. *Bangladesh Journal of Agricultural Research* 19: 159-164.

8. Iqbal, A., Ayub, M., Zaman, H. and Ahmed, R. 2006. Impact of nutrient management and legume association on agroqualitative traits of maize forage. *Pakistan Journal of Botany* 38: 1079-1084.
9. Valk, H. 2000. Effect of reducing nitrogen fertilizer on grassland on grass intake, digestibility and milk production of dairy cows. *Livestock production Science* 63(1): 27-38.
10. Berzsenyi, Z. and Lap, D. Q. 2001. Effect of sowing time and N fertilisation on the yield and yield stability of maize (*Zea mays* L.) hybrids between 1991-2000. *Novenytermeles* 50(2): 309-331.
11. Nielsen, R.L., Thomson, P. R., Brown, G. A., Halter, A. L., Wells, J. and Wuethricc, K.L. 2002. Delaying planting date effects on flowering and grain maturation of corn. *Agronomy Journal* 93: 540-547.
12. Ali, Q., Ali, A., Waseem, M., Muzaffar, A., Ahmad, S., Ali, S., Awan, M. and Samiullah, T. 2014." Correlation analysis for morpho-physiological traits of maize (*Zea mays* L.)." *Life Science Journal* 11: 9-13.
13. Otegui, M.E. and Melon, S. 1997. "Kernel set and flower synchrony within the ear of maize. I. Sowing date effects. *Crop Science* 37: 441-447.
14. Hicks, D.R., Harrington, I.D. and McGahen, J.H. 1993. Maximizing the advantages of early com planting. National corn handbook crop management. West Lafayette, Indiana, USA: Purdue University Cooperative Extension Service.
15. Qureshi, A.S., Qadir, M., Heydari, N., Turral, H. and Javad, A. 2007. A review of management strategies for salt-prone land and water resources in Iran. International water management Institute 30P (IWMI working paper 125) Colombo, Srilanka.
16. Ogbomo, K.E.L. and Remison, S.U. 2009. Growth and yield of maize as influenced by sowing date and poultry manure application. *Notulea. Botanicae. Horti. Agrobotanici. Cluj* 37(1): 199-203.
17. Moosavi, S.G., Seghatoleslami, M. J. and Moazeni, A. 2012. Effect of planting date and plant density on morphological traits, LAI and forage corn yield. *International Research Journal of Applied and Basic Sciences* **3**(1): 57-63
18. Kharazmshahi, H. A., Zahedi, H. and Alipour. A. 2015. Effects of sowing date on yield and yield components in sweet maize (*Zea mays* L.) hybrids. *Biological Forum International Journal* **7**(2): 835-840.
19. Panvar, D., Singh, P., Sumeriya, H.K., Jat, N., Verma, S. N.2015.Response of sorghum genotypes to different fertility levels on yield and nutrient content. *Progressive Res* 10: 164-166.
20. Hussain, N., Zaman, Q., Nadeem, M.A. and Aziz. A. 2010. Response of maize varieties under agroecological conditions of Dera Ismail Khan. *Indian Journal of Agricultural Research* 48(1): 59-63.
21. Beiragi, M.A., Khorasani, S.K., Shojaei, S.H., Dadresan, M., Mostafavi, K. and Golbashy, M. 2011. A study on effects of planting dates on growth and yield of 18 corn hybrids (*Zea mays* L.). *American Journal of Experimental Agriculture* 1(3): 110-120.
22. Martin, M. and Williams, II. 2008. Sweet corn growth and yield responses to planting dates of the North Central United States. *Hortscifnc* 43(6): 1775-1779.
23. Shivadhar, S.D., Gupta, S.N., Tripathi, Suchit, K. and Rai, S.K. 2005. Production potential of fodder sorghum varieties under different nitrogen levels and sowing dates. *Indian Journal of Agricultural Sciences* 75(3): 572-575.
24. Sonwar, S.N., Wani, A.G., Dacharne, D.P., Patil. H.M. 2008. Effect of seeding dates and planting layouts on growth, Juice quality and grain yield of sweet sorghum. *Journal of Maharashtra agriculture Universities* 33(1): 108-110.
25. Ahmed, A., Munsif, F., Arif, M., Inamullah and Nuaman, M. 2011. Yield and yield components of maize as affected by sowing dates and sowing methods. *Fuuast Journal Biology* 1(1): 75-80.
26. Rasul, F., Cheema, M.A., Sattar, A., Saleem, M.F. and Wahid, M.A. 2012. Evaluating the performance of three mungbean varieties grown under varying inter-row spacing. *Journal of Animal and Plant Sciences* 22(4): 1030-1035.
27. Beiragi, M.A., Khorasani, S.K., Shojaei, S. H., Dadresan, M., Mostafavi, K. and Golbashy, M. 2011. A study on effects of planting dates on growth and yield of 18 corn hybrids (*Zea mays* L.). *American Journal of Experimental Agriculture* 1(3): 110-120.
28. Martin, M. and Williams, II. 2008. Sweet corn growth and yield responses to planting dates of the North Central United States. *Hortscifnc* 43(6): 1775-1779.
29. Shivadhar, S.D., Gupta, S.N., Tripathi, Suchit, K. and Rai, S.K. 2005. Production potential of fodder sorghum varieties under different nitrogen levels and sowing dates. *Indian Journal of Agricultural Sciences* 75(3): 572-575.
30. Anonymous. 2012. Annual Kharif-Maize Progress Report 2012. Directorate of Maize Research, IARI, New Delhi
31. Singh, V.K., Bajaj, R.P., Sisodia, R.J. 1992 Effect of sowing date and plant population on yield of maize. *Current Research* 21(2): 24-25

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 846-850 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Sowing Dates and Genotypes of Maize Showed Profound Impact on Dry Matter Accumulation and Green Fodder Yield

Umer Rashid Bhat*[1]; Bilal Ahmad Lone[2], Mohd Aslam Dar[4], Zahoor Ahmad Dar[3], Tauseef Ahmad Bhat[1], Faisul ur Rasool[3], Fayaz Ahmad Bahar[3] and Mohammad Anwar Bhat[1]

[1]*Division of Agronomy, FOA, Wadura, Sopore, SKUAST-Kashmir, J&K, India*

[2]*Section of Agro-Meteorology, FOH, Shalimar, Srinagar, SKUAST-Kashmir, J&K, India*

[3]*Dryland Agriculture Research station, Budgam, SKUAST-Kashmir, J&K, India*

[4]*Division of Genetics and Plant Breeding, FOA, Wadura, Sopore, SKUAST-Kashmir, J&K, India*

Abstract

A field experiment was carried out at Agronomy research farm, FoA, Wadura, Sopore, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during *kharif* 2019. The experiment comprised of two factors with four dates of sowing viz. 30th April, 10th May, 20th May and 30th May as main plot treatments and three genotypes viz. SFM-1, PMC-6 and J-1006 as sub-plot treatments laid in split plot experimental design replicated thrice with the aim to find out optimum sowing date and genotype with respect to respect to dry matter accumulation and green fodder yield. Experimental results showed that maximum and minimum dry matter accumulation registered at 60 DAS and harvest with sowing on 30th April and 30th May respectively. SFM-1 noticed with maximum dry matter accumulation at 30, 60 DAS and harvest than PMC-6 and J-1006 respectively. Higher and lower crop growth rate, relative growth rate and net assimilation were recorded at 30- 60 DAS and 60- 90 DAS with sowing date of 30th April and 30th May respectively. In case of genotypes, SFM-1 showed higher crop growth rate from 30- 60 DAS and 60-90 DAS. PMC- 6 marked with higher relative growth rate and net assimilation rate at 30- 60 DAS, whereas SFM-1 have higher relative growth rate and net assimilation rate at 60- 9 0 DAS. Dry matter accumulation at emergence was non-significant with respect to sowing dates and genotypes. Crop growth rate, relative growth rate and net assimilation rate at emergence- 30 DAS were non- significant both with sowing dates and genotypes. PMC-6 and J-1006 were statistically at par with each other with foresaid studied parameters. Green fodder yield was statistically higher recorded on 30th April, while as, lowest reported on 30th May sowing date. Genotype SFM-1 registered higher green fodder yield among genotypes, lowest with J-1006 but statistically par with PMC-6.

Key words : *Dry matter accumulation, crop growth rate, green fodder yield, relative growth rate, net assimilation rate.*

Introduction

Maize (*Zea mays* L.) is the third major cereal crop of the world and in India ranks third after wheat and rice. Maize is considered as extensive cereal crop primarily due to highest productivity among cereals and acquires wider adaptability in varied agroclimatic conditions hence, known as 'Queen of Cereals' [1]. In world around 190 million hectares of area with production of about 1438 million tonnes is under maize cultivation [2]. In India about 9.50 million hectares with annual production of 27.23 million tonnes and productivity of 2870 kg hectare^{-1} is under maize cultivation [3]. The area under fodder production in India is around 9.85 million hectares and accounts only 4 percent of cultivated area and production of about 462 million tonnes for green fodder and 394 million tonnes for dry fodder respectively [4.] In the union territory of Jammu and Kashmir maize is the second most important cereal crop after rice and is grown on an area of 0.31 miilion hectare with production of 0.51 million tonnes with an average productivity of 1650 kg ha^{-1} [3]. In union territory of Jammu and Kashmir, about 90.6% of the total area under maize is planted under rainfed conditions [5]. Maize (*Zea mays* L.) is considered as important double-purpose crop grown widely in *kharif* season used in human diet as grain as well as animal feed. Maize forage supplies large amounts of energy rich forage for dairy animal diets; free from anti nutritional factors so can be fed to cattle at any growth stage [6].The maize crop is having many desirable fodder qualities due to which it is preferred as compared to other cultivated non fodder crops viz; high productivity, high production potential, broader adaptability, rapid growing nature, succulence, palatability, free from toxicants, rich in protein and minerals and having high digestibility than non-legume fodder, body weight and milk quality increases in cattle [7]. Hence, it is widely known as ready-made fodder crop. Maize is highly nutritive, excellent, and sustainable fodder for livestock [8]. The green fodder of maize possesses lactogenic properties and therefore, suited for milch cattle [9]. There is modifying effect on the growth and development of maize plants with the environmental changes (sunshine, temperature) associated with different sowing dates. Growth and yield of maize is significantly

Table-1 : Dry matter accumulation (q ha^{-1}) of maize as influenced by sowing dates and genotypes.

Treatments	Emergence	30 DAS	60 DAS	Harvest
Dates of sowing				
30th April	4.01	25.88	94.83	150.82
10th May	4.03	28.86	89.65	138.90
20th May	4.05	32.63	85.50	129.65
30th May	4.07	33.34	82.24	122.65
SEm±	0.03	0.40	1.20	1.55
CD (P= 0.05)	NS	1.40	4.08	5.27
Genotypes				
SFM-1	4.08	31.74	90.16	140.14
PMC-6	4.04	29.86	87.62	134.98
J-1006	4.00	28.93	86.47	132.98
SEm±	0.02	0.36	0. 53	0.67
CD (P= 0.05)	NS	1.08	1.58	2.02

Table-2 : Crop growth rate (g day^{-1}) of maize and green fodder yield (q ha^{-1}) as influenced by sowing dates and genotypes.

Treatments	Emergence-30 DAS	30-60 DAS	60-90 DAS	Green fodder yield
Dates of sowing				
30th April	0.77	2.30	1.87	470.21
10th May	0.90	2.03	1.64	462.76
20th May	1.06	1.76	1.47	455.69
30th May	1.09	1.63	1.35	451.15
SEm±	0.09	0.01	0.01	1.27
CD (P= 0.05)	NS	0.04	0.04	4.36
Genotypes				
SFM-1	1.03	1.95	1.65	462.48
PMC-6	0.95	1.93	1.56	459.01
J-1006	0.91	1.92	1.53	458.35
SEm±	0.04	0.004	0.02	1.02
CD (P= 0.05)	NS	0.012	0.06	3.06

affected by sowing dates. Greater the deviation from optimum date of sowing of each hybrid greater the reduction in yield [10]. One of the challenges for maize growers at present is to find the narrow interval between sowing earlier and sowing later [11]. Maize sown earlier performs better and yields more due to the fact that the vegetative phase of life cycle prevails in the cooler part of the season with less moisture stress [12]. Early sowing is beneficial compared to late sowing due to long growth span which allows more choice of hybrid maturities and more chances for re plant. In earlier sowing tasseling and silking period lies before to moisture stress risk and drought damage [13]. Harvesting is done earlier in the season when conditions are better which minimize time losses [14]. One of the advantages of early sowing is that female flowering happens before month of July which is the month of stress because of water deficiency. Late sowing adversely decline maize production viz; the effective growing season is shortened, crop photosynthesis is declines and crop is exposed to high risk lethal cold temperatures before grain maturation late in the season, insect and disease stress and moisture and heat stress during pollination. There is accelerated crop development in late sowings due to presence of increased temperatures during crop duration which decline assembled solar radiation causing reduction in biomass production [13].Choosing of appropriate sowing date with a good variety guarantee higher maize production in addition to recommended agro management practices [15]. For achieving higher efficiency from available nutrients, water, and solar energy, selection of optimum sowing date for already existing varieties is unavoidable [16].

Material and Methods

The present investigation was carried at the Agronomy Research Farm, FoA, Wadura, Sopore, SKUAST-Kashmir during *kharif* 2019 that lies between 34^{o} 21' N latitude and 74^{o} 23' E longitude having an altitude of 1590 m above the mean sea level. The climate is temperate and continental type characterized by hot summers and severe winters with average annual precipitation is 812 mm (average of past thirty years) and more than 80 percent of precipitation occurs during December to April in the form of rains and snow received from western disturbances. The mean maximum and minimum

Table-3 : Relative growth rate (g g^{-1} day^{-1}) of maize at 30 days interval as influenced by sowing dates and genotypes.

Treatments	Emergence-30 DAS	30-60 DAS	60-90 DAS
Dates of sowing			
30th April	0.073	0.044	0.016
10th May	0.079	0.038	0.015
20th May	0.085	0.032	0.014
30th May	0.086	0.030	0.013
SEm±	0.003	0.0003	0.0001
CD (P= 0.05)	NS	0.0010	0.0003
Genotypes			
SFM-1	0.083	0.035	0.015
PMC-6	0.080	0.036	0.014
J-1006	0.079	0.037	0.014
SEm±	0.002	0.0001	0.0001
CD (P= 0.05)	NS	0.0003	0.0003

Table-4 : Net assimilation rate (g m^{-2} day^{-1}) of maize at 30 days interval as influenced by sowing dates and genotypes.

Treatments	Emergence-30 DAS	30-60 DAS	60-90 DAS
Dates of sowing			
30th April	40.94	25.55	10.31
10th May	50.92	22.97	9.55
20th May	56.03	19.92	8.91
30th May	56.58	18.73	8.80
SEm±	4.73	0.17	0.03
CD (P= 0.05)	NS	0.57	0.11
Genotypes			
SFM-1	49.95	21.38	9.61
PMC-6	51.60	21.82	9.30
J-1006	51.80	22.17	9.27
SEm±	2.65	0.07	0.05
CD (P= 0.05)	NS	0.22	0.15

temperatures during crop growth season were 33.34 ^{o}C and 6.81 ^{o}C respectively. The total precipitation amounted to 398.1 mm during crop growth season. The soil of the experimental site was silty clay loam in texture, with medium in available nitrogen, phosphorus and potassium and neutral pH. The experiment consisting of two factors viz., four sowing dates (30th April, 10th May, 20th May and 30th May) and three genotypes (SFM-1, PMC-6 and J-1006) laid out in split plot design (SPD) taking sowing dates as main plots treatments and genotypes as sub plot treatments with three replications. A fertiliser dose of 10 t ha^{-1} FYM, 120 kg ha^{-1} nitrogen, 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} was applied uniformly to each plot. For the purpose of recording data, five plants were randomly selected and tagged from every plot of each replication.

Dry matter estimation : For dry matter estimation, plant samples were oven dried for 5-6 at 60- 65 ^{0}C to a constant weight. The weight was recorded in grams and then converted in to q ha^{-1}.

Crop growth rate : Crop growth rate was computed by the formula given by [17].

$$CGR\ (g\ day^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where, W_1 and W_2 = Dry matter production per plant at time t_1 and t_2, respectively.

Relative growth rate : Relative growth rate was calculated by using the formula suggested by [18].

$$RGR\ (g\,g^{-1}\,day^{-1}) = \frac{Log\,e\,W_2 \quad Log\,e\,W_1}{t_2 \quad t_1}$$

Where, W_1 = Dry weight of plant at time t_1, W_2 = Dry weight of plant at time t_2

Net assimilation rate : Net assimilation rate was calculated by using formula given by [19].

$$NAR\ (gm^{-2}\,day^{-1}) \quad \frac{W_2 \quad W_1}{t_2 \quad t_1} \quad \frac{log\,eL_2 \quad log\,eL_1}{L_2 \quad L_1}$$

Where,

L_2 and L_1 are the leaf area, W_2 and W_1 are dry weight at time t_2 and t_1 respectively. Leaf area was calculated by multiplying leaf area index with ground area.

Green fodder yield : The fodder yield of each net plot (leaving border and penultimate rows) was harvested and the weight from each plot was recorded separately as kg $plot^{-1}$ and then converted into q ha^{-1}.

Results and Discussion

Dry matter accumulation : Higher dry matter accumulation (Table-1) was recorded on 30th April sowing date than the other sowing dates from 60 DAS and up to harvest. The reason could be traced to exploitation of favorable climatic condition at important growth stages by the 30th April sown crop and higher leaf number which might have provided more photosynthetic area (LAI) contributed more dry matter. Lowest dry matter accumulation recorded in 30th May sowing may be due to presence of unfavorable growth conditions. While as dry matter accumulation showed non-significant difference in case of sowing dates and genotypes. [20] and [21] revealed that delayed sowing in maize decrease dry matter yield.While as SFM-1 registered maximum dry matter accumulation among genotypes taken at 30, 60 DAS and at harvest. SFM-1 registered higher dry matter accumulation might be due more profuse growth viz; higher plant height, leaf area and leaves $plant^{-1}$ under given environmental conditions. Difference in dry matter content among varieties noted by [22] and [23].

Crop growth rate, relative growth rate and net assimilation rate : Sowing date of 30th April and 30th May

registered higher and lower crop growth rate, relative growth rate and net assimilation rate at 30- 60 DAS and 60- 90 DAS respectively (Table 2, 3 and 4). However crop growth rate, relative growth rate and net assimilation rate comes out to be non-significant at emergence-30 DAS both with in sowing dates and genotypes. In case of genotypes, SFM-1 reported higher crop growth rate at 30-60 DAS and 60- 90 DAS, more relative growth rate and net assimilation rate at 60-90 DAS followed by PMC-6 and J-1006 respectively. Higher crop growth rate, relative growth rate and net assimilation rate on sowing of crop on 30th April may be attributed to increased dry matter production which occurred due to the higher leaf area development, which is the potential site of photosynthesis. While as, late sowing crop obtains low crop growth relative growth rate, and net assimilation rate is mainly due to unfavorable environmental conditions experienced during growing duration which decreased leaf area development and ultimately dry matter production. [24] finded that early sowing recorded higher dry matter content due to more net gain in photosynthesis. [23] finded that delay in planting had a negative impact on net assimilation rate and crop growth rate. [25] Indicated that delayed sowing of decreases crop growth rate effectively. SFM-1 recorded maximum crop growth rate and net assimilation rate at 30-60 and 60- 90 DAS compared to other two genotypes due to unexceptional plant stature with maximum plant height and leaf area. The present findings are in according with the conclusions noticed by [26] and [27].

Green fodder yield : Data pertaining in (Table-2) indicated that among sowing dates, 30th April sowing recorded maximum green fodder yield and the lowest green fodder yield was obtained on 30th May sowing. Crop sown earlier got sufficient time duration to use resources available and favorable temperature at later growth stages of crop while as late sown crop got less time available to utilize growth factors which is responsible for lower leaf area index and stunted plant growth which decreases dry matter production and insufficient assimilates partitioning towards sink for superior vegetative growth, causing a reduction of yield and yield contributing elements in contrast to timely sown crop. Similar conclusions were drawn by [23] and [24] .Among genotypes, SFM-1 recorded maximum green fodder followed by PMC- 6 and J- 1006 respectively. The highest green fodder yield in SFM- 1 is contributed by efficient yield attributes *viz*., higher plant height, leaf area, leaf number plant^{-1} and dry matter production. [25] and [26] find out that maize genotypes significantly differ in biomass yield.

Conclusions

Present investigation concluded that to realize higher dry matter content, crop growth rate, relative growth rate, net assimilation and green fodder yield sowing must be done around 30th April with genotype SFM-1.

References

1. Choudhari, V.V. and Channappagouda, B.B. 2015. Effect of organics on morpho-physiological traits and grain yield of maize (*Zea mays* L.). *The Bioscan* 10 (1): 339-340.
2. Food and Agriculture Origanisation, 2019.
3. Directorate of Economics and Statistics. 2019
4. Directorate of Economics and Statistics. 2015
5. Directorate of Economics and Statistics. 2017.
6. Dahmardeh, M., Ghanbari, A., Syasar, B. and Ramroudi, M. 2009. Effect of intercropping maize with cowpea on green forage yield and quality evaluation. *Asian Journal of Plant Science* 8(3): 235-239
7. Sattar, M. A., Haque, M.F., Rahman, M.M. 1994. Intercropping maize with broadcast rice at different row spacing. *Bangladesh Journal of Agricultural Research* 19: 159-164.
8. Iqbal, A., Ayub, M., Zaman, H. and Ahmed, R. 2006. Impact of nutrient management and legume association on agroqualitative traits of maize forage. *Pakistan Journal of Botany* 38: 1079-1084.
9. Valk, H. 2000. Effect of reducing nitrogen fertilizer on grassland on grass intake, digestibility and milk production of dairy cows. *Livestock production Science* 63(1): 27-38.
10. Berzsenyi, Z. and Lap, D. Q. 2001. Effect of sowing time and N fertilisation on the yield and yield stability of maize (*Zea mays* L.) hybrids between 1991-2000. *Novenytermeles* 50(2): 309-331.
11. Nielsen, R. L., Thomson, P. R., Brown, G. A., Halter, A. L., Wells, J. and Wuethricc, K. L. 2002. Delaying planting date effects on flowering and grain maturation of corn. *Agronomy Journal* 93: 540-547
12. Ali, Q., Ali, A., Waseem, M., Muzaffar, A., Ahmad, S., Ali, S., Awan, M. and Samiullah, T. 2014." Correlation analysis for morpho-physiological traits of maize (*Zea mays* L.)." *Life Science Journal* 11: 9-13.
13. Otegui, M. E. and Melon, S. 1997. "Kernel set and flower synchrony within the ear of maize. I. Sowing date effects. *Crop Science* 37: 441-447.
14. Hicks, D. R., Harrington, I. D. and McGahen, J. H. 1993. Maximizing the advantages of early com planting. National corn handbook crop management. West Lafayette, Indiana, USA: Purdue University Cooperative Extension Service.
15. Qureshi, A. S., Qadir, M., Heydari, N., Turral, H. and Javad, A. 2007. A review of management strategies for salt-prone land and water resources in Iran. International water management Institute 30P (IWMI working paper 125) Colombo, Srilanka.
16. Ogbomo, K. E. L. and Remison, S. U. 2009. Growth and yield of maize as influenced by sowing date and poultry manure application. *Notulea. Botanicae. Horti. Agrobotanici. Cluj* 37(1): 199-203.
17. Radford, P. J.1967. Growth analysis formulae- their use and abuse. Crop Science 7(3): 171-175.

18. Blackman, V. H. 1919. The compound interest law and plant growth. *Annals of Botany* 33(3): 353-360.

19. Vernon, A., Allison, J. A. 1963. A method of calculating net assimilation rate. Nature 200: 814.

20. Girijesh, G. K., Swamy, A. S. K., Sridhara, S., Dinesh K. M., Vageesh, T. S. and Nataraju, S. P. 2011. Heat use efficiency and helio-thermal units for maize genotypes as influenced by dates of sowing under southern transitional zone of Karnataka State. *International Journal of Science and Nature* 2(3): 529- 533.

21. Maddonni, G. A., Otegui, M. E. and Bonhomme, R. 2004. Grain yield components in maize: II. Postsilking growth and kernel weight. *Field Crops Research* 56(3): 257-264

22. Mishra, J. S., Kumar, R., Ravikumar, S., Kumar, R., Praksh, V., Rao, k. k. and Bhatt, B. P. 2017. Production potential of improved grain sorghum cultivars (*Sorghum bicolor*) under staggered plantings in non-traditional areas of eastern in India. *Indian Journal of Agronomy* 62(1): 74-80.

23. Ma, G.S., Xue, J.Q., Lu, H.D., Zhang, R.H., Tai, S.J. Ren, J.H. 2007. Effects of planting date and density on population physiological indices of summer corn (*Zea mays* L.) in central Shaanxi irrigation area. Ying Yong Sheng Tai Xue Bao, 18(6): 1247-1253.

24. Oktem, A., oktem, A. G. and Coskun, Y. 2004. Determination of sowing dates of sweet corn (*Zea mays* L. sacc harata sturt) under sanliurfa conditions. *Turkish Journal of Agricultural Forestry* Oktem, A., oktem, A. G. and Coskun, Y. 2004. Determination of sowing dates of sweet corn (*Zea mays* L. sacc harata sturt) under sanliurfa conditions. *Turkish Journal of Agricultural Forestry* 28(2): 83-91.

25. Staggenborg, S. A., Fjell, D. L., Devlin, D. L., Gordon, W. B., Maddux, L. D. and Marsh, B. H. 1999. Selecting optimum planting date and plant population for dry land corn in Kansas. *Journal of Production Agriculture* Oktem, A., oktem, A. G. and Coskun, Y. 2004. Determination of sowing dates of sweet corn (*Zea mays* L. sacc harata sturt) under sanliurfa conditions. *Turkish Journal of Agricultural Forestry* 28(2): 83-91.

26. Staggenborg, S. A., Fjell, D. L., Devlin, D. L., Gordon, W. B., Maddux, L. D. and Marsh, B. H. 1999. Selecting optimum planting date and plant population for dry land corn in Kansas. *Journal of Production Agriculture* Oktem, A., oktem, A. G. and Coskun, Y. 2004. Determination of sowing dates of sweet corn (*Zea mays* L. sacc harata sturt) under sanliurfa conditions. *Turkish Journal of Agricultural Forestry* 28(2): 83-91.

27. Staggenborg, S. A., Fjell, D. L., Devlin, D. L., Gordon, W. B., Maddux, L. D. and Marsh, B. H. 1999. Selecting optimum planting date and plant population for dry land corn in Kansas. *Journal of Production Agriculture* 12(1): 85-90.

28. Varma, V. S. 2013. Standradisation of alternate planting window in hybrid seed production of maize (*Zea mays* L.) M. Sc. (Ag.) Thesis Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad.

29. Shargi, Y., Rad, A. H. S., Band, A. A., Mohammadi, N. G. and Zahedi, H. 2011. Yield and yield components of six canola (*Brassica napus* L.) cultivars affected by planting date and water deficit stress. *African Journal of Biotechnology* 10(46): 9309-9313.

30. Ahmed, A., Munsif, F., Arif, M., Inamullah and Nuaman, M. 2011. Yield and yield components of maize as affected by sowing dates and sowing methods. *Fuuast Journal Biology* 1(1): 75-80.

31. Rasul, F., Cheema, M. A., Sattar, A., Saleem, M. F. and Wahid, M. A. 2012. Evaluating the performance of three mungbean varieties grown under varying inter-row spacing. *Journal of Animal and Plant Sciences* 22(4): 1030-1035.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 851-854 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Comparative Performance of Pandharpuri Buffalo Calves under Different Rearing Systems

V.G. Patil[1], S.M. Bhokre[2*], A.V. Khanvilkar[3] and K. Vijay[4]
Department of LPM, KNP College of Veterinary Science, Shirwal, Satara, M.H.
**Corresponding Author Email : drsaibhokre@gmail.com*

Abstract

The study was undertaken at the Instructional Livestock Farm Complex and Central Instrumental Facility, Department of Livestock Production and Management at Krantisinh Nana Patil College of Veterinary Sciences, Shirwal (M.S.). All the experiment was conducted for the period of 12 week with daily recording of parameters during experiment period from April 2016 to July 2016. The parameters observed were in terms of growth rate, feed and water intake, The mean daily average feed and water intake per day per animal under conventional and loose rearing system were 8.58±0.017 (kg/day) and 9.62±0.13(litre/day), and 8.92±0.19 (kg), and 10.28± 0.23(litres/day), respectively. The mean daily group average feed intakes under conventional and loose rearing system were 60.10±0.017(kg/day), and 62.43±0.19(kg/day), respectively. The mean daily group average water intakes under conventional and loose rearing system were 67.35±0.13 (litre/day), and 71.98±0.23 (litre/day), respectively. The mean weekly group feed intake under conventional and loose rearing system were 420.74±6.81 (kg/week), and 436.68±7.66 (kg/week), respectively. The mean weekly group water intakes under conventional and loose rearing system were 471.57±7.69 (litre/week),503.92±11.45(litre/week), respectively. The result of most of the parameters were satisfactory in loose rearing system as compared to conventional rearing system thus it may lead to concrete conclusion that, loose rearing system is more suitable than conventional rearing system for Pandharpuri buffalo calves.The parameters i.e. growth rate, feed, physiological parameter, haematological parameter, screening of parasite and behavioural observations recorded, better growth performance and improved behaviour response in loose rearing system. The overall performances of Pandharpuri buffalo calves under loose rearing system were found to be better than that, of conventional rearing system in the present study.

Introduction

Livestock sector alone contributes nearly 25.6% of value of output at current prices of total value of output in agriculture, fishing, & forestry sector. Livestock sector plays an important role in Indian economy and is an important sub-sector of Indian Agriculture. The contribution of agriculture (including all of the allied activities) in India accounted for 13.7% of the GDP (at constant 2004-05 prices), in the year 2012-13 as compared to 18.9% in 2004-05. The contribution of livestock and fishery sector to Gross rate Domestic Product was 4.11% at 2012-13 prices. The overall growth rate in livestock sector is steady and is around 6-8% and this has been achieved despite the fact that investment in this sector was not substantial Livestock provides stability to family income especially in the arid and semi-arid regions of the country famine and other natural calamities, (11th Five Year Plan Document-2012-2017, Planning Commission of India).Buffalo are highly productive animals and are able to perform even under very poor conditions of nutrition and management. However, if they are provided with better conditions their productive efficiency could be improved. In this context, several aspects need consideration, like starting with housing, calf and heifer management, health care and information management system.Housing instinct is widely prevalent in the animal kingdom and has been a matter of great concern since domestication of livestock. Its basic aim is to ameliorate the range of the animal's microenvironment in order to optimize their production by protecting them from climatic stress, providing them clean and comfortable shelter and ensuring proper feeding and management. (Basant bias) Study of behaviour of animals under specific conditions is very essential to assess its comfort and welfare. It is always necessary to provide housing facilities and other amenities to exploit genetic potentials of the dairy animals. Animal comfort can be indicated by behaviour of the animal under a set of atmosphere. The time spent by the animal in lying down, standing and walking, time spent in open or in shaded area and aggression are the important behavioural indicators and thus are included in the present study.The evaluation of body cleanliness also gives some information on animal comfort and health.Pandharpuri buffalo breed was originated from Pandharpur tehsil of Solapur district of Maharashtra state. The breed is distributed in Solapur, Satara, Pune, Sangli, Kolhapur and adjusting parts of western Maharashtra. The climate of breeding tract is dry and semi-arid. Pandharpuri buffalo are medium milk producer and famous for adaptation to adverse climatic conditions.

Materials and Methods

The rearing affects the growth, health and production performance of animal. The extent of reduction in feed intake appears to be directly related to the comfort zone of animal. Hence, the design of rearing in animal should be such that animal remain comfortably in a house to have a maximum profit. The study was designed to different rearing system influencing growth performance of calves. The study planned for studying "Comparative performance of Pandharpuri Buffalo calves under different rearing systems". Fourteen Pandharpuri Buffalo calves were separated in two equal treatment groups of 10-12 month of age of both sexes. One group was assigned for loose rearing with a space of 50 to 60sq.ft for individual calf and 18-20 sq.ft for conventional rearing, respectively. Conventional rearing system had concrete floor whereas, loose rearing system had katcha floor. The calves were vaccinated as per routine farm schedule.

The measured quantity of clean water was provided three times in a day to the animals in the conventional rearing system whereas; the animals in the loose rearing had water available throughout the day. Amount of water intake in 24 hours counted as total water intake by deducting the left over on daily basis.

Comparative study in relation to the body weight and growth rate, feed and water intake, physiological parameters, haematological parameters, health aspects, cleanliness score and behavioral aspects with the help of the increased efficiency of calves to certain extent with improved managemental practices on the farm were studied in different rearing systems.

Results and Discussion

The weekly body weight gain (kg) of Pandharpuri buffalo calves under conventional and loose rearing system are presented in Table-2 and depicted in Fig.-2.

The overall average weekly body weight gain of Pandharpuri buffalo calves under conventional rearing system was 0.97±0.021 (kg). The average weekly body weight gain (kg) of Pandharpuri buffalo calves under conventional rearing system for the period of 1-12 weeks of experimentation period were 0.85±0.10, 1.01±0.09, 1.21±0.13, 0.87±0.08, 0.97±0.07, 0.99±0.06, 0.89±0.05, 0.95±0.04, 0.92±0.09, 0.99±0.03, 1.03±0.09 and 0.98±0.07(kg), respectively.

The overall average weekly body weight gain of Pandharpuri buffalo calves under loose rearing system was 1.01± 0.026(kg). The average weekly body weight gain (kg) of Pandharpuri buffalo calves under loose rearing system for 1-12 weeks of experimentation period were1.01±0.06, 1.08±0.05, 1.06±0.15, 0.99±0.81, 0.98±0.06, 0.85±0.058, 0.98±0.06, 1.96±0.07, 1.12±0.10, 0.91±0.06, 1.01±0.09 and 1.06±0.09 (kg), respectively.

The non-significant difference was observed in weekly body weight gain of Pandharpuri buffalo calves under loose rearing system as compared to conventional rearing system. The non- significant difference observed in the present study for weekly body weight gain was in agreement with the findings Byron *et.al,* (1977), reported the significant higher growth rate of Buffalo calves in open shade area as compared to open area. In contrast Mahmoud *et.al,* (2008) reported the better growth performance of calves under conventional rearing as compared to loose rearing, which is in contrast with the finding of Singh, *et al.* (2009).

The non-significant difference of the weekly body weight gain observed in Pandharpuri buffalo calves under loose rearing system might be attributed to the prevailing environmental conditions. The Pandharpuri buffalo calves under loose rearing system were free to move in their paddock area to adjust their body temperature and physiological activity with the prevailing summer environment conditions.

The daily average feed and water intake per day per animal in Pandharpuri buffalo calves under conventional and loose rearing system are presented in Table 4 and depicted in Fig.-4.

The overall average feed intake (kg/day) of Pandharpuri buffalo calves under conventional rearing system was. The average daily feed intake 8.58±0.017 (kg/day) of Pandharpuri buffalo calves under conventional rearing system for 1-12 weeks of experimentation period were 7.67±0.07, 7.96±0.04, 8.28±0.05, 8.45±0.07, 8.42±0.06, 8.54±0.04, 8.58±0.04, 8.67±0.05, 8.89±0.05, 9.02±0.08, 9.17±0.09 and 9.34±0.09 (kg/day), respectively.

The overall average feed intake (kg/day) of Pandharpuri buffalo calves under loose rearing system was8.92±0.19 kg. The average daily feed intake (kg/day) of Pandharpuri buffalo calves under loose rearing system for 1-12 weeks of experimentation period were 8.24±0.10, 8.33±0.06, 8.42±0.08, 8.59±0.08, 8.63±0.10, 8.71±0.08, 8.85±0.01, 8.99±0.01, 9.33±0.01, 9.52±0.01, 9.67±0.08 and 9.79±0.08 (kg/day), respectively.

The average daily feed intake under loose rearing system is slightly higher than the conventional rearing system but the differences were statistically non-significant. Feed intakes for first 5 weeks were slightly higher for the calves of conventional rearing system as compared to loose rearing system. Feed intakes for the last 7 weeks were slightly higher for the calves of loose rearing system as compared to

Table-1 : Daily average feed (kg/day) and water intake (lit/day)/animal in Pandharpuri buffalo calves under conventional and loose rearing system.

Weeks	Feed intake (kg/day)		Water intake (lit/day)	
	Conventional rearing	Loose rearing	Conventional rearing	Loose rearing
1	7.67±0.07	8.24±0.10	8.68±0.07	8.85±0.05
2	7.96±0.04	8.33±0.06	8.98±0.06	9.02±0.14
3	8.28±0.05	8.42±0.08	9.39±0.15	9.64±0.15
4	8.45±0.07	8.59±0.08	9.44±0.15	9.73±0.14
5	8.42±0.06	8.63±0.10	9.44±0.15	9.55±0.17
6	8.54±0.04	8.71±0.08	9.49±0.15	9.9±0.08
7	8.58±0.04	8.85±0.01	9.61±0.15	10.14±0.07
8	8.67±0.05	8.99±0.01	9.77±0.14	10.28±0.07
9	8.89±0.05	9.33±0.01	9.86±0.011	10.55±0.08
10	9.02±0.08	9.52±0.01	9.99±0.10	10.76±0.08
11	9.17±0.09	9.67±0.08	10.19±0.09	10.94±0.06
12	9.34±0.09	9.79±0.08	10.39±0.08	11.14±0.07
Average	8.58±0.017	8.92±0.19	9.620±.13	10.280±.23
t-value	1.607 NS		2.439*	
	Non-significant		Significant	

conventional rearing system. There were non-significant differences observed for daily average feed intake of Pandharpuri buffalo calves under conventional and loose rearing system.

The non-significant differences observed in the daily feed intake of Pandharpuri buffalo calves in conventional and loose rearing system.The values arein contrast with findings of Byron et.al,(1977). They reported the high feed consumption with significant differences of yearling steers in confined and loose rearing system. The similar findings were also reported by Anjali and Singh (2005) in Murrah Buffalo calves. The non-significant differences observed in Pandharpuri buffalo calves for daily average feed consumption under conventional and loose rearing.

System may be indicative of fact that Pandharpuri buffalo breed of Buffalo calves being on descript breed with home tract of environmental conditions is well acclimatized in this area with all environmental extremities. This might have developed the potential of Pandharpuri buffalo calves to sustain and acclimatized the changed environmental conditions in both conventional and loose rearing without altering the daily feed consumption. This may to lead the conclusion that Pandharpuri buffalo calves are best suited under environmental as well as loose rearing system without altering the feed consumption.

Conclusions

Form the present study entitled “Comparative performance of Pandhrpuri buffalo calves under different Rearing systems” following conclusions were drawn. There was non-significant difference observed for the body weight, daily growth rate, and daily average feed consumption under loose rearing system as compared to conventional rearing system. The water intake of Pandharpuri buffalo calves is higher in looserearing system than that of conventional rearing system. Is indicating that, the Pandharpuri buffalo calves under loose rearing were more comfortable and found stress free.

References

1. Aggarwal. A. and Mahender Singh (2007). Economics of using mist and fan System During Summer and in-house Shelter during winter for alleviating Environmental Stress in Dairy Animals *Indian J. of Agri. Econ. 62 (2):* 273-274.
2. Andersson Monica (1986). Effects of number and location of water bowls and social rank on drinking behaviour and performance of loose-housed dairy cows P.p.139-146 in Fifth International Dairy Housing Proceedings of the 29-31. January 2003 Conference (Fort Worth, Texas USA) 701P0203.
3. Beecler B.R., Jolles A.E., Ezenwa V.O. (2009). Ealuation of Hematologic values in free-ranging in african buffalo. *J. of Wildlife Diseases,* 45(1), 2009, pp. 57–66.
4. Byron, M. Lea., Hoffman M. P and Self H. L., (1977). Comparison of confinement, shelter and no shelter for finishing steers. *Indian J. Ani.* Sci. 44: 717-719.
5. Chavan P.B.,Damle P.S., Waghmode H.J., Bendre M.U., Kurve V.P and maske D. K. (2008). Seasonal prevalence of gastrointestinal parasitism in goats at Nagpur. Veterinary world, 1(12): 360.
6. De Rosa G., F. Grasso., A. Braghieri., A. Bilancione., A. Di Francia. and F. Napolitano (2009). Behavior and milk production of buffalo cows as affected by housing system. *J. Dairy Sci.* 2009. 92: 907-912.
7. ICAR-1998. Nutrition requirement of livestock and poultry. Indian council of agriculture research, New Delhi.

8. Jat, R.P. and B.L Yadav. (2010). Growth and behavior pattern of buffalo calves under different shelter modification. *Indian J. Anim. Sci.* 80 (7): 686-689, July 2010.
9. Konggaard S.P. (1977). Comparison between conventional and tie-barn and loose housing system with respect to milk production, feed conversion and reproductive performance of dairy cows. *Livestock Prod. Sci.* 4(1): 69-77.
10. K. Kishor, M. Mahender., Ch. Harikrishna (2013). A study on buffalo management practices in khammam district of Andhra pradesh. *Buffalo bulletion* 32(2) 97-119, June 2013.
11. Korsun, B. A. (1993). Feeding cows under shaded awnings during summer. Molochno-Myasne-Skotarstvo, 82: 52-54.
12. Leonie Roland., M. Drillich., M. Iwersen (2014). Hematology as diagnosis I bovine medicine J., 26(5) : 592-598.
13. Mullick, D.N. (1964). Review of investigations on the physiology of Indian buffaloes. *Indian J. Dairy Sci*., 17: 45-50.
14. Mahmoud, M.A. and Gary, F.B. (2008). The study of tie barn and loose housing system in bovines. UAR *J. Anim. Prod.* (egypt). 12: 92.
15. Metz (1975). Time patterns of feeding and rumination in domestic cattle. Meded, Landbouwhogesh, Ph.D.Diss. NL 75-12, Wageningen, Netherland.
16. Mishra N., Parasd H.K., Mohantay T. M., Kumaresan A.K. (2015). A Simulation Study on Growth Performance in Murrah Buffaloes Using Management Information System. *Indian Vet. J.,* May 2015, 92 (5) : 43-45.
17. Nagpaul P.K and Roy Biswajit ,(2004) Shelter management for sustainable animal production performance under different agro-climatic region. National training programme on sustainable production in Farm Animals Through Breeding and Management Interventions, pp 94-97.
18. Napolitano, F.,Grasso, F., Saltalamacchia, F., Martiniello, P., Bilancione, A., Pacelli, C., De Rosa, G., (2007). Grazing behaviour of buffalo heifers. *Ital. J. Anim. Sci.* 6 (Suppl. 2): 1256-1259.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 855-858 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Evaluation of Fungicides and Biocontrol Agents against Wilt Disease of Coriander Caused by *Fusarium oxysporum* f. sp. *corianderii*

V. Kumar[1], Pooja[2*], K.C. Singh[3] and P. Bahuguna[4]

[1]*Department of Plant Pathology, College of Horticulture, VCSG UUHF Bharsar Pauri Garhwal*

[2]*Department of Plant Pathology, College of Horticulture, VCSG UUHF Bharsar Pauri Garhwal*

[3]*Department of Natural Resource Management, College of Horticulture, VCSGUUHF Bharsar Pauri Garhwal*

[4]*Department of Basic and Social Science , College of Horticulture, VCSGUUHF Bharsar Pauri Garhwal*

***Corresponding Author Email** : vijaykumar.india28@yahoo.in*

Abstract

The fungus, *Fusarium oxysporum* f. sp. *corianderii,* causes wilt and root rot of cilantro and has been reported in California, India, and South America. This strain of *Fusarium* can survive many years in soil in the absence of a cilantro crop.In the *in-vitro* evaluation of fungicides Carbendazim 50% WP inhibited 100% growth of the pathogen at 200, 300, 400 and 500 ppm concentration followed by Carbendazim 12%+ Mancozeb 63% WP which inhibited 100% mycelial growth at 500 ppm concentration. In the *in-vitro* evaluation of biocontrol agents *Trichoderma harzianum* showed maximum growth inhibition (76.53%) followed by *Trichoderma viride* (73.17%). While the minimum growth inhibition were recorded in *Bacillus subtilis* (48.05%).In the *in-vivo* evaluation of fungicides and biocontrol agents Carbendazim 50% WP has shown minimum wilt incidence (10.6%) with the maximum seed yield *i.e* 68.08 gm/plot. Among the biocontrol agents *Trichoderma harzianum* has shown minimum wilt incidence (21.53%) followed by *Trichoderma viridae* (24.39%) with the seed yield of 61.70 gm/plot.

Key words : *Fusarium oxysporum f. sp. corianderii, inhibition, wilt incidence etc.*

Introduction

Coriander (*Coriandrum sativum*) is an annual herb in the family Apiaceae. It is also known as Chinese parsley or dhania or cilantro. All parts of the plant are edible, but the fresh leaves and the dried seeds (as a spice) are the parts most traditionally used in cooking. Coriander is used in cuisines throughout the world. According to the NHB (National Horticultural Board, 2017-18) data the Madhya Pradesh is the largest producer of coriander in past years with the approximately 55% share of total production followed by the Rajasthan. Uttarakhand shares 1146.65 ha area in coriander production and produces approximately 3191.12 MT coriander every year. The important diseases are wilt caused by *Fusarium oxysporum* (Narula and Joshi 1963, Srivastava 1972).The wilt disease causes up to 60 per cent yield loss in coriander (Manoranjitham *et al.,* 2003). The seed yield losses caused by Fusarium wilt ranges from 5 to 60 per cent in Rajasthan and 15 to 25 per cent in Gujarat (Prasad and Patel, 1963). Whereas, Mathur and Prasad (1964) reported an average seed yield loss of 20 per cent in Rajasthan due to Fusarium wilt with disease incidence of 70 to 80 per cent.

Materials and Method

***In-vitro* evaluation of fungicides and biocontrol agents against *Fusarium oxysporum* f.sp. *corianderii.* :** To study the efficacy of six fungicides against fusarium wilt of coriander pathogen (*Fusarium oxysporum* f. sp. *corianderii*) "Poisoned Food Technique" (Nene and Thapliyal, 1993) was employed. Six different fungicides namely Propiconazole 25% EC, Carbendazim 12%+ Mancozeb 63%, Carbendazim 75% WP, Captan70%+ Hexaconazole 5% WP, Chlorothalonil 75% WP and Mancozeb 75 WP with a control were tested at different concentrations like 100ppm, 200ppm, 300ppm, 400ppm and 500ppm. Mycelial growth of fungus was observed after 7 days of inoculation.A 4 mm disc was cut aseptically from ten days old culture with the help of sterilized cork borer and placed in the middle of Petriplates and these inoculated plates were incubated at 25±1°C in BOD incubator. Suitable control were kept in which the culture disks were grown under same conditions on PDA without fungicides. After 7 days of inoculation, diameter of fungal growth was measured in each case. The per cent inhibition of the radial mycelial growth of the pathogen over control was calculated as per formula given by Vincent (1947).

$$PGI = \frac{C - T}{C} \quad 100$$

Where; PGI = Percent growth inhibition, C= Radial growth of fungus in control and T = Radial growth of fungus in treatment.

For the *In-vitro* bioassay of 6 bio control agents *Trichoderma asparallum, Pseudomonas fluorescence, Trichoderma viride, Bacillus subtilis, Trichoderma*

Table-1 : Effect of fungicides on per cent growth inhibition of the pathogen at different concentrations.

T. No.	Treatments	100 ppm± S.E. (m)	200 ppm± S.E. (m)	300 ppm± S.E. (m)	400 ppm± S.E. (m)	500 ppm± S.E. (m)
T_1	Control	0.00 ± 0.00 (0.00)	0.00 ± 0.00 (0.00)	0.00 ± 0.00 (0.00)	0.00 ± 0.00 (0.00)	0.00 ± 0.00 (0.00)
T_2	Propiconazole 25% EC	68.14*±0.44 (55.61)	75.89*±0.26 (60.57)	78.26*±0.37 (62.18)	83.45*±0.50 (65.97)	88.96*±1.17 (70.61)
T_3	Carbendazim 12%+ Mancozeb 63% WP	75.28*±0.91 (60.16)	81.13*±0.42 (64.23)	88.56*±1.27 (70.26)	93.73*±0.58 (75.50)	100.00*±0.00 (90.00)
T_4	Carbendazim 50% WP	98.81*±0.28 (83.78)	100.00*±0.0 (90.00)	100.00*±0.00 (90.00)	100.00*±0.00 (90.00)	100.00*±0.00 (90.00)
T_5	Captan 70%+ Hexaconazole 5% WP	58.50*±0.68 (49.87)	63.25*±0.72 (52.66)	66.34*±1.04 (54.52)	72.01*±0.15 (58.03)	77.06*±0.94 (61.37)
T_6	Chlorothalonil 75% WP	43.54*± 1.05 (41.27)	47.48*±0.83 (43.53)	49.99*±0.50 (44.98)	54.35*±0.88 (47.47)	59.15*±0.73 (50.46)
T_7	Mancozeb 75% WP	46.59*±0.75 (43.02)	50.86*±1.36 (45.47)	54.04*±0.28 (47.30)	60.41*±0.39 (50.99)	67.37*±1.16 (55.14)
	S.E.(d)	0.96 (0.69)	0.97 (0.57)	0.95 (0.74)	0.66 (0.52)	1.09 (0.81)
	C.D(0.05)	2.08 (1.49)	2.11 (1.24)	2.06 (1.62)	1.44 (1.12)	2.36 (1.76)

( ) Angular transformed values, *Significant at 5% level of significance as compared with control.

Table-2 : Antagonistic effect of biocontrol agents on mycelial growth and per cent growth inhibition of pathogen.

Treatment No.	Treatments	Mycelial growth (mm) ± S.E.(m)	Per cent mycelium growth inhibition ± S.E.(m)
T_1	Control	56.16 ± 0.44	0.00 ± 0.00 (0.00)
T_2	*Trichoderma asperellum*	17.40* ± 0.87	68.99* ± 1.68 (56.15)
T_3	*Pseudomonas fluorescens*	22.56* ± 0.23	59.81* ± 0.27 (50.63)
T_4	*Trichoderma viride*	15.06* ± 0.58	73.17* ± 0.93 (58.79)
T_5	*Bacillus subtilis*	29.16* ± 0.44	48.05* ± 1.17 (43.86)
T_6	*Trichoderma harzianum*	13.16* ± 0.60	76.53* ± 1.21 (61.01)
T_7	*Bacillus cereus*	25.23* ± 0.50	55.05* ± 1.09 (47.88)
	S.E.(d)	0.78	1.49 (0.93)
	C.D. (0.05)	1.7	3.24 (2.01)

( ) Angular transformed values, *Significant at 5% level of significance as compared with control.

harzianum and *Bacillius ceresus* will be evaluated against *Fusarium oxysporum* f.sp. *corianderii* via Dual culture Methodology (Faheem *et al*., 2010). The fungal antagonists were revived on potato dextrose agar plates, whereas, the bacterial antagonists were revived on the nutrient agar plates by incubating 25±1°C in BOD incubator for 3-4 days after inoculation. During the dual culture methodology the bio control agents and the test fungus were inoculated both side on single Petriplate containing solidified PDA medium. 3 replications were maintained for each treatment with one control by maintaining only pathogen and bio agent individually. The inoculated plates were incubated at 25±1°C in BOD incubator.The per cent inhibition of the mycelial growth of the pathogen over control was calculated as per above mentioned formula given by Vincent (1947).

In-vivo* evaluation of fungicides and biocontrol agents against *Fusarium oxysporum* f.sp. *corianderii.: With a view to know the effectiveness of fungicides and biocontrol against *Fusarium oxysporum* f.sp. *corianderii*underneath *in-vivo* conditions, these fungicides and bio control agents were applied through seed treatment. Seed treatment is effective tools for dominating seed borne diseases. Within the study seven fungicides and seven bio control agents were evaluated as seed treatment. Each fungicides and bio control agents were treated separately. The seed is dressed with dry formulation and wet treated with a liquid formulation. Dressing was applied manually at field. Seeds were spread on a polyethene sheet and needed amount of fungicides and bio control agents sprinkled on seeds and mix mechanically. The fungicides were obtained from Plant Pathology Laboratory, College of Horticulture, VCSG, UUHF Bharsar while the biocontrol agents were obtained from Biocontrol Unit, College of Forestry, VCSG, UUHF, Ranichauri. The fungicides were taken @2 gm/kg for dry formulation and 1 ml/kg for liquid formulation and biocontrol were taken @4 gm/kg as a seed treatment.

Results and Discussion

***In-vitro* study of fungicides and biocontrol agents :** In this experiment 6 fungicides were evaluated for the

Table-3 : Effect of fungicides on per cent disease incidence and seed yield of coriander under field condition.

T. No.	Treatment	Dose	Percent disease incidence (PDI)		Mean	Disease reduction over control (%)	Total yield (gm/Plot)	Increase in yield over control (%)
			45 DAT ± S.E. (m)	90 DAT ± S.E. (m)				
T_1	Control	0	76.33 ± 2.40 (61.14)	74.00 ± 3.05 (59.40)	75.16	-	30.19±0.88	-
T_2	Propiconazole 25% EC	1 mL/kg	16.00* ± 1.15 (23.54)	16.13* ± 1.09 (23.64)	16.16	78.49	60.26*±0.43	99.60
T_3	Carbendazim 12%+ Mancozeb 63% WP	2 gm/kg	14.66* ± 0.70 (22.49)	12.40*±0.69 (20.59)	13.53	81.99	62.92*±1.42	108.41
T_4	Carbendazim 50% WP	2 gm/kg	11.20* ± 0.69 (19.52)	10.00*±0.23 (18.42)	10.6	85.89	68.08*±1.43	125.50
T_5	Captan 70%+ Hexaconazole 5% WP	2 gm/kg	20.40* ± 0.83 (26.83)	22.00*±1.15 (27.94)	21.2	71.79	57.05*±0.97	88.96
T_6	Chlorothalonil 75% WP	2 gm/kg	28.53* ± 0.81 (32.27)	29.33* ± 1.76 (32.76)	28.93	61.50	52.73*±0.84	74.66
T_7	Mancozeb 75% WP	2 gm/kg	26.40* ± 1.38 (30.89)	26.26* ± 1.39 (30.76)	26.33	64.96	54.73*±0.25	81.28
S.E.(d)			1.47 (0.98)	2.18 (1.46)		-	1.40	-
C.D.(0.05)			3.25 (2.17)	4.81 (3.23)		-	3.10	-

( ) Angular transformed values, *Significant at 5% level of significance as compared with control.

Table-4 : Effect of biocontrol agents on per cent disease incidence and seed yield of coriander under field condition.

T. No.	Treatment	Dose	Per cent disease incidence (PDI)		Mean	Disease reduction over control (%)	Total yield (gm/ Plot)	Increase in yield over control (%)
			45 DAT± S.E.(m)	90 DAT± S.E.(m)				
T_1	Control	0	73.33 ± 1.33 (58.90)	68.00 ± 2.30 (55.55)	70.66	-	29.58 ± 0.61	-
T_2	*Trichoderma asperellum*	4 gm/kg	27.60* ± 1.22 (31.66)	24.80*±0.69 (29.85)	25.70	63.62	57.26*±0.88	93.57
T_3	*Pseudomonas fluorescens*	4 gm/kg	29.06*±0.58 (32.60)	28.00*±0.46 (31.93)	28.53	59.62	55.24*±1.11	86.74
T_4	*Trichoderma viride*	4 gm/kg	26.26*±0.93 (30.81)	22.53*±1.39 (28.30)	24.39	65.48	58.80*±0.79	98.78
T_5	*Bacillus subtilis*	4 gm/kg	32.40* ± 1.51 (34.67)	31.46* ± 0.96 (34.10)	31.43	55.51	52.59*±0.87	77.78
T_6	*Trichoderma harzianum*	4 gm/kg	21.33*±0.70 (27.49)	21.73*±0.48 (27.77)	21.53	69.53	61.70*±1.05	108.58
T_7	*Bacillus cereus*	4 gm/kg	30.93*±0.70 (33.77)	30.13*±1.41 (33.26)	30.53	56.79	53.66*±0.45	81.40
S.E.(d)			1.48(0.95)	1.79 (1.12)		-	1.24	-
C.D. (0.05)			3.26(2.09)	3.94 (2.48)		-	2.73	-

( ) Angular transformed values, *Significant at 5% level of significance as compared with control.

different concentrations *i.e.* 100, 200, 300, 400 and 500 ppm under laboratory conditions. The result revealed that Carbendazim 50% WP inhibited 100% growth of the pathogen at 200, 300, 400 and 500 ppm concentration followed by Carbendazim 12%+ Mancozeb 63% WP which inhibited 100% mycelial growth at 500 ppm concentration. Similar results were reported by Jat *et al.* (2017) that Bavistin (Carbendazim) inhibited the fungal growth at 200 and 500 ppm followed by companion (Carbedazim 12% + Mancozeb 63%) against *Fusarium oxysporum* f.sp. *corianderii*. Singh *et al.* (2017) also reported that fungicides Carbendazim 50% WP and Carbendazim 12%+ Mancozeb 63% WP were quite effective that they completely supressed the mycelial growth and sporulation at all the concentrations (50ppm to 1000 ppm) against *Fusarium oxysporum* inflicting wilt of Chilli.

Biocontrol agents are important means of disease management as they are ecofriendly in nature. In the present investigation 6 biocontrol agents were evaluated against *Fusarium oxysporum* f.sp. *corianderii*. Among these bioagents namely *Trichoderma harzianum*showed maximum growth inhibition (76.53%) followed by *Trichoderma viride*(73.17%). While the minimum growth inhibition were recorded in *Bacillus subtilis*(48.05%). Similar findings were reported by Jat *et al.* (2017) that

Trichoderma harzianum was found best to inhibit of mycelia growth. Ghaghara *et al.* (2020) also reported that *Trichoderma harzianum* reduced maximum mycelial growth of *Fusarium oxysporum* f.sp. *corianderii* in fungal biocontrol agents, while the bacterial antagonists *Bacillus subtilis* was found least effective against fungal pathogen.

***In-vivo* study of fungicides and biocontrol agents :** In the present investigation all the fungicides were found significantly superior in controlling wilt incidence under field condition. Among the fungicides Carbendazim 50% WP has shown minimum wilt incidence (10.6%) followed by the Carbedazim 12% + Mancozeb 63% (13.53%). Carbendazim showed maximum disease reduction over control *i.e.* 85.89%.The Carbendazim 50% WP also showed maximum seed yield *i.e* 68.08 gm/plot. It is also observed that Carbendazim increased 125.50% yield over control. Similar results were obtained by Jat *et al.* (2017) that seed treatment with Bavistin resulted lowest wilt incidence 10.39%, with maximum yield followed by the companion that showed wilt incidence of 12.22%.

In the present study it was revealed that biocontrol agents are also an effective tool against wilt disease of Coriander caused by *Fusarium oxysporum* f. sp. *corianderii.* Among the biocontrol agents *Trichoderma harzianum* (21.53%) has shown minimum wilt incidence followed by *Trichoderma viridae* (24.39%). *Trichoderma harzianum* also shown maximum disease reduction over control *i.e.* 69.53%. It also observed that *Trichoderma harzianum* given maximum yield among all the biocontrol treatments *i.e.* 61.70 gm/plot. It increased 108.58 % yield over control. Similar findings were also reported by Jat *et al.* (2017) that the seed treatment @ 4 gm/kg seed was found to be more effective in reducing the wilt incidence to 20.81% and 61.75% disease management under field condition and gave maximum yield. Muthulakshmi *et al.* (2002)stated that seed treatment with *Trichoderma viridae* @4gm/kg of seed was helpful in reducing the wilt incidence to 5.3%.

Conclusions

In the *in-vitro* evaluation of fungicides Carbendazim 50% WP inhibited 100% growth of the pathogen at 200, 300, 400 and 500 ppm concentration followed by Carbendazim 12%+ Mancozeb 63% WP which inhibited 100% mycelial growth at 500 ppm concentration.In the *in-vitro* evaluation of biocontrol agents *Trichoderma harzianum* showed maximum growth inhibition (76.53%) followed by *Trichoderma viride* (73.17%). While the minimum growth inhibition were recorded in *Bacillus subtilis* (48.05%). In the *in-vivo* evaluation of fungicides and biocontrol agents Carbendazim 50% WP has shown minimum wilt incidence (10.6%) with the maximum seed yield *i.e* 68.08 gm/plot. Among the biocontrol agents *Trichoderma harzianum* has shown minimum wilt incidence (21.53%) followed by *Trichoderma viridae* (24.39%) with the seed yield of 61.70 gm/plot.

References

1. Faheem, A., Razdan, V.K., Mohiddin, F. A., Bhat, K.A. and Sheikh, P.A. 2010. Effect of Volatile metabolites of *Trichoderma* species against seven fungal plant pathogen *in-vitro. Journal of Phytopathology*. 2: 34-37.
2. Ghaghara, A.G., Rajani, V.V., Bhaliya, C.M., Rupapara, M.D. and Jotangiya, K.S. 2020. Effeicacy of biocontrol agents against *Fusarium oxysporum* f.sp. *corianderii* causing wilt of coriander under *in-vitro* condition. *International studies of chemical studies.* 8(1): 2953-2955.
3. Jat, M. K., Ahir, R. R. and Kakraliya, G. L. 2017. Evaluation of fungicides as seed treatment against coriander wilt disease caused by *Fusarium oxysporum* f.sp. *corianderii. International Journal of Plant Protection.* 10(1): 92-95.
4. Jat, M.K., Ahir, R.R., Choudhary, S. and Kakraliya, G. L. 2017. Management of coriander wilt using Biocontrol agents. *International Journal of Chemical Studies*. 5(2): 523-525.
5. Manoranjitham, S.K., Rabindran, R. and Doraisamy, S. 2003. Management of seedborne pathogens and wilt disease of coriander. *Madras Agricultural Journal.* 90(4-6): 298-300.
6. Mathur, B.N. and Prasad, N. 1964. Studies on wilt disease of cumin caused by *Fusarium oxysporum*f.sp. *cumini. Indian Journal of Agricultural Sciences,* 34(2): 131-137.
7. Muthulakshmi, P., Chezhiyan, N., Muthukrishnan, K. and Doraisamy, S. 2002. Management of coriander wilt using biocontrol agents. *Journal of spices and Aromatic Crops.* 11(2): 138-140.
8. Narula, S. C. and Joshi, P. S. 1963.*Fusarium oxysporum Sch.* f.sp. *corianderii. Science and Cultures.* 29: 206.
9. Nene, Y. L. and Thapliyal, P. N. 1979.Fungicides in plant disease control. Oxford and IBH publishing Co. Pvt. Ltd. New Delhi. 325.
10. Prasad, N. and Patel, P.N. 1963.*Fusarium* wilt of cumin in Gujrat state. *Indian Plant Disease Reporter.* 47(6): 528-531.
11. Singh, J.K., Kumar, M., Kumar, S., Kumar, A. and Mehta, N. 2017. Effect of chemicals and antagonists on growth aand sporulation of *Fusarium oxysporum* causing wilt of chilli (*Capsicum annuum* L.). *International Journal of Chemical Studies.* 5(5): 2175- 2181.
12. Srivastava, U.S. 1972. Effect of interaction of factors on wilt of coriander caused by *Fusarium oxysporum* f. sp. *corianderii* Kulkarni, Nikam & Joshi. *Indian Journal of Agricultural Science.* 42: 618-620.
13. Vincent, J.M. 1927. *Distortion of fungal hyphae in presence of certain inhibitors*. Nature 159-85.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 859-865 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Genetically Modified Crops-A Promising Innovation for Enhancing Food Security and Role of Extension in Diffusing GM Technology

Chappidi Venkata Pujitha[1*], Sundar Barman[2] and B. Jaswanth Naik[3]
Department of Extension Education, Assam Agricultural University, Jorhat
**Corresponding Author Email : chappidi.pujitha.amj20@aau.ac.in*

Abstract

With the increase in the population, there is an increase in the food demand. The issue is to be addressed by innovative modern technology and as such genetically modified crops paved the way. The use of genetic engineering to transfer the desirable genes into crops creates genetically modified crops. The benefits include increased tolerance to biotic and abiotic stress, herbicides, and enhanced nutritional values. Based on the review of some literature, it is proved that the adoption of GM crops increases the farmer's income and reduces the chemical use thus protecting the soil health. Instead of many benefits, there are some myths like allergies and gene flow, which are against the adoption and commercialization of GM crops. This concern requires a lot of attention by extension to provide motivation and awareness to people. The paper discusses the importance of GM crops to meet food security and the role of extension in the transfer of technology.

Key words : *GM crops, food security, extension strategies.*

Introduction

Food and Agriculture Organization (FAO) defined food security as when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Food security means not just increasing the food grain production, but also making the food available and accessible to all sections of the people. India being an agricultural country, still faces the problem to meet the food requirements of the growing population. According to the global hunger index 2021, India is ranking at 101 positions with about 189.2 million undernourished people, 33 lakh malnourished children and 15% of the population sleeps hungry every night. Accordingly, an article from economic times reported that the population is estimated to reach 9.2 billion by 2050 and there comes a need to uplift food grain production to 333 million tonnes by 2050. On the other hand, the percentage of agricultural workers is likely to drop to 25.7 percent by 2050 from the earlier 58.2 percent in 2001 and the average landholdings have decreased from 1.41 hectares in 1995-96 to 1.08 hectares in 2015-16. Fig 1 and 2 shows the growth of food production and population in India respectively over years.

Evolution of Indian Agriculture : Eradicating hunger was always one of the main goals of the United Nations millennium development goals. In the process of eradicating hunger, there have been continuous changes in the Indian agriculture to meet all the challenges of overpopulation, climate change, labors migration, and a decrease in cultivable land. The changes varied from

Beginning of 19th century – using traditional methods

Beginning of 20th century - shifting to the green revolution by using pesticides, insecticides to meet food sufficiency

Beginning of 21st century - shifting to organic farming due to observation of damage to the environment by the farmers but with organic farming, the food security can only be met in long term practice.

Present–need for an innovative approach to address the food security of the growing population

Need for GM Crops : Biotechnology is one such innovation, wherewith the help of genetic engineering, plants are inserted with desirable traits and transgenic crops are developed. "Genetically modified crops are crops derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally e.g. through the introduction of a gene from a different organism". BT cotton is modified by the insertion of genes from a soil bacterium, Bacillus thuringiensis to kill caterpillar pests. Food security can't be achieved only by GM crops, but the blending of traditional technologies with biotechnologies can help to solve the problem. Many studies have proved the role of GM crops in providing food safety and security but it is still a controversial topic to the public.

Pros of GM crops

Nutritional enhancement : Higher vitamin content; more healthful fatty acid profiles

Stress tolerance : Tolerance to high and low temperatures, salinity, and drought

Disease resistance : For example, orange trees resistant to citrus greening disease or American chestnut trees resistant to fungal blight.

Post-harvest traits : More storage period, slow ripening

Biofuels : Plants with altered composition for more efficient conversion to ethanol

Phytoremediation : Plants that extract and concentrate contaminants like heavy metals from polluted sites.

Edible vaccines : Vaccines produced in food crops can be directly consumed and effectively elicit an immune response to a particular pathogen.

Cons of GMOs : Besides many benefits, some scientists do not approve GM crops and even a few articles were distributed on outcomes of GM crops, however, all were wrong. There is no demonstrated learn about the cons of GM crops, these are focuses raised by Anti-GMO just to prevent the entry of GM into India. The focuses are :

Allergenicity

Gene transfer

Outcrossing

Superweeds and super pests

Status of GM crops at national and international level : GM crops were first introduced in the USA in 1994 with the Flavr Savr tomato variety, which has desirable characteristics like slow ripening process, delaying softening, and rotting. With the benefits of GM crops, the area under GM crops has increased from 1.7mha in 1996 to 190.4mha in 2019 (ISAAA). Due to the increased adoption of GM crops, it is considered as fastest adopted crop technology. Besides its fast adoption, there are still protests going against this technology. Only some countries like the USA, Canada, and Japan had commercialized both food and non-food crops.

As indicated by the International Service of Acquisition of Agri-biotech Application (ISAAA), India has been positioned as the fifth biggest country as far as a region under biotech crops as shown in fig3. The Genetic Engineering Appraisal Committee (GEAC) is the peak body that takes into consideration for approval of GM crops and the only crop approved in India is GM cotton. The GEAC in 2007, suggested the approval of BT brinjal, yet the drive was impeded in 2010. BT brinjal, tomato, bhindi, rice, soya bean - under assessment and trial and error stage. BT cotton was at first supported in India on March 26th, 2002 for commercial development in six states. In addition to reducing production costs and increasing profit, it has lowered farming risk and improved farmers' viewpoint. It changed the scenario, as cotton productivity nearly multiplied in six years. India's portion in the worldwide production of cotton expanded from 12% in 2002 to 25% by 2014(ISAAA). From a net importer of cotton, India turned into the second-biggest exporter of cotton. At present over 95% of the nation's cotton region has gone under BT cotton and the yield has additionally expanded from 191 kg/ha to 436 kg/ha (pib.gov.in). fig 4 shows the most adopted GM crops all over the world.

Following endorsement for GM cotton, a few organizations also supported GM crops, expecting comparable ground breaking changes in Indian farming. BT brinjal was one such innovation suggested for commercialization in October 2009, after it finished administrative assessment in seven years, and is as yet under the ban. In the meantime, this innovation has been embraced in Bangladesh. A review by Ahmed et al (2013) on the effect of BT brinjal showed a 51% decrease in the quantity of pesticide application, 42% increment in the yields and there is no record of damage to human wellbeing. Whenever All India Composed Vegetable Improvement Task (AICVIP) directed field trails with BT brinjal crossbreeds in 2007, the paths were led in 2004 and 2005, the outcomes were is there was a normal decrease of 41.8% in the utilization of bug spray and 133.6% increment in the natural product yield. It is demonstrated that the development of BT brinjal has such countless advantages however dissenters are still against the choice.

Table-1 concludes that there is no regular trend in area and yield increase every year. The government of India after recognizing the importance of GM crops, has started conducting field trials in 8 different states by obtaining a nonobjection form from the state government. The states and crop trails are Punjab- mustard, maize; Haryana-maize, cotton; Delhi-mustard; Rajasthan- cotton; Gujarat-cotton, maize; Maharashtra-brinjal, rice, maize, cotton; Andhra Pradesh-chickpea, cotton; Karnataka-cotton. Brinjal, mustard, and potato are some of the crops which are awaiting permission for large-scale field trials and seed production. The varieties of some GM crops are:

Bt- cotton : MECH 12 Bt, RCH 2 Bt, Ncs-207, MRC-6322 Bt

Bt brinjal : mhb-4 Bt, mhb 9 Bt, mhb 80 Bt, Jaya and BSS-793

GM mustard: Dhara Mustard Hybrid 11 (DMH11)

GM potato: new leaf variety, innate potato, amflora

Gm soybean: roundup ready soybean

GM Crops safety issue : One of the main concerns for least adoption of GM crops is their safety, many farmers and consumers believe that GM crops are not safe to consume due to their side effects like allergenicity and

Table-1 : Area, Production and Yield of BT cotton crop in India.

Year	Area (lakh ha)	Percent change in area (%)	Production (lakh bales)	Yield (kg/ha)	Percent change in yield (%)
2002-03	0.29	-	86.21	191	-
2003-04	0.92	68.47	137.28	307	37.78
2004-05	4.85	81.03	164.29	318	3.459
2005-06	12.34	60.69	184.99	362	12.15
2006-07	33.54	63.20	226.32	421	14.01
2007-08	54.72	38.70	258.84	467	9.85
2008-09	66.69	17.94	222.76	403	-15.88
2009-10	85.52	22.01	240.72	403	0
2010-11	96.32	11.21	330.00	499	19.23
2011-12	107.58	10.46	352.00	491	-1.62
2012-13	105.43	-2.03	342.20	486	-1.02
2013-14	110.35	4.45	359.62	510	4.70
2014-15	119.40	7.57	348.05	462	-10.38
2015-16	106.83	-11.76	300.05	415	-11.32
2016-17	89.43	-19.45	325.77	511	18.78
2017-18	110.76	19.25	328.05	477	-7.12
2018-19	117.81	5.98	287.08	386	-23.57
2019-20	117.47	-0.28	322.67	436	11.46

(Source : Directorate of Economics and statistics, www.pib.gov.in).

harm to the environment. Besides these controversies many national and international institutions like the world health organization (WHO), food and drug administration (FDA), U.S Department of Agriculture (USDA), Environmental Protection Agency (EDA), American Association for the Advancement of Science (AAAS), American Society of Plant Biologists (ASPB) and French Academy of Medicine have studied and supported that GM crops are as safe as conventionally grow crops. NAS stated that “To date, no adverse health effects attributed to genetic engineering have been documented in the human population”. Along with the institutions scientists like Norman Borlaug, have stated that “It is better to die eating GM food instead of dying of hunger”. M.S.Swaminathan also stated that “GM foods have the potential to solve many of the world’s hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides”. European commission prepared a report by concluding more than 130 research projects for 25 years which involves more than 500 independent research groups stated that genetically modified organisms are no more risky than conventional plant growth technologies.

Why choose GM crops over other crops? : Many scientists consider that other farming practices like organic farming are also efficient in solving food insecurity, but the following are the reasons why we have to choose GM crops over others, Increased crop yields, Reduce need for crop protection.

One of the main benefits of GM crops is to produce plants with desirable characteristics like increasing yield and reducing the need for crop protection by genetic engineering process. The GM crops can provide resistance to biotic and abiotic stress and insects and pests, hence there will be increased yield due to less damage. Crop protection can be increased by inserting genes into the plant directly to act against insects, pests, and viruses, thus helping in reducing the use of insecticide and pesticides and reducing the cost of cultivation. The reduced spraying of chemicals also makes GM crops safe to consume.

A study by Subramanian (2009) resulted in that usage of BT cotton has increased the yield up to 30-40% with reduced use of insecticide by 50%, resulting in a net profit of US$156 per hectare. Another study by Sadashivappa and Quim (2009) resulted in the adoption of BT cotton showed a 43% rise in yield, a 21% decline in several sprays, and a 70 %increase in net profit margin. A meta-analysis by Klumper and Qaim (2014) on the impacts of Genetically Modified Crops resulted in the adoption of GM technology has reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%.

Enhanced nutrient composition and food quality : The transfer of genes also helps to nutritionally enhance the quality of foods with desirable characteristics. Nutritionally enhanced GM crops under development include varieties of wheat free of gluten, a major cause of food allergy; vegetables with higher vitamin E content to help fight heart disease; and “golden rice” genetically engineered to contain vitamin A and iron to prevent common nutritional deficiencies in developing countries.

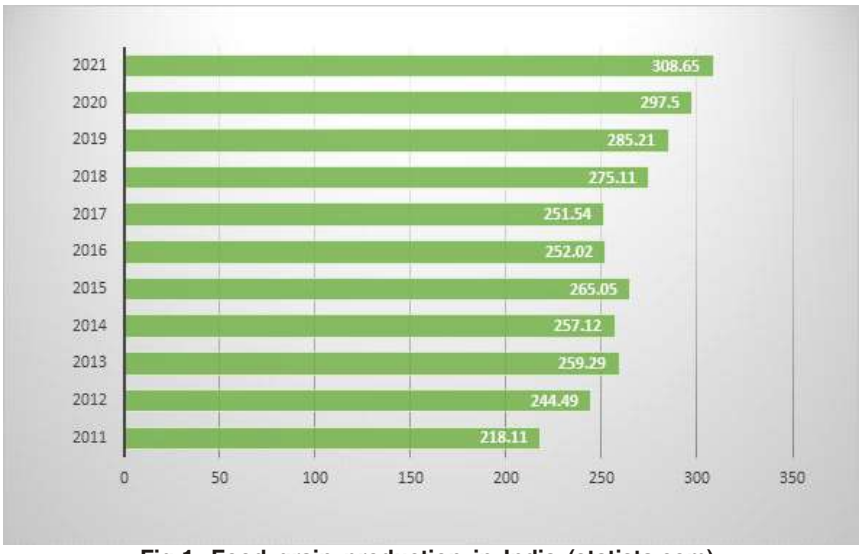


Fig-1. Food grain production in India (statista.com).

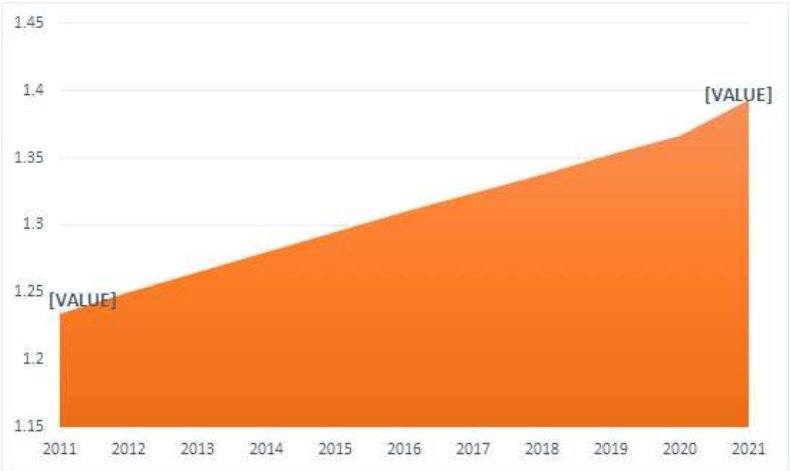


Fig-2 : Increasing trend of population in India (macrotrends.net).

Reduce costs of food or drug production : With the increased use of GM crops, food production increases and increased supply reduces the prices of food. Certain GM crops are under development especially to produce vaccines, which is important to protect people's health in developing nations during epidemics. GM insulin is being used by humans since 1970, but there was no single report indicating the hazard. Recently developed vaccines Covishield and Covaxin against COVID-19 are also a product of modern biotechnology.

Greater food security : A study by Qaim and Kouser on genetically modified crops and food security in four different states like Maharashtra, Karnataka, Andhra Pradesh, and Tamil Nadu has revealed that the adoption of GM crops has reduced the food insecurity problem by 15-20% and total calorie consumption has increased by 74kcal per AE and day per ha of BT cotton. ISAAA in a report mentioned that the continuous adoption of biotech crops for 24 years can be a solution to poverty, malnutrition, food insecurity, crop disease, and climate change problems.

Regulatory process of GM crops in India : Like a coin has two sides, every technological innovation has its own set of benefits and risks. The government of India has developed a model for regulation of safety of GM crops, the process follows the steps- the applicant i.e seed companies or plant breeders, it develops a new transgenic crop, and the first step is to apply for approval with all the details about the crop and characteristics developed to Institutional Biosafety Committee (IBSC). Fig.-5 shows the flowchart for regulation of GM crops in India.

The application is screened and on approval forwarded to the review committee on genetic manipulation (RCGM) with information on experimental designs. The RCGM conducts biosafety research level I (BRL-I) trails if approved biosafety research level-II (BRL-II) trails are conducted. Based on the plant species/ gene combination, several locations for BRL-II are

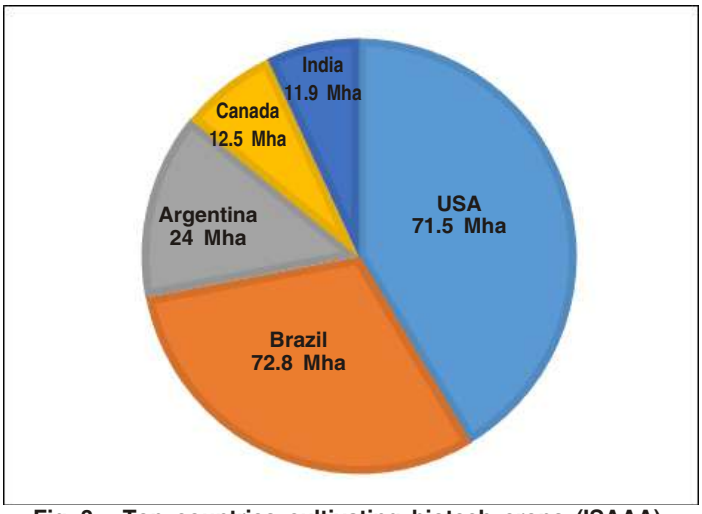


Fig.-3 : Top countries cultivating biotech crops (ISAAA).

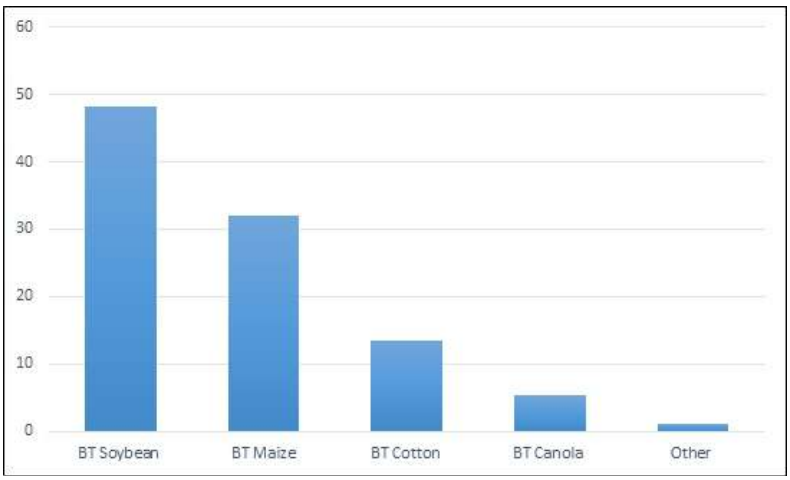


Fig.-4 : Most adopted BT crops (ISAAA).

decided. If approved by GEAC, the crop is allowed for commercialization, if not it is considered again. The role of the Central compliance committee (CCC) is to monitor the field trials of RCGM and GEAC. There should be approval of RCGM and GEAC for a person to establish confined field trails.

Role of extension in transfer of GM crops : Any improved technology should diffuse through the value chain for the successful transfer of technology and it is the role of extension personnel to diffuse the technology, there is always a gap in extension, where the technology is transferred to the only farmer and the remaining stakeholders like input dealers and consumers are not know about the technology, thus new technology should be diffused to all stakeholders related to the technology. It is known that the adoption of GM crops has always been inconsistent, due to the wrong perception of farmers and consumers about them. The major stakeholders involved related to GM crops are input dealers, farmers, service providers, and consumers.

Input dealers : Even if farmers want to adopt new technology, the accessibility and availability of the technology are lacking, hence many times there is a failure in the adoption of new technology. It was found that the information received by farmers from progressive farmers and input dealers was adopted more (Babu *et al.,* 2012). However, most Agri-input dealers have insufficient knowledge about GM crops so extension personnel has to provide neat scientific information and understanding about GM crops with knowledge about location-specific crops and varieties. As BT cotton was adopted by a large number of farmers, there was monotony in seed companies and prices were raised, the government to make seeds available to all marginal and small farmers, there were regulations in the prices of seeds, hence there is a need to provide input dealers about laws about the regulation of GM crops. After the popularization of BT cotton seeds many duplicate seeds were available in markets and farmers faced a problem, so the dealers should also know the proper source of obtaining GM seeds.

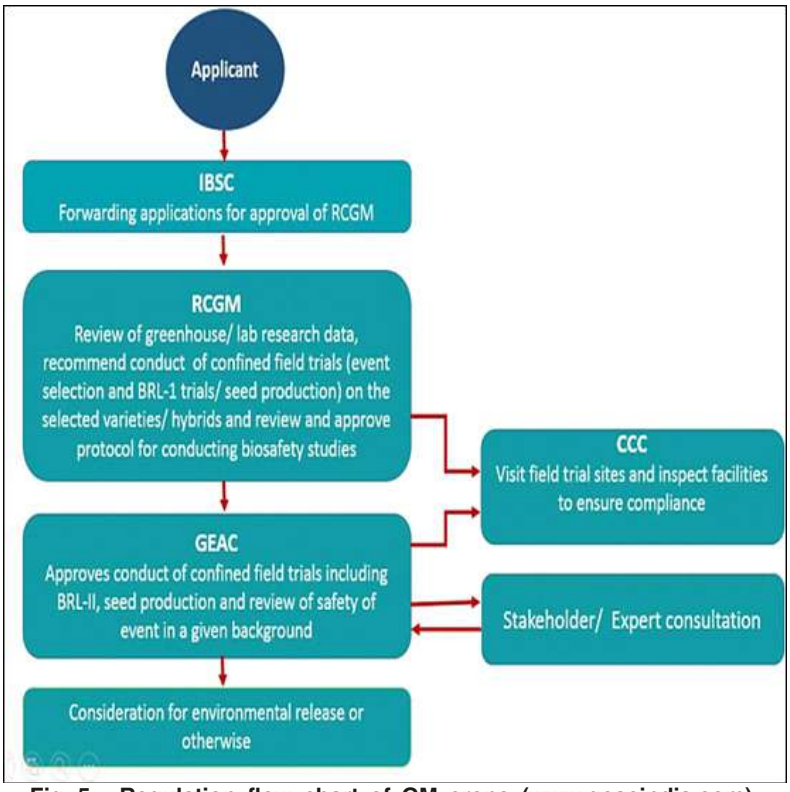


Fig.-5 : Regulation flow chart of GM crops (www.geacindia.com).

Farmers : Farmers are the most important stakeholders whose adoption affects the success of GM crops. The lack of knowledge about new technologies causes a major barrier to their acceptance (Cardello *et al.,* 2007). The extension personnel initially had to provide awareness about the GM crops and then explain to them the scope and importance of GM crops in providing food security and increasing the income of farmers. Then training about how to cultivate GM crops should be provided, Motivating farmers to adopt GM crops by explaining the results of field trials, lack of financial sources is considered as one of the main reasons why the small and marginal farmers have not adopted the technology so financial support and subsidies to a farmer for growing GM crops.

Service providers : Any improved technology without proper marketing is a loss. So the people in the middle of farmers and consumers should also be provided training about knowledge and preference of GM crops by farmers and consumers, explaining the different marketing channels for distribution of the products, and conducting exhibitions to provide the latest information about GM crops. It is also important to provide knowledge about the importance and value of GM crops in other countries so that the middlemen can export the products and gain profit.

Consumer : These are the second main stakeholders who are important in the success of an innovation, a technology after successful production and when there is no demand for the product then it is waste, so the consumers should also be provided knowledge about GM crops. The biggest concern of consumers is risk. Public perception and acceptance are dependent on trust and whether the products or processes benefit them as citizens and consumers. The extension personnel should hold meetings and educate the importance and advantages of GM crops and explain the regulatory process followed by the government to assure the safety of GM crops for consumption purposes. The extension personnel should gain trust and help them overcome their prejudice.

Conclusions

The utilization of genetically modified organisms is significant to fulfill expanding needs and further develop existing circumstances common in our current circumstances. We are at a restless crossroads where, on one hand, we are confronted with remarkable dangers to human wellbeing and climate, while then again we have chances to change the status quo done. Guidelines concerning the utilization of GMOs need a more extensive reason for the choice. By considering the facts about GM crops as solutions to problems and believing in safety, the adoption and introduction of transgenic crops should be increased in India. Endeavors should be advanced for appropriate preparation of farmers about GM innovation

for legitimate reception and increment of income and food handling.

References

1. Qaim, M., and Zilberman, D. (2003). Yield effects of genetically modified crops in developing countries. *Science*, *299* (5608), 900-902.
2. Cardello, A. V., Schutz, H.G., and Lesher, L.L. (2007). Consumer perceptions of foods processed by innovative and emerging technologies: A conjoint analytic study. *Innovative Food Science & Emerging Technologies,* 8(1), 73-83.
3. Qaim, M., Subramanian, A., & Sadashivappa, P. (2009). Commercialized GM crops and yield. *Nature Biotechnology*, *27*(9), 803-804.
4. Azadi, H., & Ho, P. (2010). Genetically modified and organic crops in developing countries: A review of options for food security. *Biotechnology advances*, *28*(1), 160-168.
5. Babu, S.C., Glendenning, C.J., Okyere, K.A., & Govindarajan, S.K. (2012). *Farmers' information needs and search behaviors* : Case study in Tamil Nadu, India (No. 1007-2016-79468).
6. McHughen, A. (2013). GM crops and foods: what do consumers want to know? *GM Crops & Food*, *4*(3), 172-182.
7. Qaim, M., & Kouser, S. (2013). Genetically modified crops and food security. *PloS one*, *8*(6), e64879.
8. Klümper, W., & Qaim, M. (2014). A meta-analysis of the impacts of genetically modified crops. *PloS one*, *9*(11), e111629.
9. Lamichhane, S.A. Genetically Modified Foods-Solution for Food Security. Int. J. Genet. Eng. Biotechnol. 2014, 5, 43–48.
10. Tyczewska, A., WoŸniak, E., Gracz, J., Kuczyñski, J., & Twardowski, T. (2018). Towards food security: current state and future prospects of agrobiotechnology. *Trends in biotechnology*, *36*(12), 1219-1229.
11. Ahmed, A. U., Hoddinott, J. F., Islam, K. M. S., Khan, A. S. M. M. R., Abedin, N., Hossain, N. Z., ... & Zubaid, S. (2019). Impacts of Bt brinjal (Eggplant) technology in Bangladesh. Project Report prepared for the US Agency for International Development (USAID).

www.fao.org
www.isaaa.org
https://pib.gov.in
https://www.statista.com/
https://www.ncbi.nlm.nih.gov

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 866-869 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Interaction Effect of Plant Geometry and Cultivars on Physiology, Yield and Quality Parameters of Turmeric (*Curcuma longa L.*)

Vaqar Malik[1*], I.S. Naruka[1], Dhanesh Kumar Raidas[2] and O.P. Dhurve[3]

[1]*Dept. of Plantation, Spices, Medicinal and Aromatic Crop, RVSKVV-KNK College of Horticulture, Mandsaur 458001 (M.P.)*

[3]*Department of Plant Physiology, RVSKVV-RAK College of Agriculture, Sehore-466001 (M.P.)*

[3]*Department of Plant Physiology, College of Agriculture, Ganjbasoda (Vidisha), 464221 (M.P.)*

**Corresponding Author Email : vaqarmalik99777@gmail.com*

Abstract

The investigation carried out during Kharif + Rabi season of 2019-20 at the RVSKVV-Herbal Garden, College of Horticulture, Mandsaur (M.P.). The experimental material comprised of nine treatment combinations of three plant spacing and three cultivars of turmeric. These treatments were sown in Factorial Randomized Block Design with four replications, to observed growth, physiological, yield and quality parameters. Physiological, yield and quality parameters were evaluated as per standard procedure. The finding will help to a great extent in combine effect of planting geometry and cultivars, the treatment combination of S_3V_2 (45×30cm + Sonali) were observed significantly superior and recorded maximum physiological parameters viz. Leaf area index (1.204), crop growth rate (0.303mg cm^{-2} day^{-1}), relative growth rate (0.308mg g^{-1} day^{-1}), leaf area duration (40648.50 cm^2 day^{-1}) and chlorophyll content in leaves (28.50 SPAD value) with yield parameters viz., number of mother's rhizomes, primary and secondary rhizomes $plant^{-1}$, and fresh yield $plant^{-1}$. However, fresh rhizomes yield (258.40 q ha^{-1}) were gave maximum in S_1V_1 (45×20cm + Sonali), and quality parameters such as, essential oil content and curcumin content (4.30% and 6.00%) was maximum in S_3V_2 (45 × 30 cm + Sonali).

Key words : *chlorophyll content, leaf area index, crop growth rate, fresh rhizomes yield, oil content, curcumin content.*

Introduction

Turmeric (*Curcuma longa* L.) belongs to family Zingiberaceae. It is known as "Indian saffron" and widely known as Golden spice of life. Turmeric is a native of South East Asia. It is a rhizomatous perennial herb grown as an annual plant. The average height of turmeric ranges from 60-90 cm. The leaves are born in a tuft, broadly lanceolate, acuminate with long leaf stalks. The inflorescence is a cylindrical spike, 10-55 cm long, 5-7 cm wide and terminal on the leafy shoot. Turmeric is grown in both tropical and subtropical regions, have a preference for a warm and humid climate with temperature ranges from 20°C to 35°C. It is a great healer of wounds owing anti-inflammatory, anti tumor and anti-fungal properties. Further, due to its anti-bacterial and antiseptic properties, it is an excellent for treating skin diseases like acne, eczema, skin cancers etc. The rhizomes contain curcuminoids, curcumin and dihydrocurcumin which are found to be natural anti-oxidants. Planting patterns can play significant role in enhancing the overall productivity of crop, it is very essential to look after the factors which are influencing the growth, yield and quality parameters. Among the different factors affecting growth, physiology, yield and quality of turmeric, spacing and selection of cultivars appear to be the most important factors. Optimum spacing between plants enables better utilization of soil moisture, nutrient, solar radiation and all the available growth factors which ultimately affect nutrients uptake, growth and yield of plants. With an increase in spacing, the total population of plant per hectare decreases but in this condition the nutrition uptake increases which makes the individual plant grow better and yield more and vice-versa. Therefore, the increase and decrease in plant population as a result of a change in plant spacing both ways has a definite pattern in relation to the yield. By adopting improved cultivars with maintaining the proper plant to plant and row to row spacing, a potential yield can be achieved (Bhadouria *et al.*, 2014). The performance of any cultivar is largely depends upon its genetical make up. The performance of the cultivar also depends upon climatic conditions of the region where it is grown. As a result, cultivars which perform well in one region may not perform well in other regions of varying climatic conditions. Hence, it is necessary to collect and evaluate the available cultivars for its suitability in the particular geographical conditions (Salimath *et al.,* 2014)

Materials and Methods

Experimental site : The experiment was laid out at the field of Herbal Garden, Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mandsaur (M.P.) during the year 2019-20. Mandsaur is situated in Malwa plateau in western part of Madhya Pradesh at north latitude of 23.45° to 24.13°and 74.44° to 75.18° east longitude and at an altitude of 435.02 meters

Table-1 : Interaction effect of plant geometry and cultivars on physiological parameters of Turmeric.

Treatments	Physiological parameters				
	LAI	CGR (mg cm^{-2} day^{-1})	RGR (mg g^{-1} day^{-1})	LAD (cm^2 day^{-1})	Chlorophyll Content (SPAD)
	150 DAP-at harvest	150 DAP-at harvest	150 DAP-at harvest	150 DAP-at harvest	At 90 DAP
S_1V_1	0.995	0.033	0.222	33590.25	26.86
S_1V_2	1.037	0.073	0.259	35003.25	27.43
S_1V_3	1.023	0.278	0.304	34531.80	27.40
S_2V_1	1.069	0.220	0.296	36092.25	27.83
S_2V_2	1.121	0.043	0.237	37829.40	28.09
S_2V_3	1.099	0.044	0.252	37099.80	27.95
S_3V_1	1.133	0.063	0.308	38232.75	28.42
S_3V_2	1.204	0.303	0.308	40648.50	28.50
S_3V_3	1.167	0.038	0.230	39400.35	28.48
S.Em ±	0.015	0.020	0.012	493.46	0.07
C D at 5%	NS	0.058	0.036	NS	0.20

Table-2 : Interaction effect of plant geometry and cultivars on yield and quality parameters of Turmeric.

Treatments	Yield parameters					Quality parameters	
	No. of mother rhizomes $plant^{-1}$	No. of primary rhizomes $plant^{-1}$	No. of secondary rhizomes $plant^{-1}$	Fresh rhizomes yield $plant^{-1}$ (g)	Fresh rhizomes yield (q ha^{-1})	Essential oil content (%)	Curcumin content (%)
S_1V_1	2.05	6.85	11.05	264.22	208.56	4.05	4.20
S_1V_2	2.30	8.00	12.00	283.42	258.40	4.20	4.90
S_1V_3	2.15	7.15	11.63	270.96	252.62	3.90	4.10
S_2V_1	2.20	7.30	12.35	286.29	200.55	4.05	5.30
S_2V_2	2.35	9.20	15.50	290.80	244.22	4.10	5.50
S_2V_3	2.30	8.05	13.40	289.31	235.93	3.70	4.40
S_3V_1	2.35	8.25	14.35	296.36	193.38	4.15	5.67
S_3V_2	2.40	9.30	16.55	328.36	226.21	4.30	6.00
S_3V_3	2.35	9.25	16.13	310.12	220.29	3.95	4.80
S.Em ±	0.02	0.12	0.24	2.47	1.69	0.07	0.10
CD at 5%	0.06	0.36	0.72	7.26	4.98	NS	0.30

above mean sea level. This region falls under agro-climatic zones no. 10 of the state.

Applied design and treatments : The experiment was laid out in Factorial Randomized Block Design with four replications. The experimental combine effect material consisting of nine configurations of cultivars (V_1 Suroma), (V_2 Sonali) and (V_3 Ranga-3) with Spacing (S_1 45 × 20 cm), (S_2 45 × 25) cm and (S_3 45 × 30 cm). The half dose of nitrogen and the full dose of potassium and phosphorus were added as basal dressing, while the remaining half dose of nitrogen was applied as top dressing at 30 and 60 days after sowing, at two equivalent splits doses.

Plant sampling and statistical analysis : Ten plants were randomly picked from each plot in the net plot and tagged for data collection and calculation and further used to calculate leaf area, leaf area index, crop growth rate, relative growth rate and leaf area duration at an interval of 30 days starting from 60 days after sowing to harvest. The chlorophyll content will be determined by using Minolata SPAD 502 plus Chlorophyll. The fresh rhizome yield was determined using electronic balance from the complete (mother, primary and secondary) rhizome weight of the sampled plants and was expressed in (q ha^{-1}). The essential oil content was estimated as per the methods suggested by ASTA (Anonymous, 1968) and curcumin content (%) determined by HPTLC method. Finally mean data of the all characters were computed for statistical analysis as per standard procedure given by (Panse and Sukhtme 1989).

Results and Discussion

Interaction effect of plant geometry and cultivars on physiological parameters : The interaction effect of plant geometry and cultivars on physiological parameters viz. crop growth rate, relative growth rate at 150 DAP- at harvest, and chlorophyll content (SPAD value) at 90DAT had significant effect. Except leaf area index and leaf area duration at 150DAP-at harvest were non significantly affect. The data presented in (Table-1, Fig.-1 and plate-1). The maximum leaf area index and crop growth rate (1.204 and 0.303mg cm^{-2} day^{-1}) of plant was recorded under

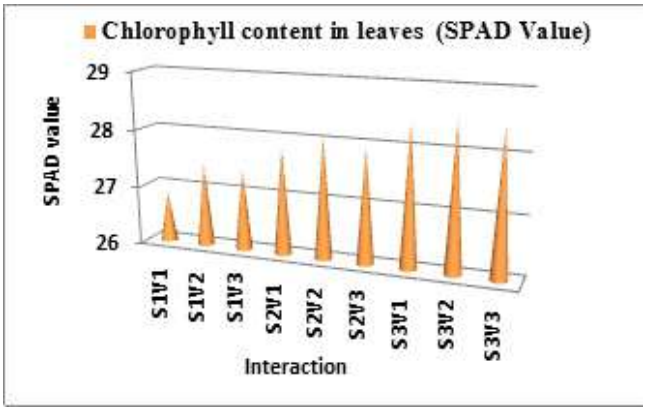


Fig.-1 : Interaction effect of plant geometry and cultivars on chlorophyll content

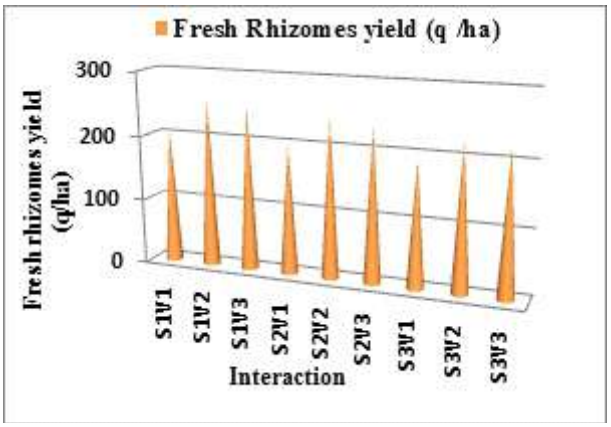


Fig.-2 Interaction effect of plant geometry and cultivars on fresh rhizomes yield (q/ha).

Plate–(a) Comparative performance of chlorophyll content of Turmeric between S_2V_1, S_3V_2 and S_1V_2.

Plate–(b) Comparative performance of chlorophyll Turmeric rhizomes between S_2V_1, S_3V_2 and S_1V_2.

treatment combination S_3V_2 (45x30cm + Sonali) followed by treatment combination of S_3 V_3 (45x30 cm + Ranga-3) and S_3V_1 (45x30cm + Suroma)). While the minimum leaf area index and crop growth rate (0.995 and 0.033 mg cm^{-2} day^{-1}) of plant at 150 DAP- at harvest, was recorded in treatment combination of S_1V_1 (45x20cm + Suroma) respectively. The maximum relative growth rate and leaf area duration of plant (0.308mg g^{-1} day^{-1} and 40648.50 cm^2 day^{-1}) at 150DAP-at harvest, respectively was recorded under treatment combination S_3V_2 (45x30cm + Sonali) followed by S_3V_3 (45x30cm + Ranga-3) (0.230 mg g^{-1} day^{-1} and 39400.35 cm^2 day^{-1}) at 150 DAP-at harvest, While, the minimum relative growth rate and leaf area duration of plant (0.222 mg g^{-1} day^{-1} and 33590.25 cm^2 day^{-1}) at 150 DAP-at harvest, respectively was recorded in the treatment combination of S_1V_1 (45x20cm + Suroma). The maximum chlorophyll content in leaves (28.50 SPAD value) was recorded under treatment combination S_3V_2 (45x30cm + Sonali) followed by (28.48 SPAD value) under S_3V_3 (45 x 30 cm + Ranga-3).While, the minimum chlorophyll content (26.86 SPAD value) in leaves was recorded under treatment combination S_1V_1 (45x20cm + Suroma). These significant variations may be attributed to vigorous vegetative growth under wider spacing, which resulted from favourable climatic condition including sun light, proper aeration, and proper nutritional environment in root zone as well as in the plant system and its might be due varietal behaviour in a particular climatic condition. The above findings are in close conformity with the findings of Rashid *et al.* (1996), Kandiannan and Chandaragiri (2008), Mohamed *et al.* (2014), Nautiyal *et al.* (2016), Datta *et al.* (2017) and Preetham *et al.* (2018) in turmeric.

Interaction effect of plant geometry and cultivars on yield and quality parameters : Interaction effect of plant geometry and cultivars on yield and quality parameters presented in (Table-2, Fig.-2 and Plate-1). In yield parameter, the combined effect showed significant variations number of rhizomes/plant (Mother, primary, and

secondary) and fresh rhizomes yield plant^{-1} (g) were recorded maximum under S_3V_2 (45x30 cm + Sonali) as compare to other treatment combinations. Significantly higher fresh rhizomes yield (258.40 q ha^{-1}) was recorded under the treatment combination of S_1V_2 (45x20cm + Sonali). These results are in close conformity with the findings of Rashid *et al*. (1996), Kandiannan and Chandaragiri (2008), Mohamed *et al.* (2014), Nautiyal *et al.* (2016), Temteme *et al.* (2017), Preetham *et al*. (2018) and Tiwari *et al*. (2019). In Case of quality parameter the combined effect was non significantly influence the essential oil content (%) except curcumin content (%) in rhizomes. The maximum value for essential oil and curcumin content (4.30 and 6.00) was observed under S_3V_2 (45x30cm + Sonali) as compare to other treatment combinations. Increased accumulation of nutrients especially in vegetative plant parts possibly with improved metabolism led to greater translocation of these nutrients to reproductive organs (Rhizomes) of the crop and due to the differences in their genotypic potential with respect to polygenic traits and adaptability to soil and climate. These findings corroborates with the finding of Deshmukh *et al*. (2005), Kumar and Gill (2010), Mohamed *et al.* (2014), Nautiyal *et al.* (2016), Datta *et al.* (2017) and Temteme *et al.* (2017) in turmeric.

Conclusions

On the basis of one year research it could be concluded that different plant geometry levels and cultivars significantly influenced the growth, physiology, yield and quality parameters of turmeric. The growth, physiology, yield and quality parameters of turmeric can be increased by S_3V_2 (45x30cm + Sonali). However, yield potential can be increased by S_1V_2 (45 x 20 cm + Sonali).

Acknowledgement

We are thankful to the Department of Plantation, Spices, Medicinal and Aromatic Crop, RVSKVV- KNK College of Horticulture, Mandsaur (M.P.) for providing lab facilities for the analysis and with thanks for the research farm of Herbal Garden, KNK College of Horticulture, Mandsaur (M.P.) for conduct of experiments. I sincerely thanks to my advisory members and other scientist for their valuable time for data analysis.

References

1. Anonymous (1968). Official Analytical Methods.2nd Edn. American spice Trade Association, 38: 9-10.
2. Bhadouria, R.S.; Singh, T.K. and Haldar, A. (2014). Effect of interaction on various planting methods and spacing on growth and yield of turmeric (*Curcuma longa* L.). *Plant Archives,* 14(2): 1047-1049.
3. Datta, N.; Ghosh, D.K. and Sarkar, T. (2017). Effect of different seed rate and spacing on yield and economics of ginger. *International Journal of Current Microbiology and Applied Sciences*, 6(9): 1120-1125.
4. Deshmukh, N.A.; Gondane, S.U.; Kadu, R.B.; Chopde, N.K. and Shembekar, R.Z. (2005). Effect of planting material and varieties on growth, yield and quality of turmeric. *Journal of Soils and Crops*, 15(2): 428-432.
5. Kandiannan, K. and Chandaragiri, K.K. (2008). Monetary and non-monetary inputs on turmeric growth, nutrient uptake, yield and economics under irrigated condition. *Indian Journal of Horticulture Sciences*, 65(2): 209-213.
6. Kumar, B. and Gill, B.S. (2010). Growth, yield and quality of turmeric (*Curcuma longa* L.) as influenced by planting method, plant density and planting material. *Journal of Spices and Aromatic Crops*, 19(1-2): 42-49
7. Mohamed, A.K.; Mahfouz, S.A. and Yosff, A. (2014). Effect of spacing and variety on the growth, yield and chemical constituents of turmeric plants. *International Journal of Medicinal and Aromatic Plants*, 4(1): 34-40
8. Nautiyal, N.; Tiwari, D.; Upadhyay, S. and Chauhan, R.S. (2016). Effect of nitrogen levels and plant spacing on growth and yield of turmeric. *International Journal of Applied and Pure Science Agriculture*, 2(10): 184-192.
9. Panse, V.G. and Sukhatme, P.V. (1989). Statistical methods for agricultural workers. Indian Council of Agriculture Research, New Delhi-108.
10. Preetham.; Ashwini.; Pavan and Kondle, R. (2018). Evaluation of turmeric variety Salem with different rhizome types and population levels on raised beds. *International Journal of Current Microbiology and Applied Sciences*, 7(4): 3202-3211.
11. Rashid, A.; Islam, M.S.; Paul, T.K. and Islam, M.M. (1996). Productivity and profitability of turmeric varieties as influenced by planting materials and spacing. *Annals of Bangladesh Agriculture*, 6(2): 77-82.
12. Salimath, S.; Venkatesha, J.; Kulkarni, S.; and Shetty, G.R. (2014). Evaluation of turmeric (*Curcuma longa* L.) cultivars for growth and yield in southern dry zone of Karnataka. *Advance Research Journal of Crop Improvement*, 5(2): 162-165.
13. Temteme, S.; Getachew, E.; Mekonnen, B. and Shimber, T. (2017). Influence of type of planting material, plant density and method of planting on the yield and quality of turmeric (*Curcuma domestica* L.) at Tepi Southwestern Ethiopia. *Advance in Crop Sciences Technology*, 5(5): 305.
14. Tiwari, S.; Pandey, R.; Shukla, M. and Namdeo, K. N. (2019). Influence of size of seed-rhizome and plant spacing on growth, yield and quality of ginger. *Annals of Plant and Soil Research*, 21(2): 158-162.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 870-877 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Measuring Price Forecasting for Market Information System in the Mustard Crop in Mahendergarh District of Haryana

Veer Sain[1]*, Gulab Singh[2] and Manoj Sharma[3]

[1]*College of Agriculture, CCSHAU Hisar, Haryana*

[2]*Krishi Vigyan Kendra, Bhiwani, Haryana*

[3]*Department of Statistics, Mathematics and Computer Science, S.K.N. College of Agriculture, SKNAU, Jobner, Rajasthan*

Abstract

The present study was conducted in four regulated markets of Mahendergarh district of Haryana (Mahendergarh, Ateli, Kanina and Narnaul) based on maximum production for the mustard crop. The data for average prices were analyzed by ARIMA model from 2005 to 2016. The results of the study revealed that ARIMA (0,1,1) and ARIMA (1,1,2) model have been selected on the basis of Root mean square error (RMSE), Mean absolute error (MAE), Mean absolute percentage error (MAPE) and Adjusted R2.The results showed that the average prices forecast for 2017 to be about 5209 per quintal with upper and lower limit 5556 to 5209 per quintal in the Mahendergarh market, 5137 per quintal with upper and lower limit 5268 to 5137 per quintal in Ateli market, 5263 per quintal with upper and lower limit 5632 to 5263 per quintal in Kanina market and 4798 per quintal with upper and lower limit 5654 to 5206 per quintal in the Narnaulmarket, respectively.

Key words : *Mustard, ARIMA, A.C.F., PACF, Mahendergarh*

Introduction

Market information is critical to the economic and social activities that comprise the development process. Developing economy has witnessed of boom agricultural (green, white, yellow, blue and now rainbow), industrial and information technology revolutions. Good communication system and information technical system reinforce commitments to sustainable productivity. The Government of India has given more thrust on food, information technology sectors and agriculture towards achievement of economic reforms for achieving high growth rate in production (Dhankar, 2003). Agricultural Marketing is the system of processing, distributing, promoting and selling goods, services and ideas to make an easy, satisfying relationship with customers in a lively environment (Pride and Ferrell, 2003). Marketing deals with customers in addition to any other business function, where building customer relationship based on customer worth and agreement is the heart of modern marketing (Armstrongand Kotler, 2010). Financial achievement depends on marketing ability, financial operations, accounting, and additional functions will not really matter if there is no requirement for the company's products and services. Moreover, the market competition is rising day by day in the fast-growing global marketing, where marketing is affected by internal and external surrounding activities. Marketing Information System is an interacting with people, equipment and procedures to arrange, analyze, evaluate, distribute, timely and right information for use by proper marketing decision-makers to improve their design, implementation, and control (Kotler and Keller, 2012). The weekly wholesale maize price data for the period April, 2010 to March, 2014 from five markets in India, this study examined the extent of market integration. The overall results of the integration analysis in India, indicated that, although, the five markets in India were co-integrated-meaning that they had a stable long run relationship. These markets were also unified in the short run. The results from trace statistics show that there were four co-integrating vectors and four common trends, which suggested that maize markets were stationary in four directions and non-stationary in four directions. Granger-causality results indicated that Hoshiarpur market price had depicted auni-directional causality on the prices of SBS Nagar. SBS Nagar market price had shown a uni-directional influence on the price of shown a bi-directional influence on the price of Ahmednagar. Vijayanagaram market price has Bengaluru. Bengaluru market price had shownuni-directional influence on the price of Ahmednagar. Ahmednagar market price had shown abi-directional influence on the price of Bengaluru. The short-run results indicated that these maize markets were not well integrated while long-run integration was evident, suggesting that the markets did eventually move together in the long term. The speed of adjustment appeared to be the inverse of distance and directly related with ease of transport. The policy implications of these resulted that structural rigidity resulting from poor infrastructure and insufficient transportation networks hampered the easy flow of information between markets and therefore, the integration of markets in the short run. Thus, in order for maize surplus regional markets to be better integrated with deficit regions, the government

Table-1 : Model statistics of different markets in Mahendergarh district of Haryana.

Mahendergarh market					Ljung Box(18)	
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**Df**	**Sig.**
Model (0,1,1) (1,1,2)	131.417	3.101	9.906	11.099	15	0.746
Ateli market					**Ljung Box(18)**	
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**Df**	**Sig.**
Model (0,1,1) (1,1,2)	143.210	3.169	10.115	24.854	15	0.035
Kanina market					**Ljung Box(18)**	
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**Df**	**Sig.**
Model (0,1,1) (1,1,2)	158.406	3.555	10.279	20.407	15	0.157
Narnaul market					**Ljung Box(18)**	
Model	**RMSE**	**MAPE**	**N-BIC**	**Statisitcs**	**Df**	**Sig.**
Model (0,1,1) (1,1,2)	127.274	2.783	9.842	18.941	15	0.216

Table-2 : Model parameters of different markets in Mahendergarh district of Haryana.

Mahendergarh market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**P**
Model	MA1	0.174	0.088	1.989	0.049
(0,1,1)	SAR1	-0.860	0.095	-9.052	0.000
(1,1,2)	SMA2	0.629	0.153	4.098	0.000
Ateli market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**P**
Model	MA1	0.990	2.137	.463	0.66
(0,1,1)	SAR1	-0.984	0.96	-10.242	0.00
(1,1,2)	SMA2	-0.903	0.104	-8.639	0.00
Kanina market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**P**
Model	MA1	0.125	0.088	1.410	0.161
(0,1,1)	SAR1	-0.795	0.099	-8.021	0.000
(1,1,2)	SMA2	0.622	0.155	4.007	0.000
Narnaul market					
Model	**Parameters**	**Estimated Parameters**	**Asymptotic S.E.**	**Asymptotic t-value**	**P**
Model	MA1	0.143	0.088	1.615	0.109
(0,1,1)	SAR1	-0.883	0.132	-6.671	0.000
(1,1,2)	SMA2	0.770	0.235	3.280	0.001

should invest in better transportation and infrastructure facilities. Kumar *et al.* (2017) discussed modelling and forecasting of soybean yield in India using ARIMA analysis. Kumar et al. (2019) developed a model to forecast the yield of wheat in Haryana by using annual time series data from 1980-81 to 2009-10. They applied different methods as a random walk, random walk with drift, linear trend, moving average, simple exponential smoothing, and ARIMA models and compared each other to find out the best model to forecast the yield. Mallick and Mishra (2019) developed univariate ARIMA models to forecast interest rates of different maturities and stress points. They found that ARIMA (2, 1, 1) forecasting model of interest rates produced a better forecast, both in the case of in-sample and out-of-sample performances. Kumar and Verma (2020) conducted a study to find out mustard yield forecast models for Bhiwani and Hisar districts of Haryana using autoregressive integrated moving average (ARIMA) technique. They found that ARIMA (0, 1, 1) and ARIMA (1, 1, 0) model is suitable for Bhiwani and Hisar districts respectively. Bhardwaj *et al.* (2015) studied the forecast price of mustard seeds. The two forms of methodological approaches, such as Univariate and multivariate techniques, were adopted for analysis. In the case of the univariate approach, ARIMA and GARCH methods were applied, whereas for multivariate vector Auto-Regressive (V.A.R.) model was used. The commodity-wise forecast results followed, for forecasting mustard price was ARIMA (0,1,1). This model gave reasonable and acceptable forecasts; it did not perform well when the volatile data series. In this study, the GARCH model was also attempted to forecast price but was not found suitable because there was no persistent volatility in the data series. In Vector Autoregressive (V.A.R.) model, lagged quantity arrival and lagged prices in the market influenced the forecasts of mustard prices to some extent. In forecasting, mustard diagnostic measures of model selection revealed that

Table-3 : Autocorrelation and partial autocorrelation functions of average monthly price in Mahendergarh market of Mahendergarh district.

Lag	Autocorrelations					Partial Autocorrelations		
	Auto-correlation	Std. errora	Box-Ljung statistic			Lag	Partial autocorrelation	Std. Error
			Value	Df	Sig.b			
1	.955	.082	134.177	1	.000	1	.955	.083
2	.912	.082	257.430	2	.000	2	-.003	.083
3	.876	.082	371.770	3	.000	3	.049	.083
4	.840	.082	477.731	4	.000	4	-.005	.083
5	.801	.081	574.808	5	.000	5	-.050	.083
6	.762	.081	663.212	6	.000	6	-.027	.083
7	.735	.081	746.019	7	.000	7	.114	.083
8	.702	.080	822.283	8	.000	8	-.071	.083
9	.672	.080	892.677	9	.000	9	.023	.083
10	.645	.080	958.046	10	.000	10	.017	.083
11	.625	.080	1019.770	11	.000	11	.052	.083
12	.606	.079	1078.209	12	.000	12	.011	.083
13	.592	.079	1134.439	13	.000	13	.078	.083
14	.574	.079	1187.670	14	.000	14	-.074	.083
15	.557	.078	1238.154	15	.000	15	.018	.083
16	.542	.078	1286.425	16	.000	16	.018	.083

a. The underlying process assumed is independence (white noise).

b. Based on the asymptotic chi-square approximation.

Table-4 : Autocorrelation and partial autocorrelation functions of average monthly price in Ateli market of Mahendergarh district.

Lag	Autocorrelations					Partial Autocorrelations		
	Autocorrelation	Std. errora	Box-Ljung statistic			Lag	Partial autocorrelation	Std. error
			Value	Df	Sig.b			
1	.955	.082	134.126	1	.000	1	.955	.083
2	.912	.082	257.298	2	.000	2	-.002	.083
3	.874	.082	371.102	3	.000	3	.030	.083
4	.837	.082	476.370	4	.000	4	.005	.083
5	.800	.081	573.193	5	.000	5	-.025	.083
6	.765	.081	662.349	6	.000	6	.005	.083
7	.739	.081	746.234	7	.000	7	.089	.083
8	.707	.080	823.558	8	.000	8	-.083	.083
9	.677	.080	894.994	9	.000	9	.015	.083
10	.651	.080	961.462	10	.000	10	.022	.083
11	.631	.080	1024.421	11	.000	11	.060	.083
12	.610	.079	1083.729	12	.000	12	-.013	.083
13	.598	.079	1141.055	13	.000	13	.100	.083
14	.585	.079	1196.456	14	.000	14	-.015	.083
15	.566	.078	1248.690	15	.000	15	-.067	.083
16	.544	.078	1297.240	16	.000	16	-.040	.083

a. The underlying process assumed is independence (white noise).

b. Based on the asymptotic chi-square approximation.

from information criteria point New ARIMA model was most suitable over R.C.H. and V.A.R. models. However, AR was the most suitable forecast model for the mustard crop from absolute accuracy in forecast performance measures. In this case, we can again include that the V.A.R. model was considered to be superior to ARIMA/GARCH models. The specific objective of the study was to estimate the price forecasts and long term relationships in prices among domestic markets.

Materials and Methods

The periodic data on average price data for the period from 2005 to 2016 were used to forecast future values using ARIMA models. The ARIMA methodology is also known as Box Jenkins methodology. The Box-Jenkins

Table-5 : Autocorrelation and partial autocorrelation functions of average monthly price in Kanina market of Mahendergarh district.

Autocorrelations						Partial Autocorrelations		
Lag	Autocorrelation	Std. errora	Box-Ljung statistic			Lag	Partial autocorrelation	Std. error
			Value	df	Sig.b			
1	.953	.082	133.386	1	.000	1	.953	.083
2	.906	.082	254.933	2	.000	2	-.013	.083
3	.865	.082	366.589	3	.000	3	.038	.083
4	.826	.082	469.131	4	.000	4	-.002	.083
5	.786	.081	562.485	5	.000	5	-.036	.083
6	.746	.081	647.204	6	.000	6	-.012	.083
7	.716	.081	725.786	7	.000	7	.082	.083
8	.686	.080	798.631	8	.000	8	-.005	.083
9	.654	.080	865.285	9	.000	9	-.039	.083
10	.625	.080	926.650	10	.000	10	.022	.083
11	.606	.080	984.640	11	.000	11	.077	.083
12	.583	.079	1038.837	12	.000	12	-.036	.083
13	.565	.079	1090.122	13	.000	13	.054	.083
14	.544	.079	1137.958	14	.000	14	-.047	.083
15	.531	.078	1183.941	15	.000	15	.080	.083
16	.523	.078	1228.930	16	.000	16	.052	.083

a. The underlying process assumed is independence (white noise).

b. Based on the asymptotic chi-square approximation.

Table-6 : Autocorrelation and partial autocorrelation functions of average monthly price in Narnaul market of Mahendergarh district.

Autocorrelations						Partial Autocorrelations		
Lag	Autocorrelation	Std. errora	Box-Ljung statistic			Lag	Partial autocorrelation	Std. error
			Value	df	Sig.b			
1	.957	.082	134.607	1	.000	1	.957	.083
2	.915	.082	258.584	2	.000	2	-.006	.083
3	.877	.082	373.286	3	.000	3	.023	.083
4	.841	.082	479.613	4	.000	4	.009	.083
5	.804	.081	577.332	5	.000	5	-.041	.083
6	.767	.081	666.907	6	.000	6	-.011	.083
7	.740	.081	751.001	7	.000	7	.102	.083
8	.708	.080	828.536	8	.000	8	-.079	.083
9	.678	.080	900.104	9	.000	9	.012	.083
10	.651	.080	966.634	10	.000	10	.027	.083
11	.631	.080	1029.509	11	.000	11	.052	.083
12	.611	.079	1088.885	12	.000	12	.002	.083
13	.597	.079	1146.113	13	.000	13	.089	.083
14	.582	.079	1200.834	14	.000	14	-.045	.083
15	.564	.078	1252.618	15	.000	15	-.026	.083
16	.545	.078	1301.470	16	.000	16	-.006	.083

a. The underlying process assumed is independence (white noise).

b. Based on the asymptotic chi-square approximation.

procedure is concerned with fitting a mixed Auto-Regressive Integrated Moving Average (ARIMA) model to a given data set. The main objective in fitting this ARIMA model is to identify the stochastic process of the time series and accurately expect future values. These techniques have also been helpful in several types of situations involving structure models for discrete-time series and dynamic systems. Although, this method was unsuitable for lead times or seasonal series with a large random component (Granger and Newbold, 1970). Previously ARIMA models have been studied concisely by George Box and Gwilym Jenkins during 1968, and their names have frequently been used synonymously with the general ARIMA process applied to time series analysis, forecasting and control. However, the optimal forecast of future values of a time series is determined by the

Table-7 : Forecasting of average monthly price of mustard crop in different markets of Mahendergarh district.

Month	Mahendergarh	Ateli	Kanina	Narnaul
January	5154	5093	5140	5149
February	5174	5115	5165	5180
March	5209	5137	5263	5206
April	5202	5159	5233	5307
May	5179	5181	5209	5308
June	5381	5203	5323	5430
July	5475	5224	5598	5563
August	5471	5246	5582	5582
September	5556	5268	5632	5654
October	5638	5290	5704	5689
November	5743	5312	5827	5782
December	5694	5333	5796	5770

Table-8 : Co-integration between selected markets for mustard selected agricultural commodities in Haryana.

Name of district	Name of Market	Dickey-Fuller test	Dickey-Fuller value	Order of integration
Mahendergarh	Mahendergarh	-1.791	-0.836	0
	Ateli	-1.039	-0.836	0
	Kanina	-1.904	-0.836	0
	Narnaul	-1.235	-0.836	0

stochastic model for that series. A stochastic process is either stationary or non-stationary. The first thing to note is that utmost time series are non-stationary, and the ARIMA model refers only to a stationary time series. Since the ARIMA models relate only to a stationary time series, the first stage of the Box-Jenkins model is reducing non-stationary series to stationary series by taking first-order differences. The main phases in setting up a Box-Jenkins predicting model are as follows :

Step 1 : Identification : The applicable value of p, d, q is found first. The techniques used for identification are the Autocorrelation Functions (A.C.F.) and Partial Autocorrelation Functions (PACF).

The ARIMA process has the algebraic form :

$$Y_t=C+?_tY_{t-1}+?_2Y_{t-2}+\ldots+?_pY_{t-p}-{}_1a_{t-1}-2a_{t-2}\ldots\ {}_qa_{t-q}+a_t$$

Where C is a constant term related to the mean of the process, it is called a mixed autoregressive moving average model of order (p, q). It contains both A.R. and M.A. terms.

The general functional forms of the ARIMA model used are :

(i) Moving Average model of order q; M.A. (q)

$$Y_t = C- {}^{1}_{i\ 1}\ {}_ia_{t\ i}\quad a_t$$

Where, a_t belongs to NID (0, ó2a)

(ii) Autoregressive model of order p; AR (p)

$$Y_t = C- {}^{p}_{j\ 1}Y_{t\ j}\quad a_t$$

(iii) Autoregressive Moving Average Model ARMA (p, q)

$$Y_t = C+ {}^{p}_{j\ 1}\ {}_jY_{t\ j}\quad {}^{q}_{i\ 1}\ {}_{ia}t\quad 1\quad a_t$$

(iv) Autoregressive Integrated Moving Average Model ARIMA (p, d, q)

$$?_p\ (B)\ ?^dY_t = C+\ {}_q(B)\ a_t$$

(v) Seasonal ARIMA model ARIMA (p, d, q) $(P,D,Q)^s$

$$?_p\ (B)\ ?^*_p(B^s)\ ?^d?^{sD}Y_t= ?^*_Q(B^s)\ {}_q(B)\ a_t$$

Where,

Y_t= Variable under forecasting

B =Lag operator

a =Error term (Y_t-Y_t, where Y_t is the estimated value of Y_t)

t =time subscript

$?_p(B)$=Non-seasonal AR

$?^*_p(B^s)$=seasonal A.R. operator

$(1-B)^d$=Non-seasonal difference

$(1-B^s)^d$=seasonal difference

${}_q(B)$=Non-seasonal MA

$?^*_p(B^s)$=seasonal M.A. operator

s =order of season (4 in quarterly data, 12 in monthly data, etc.)

The above model contains p+q+P+Q parameters,

which need to be estimated. The model is non-linear in parameters.

Step 2 : Estimation : For estimating the parameters of the ARIMA model, the algorithm is as follows :

For p, d, q, P, D and Q each = 0 to 2

Execute SPSS ARIMA with the set parameters.

Record the parameters and corresponding fitting error until all possible combinations are tried. Select the parameters that produce the least fitting error. This algorithm tries all combinations of parameters, which are limited to an integer lying between zero and two. The combination with the least fitting error will be searched. The range limitations of the parameters are set to restrict the search to a reasonable scope. Parameters greater than two are rarely used in practices as per literature.

Step 3 : Diagnostic Checking : Having chosen a specific ARIMA model and having projected its parameters, the fitness of the model is verified. One simple test is to see if the residuals estimated from the model are white noise; if not, we must start with another ARIMA model. The residuals were analysed using Box-Ljung statics.

Step 4 : Forecasting : One of the reasons for the popularity of ARIMA modelling is its success in forecasting. In many cases, the forecasts obtained by this method are more reliable than those obtained from the traditional econometrics modelling, particularly for short–term forecasts. An Autoregressive Integrated Moving Average process model describes how a time series variable is related to its past value. Primarily an ARIMA model is used to produce the best weighted average forecasts for single time series (Rahulamin and Razzaque 2000). The accuracy of forecasts for both Ex-ante and Ex-post were using the following test (Markidakis and Hibbon, 1979) as Mean absolute percentage error (MAPE).

Results and Discussion

In this study, we used the data average prices for 2005 to 2016. As we have earlier stated, developing the ARIMA model for any variable involves identification, estimation, verification, and forecasting. Each of these four steps is now explained for mustard average prices.

Model Identification : The ARIMA model estimated only after transforming the variable under forecasting into a stationary series for forecasting mustard average price. The stationary series has value only around a constant mean and constant variance over time. In this difference of order, one was sufficient to achieve stationarity in mean, then newly constructed variable X_t could be examined for stationary. The graph of X_t was stationary in the mean. The next stages are to classify the values of p, d and q. For this, the autocorrelation and partial autocorrelation coefficients of various orders of $X_t$are computed. The model statistics showing goodness fit for Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), Normalized Bayesian Information Criterion (Normalized B.I.C.), Ljung-Box statistics are depicted in Table 1. The Box-Ljung statistics of the ARIMA model for cotton in Mahendergarh, Ateli, Kanina and Narnaul markets of Mahendergarh district are presented in Table 2 and show significant statistics. The model statistics are given in Table 1. The table shows that the seasonal ARIMA models in orders of (0, 1, 1) (1, 1, 3) were found satisfactory for the prices of the mustard crop.

Model Estimation and Verification : The prices model parameters for mustard average were estimated using the SPSS package. In Table 2, Results of estimation are reported. The model verification is concerned with checking the residual of the model to see if they contain any systematic pattern that can still be removed to improve the chosen ARIMA. It was done byexaming the autocorrelations and Partial autocorrelations of the residuals of various orders. The A.C.F. and PACF of residual also indicate a good model fit. The time series plot of the residual showed a scattered trend; therefore, models were appropriately fitted by residual analysis. In Table 2, the model parameters have been presented. The results show that there was no transformation accounted for the model fitting. It showed that none of the series was stationary and hada volatile trend. In Mahendergarh, Ateli, Kanina and Narnaul markets, the data set only first-order differentiation was found to be fit and seasonal A.R. (p) of Lag 1 and seasonal M.A. (q) of Lag 2 were fitted with the degree of differentiation. The tentative models were identified based on Autocorrelation (A.C.F.) and Partial Autocorrelation (PACF) at a fixed interval, showing signs for the price of the mustard crop in Mahendergarh district markets (table 3 to 6).

Forecasting with ARIMA Model : ARIMA models are established mainly to forecast the corresponding variable. An important measure of the sample period forecasts accuracy was computed to judge the forecasting ability of the fitted ARIMA model. The forecasting performance of the model was judged by computing Mean Absolute Percent Error (MAPE). The model with less MAPE was favored for predicting purposes. Forecasting was done through identified models for the variable prices of the mustard crop in selected district markets. Using the obtained model, the ex-post forecasted values, considering January 2005 to December 2016, were computed and presented in Table 7. It was observed that the forecasted price in Mahendergarh, Ateli, Kanina and

Narnaul markets moved in the same direction with observed values.

Price Forecasts for Mustard : The price forecasts in the main market of Mahendergarh district (Mahendergarh market) obtained for the year 2017 for arrival season in March to September were observed between `5556 to 5209, `5268 to 5137 in Ateli market, `5632 to 5263 in Kaninamarket and `5654 to 5206 per quintal in Narnaul market. While the forecasts for the remaining months (from October to Februrary) were in the range `5638 to 5174 in the Mahendergarh market, `5290 to 5115 in Ateli`5704 to 5165 in Kanina market and `5689 to 5180 per quintal in the Narnaul market. Therefore, it is advisable for the farmers to store their produce and sell in the months where they realize the better/higher price (table 7).

Co-integration between Selected Markets for Mustard : Co-integration is a statistical property obtained by given time series data set defined by the concepts of stationarity and the order of integration of the series. The stationary series is one with a mean value that will not change during the sampling period. For an illustration, the mean of a subset of a given series does not vary significantly from the mean of any other subset of the same series. Further, the series will regularly return to its mean value as variations occur. In other words, a non-stationary series will show a time-varying mean. The order of integration of a series is known by the digit of periods the series must be differenced in order to produce a stationary series. Co-integration analysis was carried out to study the long-run relationship of the average price of cotton for Mahendergarh districts in all four markets. The Dickey-Fuller test was used to study the order co-integration of prices midst different markets.

The perusal of Table 8 revealed that the dickey-fuller test 'tau' was found highly significant for all the Mahendergarh district markets of the mustard. That is clearly shown that there is a long relationship, and this shows that the price will remain constant over time.A similar observation was made by Kaur *et al*. (2016); Pant *et al*. (2015).

Conclusions

In our study, the developed model for average prices for mustard in the selected markets were ARIMA (0, 1, 1) (1, 1, 2) have been found satisfactory for average monthly price of mustard in Mahendergarh district, respectively. Forecasting has been computed through identified models for the variables i.e. average monthly prices of mustard in Mahendergarh district markets. Using the obtained models, the ex-post forecasted values, considering the January 2005 to December 2016 were computed and showing average monthly prices of mustard crop in selected district markets. It has been observed that the forecasting of average monthly prices in Mahendergarh, Ateli, Kanina and Narnaul markets were moving in increasing same trend with observed values. From the forecast variable by using the developed model, it can be seen that the forecasted average price increases in the following years. The validity of the estimated value can be tested when data for the lead periods become available. The Dickey-Fuller test suggested that the order of integration of prices among different markets selected was similar with zero suggesting that the series/prices are integrated in the long-run and therefore bear a relationship to each other thus ratifying the law of one prices in Mahendergarh district. Researchers can use the model for forecasting average prices in Mahendergarh. However, it should be updated from time to time with the incorporation of recent data. These projections help the government make policies with regard to relative price structure, production and consumption and establish relations with other countries of the world.

References

1. Armstrong, G. and Kotler, P. (2010). Marketing: An Introduction, 10th edition. New Jersey, Prentice Hall International.
2. Bhardwaj, S.P., Paul, R.K. and Singh, K.N. (2015). Price forecast: An instrument for improvement in agricultural production and marketing in Rajasthan-A case study of rapeseed and mustard seeds. *Indian Journal of Agricultural Marketing*, (Conf. Spl.) 29(2): 163-186.
3. Box, G.E.P. and Jenkin, G.M. (1976). Time Series of Analysis, Forecasting and Control, Sam Francisco, Holden-Day, California. USA. 587.
4. Dhankar, G. H. (2003). Development of internet-based agricultural marketing system in India. *Agricultural Marketing*, 45(4) : 7-16.
5. Granger, C.W.J. and Newbold, P. (1970).Spectral methods. *Econometrica*. 30: 424-438.
6. Kaur, G., Sharma, R.D. and Mahanjan, N. (2016). Evaluation of price support and marketintegration system of maize price in Bengaluru. *Indian Journal of Agricultural Marketing*, 1: 56-65.
7. Kotler, P. and Keller, K. (2012). Marketing Management, 14th edition. Upper Saddle River, N.J. Prentice-Hall International, 657.
8. Kumar A, Verma U. Forecasting mustard yield in Haryana with ARIMA model, The Pharma Innovation 2020; 9(4): 136-140.
9. Kumar A, Deepankar PK, MJ, Kumar A. Wheat yield forecasting in Haryana: A time series approach, Bulletin of Environment Pharmacology and Life Sciences 2019; 8(3): 63-69.
10. Kumar M, Raman RK, Kumar S. Forecasting of soybean yield in India through ARIMA model, *International Journal of Pure and Applied Bioscience* 2017; 5(5): 1538-1546.
11. Makridakis, S. and Hibbon, M. (1979). Accuracy of

forecasting: An empirical investigation. *Journal ofRoyal Statistical Society*, 41(2): 97-145.

12. Mallick AK, Mishra AK. Interest rates forecasting and stress testing in India: An ARIMA approach, Palgrave Communications 2019; 5(32): 1078-1088.
13. Pant, S., Sethi, R. and Bhandari, M. (2015). A study on the price instability and price behaviour of cotton in Andhra Pradesh. *Indian Journal of Agricultural Marketing*, 2: 51-59.
14. Pindhyck, S.R. and Rubinfeld, D.L. (1991*). Econometric models and economic forecasts.* New York: McGraw Hill.596.
15. Pride, W. and Ferrell, O. (2003). Marketing: Basic Concepts and Decisions, 12th edition. Boston, Houghton Mifflin Company, p. 736.
16. Rahulamin, M.D.and Razzaque, M.A. (2000). Autoregressive Integrated Moving Average Modeling for Monthly Potato Prices in Bangladesh. *Journal of Financial Management and Analysis*, 13(1): 74-80.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 878-882 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Variability and Correlation Coefficient Analysis in Elite germplasm of Groundnut (*Arachis hypogaea* L.)

Vicky Yadav[1], P.B. Singh[1], Dikshita Joshi[1], Devendra Jain[2] , Vishal Pareek[1], Anjali Sharma[1] and Sarita Choudhary[1]

[1]*Department of Genetics and Plant Breeding, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*

[2]*Department of MBBT, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*

Email : 7298vicky@gmail.com

Abstract

Twenty five groundnut (*Arachis hypogaea* L.) elite germplasm were evaluated during Kharif- 2021 at Udaipur, Rajasthan. The genotypes were planted in a randomized block design with three replications. Observations for fourteen characters viz., days to 50% flowering, duration between flowering to pegging, days to maturity, plant height (cm), number of branches per plant, sound mature kernels (%), kernel weight per plant (g), 100-kernel weight (g), shelling percentage (%), dry pod yield per plant (g), biological yield per plant (g), harvest index (%), oil content (%) and protein content (%) were recorded and analysed to estimate variability parameters, correlation and path coefficient. The results revealed that differences between the estimates of GCV and PCV were found least for most of the characters. However, higher estimates of GCV were observed for harvest index (13.79%) followed by plant height (13.20%) and number of branches per plant (12.99%). Maximum heritability was found for oil content (95.08%) followed by plant height (93.02%) and 100-kernel weight (92.80%). While, maximum genetic gain was observed for plant height (26.22%) followed by number of branches per plant (24.50%) and harvest index (23.16%). Thus, traits viz., harvest index, plant height, oil content and number of branches, indicated the presence of additive gene effects as they showed high GCV, heritability and genetic gain. Hence, for improvement of dry pod yield selection can be made for above characters. Association estimates revealed that dry pod yield per plant was positively correlated at both genotypic and phenotypic levels with harvest index. Sound mature kernel exhibited positive and significant correlations coefficient with biological yield (rg = 0.65** and rp = 0.37**) at both genotypic and phenotypic levels. Estimation of path analysis is not possible for present experimental material because dependent character i.e. dry pod yield per plant (g) is not significant at both 1% and 5% level of significance.

Key words : *Groundnut, Variability, Heritability, Correlation, Path coefficient, Dry pod yield*

Introduction

Groundnut (*Arachis hypogaea* L.), the “king of oilseeds” also known as peanut, earthnut, monkey nut, panda, poor man’s cashew nut and manila nut, is a significant oilseed crop growing in tropical and subtropical regions of the world. It belongs to subfamily Papilionaceae of the family Fabaceae. It is self-pollinated and has chromosomal number (2n= 4x = 40) (Stebins, 1957; Stalker and Dalmacio, 1986) with genome size 2800 Mb/IC. Peanuts are grown for their high edible oil content (45-50%) and digestible protein content (25-30%). It is the richest plant source of thiamine and also contains a significant amount of niacin, which is deficient in cereals. Peanut is also a good source of vitamins E, K, and B (Encyclopaedia of Agricultural Science, 1994: Robertson, 2003).

Genetic improvement for quantitative traits depends on the nature and amount of variability present in the genetic stock and the extent to which the desirable traits are heritable. So, knowledge of the nature and magnitude of variability and heritability in a population is one of the prerequisites for successful breeding program in selecting genotypes with desirable characters (Dudly and Moll, 1969). Dry pod yield is the result of the expression and association of several plant growth components, which contribute additively or help in some conditions in modifying the expression of other traits directly or indirectly.

Since, groundnut pods develop below the ground level hence, genotypes for yield cannot be screened or evaluated prior to harvest. Correlation and path analysis will establish the extent of association between yield and its components and will also bring out the relative importance of their direct and indirect effects and thus, give a clear understanding of their association with yield. Therefore, association studies are very important. Keeping this in view, the present investigation was carried out to explore the genetic variability by determining the magnitude of genotypic coefficient of variation, heritability estimates and genetic gain of different morphological traits, their correlation and direct, indirect effects in 25 groundnut elite germplasm.

Table-1 : Estimates of mean squares, character mean, range and five best genotypes identified from groundnut genotypes.

S. No.	Characters	Mean sum of square	Mean	Range		Three best genotypes
				Min.	Max.	
1.	Days to 50% flowering	8.80**	33.38	30.5	36.5	UG-243, UG-129, JL-501
2.	Duration between flowering to pegging	6.19**	12.47	10.90	15.10	UG-130, UG-126, UG-132
3.	Days to maturity	52.53**	104.60	97	111	UG-127, UG-128, UG-118
4.	Plant height (cm)	80.92**	38.87	31.33	48.07	UG-130, UG-129, UG-117
5.	Number of branches per plant	2.50**	6.82	5.50	8.73	UG-129, UG-221, UG-118
6.	Kernel weight per plant (g)	1.19**	5.35	4.60	6.47	UG-128, JL-501, UG-124
7.	100-kernel weight (g)	47.77**	40.61	31.60	47.63	GG-7, UG-243, UG-123
8.	Sound mature kernels (%)	41.39**	85.33	78.50	91.50	UG-221, UG-120, UG-124
9.	Shelling percentage (%)	18.02**	71.35	65	75.20	UG-243, SG-99, UG-130
10.	Dry pod yield per plant (g)	6.91**	13.24	10.60	16.7	UG-122, UG-124, UG-243
11.	Biological yield per plant (g)	32.53**	31.71	26.70	37.50	UG-118, UG-130, TG-37A
12.	Harvest index (%)	118.76**	42.22	32.79	54.40	JL-501, UG-125, UG-119
13.	Oil content (%)	16.52**	43.47	40.30	48.77	GG-7, TG-37A, JL-501
14.	Protein content (%)	6.46**	21.63	19.00	24.70	UG-130, UG-120, UG-125

*, ** Significant at 5% and 1% respectively.

Table-2 : Estimates of PCV, GCV, heritability (broad sense), genetic advance and genetic gain for different characters in Groundnut.

S. No.	Characters	GCV	PCV	h^2	GA	GG
1.	Days to 50 % flowering	5.02	5.34	88.67	3.25	9.75
2.	Duration between flowering to pegging	11.17	12.21	83.57	2.62	21.03
3.	Days to maturity	3.92	4.13	89.97	8.01	7.66
4.	Plant height	13.20	13.68	93.02	10.19	26.22
5.	Number of branches per plant	12.99	14.17	83.86	1.67	24.50
6.	Kernel weight per plant	11.38	12.51	82.78	1.14	21.33
7.	100-kernel weight	9.70	10.07	92.80	7.82	19.25
8.	Sound mature kernels	4.07	4.86	70.42	6.01	7.05
9.	Shelling percentage	3.20	3.86	69.06	3.91	5.49
10.	Dry pod yield per plant	10.30	13.48	58.36	2.15	16.22
11.	Biological yield per plant	9.57	11.84	65.27	5.05	15.93
12.	Harvest index	13.79	16.91	66.47	9.78	23.16
13.	Oil content	5.35	5.49	95.08	4.67	10.75
14.	Protein content	6.45	7.40	75.84	2.50	11.57

Materials and Methods

Twenty five groundnut genotypes were grown in Randomized Block Design with three replications at instructional farm of College of Technology and Agricultural Engineering (CTAE), during Udaipur in kharif, 2021. Each genotype was sown in five rows of five meter length. Recommended cultural practices were adopted to raise a healthy crop.

Observations were recorded on five competitive plants for characters viz., plant height (cm), number of branches per plant, sound mature kernels (%),kernel weight per plant (g), 100-kernel weight (g), shelling percentage (%), dry pod yield per plant (g), biological yield per plant (g) and harvest index (%). While, days to 50% flowering and days to maturity were observed on plot basis.

Analysis of variance was carried out as per method suggested by Fisher (1918). Genotypic coefficient of variation and Phenotypic coefficient of variation as per the method suggested by Burton (1952), heritability (broad sense) was calculated according to formula suggested by Lush (1941) and genetic gain as per Johnson et al (1955). The phenotypic and genotypic correlation coefficients were computed as per Al-Jibouri et al. (1958). Path coefficient analysis was done using genotypic correlation coefficients as suggested by Dewey and Lu (1959).

Results and Discussion

Analysis of variance indicated that mean sum of squares were significant for all the characters studied. All of the fourteen characters exhibiting significant variation among the genotypes were used for analysis (Table-1).

However, higher estimates of GCV were observed

Table-3 : Estimation genotypic (rg) and phenotypic (rp) correlation coefficients for different characters in groundnut.

S. No.	Character		Days to 50% flowering	Duration Between Flowering to Pegging	Days to maturity	Plant height	No of branches / plant	Kernel weight / plant	100-Kernel weight	Sound mature kernel	Shelling percentage	Dry pod yield / plant	Biological yield / plant	Harvest index	Oil content	Protein content
1.	Days to 50% flowering	Rg		-0.52**	0.50**	0.18	-0.03	-0.05	0.03	-0.27	0.17	0.17	-0.06	0.18	-0.13	-0.19
		Rp		-0.44**	0.43**	0.16	-0.04	-0.03	0.05	-0.21	0.10	0.10	-0.07	0.13	-0.12	-0.15
2.	Duration Between Flowering to Pegging	Rg			-0.11	0.35	0.15	0.08	-0.30	-0.13	-0.06	-0.25	0.21	-0.33	-0.15	0.23
		Rp			-0.03	0.29	0.09	0.04	-0.26	-0.11	-0.01	-0.18	0.20	-0.28	-0.12	0.21
3.	Days to maturity	Rg				0.08	-0.15	0.06	-0.14	-0.02	0.14	0.07	0.08	-0.02	-0.30	0.11
		Rp				0.04	-0.16	0.03	-0.12	-0.00	0.15	0.07	0.08	-0.01	-0.26	0.06
4.	Plant height	Rg					0.10	0.04	-0.22	-0.09	0.15	0.19	0.39*	-0.13	-0.24	0.09
		Rp					0.11	0.02	-0.21	-0.10	0.09	0.11	0.33*	-0.14	-0.25	0.07
5.	No of branches / plant	Rg						-0.14	-0.26	0.14	-0.10	0.49**	0.07	0.32	-0.27	-0.13
		Rp						-0.12	-0.21	0.09	-0.05	0.30*	0.11	0.16	-0.23	-0.10
6.	Kernel weight / plant	Rg							-0.18	-0.02	-0.16	-0.03	0.25	-0.16	-0.05	0.05
		Rp							-0.17	0.02	-0.12	-0.03	0.15	-0.12	-0.06	0.06
7.	100-Kernel weight	Rg								0.04	0.14	0.08	0.09	0.02	0.23	0.05
		Rp								0.01	0.14	0.07	0.08	0.01	0.22	0.03
8.	Sound mature kernel	Rg									0.06	0.18	0.64**	-0.34	-0.20	0.09
		Rp									-0.01	0.15	0.37**	-0.16	-0.16	0.06
9.	Shelling percentage	Rg										0.23	0.08	0.11	-0.23	-0.05
		Rp										0.18	0.02	0.13	-0.16	-0.04
10.	Dry pod yield / plant	Rg											0.08	0.70**	-0.08	0.11
		Rp											0.15	0.70**	-0.05	0.03
11.	Biological yield / plant	Rg												-0.65**	-0.09	-0.05
		Rp												-0.59**	-0.09	-0.04
12.	Harvest index	Rg													0.04	0.14
		Rp													0.05	0.05
13.	Oil content	Rg														0.28
		Rp														0.26
14.	Protein content	Rg														
		Rp														

for harvest index (13.79%) followed by plant height (13.20%) and number of branches per plant (12.99%). Maximum heritability was found for oil content (95.08%) followed by plant height (93.02%) and 100-kernel weight (92.80%). While, maximum genetic gain was observed for plant height (26.22%) followed by number of branches per plant (24.50%) and harvest index (23.16%). Similar results were also reported by Shoba *et al.* (2012), Namrata *et al.* (2016) and Saini, *et al.* (2018).

Based on mean values, three best genotypes UG-122, UG-124, UG-243 were identified for dry pod yield per plant. In addition to this, genotype UG-243 was also showed higher shelling percentage. Similarly, genotype UG-118 and JL-501 exhibited highest biological yield and oil content. Genotype UG-130 had highest protein content (Table.1).

Estimates of heritability varied from dry pod yield per plant (58.36%) to oil content (95.08%). All characters under study exhibited more than 50 % heritability. High heritability estimates coupled with high genetic gain were observed for plant height, kernel yield per plant and 100-kernel weight (Table-2). High heritability and genetic gain was also reported by Babariya, *et al.* (2012), Dhakar, *et al.* (2017) and Kadam *et al.* (2018).

Correlation studies revealed that dry pod yield per plant was positively correlated at both genotypic and phenotypic levels with harvest index. Sound mature kernel exhibited positive and significant correlations coefficient with biological yield (rg = 0.65** and rp = 0.37**) at both genotypic and phenotypic levels. Plant height established positive and significant correlation coefficient with biological yield / plant (rg = 0.39* and rp = 0.33*) at both genotypic and phenotypic level. Number of branches per plant had positive and significant correlation with Dry pod yield / plant (rg = 0.49* and rp = 0.30*) at both genotypic and phenotypic level (Table-3).

Estimation of path analysis is not possible for present experimental material because dependent character i.e. dry pod yield per plant (g) is not significant at both 1% and 5% level of significance.

Similar findings have already been reported by Dhaliwal *et al.* (2010), Shoba *et al.* (2012), Singh *et al.* (2017) and Boparai *et al.* (2020).

Conclusions

An overall view of the present investigation revealed that the genotypes UG-118, UG-122, UG-128, UG-129, UG-130, UG-221, UG-243, TAG 24, SG 99, JL-501 and GG-7 were found to have considerably high mean values for traits like dry pod yield per plant, plant height, sound mature kernels, number of branches per plant, 100-kernel weight, kernel weight per plant, shelling percentage, biological yield per plant, harvest index, duration between flowering to pegging, oil content while genotypes UG-130 and TG 37 A have considerably low mean values for traits like days to 50 per cent flowering and days to maturity, respectively. So above genotypes can be further used in breeding programme.

References

1. Agriculture Statistics, 2020. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India. (www.indiastat.com)
2. Ali, M.A., Pal, A.K., Baidya, A. and Gunri, S.K., 2021. Variation in dry matter production, partitioning, yield and its Correlation in Groundnut (Arachis hypogaea L.) genotypes *Legume Research* 44 (6): 41-44.
3. Awatade, S.M., Thawar, B.L., Jadhav, B.B. and Gaikwad, K.J. 2010. Correlation and path coefficient analysis in groundnut. *Journal of Maharashtra Agriculture University,* 35 (2): 29-31.
4. Babariya, C.A. and Dobariya, K.L. 2012. Correlation coefficient and path coefficient analysis for yield components in groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding,* 3 (3): 932-938.
5. Boparai, A.K., Sood, V.K., Singh, M. and Katna, G. 2020. Genetic variability and inter-relationship studies in advanced interspecific derivatives of chickpea. *Agricultural Research Journal, of Food,* 57(6): 826.
6. Dhakar, T. R. Sharma, H., Kumar, R. and Kunwarram 2017. Correlation and path analysis for yield its contributing traits in groundnut *(Arachis hypogaea L.). International Journal of Agriculture Sciences,* 9: 3997-3999.
7. Dhaliwal, G.P.S., Nagda, A.K. and Mittal, V.P. 2010. Intertrait associations and path analysis studies in groundnut (*Arachis hypogaea* L.). *Crop Improvement,* 37(1): 57-60.
8. Fisher, R.A. 1918. The correlations among relatives on the supposition of Mendelian inheritance. *Tran. Royal Society, Edin.,* 52: 399-433.
9. Ganvit, R.S. and Jagtap, P.K. 2018. Character association and path co-efficient analysis studies for yield and its contributing traits in groundnut (*Arachis hypogaea* L.). *International Journal of Current Microbiology and Applied Sciences, 7*(11): 3566-3572.
10. Hampannavar, M.R., Khan, H., Temburne, B.V., Janila, P. and Amaregouda, A. 2017. Genetic variability, correlation and path analysis studies for yield and yield attributes in groundnut (*Arachis hypogaea* L.). *Journal of Pharmacognosy and Phytochemistry,* 7 (1): 870-874.
11. Kadam, V.K., Chavan, B.H., Deshmukh, M.P. And Mali, A.R. 2018. Study on character association and path analysis in summer groundnut (*Arachis hypogaea* L.). *Journal of Pharmacognosy and Phytochemistry,* 7 (3): 3654-3657.
12. Mandal, G.S., Das, A., Dutta, D., Mondal, B. and Senapati, B.K. 2017. Genetic variability and character association studies in groundnut (*Arachis hypogaea* L.). *Scholars Journal of Agriculture and Veterinary Sciences*, 4 (10): 424-433.

13. Mukhtar, A.A., Tanimu, B., Ibrahim, S., Abubakar, I.U. and Babaji, B.A. 2013. Path analysis and percentage contribution of different growth characters to pod yield of groundnut (*Arachis hypogaea* L.) at Kadawa, Sudan savanna, Nigeria. *Archives of Agronomy and Soil Science,* 59 (1): 127-132.
14. Nandini, C. and Savithramma, D.L. 2012. Character association and path analysis in F8 recombinant inbred line population of the cross NRCG 12568 x NRCG 12326 in groundnut (*Arachis hypogea* L.). *Asian Journal of Bio Science,* 7 (1): 55-58.
15. Namrata, Sharma, H. Bisen, P. Ranwah, B.R. 2016. Variability Assessment and Path Coefficient Analysis in Groundnut *(Arachis hypogaea* L.) Genotypes in Sub-Humid Southern Plains of Rajasthan. *Trends in Biosciences* 9(11): 242-246.
16. Patil, S.K., Shivanna, S., Irappa, B.M. and Shweta. 2015.Genetic variability and character yield attributing components in groundnut. *International Journal of Recent Scientific Research,* 6:4568-4570.
17. Prabhu, R., Manivannan, N.,Mothilal, A. and Ibrahim, S.M. 2015. Correlation coefficient analysis for yield and yield attributes in groundnut *(Arachis hypogaea* L.*). Plant Archives* 15: 685-689.
18. Rasheed, B., Rasheed, H.U., Farid, A. and Khan, A. 2015. Characters association and path analysis of peanut (*Arachis hypogaea* L.) for pod yield. *Journal of Agricultural Science and Research*, 2(1): 79-84.
19. Reddy, A.T., Sekhar, M.R., Bharathi, A.V., Pathy, T.L. Reddy,G.L., and Jayalakshmi V. 2017. Correlation and Path Analysis of Kernel Yield and its Components in Groundnut (*Arachis hypogaea* L.). *International Journal of Current Microbiology and Applied Sciences,* 6: 10-16.
20. Saini, H. and Sharma, M.M. 2018. Genetic variability and character association study in a RIL population for yield and quality traits in groundnut (*Arachis hypogea* L.). *International Journal of Chemical Studies*, 6(6): 2179-2185.
21. Shoba, D., Manivannan, N. and Vindhiyavarman, P. 2012. Correlation and path coefficient analysis in groundnut (*Arachis hypogaea* L.). *Madras Agricultural Journal*, 99 (1-3): 18-20.
22. Singh, P.B., Bharti, B., Kumar, A., Singh, R., Kumar, N. and Rathnakumar, A.L. 2017. Genetic characterization, character association for yield and yield component traits in groundnut (*Arachis hypogaea* L.). *Electronic journal of plant breeding*, 8: 1229-1235.
23. Zaman, M. A., Tuhina-Khatun, M., Ullah, M. Z., Moniruzzamn, M. and Alam, K. H. 2011. Genetic variability and path analysis of groundnut (*Arachis hypogaea* L.). *The Agriculturists,* 9 (1/2): 29-36.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 883-887 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Bio-Efficacy and Phytotoxity Evaluation of Mancozeb 35% SC against Disease Complex of Apple

Vijay Kumar* and Tannu Rani
Department of Plant Pathology, College of Horticulture VCSG UUHF Bharsar, Pauri Garhwal, U.K.
**Corresponding Author Email : vijaykumar.india28@yahoo.in*

Abstract

The present investigation was undertaken to study the response of Bio-efficacy and Phytotoxicity evaluation of Mancozeb 35% SC against disease complex of Apple. RCBD experiment was conducted for two years for diseases of Apple (2017-2018). This trial was conducted in Apple Nursury of College of Horticulture, VCSG UUHF Bharsar, Pauri Garhwal, Uttarakhand. Mancozeb 35% SC @ 15.68 a.i. was found highly and significantly more effective for the control of *Marsonina* leaf fall disease of apple during both crop season. *Mancozeb* 35% SC @ 15.68 a.i. was also found highly effective against *Alternaria* leaf spot disease of apple during both cropping seasons. Mancozeb 35% SC @ 15.68 a.i. was also found maximum effective against Sooty Blotch disease of apple during both cropping seasons. Mancozeb 35% SC (Eurofil) @ 31.36 % a.i. and 37.63 % a.i. was found non toxic to apple plant and there was no phytotoxicity recorded in these treatments. Mancozeb 35% SC (Eurofil) @ 15.68 a.i. recorded highest yield over untreated control during 2017 & 2018.

Key words : *Apple, Alternaria mali, disease severity, MANCOZEB 35% SC, Marsonina coronaria, phytotoxity, sooty blotch.*

Introduction

India ranks second in the world in the production of fruit and ranks fifth in the world in exporting apples. For India's marketing year 2017-2018, apple production is forecast at 2.3 million metric Tons (MMT). But Indian apple production is limited to the hill states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. And these are the states where people cannot get instant help if crop has any kind of disease because of the various reasons like bad weather, lack of transportation facility etc Shindhi (2016) and Shaik (2019).

Common diseases are Sooty blotch in apple caused by a complex of fungi (Grabowski 2004, Batzer *et al*., 2005, Frank *et al*., 2010 and Dham, 2019). These are dark, shiny raised blotches with irregular or lobed edges appear on the suface of fruit having this fungal disease (*International journal of computer application* 2016). Among various methods, chemical spray offers the most effective way to control Sooty blotch (Lee *et al*., 2009).

Marsonina coronaria is responsible for widespread premature defoliation in apple and was observed in 1992 India. *Marsonina mali* disease was first reported from Japan (Miyake, 1907). It has been reported in Italy in 2003, Germany in 2010 and in Austria in 2011 (Schrader and Steinmoller, 2013). The disease symptoms appear in the form of dark green circular patches on upper surface of leaf giving rise to 5-10mm brown leaf spot which become dark brown on maturity it also develop on the lower surface of the leaf. All the available available commercial cultivars of Apple were found susceptible to the disease (Sharma *et al*., 2010; Sharma *et al*., 2012; Li *et al*., 2012). Alternaria leaf spot also very important disease in apple. However, appearance of disease as fruit spots on the produce makes it unsalable in the market leading to direct economic loss which varies among the different cultivarss (Sharma and Gautam, 1997).

Considering the importance of these diseases we have completed research work with following objectives "Bio-efficacy and Phytotoxity evaluation of Mancozeb 35%SC against disease complex of Apple".

Materials and Methods

Field experiment was conducted during 2017 and 2018 crop season and following observations to be recorded.

***Marssonina* leaf fall, *Alternaria* leaf spot and Apple scab :** Disease severity of *Marsonina* leaf fall and Alternaria leaf spot and apple scab in apple were recorded the following 0-5 disease rating scale by counting the infection in 100 leaves/treatment.

0=Disease free

1=0-3% leaf area covered with disease lesions

2=4-6% leaf areas covered with disease lesions

3=7-12% leaf area covered with disease lesions

4=13-25% leaf areas covered with disease lesions

5=More than 25% leaf area covered with disease lesions or chlorotic leaf with petiole infection.

For calculating disease Severity, below mentioned formula was followed : (Singh, R.S. 2018)

$$\frac{\text{Sum of all disease ratings}}{\text{Total no. of ratings} \quad \text{max. disease grade}} \quad 100$$

(James explained severity as the area of plant tissue affected by disease, wheras Horsfall and cowling expand the definition to area and volume of piant tissue affected).

Sooty Blotch : Disease is caused by multiple organisms like *Leptodontium elatius, Peltaster fructicola* and *Geastrumia polystigmatis.* This disease severity on apple fruit was recorded the following disease rating scale by counting the infection on 100 fruits/treatment.

Sooty blotch was rated on a 0 to 3 scale,

Where, 0 = no disease; 1 = trace (< 1% fruit surface affected); 2 = 1 to 5% fruit surface affected; 3 = > 5% fruit surface affected.

Phytotoxicity : Observations on Phytotoxicity symptoms like effect on Vein clearing, Necrosis, Wilting, Hyponasty, Epinasty, etc. after 0, 1, 3, 5, 7, 10 and 15 days after each treatment on 0 to 10 scales were recorded by following below mentioned scale.

% injury	Rating	% injury	Rating
0	No phytotoxicity	41-50	5
1-10	1	51-60	6
11-20	2	61-70	7
21-30	3	71-80	8
31-40	4	81-90	9
		91-100	10

Year	2017 and 2018
Crop	Apple
Variety	Red Delicious
Replications	3 (Three)
Design	RBD
Spacing (Row to Row x Plant to Plant)	7m x 7 m
Age of the trees	10 year in 2017 and 11 Years in 2018
Number of trees/plot	1 tree/plot; 204 trees/ha
Plot size	49 m^2
Spray volume/ha	650 l/ha
Soil Type	Sandy Loam
Crop stage at the time to application	Walnut size fruit stage
Number of application	03
Application date	Crop Season 2017 1st June (0 days), 10th June, 20th June Crop Season 2018 (0 Days) 3rd June, 13th June, 23th June
Method of application and equipment	Knapsack Sprayer
Use of other pesticide if any	NA
Date of Harvesting	Fruit yield was good

Results and Discussion

Crop Season 2017

Bio-efficacy against Premature leaf fall (*Marsonina* coronaria) : Mancozeb 35 % SC @18.81 a.i. Disease severity of 4.77 (82.3%) which is at par with Mancozeb 35% SC @ 15.68 a.i. recorded significantly less disease severity of 5.27 (80.45%) after 10 days after 3rd spray and Mancozeb 35% SC @ 12.54 a.i. recorded 7.77 (71.16%) disease severity (Table-1).

Bio-efficacy against *Alternaria* leaf fall (*Alternaria mali*) : In fungicidal treatments Mancozeb 35% SC @18.81 a.i. recorded 3.40 (87.86%) disease severity which is on par Mancozeb 35% SC @15.68 a.i. with less disease severity of 4.37 (84.4%) and Mancozeb 35% SC @ 12.54 a.i. Showed 7.57(72.98%) disease severity at 10 days after 3rd spray (Table-2).

Bio-efficacy against Sooty blotch (*Leptodontium elatius, Peltaster fructicola* and *Geastrumia polystigmatis*) : In fungicidal treatments Mancozeb 35% SC @18.81 a.i. recorded 0.00 (100%) disease severity which is on par Mancozeb 35% SC @15.68 a.i. with less disease severity of 0.07 (97.78%) and Mancozeb 35% SC @ 12.54 a.i. showed 0.60 (80.00%) disease severity on fruits at 10 days after 3rd spray (Table 3)

Phytotoxicity : Phytotoxicity symptoms were not observed in any of the treatment of Mancozeb 37.5% SC @ 31.36 (Double dose) and 37.63 (triple dose), on Yellowing, Chlorosis, Leaf tip injury, wilting, Hyponasty, Epinasty (Table 4a–4c).

Yield : Apple fruit yield indicated that all the treatments were significantly superior over untreated control. Highest fruit yield was recorded in trees sprayed with Mancozeb 35% SC (Eurofil) 18.18 a.i. / 10 liters of water recorded 4.30 quintals/ha which is at par with Mancozeb 35% SC (Eurofil) @ 15.68 a.i. / 10 liters of water i.e., 4.00 quintals/ha (Table-5).

Crop season 2018

Bio-efficacy against Premature leaf fall (*Marsonina coronaria*) : Mancozeb 35 % SC @18.81 a.i. Disease severity of 2.74 (92.02%) which is at par with Mancozeb 35% SC @ 15.68 a.i. recorded significantly less disease severity of 3.14 (90.85%) after 10 days after 3rd spray and Mancozeb 35% SC @ 12.54 a.i. recorded 6.30 (81.60%) disease severity (Table-1).

Bio-efficacy against Alternaria leaf fall (*Alternaria mali*) : In fungicidal treatments Mancozeb 35% SC @18.81 a.i. recorded 4.70 (85.46%) disease severity which is on par Mancozeb 35% SC @15.68 a.i. with less disease severity of 5.57 (82.78%) and Mancozeb 35% SC @ 12.54 a.i. Showed 8.87 (72.58%) disease severity at 10 days after 3rd spray (Table-2)

Bio-efficacy against Sooty blotch (*Leptodontium elatius, Peltaster fructicola* and *Geastrumia polystigmatis*) : In fungicidal treatments Mancozeb 35% SC @18.81 a.i. recorded 0.00 (100.0%) disease severity which is on par Mancozeb 35% SC @15.68 a.i. with less

Table-1 : Efficacy of fungicides against Pre mature leaf fall disease (*Marsonina coronaria*) of apple under field condition.

Treatments	Dose/10 L of Water		Pre mature leaf fall			
	a.i	Formulation	% Disease severity		% disease control over UTC	
			2017	2018	2017	2018
Mancozeb 35% SC (Eurofil)	12.54	28	7.77 (15.05)	6.30 (14.52)	71.16	81.60
Mancozeb 35% SC (Eurofil)	15.68	35	5.27 (13.27)	3.14 (10.2)	80.45	90.85
Mancozeb 35% SC (Eurofil)	18.81	42	4.77 (12.61)	2.74 (9.51)	82.30	92.02
Mancozeb 75% WP	22.5	30	10.60 (19.00)	9.27 (17.69)	60.64	72.93
Captan 75% WP	22.5	30	10.24 (18.63)	12.00 (20.23)	62.00	64.95
Untreated Control	-	-	26.94 (31.24)	34.24 (35.78)	0.00	0.00
CD at 5% level			2.35	3.03		
SE(m)			0.74	0.96		

Figures in the parentheses are angular transformed value, *UTC=Untreated control

Table-2 : Efficacy of fungicides against *Alterneria* leaf Spot (*Alterneria mali*) disease of apple under field condition.

Treatments	Dose/ 10 L of Water		*Alterneria* Leaf spot			
	a.i.	formulation	% Disease severity		% disease control over UTC	
			2017	2018	2017	2018
Mancozeb 35% SC (Eurofil)	12.54	28	7.57 (15.9)	8.87 (19.25)	72.98	72.58
Mancozeb 35% SC (Eurofil)	15.68	35	4.37 (12.06)	5.57 (13.37)	84.40	82.78
Mancozeb 35% SC (Eurofil)	18.81	42	3.40 (10.62)	4.70 (12.52)	87.86	85.46
Mancozeb 75% WP	22.5	30	10.10 (15.41)	12.67 (22.35)	63.93	60.82
Captan 75% WP	22.5	30	11.17 (17.01)	13.77 (23.70)	60.12	57.42
Untreated Control	-	-	28.00 (31.94)	32.34 (34.64)	0.00	0.00
CD at 5% level			1.93	2.63		
SE(m)			0.61	0.83		

Figures in the parentheses are angular transformed value, *UTC=Untreated control

disease severity of 0.07 (97.78%) and Mancozeb 35% SC @ 12.54 a.i. Showed 0.73(75.56%) disease severity on fruits at 10 days after 3rd spray (Table-3).

Bio-efficacy against apple scab (*Venturia inaequalis*) : We conducted trials on bioefficacy and phytotoxicity evaluation of Mancozeb 35% SE against apple scab for 2017 and 2018 crop season. In both seasons apple scab was not appeared in the trials at Bharsar.

Phytotoxicity : Phytotoxicity symptoms were not observed in any of the treatment of Mancozeb 37.5% SC @ 31.36 (Double dose) and 37.63 (triple dose), on Yellowing, Chlorosis, Leaf tip injury, wilting, Hyponasty, Epinasty (Table 4a–4c).

Yield : Apple fruit yield indicated that all the treatments were significantly superior over untreated control. Highest fruit yield was recorded in trees sprayed with Mancozeb 35% SC (Eurofil) 18.18 a.i. / 10 liters of water recorded 4.20 quintals/ha which is at par with Mancozeb 35% SC (Eurofil) @ 15.68 a.i. / 10 liters of water.

Conclusions

To evaluate the bio-efficacy and Phytotoxicity of Mancozeb 35% SC against different diseases of apple at College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry Bharsar, Pauri-Garhwal-246123 Uttarakhand the trials were conducted during crop season 2017 and 2018 and summary of the trials are given below :

Mancozeb 35% SC @ 15.68 a.i. was found highly and significantly more effective for the control of Marsonina leaf fall disease of apple during both crop season 2017 and 2018.

Table-3 : Efficacy of fungicides against Sooty blotch disease of apple under field condition.

Treatments	Dose/ 10 L of Water		Sooty Blotch			
	a.i.	Formulation	% Disease severity		% disease control over UTC	
			2017	2018	2017	2018
Mancozeb 35% SC (Eurofil)	12.54	28	0.60 (4.41)	0.74 (4.84)	80.00	75.56
Mancozeb 35% SC (Eurofil)	15.68	35	0.07 (0.86)	0.07 (0.86)	97.78	97.78
Mancozeb 35% SC (Eurofil)	18.81	42	0.00 (0.00)	0.00 (0.00)	100.00	100.00
Mancozeb 75% WP	22.5	30	0.27 (2.40)	0.50 (3.92)	91.11	83.33
Captan 75% WP	22.5	30	1.07 (5.89)	1.77 (7.54)	64.44	41.11
Untreated Control	-	-	3.00 (9.98)	3.00 (9.98)	0.00	0.00
CD at 5% level			2.93	2.19		
SE(m)			0.76	0.69		

Figures in the parentheses are angular transformed value, *UTC=Untreated control

Table-4a : Phytotoxicity of Mancozeb % SC (Eurofil) in Apple (Crop season 2017 & 2018).

S. No.	Treatments	Concentration (%)		Yellowing (Days after spray)							Chlorosis (Days after spray)						
		a.i.	Formulation	0	1	3	5	7	10	15	0	1	3	5	7	10	15
1.	Mancozeb 35 % SC (Eurofil)	31.36	70 ml	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	Mancozeb 35% SC (Eurofil)	37.63	84 ml	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	Untreated control	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table-4b : Phytotoxicity of Mancozeb 35 SC in Apple (Crop Season 2017 & 2018).

S. No.	Treatments	Concentration (%)		Leaf tip injury (Days after spray)							Wilting (Days after spray)						
		a.i.	Formulation	0	1	3	5	7	10	15	0	1	3	5	7	10	15
1.	Mancozeb 35 %SC (Eurofil)	31.36	70 ml	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.	Mancozeb 35% SC (Eurofil)	37.63	84 ml	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	Untreated control	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table-4c : Phytotoxicity of Mancozeb 37.5% SC in Apple (Crop Season 2017 & 2018).

S. No.	Treatments	Concentration (%)		Hyponasty and Epinasty (Days after spray)						
		a.i.	Formulation	0	1	3	5	7	10	15
1.	Mancozeb 35 % SC (Eurofil)	31.36	70 ml	0	0	0	0	0	0	0
2.	Mancozeb 35% SC (Eurofil)	37.63	84 ml	0	0	0	0	0	0	0
3.	Untreated control	-	-	0		0	0	0	0	0

Table-5 : Fruit yield after application of Mancozeb 35% SC against disease complex of apple under field condition during 2017 and 2018.

Sl. No.	Treatments	Dose/ 10 L of Water		Yield (Qtl./ha)	
		a.i.(in g)	Formulation (in g/ml)	2017	2018
1.	Mancozeb 35% SC (Eurofil)	12.54	28	3.47	3.03
2.	Mancozeb 35% SC (Eurofil)	15.68	35	4.00	3.87
3.	Mancozeb 35% SC (Eurofil)	18.81	42	4.30	4.20
4.	Mancozeb 75% WP	22.5	30	3.53	2.93
5.	Captan 75% WP	22.5	30	3.10	2.87
6.	Untreated Control	-	-	2.57	2.27
		CD @ 5%		0.39	0.53
		SE(m)		0.12	0.16

Mancozeb 35% SC @ 15.68 a.i. was also found highly effective against Alternaria leaf spot disease of apple during both cropping seasons.

Mancozeb 35% SC @ 15.68 a.i. was also found highly effective against Sooty Blotch disease of apple during both cropping seasons.

Mancozeb 35% SC (Eurofil) @ 31.36 % a.i. and 37.63 % a.i. was found non toxic to apple plant and there was no phytotoxicity recorded in these treatments.

Mancozeb 35% SC (Eurofil) @ 15.68 a.i. recorded highest yield over untreated control during 2017 & 2018.

Showed 3.87quintals/ha (Table-5).

Acknowledgement

I would like to express my sincere gratitude to Indofill Industries limited funding agency. I am thankful to staff members of Department of Plant Pathology for their valuable contribution.

References

1. Sindhi, K., (2016). Quality evaluation of Apple fruit: A Survey. *International Journal of Computer Applications.* 136(1) : 776-779.
2. Shaik, S. M., (2019). An Overview of Apple Scab its Cause and Management Strategies. *EC Microbiology* 15(4) : 283-287.
3. Grabowski, M., (2004). Etiology of sooty bloch in selected regions of southern Poland. *Phytopathology.* 35(1) : 73-81.
4. Batzer, J.C., (2005). Expansion of Sooty blotch and flyspeck complex on apples based on analysis of ribosomal DNA gene sequences and morphology. *Mycologia.* 97 (6) : 1268-1286.
5. Frank, J., (2010). Microcyclosporella: novel genera accomadating epiphytic fungi causing sooty blotch on apple. *Persoonia*. 24(3) : 93-105.
6. Dharm, P., (2019). A Review of Apple Diseases Detection and Classification. *International Journal of Engineering Research and Technology*. 8(3) : 76-81.
7. Lee, D.H., (2009). Biological characterization of *Marsonina coronina* associated with apple blotch disease. *Mycobiology*. 39(3) : 200-205.
8. Miyake, I., (1907). Ueber einige Pilz- Krantheiten unserer Nutzpflanzen. *Botany. Mag*. 21(3) : 39-44.
9. Schrader, G. and Steinmoller. S., (2013). Express-PRA for Diplocarpon mali Y. Harada and Sawamura. *Julius Khun institute for plant health*. 9, January, 56(1) : 1-11.
10. Sharma, N. Thakur, V. S. Sharma, S. Mohan, J. and Khurana, S. M. P., (2010). Development of Marssonina blotch in different genotypes of apple. *Indian Phytopathology*. 64(4) : 358-363.
11. Sharma, N. Thakur, V.S. Sharma, S. Mohan, J. and Khurana, S. M. P., (2012). Variations in morphological parameters of apple cultivars in relation to pre mature leaf fall caused by *Marsonina Coronina. J. Mycology. Plant Pathology.* 40(30) : 454-459.
12. Li, Y., Hirst, P. M., (2012). Resistance to *Marsonina coronina* and *Alternaria alternata* apple Pathotype in the major apple cultivars and rootstocks used in China. *Hortscience.* 47(9) : 1241-1244.
13. Sharma, J. N. and Gautam, D.R., (1997). Studies on premature leaf fall in apple – *A new problem Indian L. Plant Protection* 25(2): 8-12.
14. Singh, R. S., (2018). Plant Diseases. 10th Ed. *Oxford and IBH Publishing* Co. Pvt. Ltd. New Delhi. 402p.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 888-893 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Foliar Spray of Agrochemicals on Physiological Growth Parameters at Different Growth Stages of Rice (*Oryza sativa* L.) Crop

Begum Yasmeen[1*], Patil, R.P.[2], Harish Menpadi[1] and Mahanthashivayogayya[3]

[1]*Department of Crop Physiology, College of Agriculture, Raichur*

[2]*Department of Crop Physiology, College of Agriculture, Bheemarayana Gudi*

[3]*Agricultural Research Station, Gangavathi, Karnataka*

**Corresponding Author Email : yasmeen16400@gmail.com*

Abstract

The experiment was carried out at Agricultural Research Station Gangavathi UAS, Raichur, Karnataka, is situated in the Northern Dry Zone of Karnataka between 15'15'40" North latitude and 76'31'40" East longitude at an altitude of 419 meter above mean sea level, to study the influence of agrochemicals on growth parameters of rice variety GNV10-89. The experiment was laid out in RCBD design with 3 replications during *kharif* season 2017. The experiment consisting of 10 different treatments *i.e.,* T_1: 25 % extra nitrogen soil application, T_2: NPK (19:19:19) @ 1.0 %, T_3: triacontanol (2.0 $mL^{-1}L$), T_4: GA_3 (50 ppm), T_5: nitrobenzene (20 ppm), T_6: salicylic acid (500 ppm), T_7: 6-BAP (20 ppm), T_8: borax (0.2 %), T_9: $T_3 + T_8$ foliar applications and T_{10}: control. The results indicated that the ANOVA was significant for all the growth parameters at different growth stages. The significantly higher LA was observed in T_2 at 75 (47.6 dm^2/hill), 95 (54.5 dm^2/hill) DAT (days after transplanting) and decreased at harvest (34.2 dm^2/hill) and lowest LA was obtained in control at 75 (14.8 dm^2/hill), 95 (24.2 dm^2/hill) DAT and at harvest (10.1 dm^2/hill). T_2 has shown the highest LAI at 75 (1.59), 95 (1.86) DAT and harvest (1.14), respectively. LAR was highest (2.03, 1.57 and 0.43) in T_2 and lowest (0.98, 1.17 and 0.17) in control at 75, 95 DAT and at harvest. Similarly the significantly higher RGR (0.0324 and 0.5571 g/g/day) was obtained in T_2 and lower (0.0137 and 0.2783 g/g/day) in the control at 75-95 DAT and 95- harvest. higher CGR (0.0294 and 0.0595 g/m^2/day) and NAR (0.0097 and 0.0421 g/ m^2/day) was observed in T_2 and lower in the control at 75-95 DAT and 95- harvest respectively.

Key words : *Rice crop, foliar spray of agrochemicals, physiological growth parameters.*

Introduction

Rice (*Oryza sativa* L.) is an important cereal crop in developing countries and also the staple food for over half of the world's population. The slogan "Rice is life" comes from the understanding that the rice based cropping systems are essential to everyone directly or indirectly for the food security, livelihood improvement, cultural heritage and sustainable development for the global peace.

There are so many constraints in rice production one of them is chaffyness characters of rice due to adverse climatic conditions and also imbalance between the source and sink may be lack of photosynthetic production or reserve food translocation in-efficiency to sink region.

The variety GNV-10-89 is most preferred variety in this region having duration of 125-130 days and suitable for both *summer* and *kharif* season. It has medium slender grains and milling percentage is around 87.35 per cent highly tolerant to blast and bacterial leaf blight diseases and non-lodging but observe more chaffyness. Research work pertaining to the effect of agrochemicals on physiological parameters, yield and yield attributing parameters to overcome with chaffyness of rice variety GNV-10-89 was carried out. Understanding of the mechanism involved in this matter help desire solution to the associated problems effectively. The functional leaves, dry matter production and leaf area index are the main growth features which might directly reflected to grain yield. Growth analysis parameters such as crop growth rate (CGR), leaf area index (LAI), relative growth rate (RGR), total leaf area (TLA) and net assimilation rate (NAR). Field experiment was carried out to study the physiological approaches for yield maximization in rice (O*ryza sativa* L.) on physiological growth analysis of rice.

Materials and Methods

The experiment was carried out at ARS (Agricultural Research Station) Gangavathi is situated in the Northern Dry Zone of Karnataka between 15'15'40" North latitude and 76'31'40" East longitude at an altitude of 419 meter above mean sea level. ARS represents irrigated transplanted rice belt of Tungabhadra command area. The maximum and minimum temperature during the crop growth period was (33.2 ^oC) and (18.8 ^oC), respectively. The maximum rainfall was (190.8 mm) in the month of August, 2017. These figures were recorded from the meteorological department, ARS, Gangavathi, University of agricultural sciences, Raichur. The rice variety, GNV-10-89 was selected for this experiment because the

chaffyness problem was found in this variety. The experiment was laid out in RCBD (randomized complete block design) with 3 replications and 10 treatments including control. Treatments are randomized by using random number table and the details of the treatments are given below. The first treatment was imposed 10 days before panicle initiation that is 65 DAT (days after transplanting) as the varietal character showed panicle initiation starts from 75 – 80 days after transplanting and second time treatment imposition on 10 days after panicle initiation (85 DAT). Observations were recorded at 10 days after each treatment imposition.

The observations were recorded at 75 DAT, 95 DAT and at harvest such as TLA (total leaf area), LAI (leaf area index), LAR (leaf area ratio), RGR (relative growth rate), CGR (crop growth rate) and NAR (net assimilation rate).

Leaf area (LA) : Total leaf area of five randomly selected hills were estimated by taking the average of five hills at peak tillering stage 75 DAT (days after transplanting), at flowering stage (95 DAT) and at harvest or before harvest of the crop. The total leaf area was calculated by using the below formula.

Total lead area = L W N K (cm^2 or dm^2)

Leaf area index (LAI) : The concept of LAI was first given by Watson (1952), to compute LAI the formula is given below as follows :

$$LAI = \frac{\text{Leaf Area}}{\text{Ground Area}} \text{ (Unit less)}$$

Relative growth rate (RGR) : RGR is computed as the mass increase per above ground biomass per day, it is calculated by using the formula given by Blackman, (1919).

$$RGR = \frac{\ln W_1 \quad \ln W_1}{(t2 \quad t1)} \text{ (g/g/day)}$$

Crop growth rate (CGR) : The concept of CGR was given by Watson (1958).

$$CGR = \frac{(w2 \quad w1)}{(t2 \quad t1) \quad A} \text{ (g/m}^2\text{/day)}$$

Net assimilation rate (NAR) : NAR directly indicates the rate of net photosynthesis. The concept of NAR was given by Gregory (1917).

$$NAR = \frac{(w2 \quad w1)}{(t2 \quad t1)} \quad \frac{(\log L_2 \quad \log L_1)}{(L2 \quad L1)} \quad \text{(g/dm}^2\text{/day)}$$

L = length of the third leaf from the top of a tiller (in cm)

W = maximum width of the same leaf (in cm)

N = number of leaves per hill

K = constant factor (0.75 for *kharif* crop and 0.73 for *rabi* crop)

W1 = dry weight of the plant at time one (in grams)

W2 = dry weight of the plant at time two (in grams)

t1 = time one (in days)

t2 = time two (in days)

log = natural logarithm

L1 = leaf area at time one (in cm^2 or dm^2)

L2 = leaf area at time two (in cm^2 or dm^2)

A = unit area (spacing)

Results and Discussion

Results

Leaf area (dm^2 $hill^{-1}$) : The data recorded on leaf area at different growth stages as influenced by different agrochemicals treatment (Table-1) indicated that the total leaf area per hill was increased upto 95 DAT and decreased there after towards maturity. At 75 DAT the foliar application of T_2 (NPK-19:19:19 @ 1.0 %) produced significantly higher leaf area (47.6 dm^2 $hill^{-1}$) over all other treatments as influenced by different agrochemicals treatment. But it was onpar with T_7 (6-BAP- 20 ppm) 44.5 dm^2 $hill^{-1}$ and T_1 (25 % extra N soil application as top dressing) 41.8 dm^2 $hill^{-1}$, respectively. T_{10} (control) recorded significantly lower leaf area (14.8 dm^2 $hill^{-1}$) as compared to remaining all other treatments. Similarly, at 95 DAT the leaf area was significantly increased in all the treatments, T_2 (NPK-19:19:19 @ 1.0 %) showed the significantly higher leaf area (54.5 dm^2 $hill^{-1}$) over all other treatments. But it was onpar with T_7 (6-BAP- 20 ppm) (51.4 dm^2 $hill^{-1}$). T_{10} (control) recorded the significantly lower leaf area (24.2 dm^2 $hill^{-1}$). A same trend was also noticed at harvest the leaf area was decreased at this stage. The treatment T_2 (NPK-19:19:19 @ 1.0 %) recorded the significantly maximum leaf area (34.2 dm^2 $hill^{-1}$) over rest of the treatments. In control the significantly minimum leaf area (10.1 dm^2 $hill^{-1}$) was observed.

Leaf area index (LAI) : The data pertaining to LAI presented in the Table 1 designate that there was increase in the ratio of LAI with advancement of crop growth and was decreased at maturity. At 75 DAT the significantly higher LAI was observed in T_2 (NPK-19:19:19 @ 1.0 %) (1.6). But it was onpar with T_7 (6-BAP- 20 ppm) (1.5) and T_1 (25 % extra N soil application as top dressing) (1.4). However, the significantly lower LAI was recorded in T_{10} (control) (0.5). Some of the treatments showed non-significant differences *i.e.,* foliar application of T_3 (triacontanol- 2.0 mL/L) 1.01, T_4 (GA_3- 50 ppm) 0.9, T_8 (borax- 0.2 %) 0.9, T_6 (salicylic acid- 500 ppm) 0.8 and T_9

Table-1 : Effect of agrochemicals on leaf area (dm^2 $hill^{-1}$), leaf area index and leaf area ratio (dm^2 g^{-1}) at different growth stages of rice crop.

Treatments	Leaf Area (dm^2 $hill^{-1}$)			Leaf Area Index			Leaf Area Ratio (dm^2/g)		
	75 DAT	95 DAT	At harvest	75 DAT	95 DAT	At harvest	75 DAT	95 DAT	At harvest
T_1 - 25 % extra N soil application as top dressing	41.8	48.4	30.3	1.39	1.60	1.01	1.97	1.60	0.4
T_2 - Foliar application of NPK (19:19:19) @ 1.0%	47.6	54.5	34.2	1.59	1.86	1.14	2.05	1.59	0.43
T_3 - Foliar application of triacontanol (2.0 mL/L)	29.8	40.1	21.7	1.01	1.38	0.74	1.65	1.54	0.3
T_4 - Foliar application of GA_3 (50 ppm)	28.2	38.3	20.4	0.94	1.28	0.68	1.63	1.48	0.32
T_5 - Foliar application of nitrobenzene (20 ppm)	38.8	45.7	26.1	1.29	1.52	0.87	1.92	1.57	0.35
T_6 - Foliar application of salicylic acid (500 ppm)	22.7	30.1	14.5	0.76	1.02	0.48	1.37	1.34	0.24
T_7 - Foliar application of 6-BAP (20 ppm)	44.5	51.4	32.3	1.47	1.70	1.06	2.03	1.57	0.42
T_8 - Foliar application of borax (0.2%)	25.6	33.9	18.2	0.85	1.22	0.59	1.47	1.44	0.29
T_9 - Foliar application of $T_3 + T_8$	31.2	43.3	23.9	1.04	1.43	0.81	1.62	1.55	0.33
T_{10} - Control	14.8	24.2	10.1	0.49	0.83	0.33	0.98	1.17	0.17
Mean	32.5	40.8	23.2	1.08	1.38	0.77	1.67	1.49	0.33
S.Em (±)	2.20	1.00	0.50	0.07	0.02	0.02	0.29	0.02	0.01
C.D. at 5%	6.50	2.90	1.60	0.21	0.06	0.05	0.09	0.05	0.02

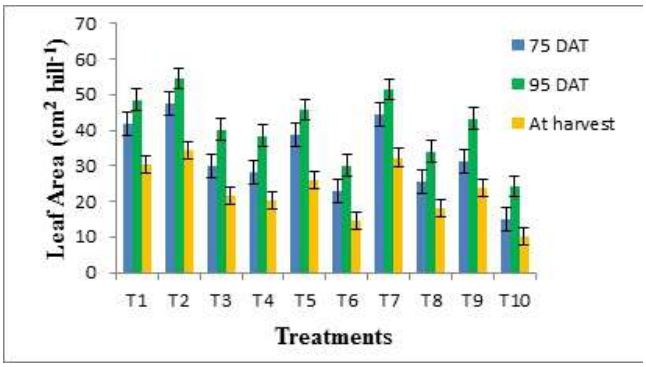
N-Nitrogen, GA_3-Gibberellic acid, 6-BAP-Benzylaminopurine

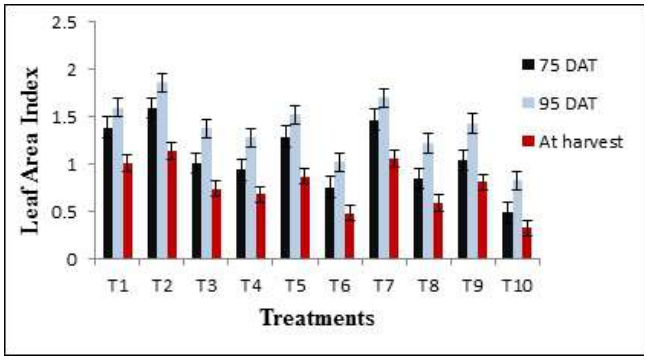
Table-2 : Effect of agrochemicals on RGR (g g^{-1} day^{-1}), CGR (g cm^{-2} day^{-1}) and NAR (g dm^{-2} day^{-1}) at different growth stages of rice crop.

Treatments	Relative growth rate (RGR g g^{-1} day^{-1})		Crop growth rate (CGR g cm^{-2} day^{-1})		Net assimilation rate (NAR g dm^{-2} day^{-1})	
	75-95 DAT	95 DAT-Harvest	75-95 DAT	95 DAT-Harvest	75-95 DAT	95 DAT-Harvest
T_1 - 25% extra N soil application as top dressing	0.0265	0.4835	0.0198	0.0465	0.0068	0.0362
T_2 - Foliar application of NPK (19:19:19) @ 1.0%	0.0324	0.5571	0.0294	0.0595	0.0097	0.0421
T_3 - Foliar application of triacontanol (2.0 mL/L)	0.0183	0.3865	0.0185	0.0404	0.0054	0.0265
T_4 - Foliar application of GA_3 (50 ppm)	0.0175	0.3654	0.0200	0.0394	0.0048	0.0226
T_5 - Foliar application of nitrobenzene (20 ppm)	0.0231	0.4687	0.0185	0.0470	0.0059	0.0314
T_6 - Foliar application of salicylic acid (500 ppm)	0.0147	0.3097	0.0150	0.0323	0.0037	0.0165
T_7 - Foliar application of 6-BAP (20 ppm)	0.0278	0.5362	0.0262	0.0435	0.0086	0.0385
T_8 - Foliar application of borax (0.2%)	0.0151	0.3271	0.0150	0.0390	0.0045	0.0194
T_9 - Foliar application of $T_3 + T_8$	0.0189	0.4283	0.0180	0.0480	0.0057	0.0321
T_{10} - Control	0.0137	0.2783	0.0146	0.0332	0.0029	0.0089
Mean	0.0208	0.4141	0.0195	0.0428	0.0058	0.0274
S.Em (±)	0.0020	0.0103	0.0063	0.0073	0.0023	0.0040
C.D. at 5%	0.0060	0.0310	0.0190	0.0220	0.0070	0.0120

(triacontanol-2.0 mL/L + borax- 0.2 %) 1.0, respectively. At 95 DAT there was marginal increase in LAI the treatment T_2 (NPK-19:19:19 @ 1.0 %) (1.9) showed significantly higher LAI as compared to all other treatments. The significantly lower LAI was observed in T_{10} (control) (0.8). However, there was non-significant differences between the treatments were noticed *i.e.,* T_3 (triacontanol- 2.0 mL/L), T_9 (triacontanol- 2.0 mL/L + borax- 0.2 %) and T_4 (GA_3- 50 ppm) 1.4, 1.4 and 1.3, respectively. A similar trend was followed at harvest there was significant decrease in LAI in all the treatments. The foliar application of T_2 (NPK- 19:19:19 @ 1.0 %) (1.14) and T_7 (6-BAP- 20 ppm) (1.06) recorded the highest LAI among all the treatments. Whereas, the significantly lower LAI was noticed in T_{10} (control) (0.3) but the treatments T_3 (triacontanol-2.0 mL/L) and T_4 (GA_3-50 ppm) were non-significant 0.7 and 0.7, respectively.

Leaf area ratio (dm^2/g) : The data related to leaf area ratio (LAR) presented in the Table-1 indicate that there was increase in the LAR with advancement of crop growth and was decreased at maturity. At 75 DAT the significantly higher LAR was observed in T_2 - (NPK 19:19:19 @ 1.0 %) (2.05) followed by T_7 (6-BAP- 20 ppm) (2.03 dm^2/g) But it was onpar with T_1 (25 % extra N soil application as top dressing) (1.97 dm^2/g). However, the significantly lower LAR was recorded in control (0.5dm^2/g). Some of the treatments showed non-significant differences *i.e.,* T_3 (triacontanol-2.0 mL/L) 1.65, T_4 (GA_3 50 ppm), 1.63 dm^2/g and T_9 (triacontanol-2.0 mL/L + borax-0.2 %) 1.62 dm^2/g, respectively. At 95 DAT there was marginal increase in





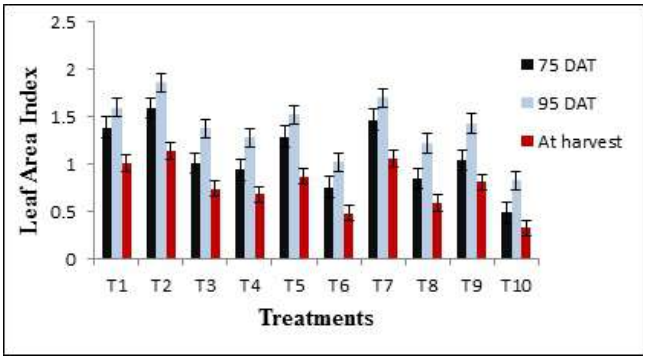
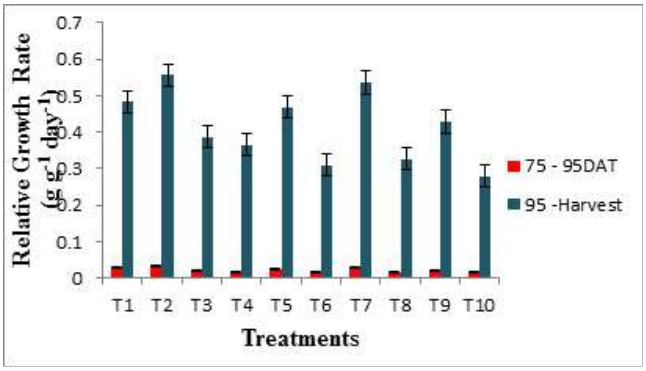


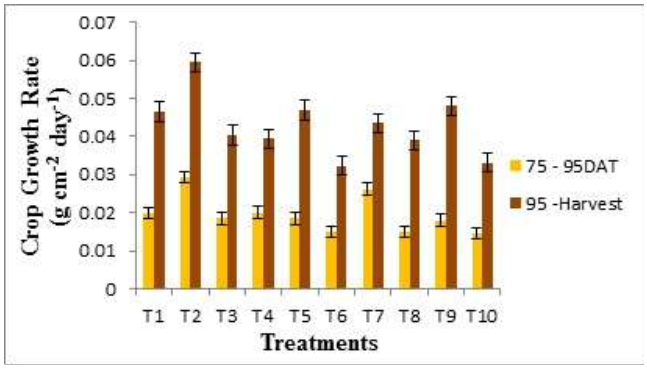
Fig.-1 : Effect of agrochemicals on leaf area (dm^2 hill^{-1}), leaf area index and leaf area ratio (dm^2 g^{-1}) at different growth stages of rice crop.

LAR, the treatment T_2 - (NPK 19:19:19 @ 1.0 %) 1.59 dm^2/g showed significantly higher LAR followed by T_7 (6-BAP- 20 ppm) 1.57 dm^2/g. The significantly lower LAR was observed in T_{10} (control) 1.17dm^2/g. However, there was non-significant differences between the treatments were noticed *i.e.,* T_2 - (NPK 19:19:19 @ 1.0 %) and T_5 - (nitrobenzene 20 ppm) that is 1.57 dm^2/g and 1.57 dm^2/g respectively. A similar trend was followed at harvest there was significant decrease in LAR in all the treatments. The foliar application of T_2 (NPK- 19:19:19 @ 1.0 %) 0.43 dm^2/g recorded the highest LAR among all the treatments. Whereas, the significantly lower LAR was noticed in T_{10} (control) that is 0.17 dm^2/g.

Relative growth rate (RGR g/g/day) : The data associated to relative growth rate (RGR) presented in the Table 2 indicate that there was increase in the RGR with advancement of crop growth from 75-95 DAT till harvest of the crop. RGR is most widely used way of estimating the plant growth. At 75-95 DAT the significantly higher RGR was obtained in T_2 - (NPK 19:19:19 @ 1.0 %) (0.0324 g/g/day) followed by T_7 (6-BAP- 20 ppm) (0.0278 g/g/day) But it was onpar with T_1 (25 % extra N soil application as top dressing) (0.0265 g/g/day). However, the significantly lower RGR was recorded in control (0.0137g/g/day). Some of the treatments showed non-significant differences such as T_3 (triacontanol- 2.0 mL/L) 0.0183 g/g/day, T_4 (GA_3-50 ppm), 0.0175 g/g/day and T_9 (triacontanol-2.0 mL/L + borax- 0.2 %) 0.0189 g/g/day, respectively. At 95 DAT-harvest there was minor increase in RGR, the treatment T_2 - (NPK 19:19:19 @ 1.0 %) 0.5571 g/g/day showed significantly higher RGR followed by T_7 (6-BAP- 20 ppm) 0.5362 g/g/day. The significantly lower RGR was observed in T_{10} (control) 0.2783 g/g/day. However, there was non-significant differences between the treatments were noticed in T_1 (25 % extra N soil application as top dressing) 0.4835 g/g/day and T_5 - (nitrobenzene 20 ppm) 0.4687 g/g/day respectively.

Crop growth rate (CGR g/m^2/day) : The data connected to crop growth rate (CGR) presented in the Table-2 designate that there was increase in the CGR with advancement of crop growth from 75-95 DAT till harvest of the crop. At 75-95 DAT the significantly higher CGR was obtained in T_2 - (NPK 19:19:19 @ 1.0 %) (0.0294 g/m^2/day) followed by T_7 (6-BAP- 20 ppm) (0.0262 g/m^2/day) But CGR was onpar with T_4 (foliar application of GA_3 50 ppm) (0.0200 g/m^2/day). However, the significantly lower CGR was recorded in control (0.0146 g/m^2/day). Some of the treatments showed non-significant differences such as T_3 (triacontanol- 2.0 mL/L) 0.0185 g/m^2/day, T_5 (foliar application of nitrobenzene 20 ppm) 0.0185 g/m^2/day and T_9 (triacontanol-2.0 mL/L + borax- 0.2 %) 0.0180 g/m^2/day, respectively. At 95 DAT - harvest





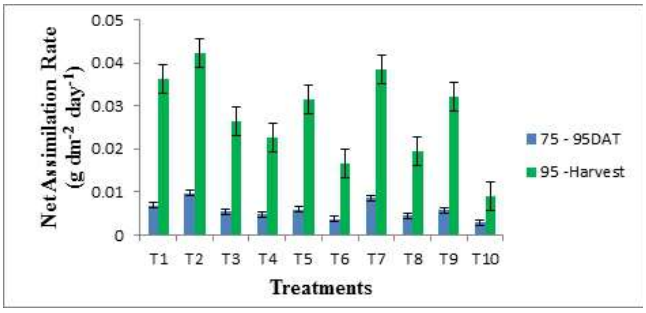


Fig.-2 : Effect of agrochemicals on RGR (g g^{-1} day^{-1}), CGR (g cm^{-2} day^{-1}) and NAR (g dm^{-2} day^{-1}) at different growth stages of rice crop.

there was inconsequential increase in CGR, T_2 - (NPK 19:19:19 @ 1.0 %) 0.0595 g/m^2/day showed significantly higher CGR followed by T_9 (triacontanol-2.0 mL/L + borax-0.2 %) 0.0480 g/m^2/day. The significantly lower CGR was observed in T_{10} (control) 0.0332 g/m^2/day. However, there was non-significant differences between the treatments were observed in T_1 (25 % extra N soil application as top dressing) 0.0465 g/m^2/day and T_5 - (nitrobenzene 20 ppm) 0.0470 g/m^2/day respectively.

Net assimilation rate (NAR g/m^2/day) : The data related to net assimilation rate (NAR) presented in the Table-2 indicate that there was increase in the NAR with advancement of crop growth from 75-95 DAT till harvest of the crop. At 75-95 DAT the significantly higher NAR was obtained in T_2 - (NPK 19:19:19 @ 1.0%) (0.0097 g/m^2/day) followed by T_7 (6-BAP- 20 ppm) (0.0086 g/m^2/day) But NAR was onpar with T_1 (25% extra N soil application as top dressing) (0.0068g/m^2/day). However, the significantly lower NAR was recorded in control (0.0029 g/m^2/day). Some of the treatments showed non-significant differences such as T_3 (triacontanol-2.0 mL/L) 0.0054 g/m^2/day, T_5 (foliar application of nitrobenzene 20 ppm) 0.0059 g/m^2/day and T_9 (triacontanol-2.0 mL/L + borax-0.2 %) 0.0057 g/m^2/day, respectively. At 95 DAT to harvest there was inconsequential increase of NAR was observed, T_2 - (NPK 19:19:19 @ 1.0 %) 0.0421 g/m^2/day showed significantly higher NAR followed by T_7 (6-BAP-20 ppm) 0.0385 g/m^2/day. The significantly lower NAR was observed in T_{10} (control) 0.0089 g/m^2/day. However, there was non- significant differences between the treatments were observed in T_5 - (nitrobenzene 20 ppm) 0.0314 g/m^2/day and T_9 (triacontanol-2.0 mL/L + borax-0.2 %) 0.0321 g/m^2/day respectively.

Discussion

Leaf area (LA) : The total leaf area of rice is a cause which is directly related to grain production because the total leaf area at flowering greatly affects the amount of photosynthates available to the panicle which was reviewed by Datta in the year 1981. The total leaf area per hill was maximum at flowering stage or at 95 DAT then decreased at harvest which was due to senescence of the older leaves. Similar observations were found by Jayanti *et al.* (2007).

Leaf area index (LAI) : The total leaf area per unit ground area is an important marker of total source available to the plant for the production of photosynthates, which accumulate in the developing sink. Variation in LAI is an vital physiological parameter that eventually determines crop yield because it influences the light interception by the crop canopy (Fageria *et al.*, 2006). In this experiment LAI was increased from peak tillering period (75 DAT) to

flowering stage (95 DAT) and thereafter decreased at maturity due to senescence of older leaves. The similar observations were recorded by Yoshida (1981) where LAI of rice increases as crop growth advances and reaches a maximum at about heading or flowering.

Relative growth rate (RGR) : It is the rate at which the newly synthesized dry matter accumulated every day and RGR is expressed as g g^{-1} day^{-1}. The mean RGR was high at 95 DAT which was the peak period of dry matter accumulation (95 DAT - harvest). The similar results was obtained by Wopereis *et al.* (1996) they observed that, overall respiration scales with total biomass, but photosynthesis only scales with photosynthetic biomass and as a result of which biomass accumulates more slowly as total biomass increases.

Crop growth rate (CGR) : CGR represents dry matter production per unit area over a period of time and it is considered as the most critical and significant growth function. The mean crop growth rate was slow between 75-95 DAT then increased linearly between 95 DAT up to harvest, the mean CGR was higher at 95 DAT until maturity thereafter decreased at harvest therefore the similar observations were recorded by Sridhar *et al.* (2019) the higher CGR at flowering and grain development stages may be due to higher LAI and decrease in CGR towards maturity may be attributed to decrease in leaf area as a result of senescence of leaves.

Net assimilation rate (NAR) : NAR is the physiological potential for converting the total dry matter into grain yield. The NAR is used as a measure of the rate of net photosynthesis minus respiration losses. In this investigation the NAR was high at peak tillering to flowering period that from 95 DAT up to harvest.

Conclusions

Foliar and soil applications of different agrochemicals showed significant differences between the treatments for different physiological growth parameters of rice.

Agrochemicals influenced the gradual increase in LA per hill, LAI and LAR at 75 DAT and 95 DAT and decreased at maturity. Among the 10 different treatments T_2 (NPK-19:19:19 @ 1.0 %) was found to be best compared with other treatments

Physiological growth parameters of rice such as RGR and CGR were significantly high at 95 DAT to harvest but NAR was high at 75 DAT to 95 DAT and T_2 (NPK- 19:19:19 @ 1.0 %) was shown good results among other treatments.

References

1. Blackman, V.H., 1919, The compound interest law and plant growth. *Ann. Bot.* 33 (01): 353-360.
2. Datta, S.K.D., 1981, Principles and practices of rice production. *International Rice Research Institute*. Las Banos, Philippines. p. 618.
3. Fageria, N.K., Baligar, V.C. and Clark, R.B., 2006, Photosynthesis and crop yield. *In Physiology of Crop Production*. 95-116, Food Products Press, New York.
4. Gregory, F.G., 1917, *Third Ann. Rep. Exp. Res. Sta., Cheshunt*, p. 19.
5. Jayanthi, T., Gali, S.K., Chimmad, V.P. and Angadi, V.V., 2007, Leaf colour chart based N management on yield, harvest index and partial factor productivity of rainfed rice. *Karnataka Journal of Agricultural Sciences.* 20(2): 405-406.
6. Sridhar, K., A. Srinivas, K. Avil Kumar, T. Ramprakash and Raghuveer Rao, P., 2019. Physiological growth parameters of *rabi* rice (*Oryza sativa* L.) under alternate wetting and drying irrigation with varied nitrogen levels. *Int. J. Curr. Microbiol. App. Sci.,* 8(01): 1-15.
7. Watson, D.J., 1952. Physiological basis of variation in yield. *Advances in Agronomy.* 4: 52-69.
8. Watson, D.J., 1958. The dependence of net assimilation rate on leaf area index. Years. *Annals of Botany*. 22:37-54.
9. Wopereis, M.C.S., Kropff, M.J., Maligaya, A.R. and Tuong, T.P., 1996, Drought stress responses of two lowland rice cultivars to soil water status. *Field Crops Research*. 46: 21-39.
10. Yoshida, S., 1981., Fundamentals of rice crop science. *International Rice Research Institute*. Los Banos, Philippines.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 894-900 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

ZBNF : An Ideal Approach to Improve Soil Fertility for Sustainable Agriculture in India

Zaira Shireen Hasan[1] and Darakhshinda Anwer[2]
Department of Agricultural Sciences, Aligarh Muslim University, Aligarh
Email : zaira.hasan656@gmail.com

Abstract

Since long, there have been discussions going on around natural farming. Using chemical farming methods of agriculture is equivalent to deterioration of the soil as well as human health as it extracts away all the essential nutrients and minerals from the soil making it infertile for future cropping. Lesser yield using natural farming methods also sink the farmers into debt leading, especially small and marginal farmers into committing suicides. Zero Budget Natural Farming means expenses on external inputs must be nearly zero. ZBNF, unlike natural farming, is not 100% conventional nor it is like chemical farming which uses high inputs and has high cost of production. ZBNF focuses on how to minimize the cost of production and maximize the productivity. Hence, ZBNF can be seen as a potential in addressing farm distress and an effective approach to help farmers incur their losses. This method promises three economic benefits: reduced costs, increased yields and higher prices but until now, it has met the expectations only in the case of reduced costs. Despite a few drawbacks ZBNF is gradually gaining popularity among the farmers and now we are hoping for better results of success through ZBNF in the future.

Key words : *ZBNF, subhash palekar, pillars of ZBNF, beejamrutha, jeevamrutha, acchadana, whapasa.*

Introduction

'Zero Budget Natural Farming (ZBNF)' is a holistic approach to farming methodologies which promote synthetic-free agriculture that is drawing from conventional Indian practices. Agriculture is the domestication of plants and distribution of techniques for raising them productive. Agriculture in India continues from the ancient civilizations. Earlier people relied on natural input methods for farming such as on farm seeds, stones, handmade plough, natural methods of irrigation like rainwater etc, but with the change in time and development in technologies, agriculture got a completely different framework and besides the natural farming, which was associated to Productiveness Farming, Organic Farming, Sustainable Agriculture, Agro-Ecology, Agro-forestry, Eco Agriculture, Chemical Farming became a need to feed the emerging population. With the introduction of the chemicals, pesticides and fertilizers came the green revolution which undoubtedly was able to feed the surplus demand of the million population, but lately proved to be a disastrous indication for the soil as well as human health, due to its imprudent use in farming and agriculture. Keeping into consideration of all these pros and cons, it became the crucial need to "switch back to the basics" and aim to target natural farming such as to minimize the use of synthetic fertilizers and to cover the huge hungry population! Mr. Subhash Palekar, an Indian agriculturist in the mid 90's, brought a super substitute to the Green Revolution's methods focused by synthetic fertilizers, which is known as 'Zero Budget Natural Farming'.

Evaluating ZBNF : ZBNF is advocated as a response to India's agricultural calamity and soaring rate of farmer self-destruction (Palekar 2005, 2006, n.d). It aims at significantly cutting production costs by finish dependency on all outsides input and credits for farming. ZBNF of course is an innovative model from all aspects. If we think deeply about it, ZBNF is exactly something like *"Aiming back to the basics"*. Talking about Zero Budget Natural Farming (ZBNF) means farming with no external inputs of any sort, concept has emerged, which foregoes the use of any chemical agricultural inputs or foreign materials in favor of a natural farming methodology that emphases on revitalizing soil and crop health through its own procedures (jivamrita; bijamrita; mulching; soil aeration; crop rotation; intercropping; crop diversification; bunds; cropping system; bio-pesticides etc.) (Biswas *et. al.,* 2020). In India, ZBNF movement began in Karnataka from 2002 to 2015, which comprised of and impulsively expanded among peasants with small and middle land holding (Khadse *et. al.,* 2017) and it seeking that increase for India's capacity to generate its own food by farming among environment which has since extended across several parts of the country and it later successfully coverage in several states (specially, of South India) of the country from side-to-side numbers of training, awareness, demonstrations, and various promotional activities (Biswas *et. al.,* 2020; Smith *et. al.*). It has been estimated that around 60,000 to a total of 100,000 farmers have enthusiastically participated in 60 training camps that has been organized above previous 10 years

(Khadse *et. al.,* 2017). The primary factors driving the expansion of ZBNF were collected from the newly emerging literature on agro ecology expansion (Altieri & Nichollas, 2008; Parmentier, 2014; Varghese & Hansen Kuhn, 2013; Wijeratna, 2018 and it was further upgraded by Miery Terán *et. al.,* 2018). They lined up eight major factors that led to ZBNF movement in India :

(i) crises that lead to the search of various opportunities.

(ii) social organization.

(iii) encouraging and effective teaching-learning programs.

(iv) potential agro ecological practices.

(v) mobilizing discourse.

(vi) external allies.

(vii) appropriate market situations.

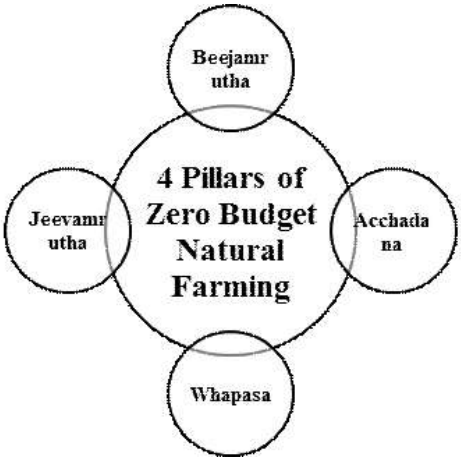
(viii) political opportunities and propitious policies.

Due to the reasons like knowledge gap, availability of seed banks, price support, and marketing issues would remain unresolved, so ZBNF still remains underrated and is facing a lot of challenges and constraints to be adopted on a national scale (Shyam *et al.,* 2019). It reduces farmers' costs through eliminating external inputs and utilizing in-situ resources. This concept was popularized by Padmashri award winner Subhash Palekar from Maharashtra to revitalize the soil, concurrently increasing incomes, reproducing ecosystem/soil health and climate resilience through diverse, multi- layered cropping systems (Anonymous, 2016). It signifies that the need for external financing is zero, and that any costs incurred can be compensated by a varied source of income which comes through farm diversification before dependence on monoculture system (Palekar, 2006). Mr. Subhash Palekar had completed training like an agricultural scientist and began his career primarily emphasizing on input-demanding cultivation for trusted on chemicals and fertilizers. Though, declining yield after its use for more than a decade made him question the practice. This was to examine the technique in detail, and he started experimenting in his personal land where he learnt that the reliance on external inputs can be lessened. After that he started sharing his knowledge with other farmers (Srijit Mishra, 2018).

The state which is on its way to adopt ZBNF : Andhra Pradesh situated in Southeastern Region of India also known as 'India's Rice Bowl' is promoting zero budget natural farming on an extensive scale. In the project of Climate Resilient under Zero Budget Natural Farming (CRZBNF), the Andhra Pradesh government intends to secure all 6 million farmers and 8 million hectares of land in the state by 2027. CRZBNF that is led by Rythu Sadhikara Samstha (RySS) – a non-profit organization established by the Government of AP to accomplish their target on time. It is primarily aimed at making farming viable, protect livelihoods dependent on agriculture and reduce agrarian hardships by reducing costs and maintaining climate-resilient farming practices. The major area of discussion involves the focus on poorest of the poor farmers which comprises of nearly 1.5 million families and the government is ready to provide support to these families by providing them with nutritional and livelihood security for minimum 5 years until they attain sustainable and viable livelihoods (Reddy *et. al.,* 2019). The reason why Andhra Pradesh is encouraging ZBNF on a large scale is because the small land holding farmers (those who cultivate less than 2 ha of land) spent 35% of their cultivation expenditure on insecticide, herbicide and synthetic fertilizers during early 2000s (Government of India, 2005) which became a major cause of farmers' indebtedness (Bharucha *et. al.,* 2020). In the early 2000s, small farmers in Andhra Pradesh earned meagre $154 annually from farming and allied sources (an average annual income of $440 and average expenditure on cultivation of $268) (Thallam *et. al.,* 2009). Consequently, more than 82% of farm households in the state were indebted, with an average outstanding loan amount of $660 per farmer (more than twice the national average of $280) (Centre for Economic and Social Studies, 2007). CRZBNF also gives relaxation in using bio-fertilizers and bio-pesticides (which has been prohibited by Mr. Palekar in ZBNF) so that farmers can rely on this technique and do not incur many losses, therefore we can also call CRZBNF a modified version of ZBNF.

What brings ZBNF to the era of chemical fertilizers?

Green revolution : The green revolution refers to an era when the country's agriculture was transformed into an industrial system due to the implementation of contemporary methods and technology such as the use of High Yielding Variety Seeds, irrigation facilities, tractors, and various synthetic fertilizers. India was able to accomplish self-sufficiency in food (Singh, 2000), by various hybrid techniques, high analysis fertilizers, irrigation facilities etc. but conversely it destroyed the traditional natural farming by making use of the liberal application of inorganic fertilizers and chemicals and much input dependent. Since always India is known for its agricultural diversity (Chand *et. al.* 2009), but due to its massive population India has also suffered a lot in food shortages and has undergone severe food crisis. In the year 1943, when Bengal famine had hit India, approximately 4 million people lost their lives due to hunger. M.S. Swaminathan a very renowned Indian geneticist and administrator, known as "Father of Green



Revolution in India", in the 1960's helped India overcome its food shortage of the million population. To feed this for large population, increased production is urgently needed; however high rising costs and roof top prices are driving farmers into debt (Smith *et. al*., 2020). Green revolution brought a phenomenal increase in food production from 115.6 million tonnes in 1960-61 (Praduman et. al., 2016) to over 281.37 million tonnes in 2018-19 (Annon., 2019). In the Union Budget 2020-21, the Indian Finance minister revised the Zero Budget Natural Farming (ZBNF) with an aim to break the input cost burdens on farmers. Excessive, unnecessary misuse of broods of green revolution has inflicted disaster on the country's food security, ecological balance, and environmental safety. Aiming to ensure food security by reviving Indian agriculture in environmentally safe way while also freeing farmers from debt cycle and suicides, zero budget natural farming (ZBNF) has surfaced, which discards uses of all the chemical farming inputs in favour of a natural way of farming i.e., revitalizing soil and crop healthiness through its own practice.

Green revolution : the inadvisable use of chemical fertilizers

Soil degradation : Presently 147 million ha of land is being degraded in India which includes various factors like water erosion (94 million ha), wind erosion (9 million ha), flooding (14 million ha), acidification (16 million ha) and salinity (6 million ha). Injudicious use of fertilizers and pesticides play a significant role in degrading the quality of soil (Bhattacharya *et. al.,* 2015). The factors that describe soil health integrates biological (microbial activities and respiration), physical (soil texture and water holding capacity of soil) and chemical (pH, EC, salinity, and soil organic matter) but overuse of chemical fertilizers alter these soil properties creating hazardous effects (Baweja *et. al.,* 2020). The inorganic constituent of chemical fertilizers deteriorates the organic and nitrogen composition of soil degenerating the microflora of soil and altering the attributes of various soil organisms. Also, the fertilizers are highly water soluble, and they leaching towards subsoil layers when irrigation is applied to the soil altering its characteristic properties. The presence of fertilizers and pesticides lowers the soil pH causing acidification and these acids accelerates the dissolution of mineral rich soil crumbs which are required for soil drainage. This results in highly compacted soil with reduced drainage and air circulation (Baweja *et. al.,* 2020). Generally the residues of fertilizers and pesticides are left in the water, contaminating the soil and deteriorating the quality of ground water. This necessitates to be managed via appropriate application of water, bio-fertilizers and organic manure (Natraj and Katyal 2014).

Human health : It is a common practice in developing countries that farmers do not pay much attention towards safety masks, gloves, and other protective gears during the spraying of pesticides. This allows the pesticides to enter the blood stream through inhalation and skin exposure affecting their vital organs and respiratory system (Bhandari, 2014; Sharma and Singhvi, 2017). Farmers are exposed to significant doses of chemicals on a regular basis, usually at a higher level than consumers (Damalas and Koutroubas, 2016). Farmers exposed to pesticides for 18 months stated the most intense signs and symptoms, including eye burning/stinging (18.42%), impaired vision (23.68%), skin redness/itching (50%) and excessive sweating/shortness of breath (34.2%) thus farmers must be made aware of the importance of wearing protective gear when handling pesticides (Choudhary 2014; Sharma and Singhvi, 2017).

4 Pillars of ZBNF

Bijamrita/Beejamrutha : The framework of beejamrutha consists of cow dung is 5 kg, urine is 5 lit, lime is 50 g and a hand full of soil mixed in 20 litre waters stored in a tank for the purpose of seed treatment (Bishnoi et al, 2018; Korav *et al,* 2020). The presence of constructive bacteria in Beejamrutha are assumed for protection the crop from hazardous soil and seed borne diseases. Microbes obtained by Beejamrutha are also capable of fixing atmospheric nitrogen, phosphate solubilization and production of IAA and GA (Sreenivasa *et al,* 2009). The existence of advantageous microbes' chiefly bacteria, yeast, actinomycetes, photosynthetic bacteria and few species of fungi are identified in cow dung (Swaminathan, 2005) which is an essential element of beejamrutha. The highest microbial load in beejamrutha is of bacteria which accounts nearly 15.4×10^5 cfu/ml followed by fungi (10.5×10^3 cfu/ml) then actinomycetes (6.8×10^3 cfu/ml) and lastly

N_2 fixers constituting nearly 3.1 x 10^2 cfu/ml (Sreenivasa *et al,* 2009).

Jivamrita/Jeevamrutha : It is homemade bio-dynamic formulation fermented microbial culture or bio-fertilizer made of water, cow dung, and urine, jaggery, legume flour, and a handful of soil as an inoculum of micro-organisms and these are a plant growth-promoting substance (Biswas *et al.,* 2020; Shreya Das *et al.,* 2020). Jivamrita meaning 'life tonic', acts as a catalytic agent that enlivens the soil, increasing microbial activity and organic matter. Jivamrita also aids in prevention of bacterial and fungal growth (Sarma and Prasada, 2016). Palekar mentions using jivamrita promotes significantly increases earthworm activity, he also discusses that merely the dung and urine of native cows (*Bos indicus*) should be used for production of jivamrita since it has a superior microculture to that of introduced European breeds. The soil is a treasure box of all nutrients which is unlocked by micro-organisms when their activities get improved by application of *Jivamrita/Jeevamrutha* (or 'nectar of life'). that there is no need for external application of fertilizers. It also checks several diseases which are soil borne. There exist two types of jivamrita; the moist form prepared as a slurry, "dhrava jivamrita", and the dry form prepared for storage up to one year at least, "ghana jivamrita" (Smith *et al.,* 2020).

Acchadana/mulching : Acchadana means mulching. ZBNF includes many types of mulching like soil mulch, straw mulch, or live mulch. There are several benefits of covering the soil with dust or plant materials (Acchadana/mulching). It protects the topsoil from erosion also it improves soil aeration and conserves soil (Biswas *et al.,* 2020). Organic mulches like dried plants produces humus on decomposition, and releases nutrients to the crop. Live mulch (using different plants) is helpful as different nutrients can be added in the soil (monocots supply potassium, phosphorus etc. while dicots or legumes fix atmospheric nitrogen). Types of mulching according to Palekar are stated below:

a.Soil Mulching : The protection of surface soil during the ploughing and avoidance of tillage practice. This method is used for promoting aeration and water retention to the soil.

b.Straw Mulching : Straw material usually refers to the addition of straw to the soil or addition of dried biomass waste of previous crops cultures throughout the action of the soil biota triggered by jivamrita, to improve decomposition and humus formation (Sarma and Prasada, 2016).

c.Live Mulching : Live mulching is like cover crops: inter-cropping of monocots and dicots, cultivated in the same field, to ensure that the soil and crops have all of the necessary elements (Palekar 2006). It has been observed that most of the ZBNF farms have abundant straw mulch, when lifted exhibits a microclimate and insect group that are very different from those observed in unmulched locations (Smith *et al.,* 2020; Srijit Mishra, 2018).

Whapasa : Whapasa stands for water vapour. Palekar strongly rejects the idea of over irrigation as the percentage of air and water filled pores in the soil are equal. Greater amount of water application will lead to the displacement of air by water which might become a principal reason for the deficiency of oxygen in the soil causing death of the plant. For optimum whapasa growth, he suggested that watering only when the sun is extreme at noon, i.e, irrigation should be scheduled only at midday. Irrigation should be minimized and in substitute furrows. Palekar also believes that ZBNF activities will reduce water use by up to 90 percent, making it suitable for rain-fed farming (Palekar 2006).

Pest Management through ZBNF : Approximately 30% of total crop yield is lost due to pest infestation annually. Palekar suggested various homemade preparations for insect and and pest management which are agniastra, neemastra and brahmastra (Palekar, 2005).

Name (Management Formulae)	Constituents	Effective Against
Agniastra	It consists as 'local cow urine is 10 liters; tobacco is 1 kg; local garlic is 500 grams; green chili is 500 grams; neem leaves pulp is 5 kg'. The amount of Agniastra is 2l that is taken in 100 lit of water for spraying.	This works well against pests such as Leaf Roller and various types of borers.
Brahmastra	These are made through 'neem leaves, custard apple leaves, lantern camellia leaves, guava leaves, pomegranate leaves, papaya leaves, and white dhatura crushed leaves and then boiled in the water'.	It controls all the sucking rodents, and various types of borers, etc.
Neemastra	In Neemastra, the contains of '24 hours fermented local cow urine (5 lit), cow dung (5 kg), and neem leaves and neem pulp (5 kg)'.	It is used to suck pests & Mealy worm.

Other practices of ZBNF

Inter-cropping / Multiple Cropping or Mixed Cropping and Crop Rotation : Inter-cropping is cultivation of two or more monocot or dicot plants or, long or short life span species in a definite row arrangement together on a land

at a time. It protects the soil from nutrients and moisture exhaustion.

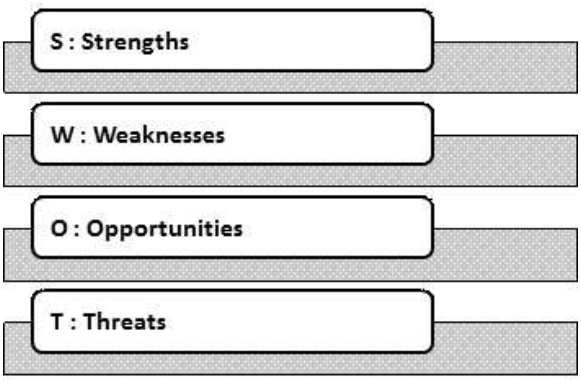
Inter-cropping helps to enhance farmers' income or provide subsistence in case of main crop failure. Leguminous crops, millets, cereals, vegetables, fruit trees, medicinal plants etc. form the component crops of inter-cropping system (Biswas *et al.,* 2020). Diversification of cropping system is another important practice of ZBNF as it breaks the habitat and consequently the build-up of pests and diseases.

Bunds and Contours : Bunds and contours are constructed with to help harvest and preserve rainwater and provide maximum efficacy for crop production.

Indigenous Earth Worm Species : Palekar totally resists the utilization of vermicompost. He insists revival of local deep soil earthworm species which can expeditiously enhance soil fertility when any organic matter is added to the soil and there is no particular need of use of external vermicompost (Sarma, Prasada, 2016; Biswas *et al.,* 2020). He also stated that exotic earth worm species specially, *Eisenia foetida* is dangerous as it absorbs toxic metals and contaminates ground water and soil.

Cow dung : The dung and urine of indigenous humped cow have greater concentration of microbes and are beneficial compared to exotic cow breed like *Holstein* (Sarma and Prasada, 2016).

SWOT Analysis of ZBNF : SWOT analysis of ZBNF defines 'Strengths, Weaknesses, Opportunities and Threats (SWOT)', is an evaluation of outside and inside environment together. There is a need to examine the ZBNF in multidimensional view before going to take it in large scale implementation, SWOT analysis of ZBNF throw a light on different perspectives and helps to understand the complete picture of it instead of one side of the coin i.e., its benefits (reduced cost of cultivation) and hence it important to do the SWOT analysis (Nayana and Veni *et al.,* 2021). SWOT analysis will also help in decision making and policy formulation for large scale implementation of ZBNF.



Benefits of ZBNF

Strength saves the farmer from debts as it shrinks the cost of cultivation and thus leading to increase in the net income (Nayana, Veni et. al., 2021).

This is to enhance soil fertility by promoting crop rotation and encourage the growth of beneficial micro-organisms like bacteria and earthworms (Palekar, 2006).

Strength in ZBNF is to realize to fetch high price for ZBNF produce because of using chemical-free inputs.

Andhra Pradesh farmers have reported enhanced soil fertility (Galab et. al., 2019).

Promotion of mulching reduces environmentally damaging practices like residue burning, multiple aeration method which reduces methane emissions from paddy fields (Suresh et al., 2020).

A very high opportunity to rural youth and especially rural women as an entrepreneurship for supplying ZBNF inputs through ZBNF input shops and possible sources. Hence can look ZBNF as an entrepreneurship avenue for their career.

Limitations of ZBNF

Farmers encounter a variety of restrictions including the availability of inputs, labour and markets. The labour requirement in ZBNF is high and as the labour wage is on a rise, expecting farmers to embrace more labour-intensive farming practices may not be a feasible alternative (Reddy et. al., 2019).

The requirement of animal manure in ZBNF is quite high and the present quantity of indigenous cattle in India is not up to the mark to support this degree of manure application on a country wide basis (Korav et. al., 2020).

Farmers must struggle in large markets to acquire a premium price for their organic products which discourages the farmers from adapting this technique (Reddy et. al., 2019).

The initial years of ZBNF are very challenging for the farmers as the yield rates tend to decline for approximately first three years leaving the farmers in huge losses and debts. The management of pests in ZBNF is quite difficult and loss of crops manifests at huge level. In the case of vegetable crops like brinjal and beans, it has been recorded that many farmers have turned against this practice and continued with chemical farming (Reddy et. al., 2019).

Also, there is no scientific acceptance for the various methods prescribed in ZBNF. The efficacy and influence of jeevamrutha, beejamrutha, brahmastra and agniastra

have yet to be evaluated, and there is no scientific evidence to support it (Korav et al., 2020).

Conclusions

ZBNF is slowly acquiring attention in the society. The governments of some states like A.P., Kerala and H.P. are supporting this technique on a big scale for the betterment of farmers as well as the environment. As the production cost in ZBNF is much lower than in chemical farming, the farmers have also taken an interest in this opportunity. The new agricultural system has released farmers' credit trap and the system has provided them a newfound sense of trust to grow. A survey carried out by 'LVC or La Via Campesina' has demonstrated the enthusiastic spirit of farmers towards the ZBNF (Anonymous., 2013).

"I am very much inspired by the teaching of Subhash Palekar that agriculture can be done without any cost. I understood that Green Revolution model of agriculture is not in benefit of the farmer and Farmer must take care of soil by mulching, jeevamrtham application and proper aeration. Soil is Annapurna (rich in nutrients) and it doesn't require anything from outside. I resolved to do Zero budget Natural Farming."

Bangaru Pothalaia, Farmer, Thopudurthi village, Anantapur district in Andhra Pradesh (Anonymous, 2013).

"In ZBNF our expenses are very low. It doesn't matter what the yield is, I still make a profit because my costs are negligible. Plus, I've added inter crops to this, so I get income from many crops and not just one. Yield is not an important concept for us."

ZBNF Farmer, Belgaum, Karnataka (Anonymous., 2013). Besides all the positive aspects, ZBNF has not received any scientific scrutiny yet. The scientists and researchers need to examine the various components of ZBNF like beejamrutha and jeevamrutha thoroughly and come up with modified version of ZBNF which would amplify the yield. This would decrease the number of farmers who turn against ZBNF when compelled with low yield. Despite all the challenges and hurdles, ZBNF has surely made an unbelievable footprint in Indian agriculture. This strategy has benefited over 40 lakh farmers across the country and is certain that in the forthcoming years this number is going to expand enormously.

References

1. Altieri, M., and C. Nicholls. 2008. Scaling up agroecological approaches for food sovereignty in Latin America. *Development* 51: 472–80. doi:10.1057/dev.2008.68.
2. Anonymous, 2013. Case study provided by La Via Campesina Contact lvcweb@viacampesina.org
3. Anonymous. 2016. "Venkaiah Naidu congratulates farmer on winning Padma Shri". *Indian Express*.
4. Anoy, 2019. Press Information Bureau (PIB), Ministry of Agriculture, Government of India. Retrived from https://pib.gov.in/newsite/PrintRelease.aspx?relid=189003.
5. Bhandari, G. 2014. An Overview of Agrochemicals and Their Effects on Environment in Nepal. *Applied Ecology and Environmental Sciences*, 2(2): 66-73.
6. Bishnoi, Ruchi and Aksaya Bhati (2017), "An Overview: Zero Budget Natural Farming", *Trends in Biosciences,* Vol.10, No.46.
7. Biswas, S., 2020. "Zero Budget Natural Farming in India: Aiming Back to the Basics". *International Journal of Environment and Climate Change* 10(9): 38-52, 2020; Article no.IJECC.59278 ISSN: 2581-8627.
8. Centre for Economic and Social Studies. (2007). Human development report 2007 Andhra Pradesh. Retrieved from https:// www.undp.org/content/dam/india/docs/human_revelop_ report_andhra_pradesh_2007_full_report.pdf
9. Chand, R., Garg, S. and Pandey, L., 2009. "*Regional Variations in Agricultural Productivity A District Level Study"*, Discussion Paper, National Centre for Agricultural Economics and Policy Research (Indian Council of Agricultural Research). New Delhi, p.1.
10. Choudhary, A., Ali, A.S. and Ali, S.A. 2014. Adverse Health Effects of Organophosphate Pesticides among Occupationally Exposed Farm Sprayers: A Case Study of Bhopal Madhya Pradesh, India. *Asian Journal of Biomedical and Pharmaceutical Sciences*, 4(35): 29-34.
11. Damalas, C.A. and Koutroubas, S.D. 2016. Farmers' Exposure to Pesticides: Toxicity Types and Ways of Prevention. *Toxics,* 4(1),1.https://doi.org/10.3390/toxics4010001.
12. Das, S., 2020. "Zero Budget Natural Farming- A holistic alternative towards sustainable agriculture". *Agriculture & Food: E-Newsletter* Article ID: 31200. DOI: 10.9734/IJECC/2020/v10i930228.
13. Galab, S., Prudhvikar, R.P., Sree Rama Raju, D., Ravi, C., Rajani, A., 2019. "Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh Kharif 2018- 19 - A comprehensive Approach using Crop Cutting Experiments". *Centre for Economic and Social Studies Nizamiah Observatory Campus, Begumpet, Hyderabad.* August 2019, pp. 21-22.
14. Khadse, A., & Rosset, P.M. (2019). Zero budget natural farming in India: From inception to institutionalization. *Agroecology and Sustainable Food Systems*, 43(7–8), 848–871.
15. Khadse, A., Rosset, P.M., Morales, H., & Ferguson, B.G. (2017). Taking agroecology to scale: The Zero Budget Natural Farming peasant movement in Karnataka, India. *The Journal of Peasant Studies*, 45(1), 192–219.
16. Khadse, Ashlesha; Peter Michael Rosset, Helda Morales and Bruce G. Ferguson (2018), Taking Agroecology to Scale: the Zero Budget Natural Farming peasant movement in Karnataka, India, *The Journal of Peasant Studies,* 45:1, 192-219, (DOI: 10.1080/03066150.2016.1276450).
17. Korav, S., Dhaka A.K., Chaudhary A. and Mamatha Y.S,

2020. "Review- Zero Budget Natural Farming a Key to Sustainable Agriculture: Challenges, Opportunities and Policy Intervention". *Indian Journal of Pure and Applied Biosciences,* (2020) 8(3), 285-295. DOI: http://dx.doi.org/10.18782/2582-2845.8091.

18. Miery Terán Giménez Cacho, M., Giraldo, O.F., Aldasoro, M., Morales, H., Ferguson, B.G., Rosset, P., Campos, C. (2018). Bringing agroecology to scale: Key drivers and emblematic cases. *Agroecology and Sustainable Food Systems*, 42(6), 637– 665.
19. Mishra, Srijith., 2018. "Zero Budget Natural Farming: Are This and Similar Practices The Answers". *Nabakrushna Choudhury Centre for Development Studies (an ICSSR institute in collaboration with Government of Odisha)* Bhubaneswar, Odisha.
20. Natraj, V.M. and Katyal, D. 2014.Study of Fertilizer Effect on soil status in and around Loni, Maharashtra, India. *Applied Sciences, Engineering and Technology,* 13: 188-192.
21. Nayana and Veni, 2021. "SWOT Analysis of Zero Budget Natural Farming". *Biotica Research Today* 3(6): 547-549.
22. Palekar, S. (2005), *The Philosophy of Spiritual Farming I* (2nd Ed.) Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra.
23. Palekar, S. (2006), *The Principles of Spiritual Farming II* (2nd Ed.) Amravati: Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra.
24. Palekar, S. (2016), Zero Budget Spiritual Farming (online), *http://bit.ly/1Pk3a8p.*
25. Parmentier, S. 2014. *Scaling-up agroecological approaches: What, why and how?* Belgium: Oxfam Solidarity.
26. Praduman, K., Joshi, P.K. and Mittal, S. 2016. "Demand vs Supply of Food in India - Futuristic Projection". (in) *Proceedings of the Indian National Science Academy.* 82 No. 5 December. pp 1579-1586.
27. Ranjan Bhattacharyya, Birendra Nath Ghosh, Prasanta Kumar Mishra, Biswapati Mandal, Cherukumalli Srinivasa Rao, Dibyendu Sarkar, Krishnendu Das, Kokkuvayil Sankaranarayanan Anil, Manickam Lalitha, Kuntal Mouli Hati and Alan Joseph Franzluebbers (2015). "Soil Degradation in India: Challenges and Potential Solutions". *Sustainability 2015*, 7, 3528-3570; doi:10.3390/su7043528.
28. Reddy, B.G., Reddy, V.R., Reddy,M.S.2019. Potential and Constraints of Zero Budgeted Natural Farming (ZBNF): A Study of Andhra Pradesh. *Indian Journal of Agricultural Economics*, Vol.74, No.3.
29. Sarma, Prasada. 2016. "Campaign to Reduce Use of Chemical Fertilizers, Pesticides." *The Hindu*, May 28 http://bit.ly/1tpq0rT.
30. Sharma, N., and Singhvi, R. 2017. "Effects of Chemical Fertilizers and Pesticides on Human Health and Environment: A Review." *International Journal of Agriculture, Environment and Biotechnology*, DOI: 10.5958/2230-732X.2017.00083.3.
31. Shyam, D. M., Dixit, S., Nune, R., Gajanan, S., and Chander, G. 2019. "Zero Budget Natural Farming-An empirical analysis". *International Journal of Applied Agricultural & Horticultural Sciences.* Vol. (6) 661-667 ; November-December, 2019.
32. Singh, R.B., 2000. "Environmental Consequences of Agricultural Development: A Case Study from the Green Revolution State of Haryana, India". *Agriculture, Ecosystems and Environment,* 82, 1-3, pp. 97-103.
33. Smith, J., Yeluripati, J., Smith, P., & Nayak, DR. (2020). Potential yield challenges to scale-up of zero budget natural farming. *Nature sustainability,* Analysis: 1-6.
34. Sreenivasa, M.N., Nagaraj Naik, and S.N. Bhat. 2009. "Beejamrutha: A Source for Beneficial Bacteria." *Karnataka Journal of Agricultural Sciences* 22 (5). University of Agricultural Sciences: 1038–40.
35. Suresh, N.S., Anantha Lakshmi Paladugula, Arunita Bose, Spurthi Ravuri, Arjun Shanker, Haritha, H., 2020. "Life Cycle Assessment of ZBNF and Non-ZBNF: A Preliminary Study in AP". Retrived from *https://cstep.in/drupal/node/932.*
36. Swaminathan, C., 2005. Food production through vrkshayurvedic way. *Technologies for natural farming.* Agriculture College & Research Institute, Madurai, Tamilnadu, India. pp:18-22.
37. Thallam, V., Raidu, D. V., Killi, J., Pillai, M., Shah, P., Kalavakonda, V., & Lakhey, S. (2009). *Ecologically sound, economically viable: Community managed sustainable agriculture in Andhra Pradesh, India*. Washington, DC: The World Bank Retrieved from http://documents.worldbank.org/curated/en/805101468267916659/pdf/759610WP0P118800agriculture0AP02009.pdf
38. Varghese, S., and K. Hansen-Kuhn. 2013. Scaling Up agroecology. Towards the realization of the right to food. *Institute for Agriculture and Trade Policy.*
39. Wijeratna, A. 2018. Agroecology Scaling Up, Scaling Out. Action Aid.
40. Zareen Pervez Bharucha, Sol Bermejo Mitjans & Jules Pretty (2020). Towards redesign at scale through zero budget natural farming in Andhra Pradesh, India, *International Journal of Agricultural Sustainability*, 18:1, 1-20, DOI: 10.1080/14735903.2019.1694465.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 901-906 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

To Study on Correlation Coefficient and Path Analysis for Yield and its Components in Wheat (*Triticum aestivum* L. em. Thell)

Aditya Kumar, Vimlesh Kumar, P.N. Singh and S.C. Gaur
Department of Genetics and Plant Breeding, Baba Raghav Das P. G. College, Deoria-274001 (U.P.)
Corresponding Author Email : scgaur101@gmail.com

Abstract

A study was undertaken to estimate the correlation coefficient and path analysis of yield and yield contributing traits in 20 wheat cultivars grown in Randomized Block Design with three replications at Research farm, B.R.D.P.G. college Deoria, U.P, during rabi season 2020-21. The 14 characters studied were days to 50% flowering, flag leaf area (cm^2), plant height (cm), days to maturity, spike length (cm), number of spikelets per spike, number of productive tillers per plant, peduncle length, number of grains per spike, Test weight (1000 grain) (g), biological yield per plant (g), grain yield per plant (g), grain yield per spike (g) and harvest index (%). The correlation coefficient estimate show at phenotypic level, Grain yield per plant showed highly significant and positive association with harvest index, number of spikelets per spike and grain weight per spike. The genotypic correlations were generally similar in nature and higher in magnitude then the corresponding phenotypic correlations. Plant height (cm) had highly significant and positive correlation with spike length; and no. of productive tillers was found highly significant and positive correlated with biological yield, days to maturity exhibited highly significant and positive correlation with harvest index, peduncle length exhibited highly significant and negative correlation with spike lengths. Existence of highly significant positive correlation amongst yield and important yield components suggested that selection would be high effective and efficient in improving these traits due to possibility of correlated response. The path-coefficient analysis, carried out at genotypic as well as phenotypic level identified, days to 50% flowering, plant height, spike length, test weight, biological yield and Harvest Index as the major direct positive contributors towards expression of grain yield per plant, while Number of grains per spike, grain weight per spike as most important indirect yield component. The characters identified above as important direct and indirect yield components merit due to consideration in formulating effective selection strategy for developing high yielding varieties in wheat.

Introduction

Wheat (*Triticum aestivum* L. em. Thell; 2n=6x=42), a self-pollinated crop of the *Germaine* family (sub-family *poaceae*) and *genus*, is the world's largest famous energy rich cereal crop. IT has been described as the "King of the cereals" because of the acreage it occupies high productivity and the prominent position it holds in the international food grain trade. It is a C^3 plant grown from temperate, irrigated to dry and high-rain-fall areas and from war, humid to dry, cold environments Undoubtedly, this wide adaptation has been possible due to the complex nature of the plants genome which provide great plasticity to the crop. The bread wheat belongs to family Gramineae and it is a hexaploid species with (2n=6x=42) having AABBDD with A, B and D genome. The species of bread wheat may be divided into diploid, tetraploid and hexaploid species with chromosome number 2n= 14=AA, 2n=14=BB, 2n=4x=28=AABB and 2n=6x=42=AABBDD respectively with basic chromosome number(x)=7 (Sleper and Poehlman; 2006). Correlation coefficient analysis appears to be a very useful approach for determining how various yield variables interact. This parameter also provides estimates of the interdependencies between grain yield and other qualities, as well as amongst themselves. This would make it easier for breeders to adopt successful selection techniques for increasing yield. By separating the correlation coefficient of grain yield and the concerned trait, path coefficient analysis determines the level of direct and indirect effect of independent variables on a dependent variable. As a result, path coefficient analysis has become the most widely used and useful statistical method for this purpose, and it can also be used to estimate the quantitative impact of direct and indirect effects caused by one or more components of grain yield, as well as the relationship between these components.

Materials and Methods

The field experiment under present investigation was conducted during *Rabi* 2020-21 at Agriculture Research farm of Baba Raghav Das Post Graduate College Deoria (U.P.). Geographically, this College is located in the east part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 68 meter (223 feet) above the mean sea level. The climate of district Deoria is semi-arid with hot summer and cold winter nearly 80% of total rain fall is received during the monsoon (only up to September) with a few showers in the winter. 20 different genotypes of wheat were sown during Rabi

season 2020-21 in Randomized Block Design with 3 Replications. The row-to-row distance was maintained at 23cm. Estimation of correlation coefficient between different characters were estimated according to Searle (1961). Path coefficient analysis was carried out according to Dewey and Lu (1959).

Results and Discussion

The estimation of phenotypic, genotypic and environmental correlation coefficients is computed among 14 characters of indigenous lines of wheat under study are presented in Table-1 (a) and 1(b). At phenotypic level plant height has exhibited highly significant and positive correlation with spike length (0.636) while positive correlation with Tiller per plant (0.603) and Test weight (0.541 whereas high significant and negative correlation with number of peduncle length (-0.171.) Days to 50% flowering has shown highly significant and positive correlation with number of spikelets per spike (0.430) and harvest index% (0.403) while highly significant and negative correlation with flag leaf area (-0.389) and Days to maturity (-0.102). Days to maturity has shown significant and positive correlation with Harvest index (0.549), Biological yield (0.486), and Spike length (0.449) while significant and negative correlation with Peduncle length (-0.065). Flag leaf area has denoted highly significant and positive correlation with Days to maturity (0.289), biological yield per plant (0.212), Peduncle length (0.174) and spike length (0.171) while significant and negative correlation with number of spikelets per spike (-0.154) and Grain weight per spike (-0.189). Peduncle length has shown moderate significant and positive correlation with Test weight (0.287) and No. of spikelets per spike (0.217) while significant and negative correlation with spike length (-0.152). Spike length per plant has shown highly significant and positive correlation with number of spikelets per spike (0.518), grain weight per spike (0.425), biological yield per plant (0.345) ,grain yield per plant (0.336) while significant and negative correlation with number of productive tillers (-0.216). Number of productive tillers has exhibited highly significant and positive correlation with biological yield per plant while highly significant and negative correlation with number of spikelets per spike (-0.322). Number of grains per spike has shown highly significant and positive correlation with grain weight per spike (0.540), number of spikelets per spike (0.508) ,harvest index (0.417) and grain yield per plant (0.308) while moderate significant and negative correlation with test weight (-0.278). Grain weight per spike has shown highly significant and positive correlation with number of spikelets per spike (0.433), harvest index (0.400), grain yield per plant (0.377) and significant and negative correlation with test weight (- 0.099). Number of spikelets per spike has shown highly significant and positive correlation with grain yield per plant (0.254) while significant and negative correlation with test weight (-0.140). Test weight has shown significant and positive correlation with biological yield per plant (0.130), harvest index (0.004) and grain yield per plant (0.113) while there is no negative correlation. Biological yield per plant has shown highly significant and positive correlation with grain yield per plant (0.765) while significant and negative correlation with harvest index (-0.126). Harvest index has shown highly significant and positive correlation with grain yield per plant (0.540) while negative correlation is not availed. The estimates of genotypic correlation coefficient between different characters showed close parallelism in direction with their corresponding phenotypic correlation coefficients. The genotype correlations were higher in magnitude then corresponding correlations at phenotypic level. At phenotypic days to 50% flowering exhibited highly significant and positive correlation with flag leaf area, number of spikelets per spike and harvest index, Plant height exhibited highly significant and positive correlation with spike length (cm), number of productive tiller per plant and test weight, Flag leaf area(cm^2) had highly significant and positive correlation with days to maturity, biological yield and spike length, Number of productive tiller per plant showed highly significant and positive correlation with Number of spikelets per spike and biological yield, Days to maturity exhibited highly significant and positive correlation with harvest index, biological yield and spike length, Peduncle length exhibited highly significant and positive correlation with test weight and number of spikelets per spike, Spike length was found highly significant and positive correlated with number grain per spike and biological yield, Number of spikelets per spike exhibited highly significant and positive correlation with grain weight per spike and harvest index, Number of grains per spike exhibited highly significant and negative correlation with biological yield, the Grain weight per spike exhibited highly significant and positive correlation with harvest index, Test weight (1000 grain) exhibited highly significant and positive correlation with harvest index and Biological yield per plant (g) exhibited highly significant and positive correlation with harvest index . Thus, harvest index and grain yield per plant emerged as closely correlated yield attributes. The strong positive association of grain yield with one or more of the above traits has also been observed by previous workers (Subhani, 2000; Ayceek and Yildirim 2006; Chaitali and Bini, 2007; Singh *et al.* 2008 Anwar *et al.,* 2009; Aydin *et al.,* 2010; Zaeifizdeh *et al.,* 2011; Vimal, S.C. *et al.,* 2016; Sidhu and Gill, 2019; Tarkeshwar *et al*., (2020); Gautam *et al*., (2021). The above discussion revealed that all the highly significant estimates of correlation coefficient observed

Table-1a : Estimates of Phenotypic correlation coefficients computed between 14 characters of indigenous lines of wheat.

S.No.	Characters	Days to 50% flowering	Plant hight (cm)	Flag leaf area	N0. 0f productive tiller	Days to maturity	Peduncle length (cm)	Spike lenght	No. of spiklets/ spike	N0.0f grain/ spike	Grain weight/ spike	Test weight (1000 grain)	Biological yield (g)	Harvest index(%)
1.	Day's to 50% flowering	1.0000	-0.071	-0.389**	0.285	-0.102**	0.232	0.011	0.430**	0.240	0.360	0.401	0.184	0.403**
2.	Plant hight(cm)		1.0000	0.138	0.603**	0.461	-0.171**	0.636**	0.527	0.517	0.415	0.541**	0.450	0.525
3.	Flag leaf area			1.000	0.101	0.289**	0.174	0.171**	-0.154	-0.045	-0.189	-0.077	0.212**	-0.0782
4.	N0.0f productive tiller				1.0000	0.504	0.146	0.660	0.694**	0.747	0.609	0.670	0.696**	0.761
5.	Days to maturity					1.0000	-0.065**	0.449**	0.332	0.367	0.398	0.294	0.486**	0.549**
6.	Peduncle length						1.0000	-0.152**	0.217**	0.041	0.152	0.287**	0.141	0.223
7.	Spike length							1.0000	0.398	0.647**	0.363	0.512	0.599**	0.391
8.	No.of spiklets/spike								1.0000	0.834	0.920**	0.843	0.736	0.857**
9.	No. of grain/spike									1.0000	0.721	0.733**	0.813**	0.677
10.	Grain weight/spike										1.0000	0.743	0.705	0.837**
11.	Test weight (gm)											1.0000	0.576	0.799
12.	Biological yield/plant (g)												1.0000	0.593
13.	Harvest index (%)													1.0000
14.	Grain yield / plant (G)	0.363	0.570	0.033	0.829	0.580	0.203	0.545	0.899	0.815	0.866	0.796	0.832	0.938

*, ** significant at 5% and 1% level, respectively.

Table-1B : Estimates of Genotypic correlation coefficients computed between 14 characters of indigenous lines of wheat.

S. No.	Characters	Days to 50% flowering	Plant hight (cm)	Flag leaf area	N0. 0f productive tiller	Days to maturity	Peduncle length (cm)	Spike lenght	No. of spiklets/spike	N0.0f grain/ spike	Grain weight /spike	Test weight (1000 grain)	Biological yield (g)	Harvest index (%)
1.	Day's to 50% flowering	1.0000	-0.084	-0.424	0.324	-0.132	0.266	0.014	0.486	0.300	0.379	0.432	0.231	0.430
2.	Plant hight (cm)		1.0000	0.143	0.715	0.581	-0.180	0.685	0.588	0.613	0.424	0.597	0.512	0.597
3.	Flag leaf area			1.0000	0.106	0.316	0.184	0.174	-0.160	-0.0492	-0.194	-0.087	0.210	-0.079
4.	N0.0f productive tiller				1.0000	0.533	0.181	0.693	0.741	0.836	0.683	0.711	0.779	0.823
5.	Days to maturity					1.0000	-0.038	0.488	0.343	0.421	0.457	0.301	0.538	0.805
6.	Peduncle length						1.0000	-0.148	0.263	0.046	0.145	0.300	0.161	0.237
7.	Spike length							1.0000	0.395	0.686	0.372	0.522	0.653	0.387
8	No.of spiklets/spike								1.0000	0.899	0.966	0.875	0.798	0.888
9.	No. of grain/spike									1.0000	0.795	0.791	0.920	0.731
10.	Grain weight/spike										1.0000	0.760	0.759	0.856
11.	Test weight (gm)											1.0000	0.609	0.825
12	Biological yield / plant (g)												1.0000	0.676
13.	Harvest index (%)													1.0000
14.	Grain yield / plant (G)	0.399	0.603	0.026	0.886	0.624	0.213	0.550	0.926	0.874	0.880	0.809	0.866	0.9521

*, ** significant at 5% and 1% level, respectively

Table-2A : Direct and indirect effects of different characters on grain yield per plant in wheat germplasm Phenotypic PATH matrix of Grain Yield/ Plant (gm).

	Day's to 50% flowering	Peduncle length (cm)	Flag leaf area	No. of productive tiller	Day's to maturity	Peduncle length (cm)	Spike length (cm)	No. 0f spiklets/ spike	N0.0f grain /spike	Grain weight/ spike	Test weight (g)	Biologica l yield (g)	Harvest index (%)
Day's to 50% flowering	0.0190	-0.0013	-0.0074	0.0054	-0.0020	0.0044	0.0002	0.0082	0.0046	0.0069	0.0076	0.0035**	0.0077
Plant height(cm)	-0.0017	0.0245	0.0034	0.0148	0.0113	-0.0042	0.0156	0.0129	0.0127	0.0102	0.0133	0.0110**	0.0129**
Flag leaf area (cm^2)	0.0015	-0.0005	-0.0037	-0.0004	-0.0011	-0.0007	-0.0007	0.0006	0.0002	0.0007	0.0003	-0.0008	0.0003
N0. Of produvtive tiller	-0.0015	-0.0032	-0.0005	-0.0053	-0.0027	-0.0008	-0.0035	-0.0037	-0.0040	-0.0032	-0.0036	-0.0037	-0.0041
Day's to maturity	0.0018	-0.0082	-0.0051	-0.0089	-0.0177	0.0012	-0.0080	-0.0059	-0.0065	-0.0071	-0.0052	-0.0086	-0.0097
Peduncle length (cm)	0.0002	-0.0002	0.0002	0.0001	-0.0001	0.0010	-0.0001	0.0002	0.0000	0.0001	0.0003	0.0001	0.0002
Spike length (cm)	0.0004	0.0202	0.0055	0.0209	0.0142	-0.0048	0.0317	0.0126	0.0205	0.0115	0.0163	0.0190	0.0124
No.of spiklets/spike	-0.0008	-0.0010	0.0003	-0.0013	-0.0006	-0.0004	-0.0008	-0.0019	-0.0016	-0.0018	-0.0016	-0.0014	-0.0016
No.of grain/spike	0.0004	0.0009	-0.0001	0.0013	0.0006	0.0001	0.0011	0.0014	0.0017	0.0012	0.0012	0.0014	0.0011
Grain weight/spike	-0.0100	-0.0116	0.0053	-0.0170	-0.0111	-0.0043	-0.0101	-0.0256	-0.0201	-0.0278	-0.0207	-0.0196	-0.0233
Test weight (1000 grain)	-0.0091	-0.0123	0.0017	-0.0152	-0.0067	-0.0065	-0.0116	-0.0191	-0.0166	-0.0168	-0.0226	-0.0131	-0.0181
Biological yield (g)	0.0780	0.1909	0.0898	0.2951	0.2061	0.0601	0.2541	0.3120	0.3446	0.2988	0.2444	0.4236	0.2514**
Harvest index (%)	0.2857	0.3724	-0.0555	0.5400	0.3897	0.1585	0.2774	0.6078	0.4799	0.5934	0.5665	0.4207	0.7088
Grain yield/plant (g)	0.3638	0.5706	0.0337	0.8295	0.5801	0.2036	0.5453	0.8995	0.8154	0.8661	0.7961	0.8321	0.9380

R Square = 0.9984 Residual Effect = 0.0403

Table-2B : Direct and indirect effects of different characters on grain yield per plant in wheat germplasm.

Characters	Days to 50% flowering	Plant height (cm)	Flag leaf area (cm^2)	No. of Productive tiller Per plant	Days to maturity	Peduncle length (cm)	Spike Length (cm)	No. of Spikelets Per spike	No. of Grain per spike (g)	Grain Weight Per spike	Test weight (1000 Grain) (gm)	Biolog ical yield / plant (g)	Harvest index (%)
Days to 50% flowering	0.0127	-0.0011	-0.0054	0.0041	-0.0017	0.0034	0.0002	0.0062	0.0038	0.0048	0.0055	0.0029**	0.0055**
Plant height (cm)	-0.0042	0.0495	0.0071	0.0354	0.0288	-0.0089	0.0339	0.0291	0.0304	0.0210	0.0296	0.0253**	0.0276**
Flag leaf area(cm2)	0.0139	-0.0047	-0.0327	-0.0035	-0.0103	-0.0060	-0.0057	0.0052	0.0016	0.0063	0.0029	-0.0069	0.0026
No. of productive tiller per plant	-0.0021	-0.0047	-0.0007	-0.0065	-0.0035	-0.0012	-0.0045	-0.0048	-0.0054	-0.0044	-0.0046	-0.0051	-0.0054
Days to maturity	0.0044	-0.0316	-0.0172	-0.0290	-0.0543	0.0021	-0.0265	-0.0186	-0.0229	-0.0249	-0.0164	-0.0292	-0.0329
Plant length (cm)	-0.0044	0.0030	-0.0030	-0.0030	0.0006	-0.0164	0.0024	-0.0043	-0.0008	-0.0024	-0.0049	-0.0026	-0.0039
Spike length (cm)	0.0004	0.0169	0.0043	0.0171	0.0120	-0.0037	0.0246	0.0098	0.0169	0.0092	0.0129	0.0161**	0.0095
No. of spikelets per spike	-0.0159	-0.0192	0.0052	-0.0242	-0.0112	-0.0086	-0.0129	-0.0327	-0.0294	-0.0316	-0.0286	-0.0261	-0.0290
N0. of grains per spike	-0.0400	-0.0816	0.0065	-0.1112	-0.0560	-0.0062	-0.0912	-0.1196	-0.1329	-0.1058	-0.1052	-0.1224	-0.0972
Grain weight per spike	-0.0159	-0.0178	0.0081	-0.0286	-0.0192	-0.0061	-0.0156	-0.0405	-0.0334	-0.0419	-0.0319	-0.0318	-0.0359
Test weight (1000 grain) (gm)	0.0073	0.0100	-0.00015	0.0120	0.0051	0.0050	0.0088	0.0147	0.0133	0.9128	0.0168	0.0102**	0.0139**
Biological yield / plant (g)	0.1256	0.2773	0.1139	0.4222	0.2915	0.0873	0.3537	0.4325	0.4987	0.4112	0.3304	0.5416	0.3665**
Harvest index (%)	0.3149	0.4076	-0.0582	0.6019	0.4422	0.1731	0.2831	0.6494	-.5346	0.6260	0.6033	0.4945	0.7308
Grain yield per plant	0.3993	0.6036	0.0266	0.8866	0.6240	0.2139	0.5502	0.9263	0.8745	0.8803	0.8096	0.8666	0.9521

R Square = 0.9998, Residual Effect = 0.0144

among the important yield components such as length of spike, grain yield per plant, number of grains per spike, spikelets per spike and plant height is significant and positive in nature.

Direct and indirect effects of different characters on grain yield are given in table-2. Harvest index (0.708) followed by biological yield/plant (0.423) exerted high order positive direct effect on grain yield. However, the direct effects of rest characters were too low to be considered of any consequent Biological yield (0.254), plant hight (0.012), Spike length (0.0124). made substantial indirect positive contribution of grain yield via biological yield. The indirect contribution of Biological yield through harvest index on grain yield was order positive spike length (0.019), plant height (0.011), Days to 50% flowering (0.0035), Grain per spike (0.0014) and indirect contribution of harvest index through biological yield on grain yield was order negative Flag leaf area(-0.008), Spikelets per spike (-0.0014),Tiller per plant (-0.0037),Test weight (-0.0131)Grain weight per spike (-0.0196). and made considerable indirect negative contribution on grain yield through harvest index. The contribution of residual factors towards variation in grain yield was very high (0.998). At genotypic level the path-coefficient analysis carried out by using genotypic path coefficient table 3(b) revealed that harvest index (0.730) followed by biological yield (0.541) made very high positive contribution toward grain yield while direct effects of rest of the character was low. High order positive indirect effects on grain yield via Harvest index were showed by biological yield (0.366), Plant height (0.027), Test weight (0.0139), Days to 50% flowering (0.0055). The indirect effects of biological yield via grain per spike was order positive Plant height (0.025), spike length (0.0161),Test weight(0.0192), Days to 50% flowering (0.0029) and made considerable indirect negative contribution on grain yield through harvest index with grain per spike(-0.097), grain weight per spike (-0.035), Days to maturity (-0.032) and biological yield with grain per spike(-0.122),grain weight/spike (-0.031), Days to maturity (-0.029), Spikelets per spike(-0.026). The contribution of residual factors towards variation in grain yield was high (0.999). At phenotypic level Yield per spike, days to 50% flowering, Plant height, peduncle length, Spike length, no. of grains per spike, biological yield and Harvest Index exerted positive direct effects on grain yield. However, rest of the traits exerted negative direct effects on the Flag leaf area, No. Of productive tillers per plant, days to maturity, no of spikelets per spike, grain weight per spike, test weight as most important direct contributors towards grain yield per plant. (Sachan and Singh, 2003; Asif *et al.,* 2004; Chaitali and Bini, 2007; Singh *et al*., 2008; Khokhar *et al*., 2010; Soni *et al.,* 2011; Gaur *et al.,* 2015; Kumar *et al*., (2020); Gautam *et al*., (2021) have also identified Yield per spike and no. of grains per spike as a character making substantial direct positive contribution towards manifestation of grain yield in wheat. In the present study, path analysis identified by Harvest index followed by biological index, plant height, and spike length. The characters mentioned above, merit due to Consideration at the time of devising selection Strategy aimed at developing high yielding varieties in wheat.

References

1. Anwar, J.; Ali, M.A.; Hussain, M.; Sabir, W.; Khan, M.A.; M, Zulkiffal and M, Abdullah (2009). Assessment of yield criteria in bread wheat through correlation and path-analysis. *The Journal of Animal & Plant Sciences,* 19(4) (2009).
2. Ayccek, M. and Yildirim, T. (2006). Path coefficient analysis of yield and yield components in bread wheat *(T. aestivum L.). Pakistan J. of Botany,* 38(2): 417-424.
3. Aydi, N.; Sermet, C.; Mut, Z.; Bayramoglu, H.O. and Ozean, H. (2010). Path analysis of yield and some agronomic and quality traits of bread wheat. (*Triticum aestivum* L.) under different environments. African Journal of biotechnology. 9(32); 5131-5134.
4. Chaitali, S. and Bini, T. (2007). Variability, character association and component analysis in wheat *(T. aestivum* L.). *Crop Research,* 34(1-3): 166-170.
5. Dewey and Lu. (1959). Correlation and path-coefficient analysis of crested wheat grass seed production. *Agron. J.,* 51: 515-518.
6. Gaur, S.C.; Gaur, A.K.; Gaur, L.B.; Singh, P.N. and Verma, S.B. (2015). Correlation and path-coefficient studies in wheat (*Triticum aestivum L.). Frontiers in crop Improvement journal* 3(1): 41-43.
7. Gautam.; Singh, Soni.; Kumar, Kamlesh and Gaur, S.C. (2021). Studies on correlation and path analysis of quantitative traits in different wheat *(Triticum aestivum* L. em. Thell.) genotypes under Alluvial soil condition. *Frontiers in Crop Improvement*, Vol. 9(special-VI): 2677-2680.
8. Khokhar, M.; Hussain, M.; Javed, Anear.; Zulkiffal, M.; Iqbal, M.M.; Khan, S.B.; Khan, MA.; Abdul, Qayyum.; Sabir, W. and Shahid, Mehmood. (2010). Correlation and path-analysis for yield and yield contributing charcters in wheat *(Triticum aestivum L.). Acta Agriculture Serbica*. 15(29): 19-24.
9. Kumar, Kamlesh.; Tarkeshwar.; Singh, Mukesh.; Gupta, Avinash.; Singh,Soni and Gaur, S.C. (2020) Character association for correlation and Path coefficient studied in bread wheat (*Triticum aestivum* L. em. Thell). *International Journal of Current Microbiology and Applied Sciences* Special-11: 1323-1330.
10. Sachan, M.S. and Singh, S.P. (2003). Genetics of yield and its components in durum wheat *(T. durum Desf). Journal of Inter. Academicia,* 7(2): 140-143.
11. Searle, S. R.; (1961), Phenotypic, genotypic and environmental correlation. *Biometrics*, 17: 474-775.

12. Sidhu, S.K. and Gill, D.S. ;(2019). Correlation and Path Coefficient Analysis of traits associated to Grain Protein Concentration and Yield in Wheat (*Triticum aestivum* L.) Cultivars. *Int. J. Pure App. Biosci.* 6(5): 937-942 (2018).
13. Singh, S.K.; Singh, B.N.; Singh, P.K. and Sharma, C.L. (2008). Correlation and path analysis in some exotic lines in wheat *(Triticum aestivum L.). New Botanist,* 35(1/4): 89-94.
14. Sleper John M. Poehlman (2006). Blackwell Publishing professinol, 2121 State Avenue, Ames, lowa 50014. pp424.
15. Soni, Kumar, Sandeep; Yadav, A.K.; Singh, B.N. and Yadav, V.K. (2011). Character association and path analysis in exotic and indigenous lines of bread wheat (*Triticum aestivum* L.) under reclaimed and salt affected soil. *Progressive Research*, 6(2): 221-223.
16. Subhani, G.M. (2000). Correlation and path coefficient analysis in bread wheat under drought stress and normal conditions. *Pakistan J. Biological Sci,* 3(1): 72-77.
17. Tarkeshwar.; Kumar, Kamlesh.; Yadav Mohit.; Gaur, S.C.; Choudhary, Ravi Prakash and Mishra, Govind (2020). Studied on Correlation and Path Coefficient for yield and its component Traits in bread wheat *(Triticum aestivum*L. em. Thell.). *International Journal of Current Microbiology and Applied Sciences* Special-11: 688-696.
18. Vimal, S.C.; Sarvjeet; Gaur, S.C. and Kumar, Pankaj (2016). Relations of yield and its Characters in mungbean [vigna radiata. (L) Wilczek]. *Progressive research: An International journal,* 11(Special- VI): *3779-3781(2016).*
19. Zaeifizadeh, Khayatnezhad, M.; Ghasemi, M.; Azimi.; Vahabzadeh, J.M. (2011). Path analysis of yield components in synthetic bread wheat (*Triticum aestivum* L. em.Thell.) genotypes. *Advances in Environment Biology*, 5(1): 98-10.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 907-910 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Seasonal Incidence of Major Insect Pests of Pigeon Pea [*Cajanus cajan* (L.) Millsp.]

Ankita Yadav[1], Anil Vyas[1], Mohd Monish[1], A.K.S. Pratihar[2], Rajesh Choudhary[3], S.K. Dhabhai[1] and Saif Ali Khan[1]

[1]*Department of Entomology, RCA, MPUAT Udaipur (Rajasthan), India*
[2]*Department of Entomology, CoA, Jodhpur (A.U., Jodhpur), Rajasthan, India*
[3]*Department of Soil Science, RVSKVV, Gwalior (Madhya Pradesh), India*
Email : ankitaya705@gmail.com

Abstract

Investigations on seasonal incidence of major insect pests of pigeon pea, *Cajanus cajan* was carried out in the Department of Entomology, Rajasthan college of Agriculture, MPUAT, Udaipur, during 2021. The seasonal abundance of major sucking insect pests on pigeon pea crop revealed that the sucking pests, *viz*., aphid, jassid, pod bug and pod borers complex, *viz*., *Helicoverpa armigera, Exelastis atomosa* and *Melanagromyza obtusa* appeared as major pests due to their high population. The incidence of aphid and jassid commenced in the fourth week of August, gradually increased and reached to its peak in first and second week of October, respectively and the population of pod bug appeared in the third week of September. The incidence of the pod borer, *Helicoverpa armigera, Exelastis atomosa* and *Melanagromyza obtusa* started in fourth week of August respectively, which gradually increased and reached to its peak in third, second and first week of October, respectively. The weather factors, *viz.,* maximum temperatures showed a positive significant correlation with aphid, jassid, pod bug, pod borer, *Helicoverpa armigera, Exelastis atomosa* and *Melanagromyza obtusa* population. The correlation coefficient of minimum temperature worked out with aphid, jassid and pod borer, *Exelastis atomosa* and *Melanagromyza obtusa* infestation showed a positive correlation. The correlation matrix of pod bug population depicted a significant negative correlation with relative humidity and negative significant correlation was found *Helicoverpa armigera* with relative humidity.

Introduction

Pigeon pea [*Cajanus cajan* (L.) Millsp.] is an important pulse crop and a major component of our daily vegetarian diet. It is not only act as a good source of protein, but also improves the soil by nitrogen fixation. Pigeon pea ranks first among the *kharif* pulses and has significant agricultural value in India due to its many applications as food, fodder, and fuel as well as its contribution in maintaining agricultural production

Pigeon pea is predominantly cultivated in tropical and subtropical regions of the world. Pigeon pea is a drought tolerant crop with large variation in days to maturity, ranging from extra short (90 days) duration to long duration (300 days). It is generally cultivated as a sole crop or as a mixed crop with short maturing cereals or legumes as well as with long duration crops like cotton and groundnut. Globally pigeon pea is cultivated on 4.64 million ha, with an annual production of 3.43 million tones and a mean productivity of 780 Kg ha^{-1}. India is the primary pigeon pea growing country in the world, accounting for 4.43 million ha area and 3.57 million tons of production and a mean productivity of 806 kg ha^{-1} (Directorate of Economics and Statistics, DAC & FW, 2021-22).

The major pest among them is, *Helicoverpa armigera*, results in a significant yield loss of 25,000 tonnes of grains per year, or more than 3750 million rupees annually. Sujithra and Chander (2014) reported that the pod borer complex caused 19.11 per cent pod damage that could be attributed to *M. vitrata* (9.7%), pod fly (5.3%), gram pod borer (2.6%) and leaf webber (2.3%). *M. obtusa* is a major pod infesting pest and has been found to cause 10 to 80 per cent damage (Revathi *et al*., 2015). Similarly, *C. gibbosa* nymphs and adults cause deformation of pods and shrivelling of grains (Srujana *et al*., 2014) resulting in predominant grain yield loss of 50,000 tonnes annually for Uttar Pradesh alone Narasimhamurthy *et al* 2013. Likewise, red gram plants infested with 8 to 16 larvae of M. vitrata suffers huge grain yield losses ranging between 50 to 68 per cent (Mohapatra *et al*., 2003) and the losses due to spotted pod borer have been estimated at US$ 30 million annually (Sunitha *et al*., 2008). Under these conditions, it is necessary to improve scientific research for the efficient management of the above mentioned insect pests in the pigeon pea environment. It is essential to have a basic understanding of the abundance and distribution of pests in relation to weather parameters before developing any insect pest management programmes for the specific agroecosystem. This information aids in determining the best management at proper time application.

Materials and Methods

In order to study the population dynamics of major sucking

insect pests on pigeon pea, the genotype ICPL-87 was sown on 20th July 2021 in five plots of 4.5 x 3.0 m^2 keeping row to row and plant to plant distance of 45 and 30 cm, respectively.

Observations :

For sucking pest complex (Aphid, Jassid and Pod bug) : The crop was left for natural infestation. The observations on major insect pests, *viz*., aphid, jassid and pod bug populations were recorded from three leaves, *viz.,* upper, middle and lower on each of five tagged plants at weekly interval from the first appearance of major insect pests till harvesting of the crop.

For Pod borer complex : To observe the borers on five plants in each plot were randomly selected and tagged. At the time of green pod stages 50 pods from the observation plant was collected separately from each plot and opened to take larvae count of pod borers. At the time of harvest pods from the observation plants was collected separately from each plot. The infested pods were further separated for recording individual bores damage on the basis of nature of damage suggested by Davies and Lateef. (1975)

Pods with large hole having irregular margin was normally considered as damage caused by *Helicoverpa armigera.*

Pods with medium sized hole having smooth round margin was considered as damage caused by *Exelastis atomosa*.

Pods with window made in the pod wall before pupation and hole left by the fly after emergence was considered as damage caused by *Melanagromyz obtusa*.

The following mathematical analyses have been done:

Pod and seed damage : To determine the per cent seed damage and seed weight loss, the whole sample was taken as a criterion. The per cent seed damage and weight loss were calculated by using the following formulae given by Gwinner *et al*. (1996).

$$\text{Per cent Weight Loss} = \frac{(W \quad Nd) \quad (Wd \quad N)}{W \quad (Nd + N)}$$

Whereas,

Wμ = weight of undamaged seeds

Nμ = number of undamaged seeds

Wd = weight of damaged seeds

Nd = number of damaged seeds

Per cent seed damage

$$= \frac{\text{No. of insect damaged seeds}}{\text{Total number of seeds in the sample}} \quad 100$$

Results and Discussion

The seasonal incidence of major insect pests on pigeon pea crop revealed that pests *viz*., aphid, jassid, pod bug, pod borers, *Helicoverpa armigera, Exelastis atomosa* and *Melanagromyza obtuse* appeared as major insect pests. The incidence of aphid, jassid was first commenced in the fourth week of August and reached to peak (19.35 aphid fourth week of August and 18.10 jassid fourth week of August), at 34.0°C maximum temperature, 28.0°C minimum temperature, 50 per cent relative humidity (aphid and jassid) and at 37.0°C maximum temperature, 26.5°C minimum temperature, 36 per cent relative humidity (aphid), thereafter, the insect population started declining. The correlation studies revealed that the infestation of aphid and jassid on pigeon pea crop showed positive significant correlation with minimum temperature (r = 0.644) and jassid showed positive significant correlation with maximum temperature (r = 0.700).

The incidence of pod bug was first commenced in the third week of September and reached to peak (0.55 pod bug third week of October), at 35.0°C maximum temperature, 24.0°C minimum temperature, 47 per cent relative humidity, thereafter, the insect population started declining. The correlation studies revealed that the infestation of pod bug on pigeon pea crop showed negative significant correlation with relative humidity (r = -0.804).

The pod borer, *Helicoverpa armigera* were recorded to population of pigeon pea shoots and fruits, latter being dominating one. The *Helicoverpa armigera* was noticed in the fourth week of August on pod borer (2.00) when the crop was in vegetative stage. Initially, the infestation was low which gradually increased and reached its peak 7.25 in the third week of October. The relative humidity had negative significant correlation (r=-0.739) with *Helicoverpa armigera*, while maximum temperature had positive correlation with pod borer infestation (r = 0.328).

The *Exelastis atomosa* commenced in the 35th SMW (fourth week of August), i.e*.,* 0.50, which gradually increased and reached its peak 3.25 in the fourth week of September. The infestation of *Exelastis atomosa* on shoot and fruit exhibited positive significant effect with maximum and minimum temperature (r= 0.703 and r = 0.777), while it was non-significant with relative humidity (r= 0.092).

The seasonal incidence of major insect pests on pigeon pea crop revealed that pests *Melanagromyza obtusa* appeared as major insect pests. The incidence of *Melanagromyza obtusa* was first commenced in the fourth week of August and reached to peak (6.25 *Melanagromyza obtusa*/5 plants), at 34.0°C maximum

Table-1 : Seasonal incidence of major sucking insect pests of pigeon pea.

SMW	Date of observations	Mean population/three leaves/plant			Meteorological parameters			
		Aphid	Jassid	Pod bug	Maximum temp	Minimum temp	Average relative humidity (%)	Total rainfall (mm)
35	27/08/2021	1.25	2.60	0.00	31.8	25.8	78.12	26.1
36	03/09/2021	2.08	3.20	0.00	31.6	26.6	80.56	40.4
37	10/09/2021	4.80	5.48	0.00	35.0	28.0	61.56	0.00
38	17/09/2021	11.68	11.20	0.15	37.8	29.5	54.30	9.40
39	24/09/2021	16.96	13.24	0.05	35.9	28.1	60.84	4.20
40	01/10/2021	19.35	16.00	0.34	34.0	28.0	50.32	0.00
41	08/10/2021	11.10	18.10	0.29	37.0	26.5	36.39	0.00
42	15/10/2021	7.00	13.96	0.33	34.6	25.2	49.65	26.00
43	22/10/2021	3.25	9.55	0.55	35.0	24.0	47.74	0.00
44	29/10/2021	2.10	4.15	0.40	33.0	20.3	32.36	0.00
45	05/11/2021	1.11	2.65	0.38	33.5	20.5	35.84	0.00
Maximum temperature		0.574	0.700*	0.135				
Minimum temperature		0.644*	0.482	-0.594				
Relative humidity		-0.091	-0.320	-0.804				
Rainfall		-0.318	-0.296	-0.494				

Table-2 : Seasonal incidence of pod borer complex of pigeon pea.

SMW	Date of observation	Population of *Helicoverpa armigera*/5 plants	Mean pod damage (%)	Population of *Exelastis atmosa*/ plants	Mean pod damage (%)	Popula-tion of *Melanogromyza obusta*/5 plants	Mean pod damage (%)	Meteorological parameters			
								Max. temp.	Min. temp.	Avg. relative humidity (%)	Total rainfall (mm)
35	27/08/2021	2.00	0.00	0.50	0.00	3.00	3.75	31.80	25.80	78.12	26.10
36	03/09/2021	2.25	0.00	0.75	2.64	2.75	5.18	31.60	26.60	80.56	40.40
37	10/09/2021	2.50	0.00	1.50	3.92	3.00	6.15	35.00	28.00	61.56	0.00
38	17/09/2021	3.75	0.00	3.00	6.69	3.75	5.00	37.80	29.50	54.30	9.40
39	24/09/2021	3.50	7.35	3.25	5.60	3.50	5.10	35.90	28.10	60.84	4.20
40	01/10/2021	4.00	9.10	2.25	6.28	6.25	8.40	34.00	28.00	50.32	0.00
41	08/10/2021	5.50	9.33	1.50	4.82	4.50	7.12	37.00	26.50	36.39	0.00
42	15/10/2021	7.25	14.42	1.25	6.25	3.50	6.25	34.60	25.20	49.65	26.00
43	22/10/2021	6.00	11.33	0.75	2.49	3.00	3.69	35.00	24.00	47.74	0.00
44	29/10/2021	5.50	11.19	0.50	1.20	2.75	3.16	33.00	20.30	32.36	0.00
45	05/11/2021	4.25	12.05	0.25	1.05	2.00	3.11	33.50	20.50	35.84	0.00
Maximum temperature		0.328	0.084	0.703*	0.710*	0.341	0.339				
Minimum temperature		-0.405	-0.595	0.777	0.695*	0.553	0.658*				
Relative humidity		-0.739	0.773	0.092	-0.085	-0.088	0.047				
Rainfall		-0.277	-0.386	-0.215	-0.115	-0.223	-0.044				

*Significant at 5% level

temperature, 28.0°C minimum temperature and 50 per cent relative humidity, thereafter, the insect population started declining. The correlation studies revealed that the infestation of *Melanagromyza obtusa* on pigeon pea crop showed positive correlation with maximum and minimum temperature (r = 0.341 and r = 0.553), while negative correlation with relative humidity and rainfall (r = -0.088 and -0.223).

Conclusion

Aphid and jassid were observed as major insect pests on pigeon pea.

The peak incidence of aphid and jassid were observed in fourth week of October, respectively.

The peak incidence of pod bug was observed in third week of October.

The population of aphid had positive significant correlation with minimum temperature and with maximum temperature, respectively.

The peak infestation of pod borer, *Helicoverpa armigera, Exelastis atomosa* and *Melanagromyza obtusa* were observed in fourth week of September.

The infestation of pod borer, *Helicoverpa armigera* had negative significant correlation with relative humidity. While, *Exelastis atomosa* had positive significant correlation with maximum and minimum temperature and *Melanagromyza obtusa* had positive correlation with maximum and minimum temperature.

References

1. Revathi, K., Sreekanth, M., Krishnayya, PV., and Srinivasa, RV., 2015 Incidence of podfly, *Melanagromyza obtusa* (Malloch) and its influence on weight loss in different pigeonpea genotypes. International *Journal of Innovative Science, Engineering & Technology*. 2(5): 460-464.
2. Srujana, Y., Keval, R., 2014 Periodic occurrence and association of pod fly and pod bug on long duration pigeonpea (Bahar) with weather parameters. *Journal of Experimental Zoology, India*. 17(2): 595-597.
3. Narasimhamurthy, GM., Keval, R., 2013 Field evaluation of some insecticides and biopesticides against tur pod bug, Clavigralla gibbosa Spinola in long duration pigeonpea. *Afr J Agric Res.* 8(38): 4876-4881
4. Mohapatra, SD., Srivastava, CP., 2003 Effect of sowing dates and genotypes on the incidence of Maruca vitrata (Geyer) and grain yield in short duration pigeonpea. *Indian Journal of Pulses Research.* 16(2): 147-149.
5. Sunitha, V., Lakshmi, KV., Ranga Rao, GV., 2008 Screening of pigeonpea genotypes against Maruca vitrata (Geyer). *Journal of Food Legumes*. 21(3): 193-195.
6. Sujithra, M. and Chander, S., 2014. Seasonal incidence and damage of major insect pests of pigeonpea [*Cajanus cajan* (L.)]. *Indian Journal of Entomology,* 76(3): 202-206.
7. Davies, J.C., and Lateef, S.S., 1975. Insect-pests of pigeon pea and chickpea in India and prospects for control. In *Proceeding of International Workshop on Grain Legumes,* 13-16.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 911-914 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Impact of Bio-fertilizer on Plant Growth and Yield Attributing Traits of French Bean (*Phaseolus vulgaris*) Var. HPR-35

Bakuru Pavan Praneeth*, Bineeta Michael Bara[1]* and Prashant Kumar Rai[1]*
Department of Genetics and Plant Breeding, SHUATS, Prayagraj, U.P.
Email : pavanlovely153@gmail.com

Abstract

The present research carried out for Impact of Bio-fertilizer on Plant Growth and Yield Attributing Traits of French Bean *(Phaseolus vulgaris)* Var.HPR-35 was made to identify the effect of seed priming of different kinds on seed quality parameters of French bean and to find out suitable seed priming method for French bean. For the purpose, 13 priming treatments including control on French bean seed were used to study under field conditions during Rabi, 2021-2022. Analysis of variance for the data revealed for all the characters under study vi., Field emergence(%), Plant height(30.60 DAS), Days to 50% flowering, Plant height at maturity, Number of Branches per plant, Number of pods per plant, Number of seed per plant, Seed yield per plant, Seed yield per plot, Biological index(gm), Harvest index(%), Seed index. Which were highly significant at 5% level of significance indicating presence of good amount of variability among treatments for those characters. In this all the parameters that T9- Vermiwash (12%) significantly affected characters studied in field experiments. At last in this experiments T9-Vermiwash (12%) was more useful for improving pant growth and yield attributes of French bean *(Phaseolus vulgaris)*.

Key words : *Rhizobium, azospirillum, vermiwash, azotobacter.*

Introduction

French bean *(Phaseolus vulgaris)* is a short duration legume, known as common bean or Kidney bean. It belongs to the family (Fabaceae) and the chromosome number is (2n=2x=22). It is a nutritious vegetable. French bean are native to central and south America. (Swaider *et al.,* 1992).

They need for the common man to eliminate malnutrition, deficiency disease and to relieve stress on cereals, there is a greater need to enhance vegetable production like rajma (kallo and Pandey 2002). It is an important vegetable for its high quality, nutritional properties and as a grain legume for its major protein source and economic value (Martins and Silva, 2004).

In Bio-fertilizer play a vital role in maintaining long term soil fertility and sustainability to increase yield of crops by 10-30% (Khandelwaal *et al.,* 2012).

French bean is a self pollinated crop. It is very nutritious and per 100g of french bean contains are Calories at 31%, protein content is 1.8g, fat content is 0.22g, and total carbohydrates are 6.97g at last the dietary fiber is about 2.7g. The world production of green beans was 23.6 million tonnes, led by China with 79% of the total world dried bean production was 26.8 million tonnes, with Myanmar, India and Brazil as leading producers. The production of French beans was 1000 tonnes, led by China with 80% of total world production. In India the French bean production increased more than 10 tonnes according to agriculture statistics at glance 2021.

In India it is largely grown in hilly areas of Himachal Pradesh, Uttarakhand, Jammu and Kashmir and North Eastern states during summer and as winter and autumn crop in parts of Uttar pradesh, Maharashtra, Karnataka, Andhra Pradesh, Punjab, Haryana, Bihar, Gujarat, Madhya Pradesh and Tamil Nadu having an area of 230078 ha with annual production of 647965 tonnes with a productivity of 28163 kg/ha. (Agriculture statistics at glance 2020).

The production and dissemination of quality seed is one of the indispensable factors to achieve anticipated yields in addition to optimum quality of the cultivar. The quality of seed alone is known to account for at least 10-15% increase in productivity.

French beans are free of fat, cholesterol and sodium and low in calories. When they are consumed tender, before the seeds are completely developed, they are poor in proteins, whereas when they are mature they are rich in proteins. French beans grown in kharif and Rabi. It is highly sensitive to frost and water logging. The temperature range for proper growth of this crop is 10-27^0 c and below 5^{0}c the flowers and developing pods and branches are damaged. It is well drained loamy soil with PH range 5.5-6.0 with cool climate and it is suited for french bean cultivation. And it can be grown in all types of soil, but loam and clay loam soils are best for obtaining high yield.

In pre-sowing germination activities early. It promotes plant growth and develops by regulating the

physical and biochemical process, it is free from disease and it produces better yield.

Materials and Methods

The experiment was carried out at field experimentation center of the department of genetics and plant breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj (U.P). During Rabi 2021-2022 Naini situated between the parallels of 25.57^0 N latitude and 81.56^0 E longitude. Prayagraj is located in the south-eastern of Uttar Pradesh and has a sub-tropical climate with extremes of summer and winter. The experimental material for present investigation consisted of 13 treatments of French bean *(Phaseolus vulgaris* L.*)* are *T0- Control, T1-Rhizobium(8%), T2- Rhizobium(10%), T3-Rhizobium(12%), T4-Azospirillum(8%), T5-Azospirillum(10%), T6-Azospirillum(12%), T7-Vermiwash(8%), T8-Vermiwash(10%), T9-Vermiwash(12%), T10-Azotobacter(8%), T11-Azotobacter(10%), T12-Azotobacter(12%)*. The experiment was laid out in Randomized Block Design (RBD) with three replications. A spacing of 45 cm between rows and 15 cm between plants within the row is maintained. The data were recorded on five randomly selected plants of each replication for all characters such as Field emergence (%), Plant height at (30,60 DAS), Days to 50% flowering, plant height at maturity, Number of branches per plant, Number of pods per plant, Number of seed per pod, Seed yield per plot, Seed yield per plant, Biological index(gm), Harvest index(%), Seed index. The statistical analysis was carried out as per the equation suggested : Analysis of variance was carried out as per standard procedure (Fisher, 1936), Analysis of variance for field observation (Panse and Sukhatme, 1967).

Results and Discussion

Field emergence : The mean performance of field emergence ranged from 93.33-85.33% with the grand mean value of 81.42%. The minimum field emergence was exhibited by treatment T0-control (85.33%). While maximum field emergence was recorded in treatment T9-Vermiwash 12% (93.33%), followed by T8-Vermiwash 10% (90.33) was significantly higher than other significant treatments. However, these were statistically as per each other (CD 5% = 2.12).

Plant height at 30 DAS : The mean performance of plant height at 30 DAS ranged from 21.63-12.54cm with the grand mean value of 17.79cm. The minimum plant height at 30 DAS was exhibited by treatment To- control (12.54cm). While maximum plant height at 30 DAS was recorded in treatment T9- Vermiwash 12% (21.63cm), followed by T8- Vermiwash 10% (20.88cm) was significantly higher than other significant treatments. However, these were statistically as per each other (CD 5% = 0.64).

Plant height at 60 DAS : The mean performance of plant height at 60 DAS ranged from 42.75-31.87cm with the grand mean value of 37.23cm. The minimum plant height at 60 DAS was exhibited by treatment T0- control (31.87cm). While maximum plant height at 60 DAS was recorded in treatment T9-Vermiwash 12% (42.75cm), followed by T8-Vermiwash 10% (39.79cm) was significantly higher than other treatments. However, these were statistically as per each other (CD 5% = 0.92).

Days to maturity : The mean performance of days to maturity ranged from 91.33-90.33 with the grand mean value of 88.56. The minimum days to maturity was exhibited by treatment T0- Control (90.33). While maximum days to maturity was recorded in treatment T3-Rhizobium 12% (91.33), was significantly higher than other treatments. However, these were statistically as per each other (CD 5% = 2.61).

Days to 50% flowering : The mean performance of days to 50% flowering ranged from 37.00-36.00 with the grand mean value of 35.69. The minimum days to 50% flowering was exhibited by treatment T0-control (36.00). While maximum days to 50% flowering was recorded in treatment T3-Rhizobium 12% (37.00) was significantly higher than other treatments. However, these were statistically as per each other (CD 5% = 1.98).

Number of branches per plant : The mean performance of no.of branches per plant ranged from 9.55-7.35 with the grand mean value of 8.24. The minimum no.of branches per plant was exhibited by treatment T0-Control (7.35). While maximum no.of branches per plant was recorded in treatment T9-Vermiwash 12% (9.55), followed by T8-Vermiwash 10% (8.82) was significantly higher than other treatments. However, these were statistically as per each other (CD 5%= 0.31).

Plant height at maturity : The mean performance of plant height at maturity ranged from 48.01-34.91 with the grand mean value of 41.76. The minimum plant height at maturity was exhibited by treatment T0-Control (34.91). While maximum plant height at maturity was recorded in treatment T9-Vermiwash 12% (48.01), followed by T8-Vermiwash 10% (45.32) was significantly higher than other treatments. However, these were statistically as per each other (CD 5% = 0.76).

Number of pods per plant : The mean performance of no.of pods per plant ranged from 19.45-14.30 with the grand mean value of 16.93. The minimum no.of pods per plant was exhibited by T0-Control (14.30). While maximum no.of pods per plant was recorded by T9-

Table-1 : Mean performance of different treatments for pre-harvest characters in French bean.

Treatments	Field emergence	Plant height at 30 DAS	Plant height at 60 DAS	Days to maturity	Days to 50 flowering	No.of branches per plant	Plant height at maturity
T_0-control	85.33	12.54	31.87	90.33	36.00	7.35	34.91
T_1-*Rhizobium* 8%	86.00	17.07	35.31	90.00	35.67	7.60	39.21
T_2-*Rhizobium* 10%	88.00	15.22	34.61	87.00	35.00	7.91	40.66
T_3-*Rhizobium* 12%	89.33	18.03	37.18	91.33	37.00	8.10	42.02
T_4-*Azospirillum* 8%	86.33	16.16	35.17	88.00	36.33	7.75	38.55
T_5-*Azospirillum* 10%	87.67	16.45	35.88	87.33	35.00	8.10	40.91
T_6-*Azospirillum* 12%	88.80	17.58	38.74	89.00	36.67	8.33	42.28
T_7-*Vermiwash* 8%	88.67	18.47	38.19	87.67	35.33	8.54	41.87
T_8-*Vermiwash* 10%	90.33	20.88	39.79	88.33	36.00	8.82	45.32
T_9-*Vermiwash* 12%	93.33	21.63	42.75	87.33	35.33	9.55	48.01
T_{10}-*Azotobacter* 8%	87.00	17.57	35.50	88.00	35.00	7.66	40.44
T_{11}-*Azotobacter* 10%	89.33	19.04	37.67	88.67	35.33	8.06	43.07
T_{12}-*Azotobacter* 12%	91.67	20.71	41.39	88.33	35.33	9.42	45.74
C.V.	1.4	2.15	1.48	1.75	3.29	2.28	1.08
S.E(m)	0.72	0.22	0.31	0.89	0.67	0.10	0.26
C.D(5%)	2.12	0.64	0.92	2.61	1.98	0.31	0.76

Table-2 : Mean performances of different treatments for post- harvest characters of French bean.

Treatments	No.of pods per plant	No.of seeds per pod	Seed yield per plant	Seed yield per plot	Biological index	Harvest index	Seed index
T_0-Control	14.30	3.13	9.16	183.27	22.88	40.07	34.73
T_1-*Rhizobium* 8%	15.15	4.25	11.14	222.80	26.54	41.98	35.26
T_2-*Rhizobium* 10%	15.96	4.59	11.72	234.47	27.08	43.31	36.02
T_3-*Rhizobium* 12%	17.24	4.81	12.63	252.67	28.46	44.43	36.69
T_4-*Azospirillum* 8%	15.67	4.33	11.85	237.07	27.56	43.01	35.93
T_5-*Azospirillum* 10%	17.55	4.59	12.20	243.93	28.03	43.52	38.53
T_6-*Azospirillum* 12%	17.77	4.86	13.49	269.87	29.02	46.51	35.20
T_7-*Vermiwash* 8%	18.15	5.38	12.12	242.40	27.15	44.65	35.27
T_8-*Vermiwash* 10%	18.25	5.58	13.65	273.07	29.36	46.54	36.13
T_9-*Vermiwash* 12%	19.45	5.88	14.98	299.60	31.53	47.50	39.21
T_{10}-*Azotobacter* 8%	15.67	5.08	12.03	240.67	27.43	43.90	35.75
T_{11}-*Azotobacter* 10%	16.95	5.21	12.86	257.13	28.12	45.72	36.23
T_{12}-*Azotobacter* 12%	18.00	5.71	14.37	287.40	30.36	47.34	38.02
C.V.	10.00	1.20	2.88	2.88	3.18	2.44	1.24
S.E.(m)	0.96	0.03	0.20	4.16	0.51	0.62	0.26
C.D(5%)	2.82	0.09	0.60	12.15	1.49	1.83	0.76

Vermiwash 12% (19.45), followed by T8- Vermiwash 10% (18.25) were significantly as per each other (CD 5% = 2.82).

Number of seeds per pod : The mean performance of no.of seeds per pod ranged from 5.88-3.13 with the grand mean value of 4.87. The minimum no.of seeds per pod was To- Control (3.13). While maximum no.of seeds per pod was recorded by T9- Vermiwash 12% (5.88), followed by T8- Vermiwash 10% (5.58) were significantly as per each other (CD 5% = 0.09).

Seed yield per plant : The mean performance of seed yield per plant ranged from 14.98-9.16 with the grand mean value of 12.47. The minimum seed yield per plant was T0-Control (9.16). While maximum seed yield per plant was recorded by T9-Vermiwash 12% (14.98), followed by T8- Vermiwash 10% (13.65) were significantly as per each other (CD 5% = 0.60).

Seed yield per plot : The mean performance of seed yield per plot ranged from 299.60-183.27 with the grand mean value of 249.56. The minimum seed yield per plot was To-Control (183.27). While maximum seed yield per plot was recorded by T9-Vermiwash 12% (299.60),

followed by T8- Vermiwash 10% (273.07) significantly as per each other (CD 5% = 12.15).

Biological Yield (gm) : The mean performance of Biological yield ranged from 31.53-22.88gm with the grand mean value of 27.96gm. The minimum biological yield was T0- Control (22.88gm). While maximum biological yield was recorded by T9-Vermiwash 12% (31.53gm), followed by T8-Vermiwash 10% (29.36), significantly as per each other (CD 5% = 1.49).

Harvest Index (%) : The mean performance of the harvest index ranged from 47.50-40-07% with the grand mean value of 44.49%. The minimum harvest index was T0-Control (40.07%). While the maximum harvest index was recorded by T9- Vermiwash 12% (47.50%), followed by T8- Vermiwash 10% (46.54%) were significantly as per each other (CD 5% = 1.83).

Seed Index : The mean performance of seed yield ranged from 39.21-34.73 with the grand mean value of 36.40. The minimum seed index was T0- Control (34.73). While the maximum seed index was recorded by T9- Vermiwash 12% (39.21), followed by T8- Vermiwash 10% (36.13), were significantly as per each other (CD 5% = 0.76).

Conclusions

Here it is concluded that treating with T9-Vermiwash (12%)/ 12 hrs recorded higher in Field emergence, Plant height at 30 & 60 DAS, no.of branches per plant, plant height at maturity, no.of pods per plant, no.of seeds per pod, seed yield per plant, seed yield per plot, Biological index(gm), Harvest index(%) and seed index followed by seed treated with T8-Vermiwash (10%) and the lowest was recorded in T0-Control. So Vermiwash 12% is suitable per plant growth and yield attributing traits of French bean.

References

1. Manjunath, M. N., Patil, P. L. and Gali, S. K. (2010). Effect of organics amenden rock phosphate and P solubilizer on P use efficiency of French bean in a Vertisol of Malaprabha Right Bank command of Karnataka. *Karnataka Journal of Agricultural Sciences,* 19(1): 30-35.
2. Mohanty, S., Sahu, G. S., Dash, S. K., Pradhan, S. R., Mangaraj, S. and Nahak, S. (2017). Integrated nutrient management for seed production in French beans (*Phaseolus vulgaris* (L.)). *International Journal of Current Microbiology and Applied Sciences,* 6(10): 3295-3303.
3. Chaudhury, K., Sannigrahi, A. K., Singh, B. (2004). Varietal evaluation of French bean for Assam plains, *Environment and Ecology*, 17(1): 236-237.
4. Das, R., Thapa, U., Debnath, S., Lyngdoh, Y.A., Mallick, D. (2014). Evaluation of French bean *(Phaseolus vulgaris* L.*)* genotypes for seed production, *Journal of Applied and Natural Science*, 6(2): 594-598.
5. Ramana, V., Ramakrishna, M., Purushotham, K., Reddy, K.B. (2010). Effect of bio fertilizers on growth, yield attributes and yield of French bean (*Phaseolus vulgaris* L). *Legume Research*, 33(3): 178- 183.
6. Rashid Harunor, A.S.M., Hossai, M.M. (2014). Yield and Quality of Green Pod Production of Bush Bean *(Phaseolus vulgaris* L.*)* As Influenced by Harvesting Time. *American Eurasian Journal of Agriculture and Environment Sci*ence, 14(11): 1221-1227.
7. Sajitha, J.P., Haripriya, K., Maheshwari, U., Stella, D. (2007). Impact of organic nutrients on yield and quality of garden peas. Acta Horticulturae, 485-487.
8. Sharma, R. and Verma, M. L. (2011). Effect of rhizobium, farm yard manure and chemical fertilizers on sustainable production and profitability of rajmash (*Phaseolus vulgaris* L.) and soil fertility in dry temperate region of north western Himalayas. *Legume Research*, 34(4): 251-258.
9. Singh, N.I. and Chauhan, J.S. (2009). Response of french bean (*Phaseolus vulgaris* L.) to organic manures and inorganic fertilizer on growth and yield parameters under irrigated condition. National Sciences, 7(5): 52-54.
10. Thakur, R. N., Arya, P. S. and Thakur, S. K. (1999). Response of french bean (*Phaseolus vulgaris* L.) varieties to fertilizer levels, rhizobium inoculation and their residual effect on onion (*Allium cepa*) in mid hills of north western Himalayas. *Indian. Journal of Agronomy, 44: 416-418*.
11. Shrestha, R., Vaidya, M.L., Bhattaraiand, E.M., Darai, R. (2008). Agro-morphological diversity in common bean *(Phaseolus vulgaris L.)* landraces of Jumla, Nepal. In: Proceedings of the fourth international food legumes research conference (Ed.M.C. Kharkwal). New Delhi, India, 639-648.
12. Pandey, Y.R., Gautam, D.M., Sharma, M.D., Thapa, R.B. and Paudyal, K.P. (2011). Variability of French bean in the western mid hills of Nepal. Kasetsart J. (Nat.Sci.) 45: 780-792.
13. White, J.W. and Laing, D.R. (1989). Photoperiod response of flowering in diverse genotypes of common bean (*Phaseolus vulgaris* L.). Field *Crops Research,* 22(2): 113-128.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 915-917 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Farmer Movement in India's Independence

Bhawna Sinha
Department of Political Science, B.R.D.P.G. College, Deoria, UP

It is generally believed that farmers have played no meaningful role in the periodic upheavals in Indian society. But tribals, tribes and farmers have played an important role in India's freedom movement. Movement of indigo farmers in the country, Pawana rebellion, Tebhaga movement, Champaran Satyagraha, Bardoli movement are all associated with the freedom movement. The farmers were the most affected by the policies of the British, so their revolt from time to time was justified.

Santhal Insurrection (1855-56) : This is the first peasant movement took place in India. The Santhals are a group of tribals largely concentrated in Bihar.

They are mainly agriculturalists. Due to the establishment of the permanent land settlement of 1793 by the Britishers, lands were taken away by them which the Santhals had cultivated for centuries.

The Blue Mutiny (1859-1862) : Poor peasants and small landlords opposed indigo planters in Bengal. In this they were helped by moneylenders whose own credit resources stood threatened by the structure of the monopsonistic rights of the planters.

The Pabna and Boora Uprisings (1872-1875) : Rich cultivators, benefiting from the commercialization of agriculture and producing cash crops, protested to secure further their occupancy rights granted nominally in 1859. In this they succeeded by 1885 when the Bengal Tenancy Act was passed. Later, by the middle twentieth century, inch tenants were transformed into rent-receivers.

Peasant Movement in Oudh (1918-1922) : The peasants of eastern Uttar Pradesh defied large landlords through a tenant's movement for security of tenure. Oppressive traditions of forced labour were attacked through fierce agrarian riots. Small landlords and the rural poor supported and led the movement. Statutory rights of occupancy were secured in 1921. The movement marked a phase of retreat for landlordism.

Deccan Rebellion : This movement started in December 1874 from Kardah village of Shirur taluka of Maharashtra. Kaluram, a usurer, obtained a house auction degree from the court against farmer Baba Saheb Deshmukh. Against this, the farmers started a movement against the usurers, the movement spread not only in Maharashtra but all over the country.

Single Movement : This movement started from Uttar Pradesh with the efforts of Home Rule League workers and Madan Mohan Malviya formed the Kisan Sabha in February 1918. In the last days of 1919, the organized rebellion of the peasants came to the fore in the open, in Hardoi, Bahraich and Sitapur districts, a movement was launched to increase the rent and collect the rent in the form of produce.

Moplah Rebellion : In the Malabar region of Kerala, there was a revolt by Moplah farmers in 1920. Initially it was against the British rule and it was supported by leaders like Mahatma Gandhi, Shaukat Ali, Maulana Abul Kalam Azad. Later the movement took the form of Hindu Muslim communal movement.

Kuka Rebellion : It was an armed rebellion by the Kuka people (Namdhari Sikhs) of Punjab in 1872. This rebellion was done in protest against the agricultural problems and the British encouraged the killing of cows. Balak Singh and his follower Guru Ram Singh ji led it, 66 Namdhari Sikhs were martyred in this movement.

Ramosi Peasants' Revolt : In Maharashtra, under the leadership of Vasudev Balwant Phadke, the Ramosi peasants raised the bell of revolt against the atrocities of the landlords. Similarly, in Andhra Pradesh, this rebellion against the British rule under the leadership of Sitaram Raju continued from 1879 to 1920-22.

Tebhaga Movement : The Tebhaga movement of 1946 was the most powerful movement among the peasant movements. In which the farmers started a struggle to reduce the rate of rent to one-third as per the recommendation of the Flight Commission. This movement was done to get two-thirds of the crop to the oppressed sharecroppers. This movement spread in 15 districts of Bengal. 50 lakh farmers participated in it and it also got the support of laborers.

Peasant Agitation in Kheda (1918) : It was a satyagraha launched under the leadership of Gandhiji, Sardar Ballavbhai Patel etc. It was also like the Champaran satyagraha based on non-violence. The Kheda (Gujrat) peasantry was mainly consisted of the Patidar peasants. The land of Kheda in Gujrat was a quite fertile land for the cultivation of Tobacco and Cotton crops.

The important causes for Kheda struggle are : The

peasants had suffered from a famine and in a large scale failure of crops. But the government did not accept it and insisted on the full realisation of land tax.

The government reassessed the Kheda land and the cultivated crops. On the basis of the collected data, the revenue was increased on land. This was unbearable for the peasants.

In some cases, the government removed the opium crop by alleging that it was without permission. This was considered to be a mischievous technique adopted by the government.

There are also some achievements of this struggle.

They are :

1. This movement has created an awakening, consciousness among the peasants about their demands. On the other hand, they sought their involvement in the struggle of independence.

2. It was settled that the well-to-do Patidar peasants would pay up the land rent and the poorer ones would be granted remissions. The bulk of the peasant mass who constituted the small farmers were by and large satisfied.

Santhal Insurrection (1855-56) : The Santhal rebellion (also known as the Sonthal rebellion or the Santhal Hool), was a rebellion in present-day Jharkhand, Eastern India against both the British East India Company (BEIC) and zamindari system by the Santhal. It started on June 30, 1855 and on November 10, 1855, martial law was proclaimed by the East India Company which lasted until January 3, 1856 when martial law was suspended and the rebellion was eventually suppressed by the Presidency armies. The rebellion was led by the four Murmu Brothers - Sidhu, Kanhu, Chand and Bhairav.

Rebellion : On 30 June 1855, two Santal rebel leaders, Sidhu and Kanhu Murmu, mobilized roughly 60,000 Santhals and declared a rebellion against the East India Company. Sidhu Murmu had accumulated about ten thousand Santhals to run a parallel government during the rebellion. The basic purpose was to collect taxes by making and enforcing his own laws. [citation needed]

Soon after the declaration, the Santhals took to arms. In many villages, the Zamindars, money lenders, and their operatives were executed. The open rebellion caught the Company administration by surprise. Initially, a small contingent was sent to suppress the rebels but they were unsuccessful and this further fuelled the spirit of the revolt. When the law-and-order situation was getting out of hand, the Company administration finally took a major step and sent in a large number of troops assisted by the local Zamindars and the Nawab of Murshidabad to quell the Rebellion. The East India Company announced a bounty of Rs. 10,000 to arrest Sidhu and his brother Kanhu Murmu. [citation needed]

A number of skirmishes occurred after this which resulted in a large number of casualties for the Santhal forces. The primitive weapons of the Santhals proved to be unable to match the gunpowder weapons of the East India Company military. Troop detachments from the 7th Native Infantry Regiment, 40th Native Infantry, and others were called into action. Major skirmishes occurred from July 1855 to January 1856, in places like Kahalgaon, Suri, Raghunathpur, and Munkatora.

The revolt was eventually suppressed after Sidhu and Kanhu were killed in action. War elephants, supplied by the Nawab of Murshidabad, were used to demolish Santhal huts during the rebellion. Of the roughly 60,000 tribesmen (many of whom were milkmen and blacksmiths) who had been mobilized during the rebellion, over 15,000 were killed, and tens of villages were destroyed.[5]

A British Army officer, Major Jervis, commented on the suppression of the rebellion : It was not war; they did not understand yielding. As long as their national drum beat, the whole party would stand, and allow themselves to be shot down. Their arrows often killed our men, and so we had to fire on them as long as they stood. When their drum ceased, they would move off a quarter of a mile; then their drums beat again, and they calmly stood till we came up and poured a few volleys into them. There was not a sepoy in the war who did not feel ashamed of himself."

The Blue Mutiny (1859-1862) : In March 1859 thousands of riots in Bengal refused to grow indigo, they started a rebellion against indigo cultivation, which came to be known as the blue rebellion or the indigo revolt. As the blue rebellion spread, ryots refused to pay rents to the planters and attacked indigo factories armed with swords and spears, bows, and arrows.

Women turned up to fight with pots, pans, and kitchen implements. Those who worked for the planters were socially boycotted, and the gomasthas – agents of planters – who came to collect rent were beaten up. Ryots swore they would no longer take advances to sow indigo nor be bullied by the planters' lathiyals – the lathi-wielding strongmen maintained by the planters.

But the question arises : Why did the indigo peasants decide that they would no longer remain silent? What gave them the power to rebel? Clearly, the indigo system was intensely oppressive. But those who are oppressed do not always rise up in rebellion.

They do so only at times. In 1859, the indigo ryots felt that they had the support of the local zamindars and village headmen in their rebellion against the planters. In

many villages, headmen who had been forced to sign indigo contracts mobilized the indigo peasants and fought pitched battles with the lathiyals.

In other places, even the zamindars went around villages urging the riots to resist the planters. These zamindars were unhappy with the increasing power of the planters and angry at being forced by the planters to give them land on long leases.

The indigo peasants also imagined that the British government would support them in their struggle against the planters. After the Revolt of 1857, the British government was particularly worried about the possibility of another popular rebellion.

When the news spread of a simmering revolt or the blue rebellion in the indigo districts, the Lieutenant Governor toured the region in the winter of 1859. The ryots saw the tour as a sign of government sympathy for their plight. When in Barasat, the magistrate Ashley Eden issued a notice stating that ryots would not be compelled to accept indigo contracts, word went around that Queen Victoria had declared that indigo need not be sown.

Eden was trying to placate the peasants and control an explosive situation, but his action was read as support for the rebellion. As the rebellion spread, intellectuals from Calcutta rushed to the indigo districts.

They wrote of the misery of the ryots, the tyranny of the planters, and the horrors of the indigo system. Worried by the rebellion, the government brought in the military to protect the planters from assault, and set up the Indigo Commission to enquire into the system of indigo production.

The Commission held the planters guilty and criticized them for the coercive methods they used with indigo cultivators. It declared that indigo production was not profitable for riots. The Commission asked the riots to fulfil their existing contracts but also told them that they could refuse to produce indigo in the future.

Peasant Agitation in Kheda (1918) : The Kheda Satyagraha of 1918 was a satyagraha movement in the Kheda district of Gujarat in India organised by Mahatma Gandhi during the period of the British Raj. It was a major revolt in the Indian independence movement. It was the third Satyagraha movement. After the successful Satyagraha conducted at Champaran Bihar in 1916, Gandhi organised the movement to support peasants who were unable to pay the revenue because of famine and plague epidemic.

In Gujarat, Mahatma Gandhi was chiefly the spiritual head of the struggle. He was assisted by the newly joined Satyagrahi Sardar Vallabhbhai Patel and other local lawyers and advocates namely Indulal Yagnik, Shankarlal Banker, Mahadev Desai, Narhari Parikh, Mohanlal Pandya and Ravi Shankar Vyas. They toured the countryside, organised the villagers and gave them political leadership and direction. Many aroused Gujaratis from the cities of Ahmedabad and Vadodara joined the organizers of the revolt, but Gandhi and Patel resisted the involvement of Indians from other provinces, seeking to keep it a purely Gujarati struggle.

The struggle : In 1918, the British authorities had increased the taxes of Kheda region by 23% while it was hit by Chappania famine and others leading to cholera and plague. Nadiad collector refused any aid from 'Anavari' system of taxes in spite of Sardar Patel and Mahatma's meetings. Patel and his colleagues organised a major tax revolt, and all the different ethnic and caste communities of (Kheda) rallied around it. The peasants of Kheda signed a petition calling for the tax for this year to be scrapped in wake of the famine. The government in Bombay rejected the charter. They warned that if the peasants did not pay, the lands and property would be confiscated and many arrested.

The tax withheld, the government's collectors and inspectors sent in thugs to seize property and cattle, while the police confiscated the lands and all agrarian property. The farmers did not resist arrest, nor retaliate to the force employed with violence. Instead, they used their cash and valuables to donate to the Gujarat Sabha which was officially organising the protest.

The revolt was astounding in terms of discipline and unity. Even when all their personal property, land and livelihood were seized, a vast majority of Kheda's farmers remained firmly united in the support of Patel. Gujaratis sympathetic to the revolt in other parts resisted the government machinery, and helped to shelter the relatives and property of the protesting peasants. Those Indians who sought to buy the confiscated lands were excluded from society. Although nationalists like Sardul Singh Caveeshar called for sympathetic revolts in other parts, Gandhi and Patel firmly rejected the idea.

References

1. Struggle for Freedom- Dr. Bipin Chandra
2. National Movement and Constitutional development-Aryan Aggarwal
3. Modern History-B.L. Grover
4. Hind Swaraj-Mahatma Gandhi.
5. Bhartiya Sanvidhan ka Vikas aur Rastriya Andolan-Dr.B.L. Fadia, Dr. R.C. Aggarwal ·Contemporary India and World-N.C.E.R.T. Class 10 Wikipedia.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 918-923 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Diversity Analysis in Spanish Bunch Type Groundnut (*Arachis hypogaea* L.)

Dikshita Joshi, P.B. Singh, Vicky Yadav, Vishal Pareek, Harshlata Regar and Aliza Maryam
Department of Genetics and Plant Breeding, RCA-MPUAT, Udaipur, Rajasthan
Email : dikshitajoshi1998@gmail.com

Abstract

Present investigation was conducted in twenty five groundnut genotypes to assess variability parameters, characters association, path coefficients and genetic divergence involving fourteen characters in order to identify superior genotypes exhibiting higher genetic diversity. Plant height and harvest index revealed significant positive correlation with dry pod yield per plant. Path coefficient analysis revealed exertion of positive direct effects on dry pod yield per plant through protein content, pods per plant, number of branches per plant, oil content, sound mature kernel and plant height.100-kernel weight, dry pod yield per plant displayed a higher level of coefficient of variation both at phenotypic and genotypic level. Genetic gain with higher heritability indicated preponderance of additive variance for 100-kernel weight. Cluster analysis exhibited substantial diversity among twenty five genotypes forming nine clusters. Two clusters [II (two genotypes) and I (sixteen genotypes)] showed the largest intra cluster distance, which suggests hybridization between these genotypes to achieve high level of heterosis for further exploitation. Five genotypes viz., UG-139, UG-245, UG-246, UG-256 and JL-501 were found superior in yield and yield component traits.

Introduction

Groundnut (Arachis hypogaea L.) is a vital oil seed crop. It is an annual, herbaceous, and self-pollinated legume that is classified under the sub-family Papilionaceae and family Fabaceae. The maximum share of groundnut production is contributed by China, India and USA. It is because of its high nutritive value that groundnut is extensively used in the food and confectionery industry. Groundnut kernel, a substantial source of edible oil (48-50%) and protein (25-28%), contains considerable amounts of vitamin E, niacin, riboflavin, thiamine, minerals and flavonoids (Janila et al., 2013). Genetic improvement for quantitative traits depends on the nature and amount of variability present in the genetic stock and the extent to which the desirable traits are heritable. So, knowledge of the nature and magnitude of variability and heritability in a population is one of the prerequisites for successful breeding program in selecting genotypes with desirable characters. Dry pod yield is the result of the expression and association of several plant growth components, which contribute additively or help in some conditions in modifying the expression of other traits directly or indirectly. Since, groundnut pods develop below the ground level hence, genotypes for yield cannot be screened or evaluated prior to harvest. Correlation and path analysis will establish the extent of association between yield and its components and will also bring out the relative importance of their direct and indirect effects and thus, give a clear understanding of their association with yield. Therefore, association studies are very important. Keeping this in view, the present investigation was carried out to explore the genetic variability by determining the magnitude of genotypic coefficient of variation, phenotypic coefficient of variation, heritability estimates, genetic advance and genetic gain of different morphological traits, their correlation, direct, indirect effects and genetic diversity in twenty five groundnut genotypes.

Materials and Methods

Twenty five groundnut genotypes were grown in Randomized Block Design with three replications at instructional farm of College of Technology and Engineering (CTAE), during Udaipur in kharif, 2021. Each genotype was sown in five rows of five meter length. Recommended cultural practices were adopted to raise a healthy crop. Observations were recorded on five competitive plants for characters viz., number of branches per plant, pods per plant, 100-kernel weight (g), shelling percentage (%), sound mature kernels (%), kernel weight per plant (g), dry pod yield per plant (g) biological yield per plant (g) and harvest index (%). While days to 50% flowering and days to maturity, oil content (%), and protein content were observed on plot basis.

Analysis of variance was carried out as per method suggested by Fisher (1918). Genotypic coefficient of variation and Phenotypic coefficient of variation as per the method suggested by Burton (1952), heritability (broad sense) was calculated according to formula suggested by Lush (1941) and genetic gain as per Johnson et al. (1955). The phenotypic and genotypic correlation coefficients were computed as per Al-Jibouri et al. (1958). Path coefficient analysis was done using genotypic correlation coefficients as suggested by Dewey and Lu

Table-1 : Estimates of mean squares, character mean, range and five best genotypes identified from groundnut genotypes.

S. No.	Characters	Mean sum of square	Mean	Range		Three best genotypes
				Min.	Max.	
1.	Days to 50% flowering	3.75**	33.39	31.75	35	UG-141, -138, UG-135
2.	Days to maturity	31.11**	107.97	101.67	113.3	GG-7, JL-501, UG-134
3.	Plant height (cm)	27.26**	38.10	34.63	45.22	UG-253, UG-252, UG-254
4.	No of branches/plant	1.00**	6.59	5.67	8.17	UG-137, UG-247, UG-251
5.	Pods/plant	3.58**	10.64	8.33	12.67	UG-246, UG-135, UG-139
6.	100-Kernel weight (g)	76.52**	42.33	33.57	42.33	UG-251, UG-247, UG-246
7.	Shelling percentage (%)	18.73**	70.87	63.10	74.70	UG-137, UG-140, UG-243
8.	Sound mature kernel (%)	19.53*	85.23	80.17	90.37	UG-247, UG-249, TG-37A
9.	Kernel yield /plant (g)	0.47	5.35	4.67	6.20	UG-256, UG-247, JL-501
10.	Dry pod yield per plant (g)	6.63**	13.06	10.17	15.90	UG-252, UG-140, UG-139
11.	Biological yield per plant (g)	29.86**	33.23	27.30	38.83	UG-139, UG-137, UG-138
12.	Harvest index (%)	61.16**	39.77	32.45	50.91	UG-254, UG-250, UG-252
13.	Oil content (%)	31.12**	41.92	35.17	46.33	UG-136, UG-256, UG-137
14.	Protein content (%)	5.30*	21.90	19.50	24.87	UG-255, UG-253, UG-250

*, **Significant at 5% and 1% respectively.

Table-2 : Estimates of PCV, GCV, heritability (broad sense), genetic advance and genetic gain for different characters in groundnut.

S. No.	Characters	GCV	PCV	h^2	GA	GG
1.	Days to 50% flowering	2.77	4.27	41.99	1.23	3.70
2.	Days to maturity	2.88	3.17	82.39	5.82	5.39
3.	Plant height	7.61	8.48	80.51	5.36	14.07
4.	No of branches / plant	8.19	9.80	69.78	0.93	14.09
5.	Pods/plant	7.86	13.89	32.01	0.97	9.16
6.	100-Kernel weight	11.78	12.23	92.82	9.90	23.38
7.	Shelling percentage	3.08	4.28	51.95	3.24	4.58
8.	Sound mature kernel	2.13	4.22	25.31	1.88	2.20
9.	Kernel yield /plant	4.60	11.01	17.43	0.21	3.95
10.	Dry pod yield per plant	10.65	12.73	70.01	2.40	18.35
11.	Biological yield per plant	9.08	10.27	78.06	5.49	16.52
12.	Harvest index	9.34	14.57	41.05	4.90	12.32
13.	Oil content	7.64	7.77	96.54	6.48	15.46
14.	Protein content	4.46	8.42	28.04	1.06	4.86

(1959). The Genetic divergence analysis was done by using D^2 statistics proposed by Mahalanobis (1939).

Results and Discussion

Analysis of variance indicated that mean sum of squares were significant for all the characters studied except kernel yield per plant (g). All the characters exhibiting significant variation among the genotypes were used for analysis (Table-1). However, moderate estimates of GCV were observed for 100-kernel weight (11.78%) followed by dry pod yield per plant (10.65%). Maximum heritability was found for oil content (96.54%) followed by 100-kernel weight (92.82) while, maximum genetic gain was observed for 100-kernel weight (23.38%).

Similar results were also reported by Rao et al. (2014), Vasanthi et al. (2016), Patidar et al. (2017), Kumar et al. (2019) and Kumari et al. (2019).

Based on mean values, three best genotypes UG-252, UG-140, UG-139 were identified for dry pod yield per plant. In addition to this, genotype UG-139 was also showed lowest shelling percentage. Similarly, genotype UG-139 and UG-136 exhibited highest biological yield and oil content. Genotype UG-255 had highest protein content (Table-1).

Estimates of heritability varied from kernel yield per plant (17.43%) to oil content (96.54%). High heritability estimates coupled with high genetic gain were observed

Table-3 : Genotypic and phenotypic correlations for yield and yield contributing traits in the groundnut genotypes.

S. No.	Character	Days to 50% flowering	Days to maturity	Plant height (cm)	No of branches / plant	Pods/plant	100-Kernel weight (g)	Shelling percentage	Sound mature kernel (%)	Kernel yield /plant (g)	Dry pod yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil percent	Protein percent
1.	Days to 50% flowering		0.32	0.17	-0.01	-0.08	0.13	0.39	0.05	0.11	-0.12	-0.21	-0.09	0.76**	-0.00
2.	Days to maturity	0.17		0.27	0.18	0.01	0.44*	-0.03	0.21	-0.09	-0.19	0.02	-0.25	0.30	-0.30
3.	Plant height (cm)	0.15	0.22		-0.39*	-0.21	-0.15	0.34	-0.55*	0.15	0.43*	-0.12	0.57**	0.12	0.66**
4.	No of branches / plant	-0.03	0.12	-0.32*		-0.17	0.17	0.23	-0.01	-0.58	-0.11	0.42*	-0.60**	-0.01	-0.44
5.	Pods/plant	0.05	0.04	-0.04	0.00		0.08	-0.01	0.42	0.32	-0.11	0.47	-0.19	-0.01	-0.81**
6.	100-Kernel weight (g)	0.06	0.40*	-0.14	0.13	0.03		-0.06	0.15	0.16	-0.57**	-0.18	-0.54**	-0.05	-0.18
7.	Shelling percentage	0.11	-0.01	0.18	0.17	-0.15	0.02		-0.29	0.40	0.35	0.06	0.10	-0.12	-0.07
8.	Sound mature kernel (%)	-0.05	0.08	-0.23	0.02	0.29**	0.07	-0.14		0.90	-0.45	0.11	-0.52	-0.03	-0.77
9.	Kernel yield /plant (g)	0.04	-0.01	0.07	-0.20	0.03	0.11	0.18	0.13		0.22	0.33	0.09	0.13	0.28
10.	Dry pod yield per plant (g)	-0.06	-0.15	0.34*	-0.09	-0.05	-0.49**	0.17	-0.13	0.03		0.34	0.70**	0.06	-0.03
11.	Biological yield per plant (g)	-0.17	0.06	-0.09	0.35*	0.19	-0.16	-0.01	0.04	0.10	0.26		-0.37	-0.03	-0.36
12.	Harvest index (%)	0.06	-0.26	0.34**	-0.34**	-0.13	-0.35**	0.05	-0.07	-0.13	0.61**	-0.36**		0.12	0.32
13.	Oil content (%)	0.50**	0.27	0.10	-0.04	0.02	-0.05	-0.09	-0.07	0.02	0.05	-0.03	0.07		-0.08
14.	Protein content (%)	0.12	-0.18	0.34**	-0.25*	-0.24*	-0.10	0.08	-0.04	-0.01	0.09	-0.19	0.34**	-0.03	

*, ** Significant at 5% and 1% respectively.

for 100-kernel weight (23.38) (Table-2). High heritability and genetic gain were also reported by Sonone et al. (2011), John et al. (2013) Roy et al. (2018) and Vinithashri et al. (2019).

Correlation analysis were conducted to study the association of traits with yield. At the genotypic level, the correlation values were calculated on the basis of additive variance, whereas at the phenotypic level, environmental deviations were incorporated (Table-3).

Correlation studies revealed that Dry pod yield per plant had positive and significant correlation with harvest index at genotypic and phenotypic level. Days to 50% flowering exhibited positive and significant correlation coefficient with oil content at both genotypic and phenotypic levels. Days to maturity had positive and significant correlation with 100-kernel weight at both genotypic and phenotypic level. Plant height established positive and significant relationship both at genotypic and phenotypic level with dry pod yield, harvest index and protein content while negative and significant correlation coefficient with number of branches per plant at both genotypic and phenotypic level but with sound mature kernel had negative and significant correlation at genotypic level only. Number of branches per plant had positive and significant correlation with biological yield per plant at both genotypic and phenotypic level while negative and significant correlation with harvest index at both genotypic and phenotypic level but with protein content at phenotypic level only. Pods per plant had negative and significant relation with protein content at both genotypic and phenotypic level.100-kernel weight had negative correlations with dry pod yield per plant as well as with harvest index at both genotypic and phenotypic level. Biological yield per plant had negative and significant correlation with harvest index at phenotypic level only. Harvest index had positive and significant correlation with protein content at phenotypic level only.

Similar findings are found in Babariya et al. (2012), Shankar et al. (2018), and Solanki et al. (2019).

Estimation of path analysis revealed that direct positive effect on dry pod yield per plant was observed in protein content (1.56) followed by pods per plant (1.31), number of branches per plant (1.25), oil content (0.77) and plant height (0.61) (Table 4). Similar findings have been reported in Babariya et al. (2012), Kumar et al. (2014), Patil et al. (2015), Jain et al. (2016) and Ram et al. (2017).

Cluster composition in the present study based on the D^2 values, 25 genotypes were grouped into nine distinctive non-hierarchical clusters. The components of

Table-4 : Genotypic path analysis for dry pod yield per plant (g) showing direct (diagonal and bold) and indirect effects of different characters on pod yield of groundnut genotypes.

S. No.	Character	Days to 50% flowering	Days to maturity	Plant height	No of branches / plant	Pods/ plant	Sound mature kernel	Biological yield per plant	Oil content	Protein content	r
1.	Days to 50% flowering	-0.70	-0.08	0.10	-0.0	-0.10	0.03	0.07	0.58	-0.00	-0.11
2.	Days to maturity	-0.22	-0.28	0.16	0.22	0.01	0.14	-0.00	0.23	-0.46	-0.18
3.	Plant height	-0.11	-0.07	0.61	-0.48	-0.27	-0.38	0.04	0.08	1.02	0.42*
4.	No of branches / plant	0.00	-0.05	-0.23	1.25	-0.22	-0.00	-0.15	-0.01	-0.68	-0.10
5.	Pods/plant	0.05	-0.00	-0.12	-0.21	1.31	0.29	-0.17	-0.00	-1.26	-0.11
6.	Sound mature kernel	-0.03	-0.05	-0.33	-0.01	0.55	0.70	-0.04	-0.02	-1.20	-0.45*
7.	Biological yield per plant	0.14	-0.00	-0.07	0.52	0.61	0.07	-0.36	-0.02	-0.56	0.33
8.	Oil percent	-0.53	-0.08	0.07	-0.01	-0.00	-0.02	0.01	0.77	-0.13	0.05
9.	Protein percent	0.00	0.08	0.40	-0.54	-1.06	-0.54	0.13	-0.06	1.56	-0.03

Residual = 0.33 *,**Significant correlation with dependent character at 5% and 1% respectively.

Table-5 : Clustering pattern of different genotypes in different clusters.

Cluster	No	Members
I	16	UG-134,UG-135,UG-136,UG-137,UG-140,UG-141,UG-248,UG-249,UG-253,UG-255,UG-256,UD-257,UG-258,TG-37A,JL-501,GG-7
II	2	UG-245,UG-251
III	1	UG-254
IV	1	UG-250
V	1	UG-252
VI	1	UG-139
VII	1	UG-247
VIII	1	UG-138
IX	1	UG-246

Table-6 : Mean values of different characters for 25 genotypes in nine clusters.

Cluster	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	Pods per plant (g)	100-kernel weight (g)	Shelling %	SMK (%)	Kernel yield per plant (g)	Dry pod yield per plant (g)	Biological yield per plant (g)	Harvest index (%)	Oil content (%)	Protein content (%)
I	33.49	107.98	38.63	6.65	10.63	40.60	71.46	85.31	5.32	13.26	33.31	39.52	41.53	21.91
II	33.50	109.83	35.85	6.87	9.33	54.03	68.73	84.08	5.27	10.83	30.00	33.93	42.17	21.45
III	34.67	105.33	40.03	5.73	11.33	40.07	70.93	84.97	5.27	13.80	27.30	50.91	44.47	21.03
IV	33.67	108.67	36.90	5.67	9.33	40.30	69.90	88.00	5.73	13.97	29.00	48.06	44.70	23.23
V	32.00	107.33	43.70	6.37	10.00	41.50	73.20	80.17	5.30	15.90	35.20	46.13	43.63	23.23
VI	32.50	108.00	35.27	6.60	12.00	38.87	63.10	84.97	5.00	14.80	38.83	40.84	44.93	20.87
VII	32.67	112.00	35.60	7.53	11.67	51.13	73.90	90.37	6.10	12.47	36.37	36.58	41.70	20.00
VIII	31.70	105.00	36.10	6.80	10.33	37.57	68.10	83.37	5.03	11.13	36.73	37.90	39.20	22.70
IX	34.83	105.67	35.17	5.97	12.67	51.03	71.77	85.80	5.80	10.60	34.43	33.80	40.57	23.00

these nine clusters are described in Table-5. Out of the nine clusters in our study, cluster I was the largest one containing sixteen genotypes, cluster II having two genotypes, cluster III to IX were comprised of one genotype in each. Cluster mean values displayed substantial divergence for all traits among the clusters designed. The genotypes belonging to cluster II registered with high mean values for 100-kernel weight (g), cluster III and IV are found superior in harvest index (%) and protein content (%). Plant height (cm), shelling percentage (%) and dry pod yield per plant (g) recorded high mean values in cluster V. Cluster VII was superior in number of branches per plant, sound mature kernel (%) and kernel yield per plant (g). High mean values for pods per plant was observed in cluster IX. Thus breeding program can be designed to utilize genotypes from clusters V, VII and IX in order to produce filial generations with a broad base of divergence (Table-6).

The intra cluster distance varied from 0.00 to 8.22 and the inter cluster distance varied from 9.11 to 14.11. The maximum intra cluster distance was found within cluster II (8.22) followed by cluster I (7.59). The maximum inter cluster distance was observed between cluster VI and cluster VII (14.84) followed by distance between cluster V and cluster IX (14.08) (table 7). The genotypes

Table-7 : Average intra and inter-cluster distance based on corresponding D^2 values.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX
I	7.59	9.65	9.65	9.11	9.67	10.36	10.32	11.19	11.11
II		8.22	11.61	11.44	11.83	11.74	11.40	13.60	12.15
III			0.00	9.20	12.50	13.03	11.67	11.85	13.77
IV				0.00	10.06	10.90	9.52	13.33	11.89
V					0.00	11.29	11.34	12.92	14.08
VI						0.00	14.84	12.54	13.51
VII							0.00	12.42	13.28
VIII								0.00	13.51
IX									0.00

Table-8 : Per cent contribution of each character towards total divergence.

S. No.	Character	Contribution %
1.	Days to 50% flowering	2.03
2.	Days to maturity	15.86
3.	Plant height (cm)	13.70
4.	No of branches / plant	0.44
5.	Pods/plant	1.86
6.	100-Kernel weight (g)	30.98
7.	Shelling percentage	7.41
8.	Sound mature kernel (%)	7.36
9.	Kernel yield /plant (g)	0.14
10.	Dry pod yield per plant (g)	1.86

involved in these clusters (UG-139, UG-247, UG-252 and UG-256) respectively have wide genotype diversity and these genotypes can be used in hybridization programme for improvement in groundnut yield. It was estimated that Contribution of individual character towards divergence was highest for 100-kernel weight (30.98%) followed by days to maturity (15.86%) and plant height (cm) (13.70) whereas kernel yield per plant (0.14%) contributed least towards divergence. Dry pod yield per plant (g) contributed only 1.86% towards divergence (Table-8).

Conclusions

An overall view of the present investigation revealed that the test genotypes UG-139, UG-245, UG-246, UG-256 and JL-501were found superior in yield and desirable yield component traits like pods per plant and kernel yield per plant. Therefore, these genotypes seem to be promising and may be used in future breeding programme of groundnut.

References

1. Agriculture Statistics, 2020. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Govt. of India. (www.indiastat.com)
2. Al-Jibouri, H.A., Miller, P.A. and Robinson, H.F. (1958). Genotypic and environmental variance in upland cotton of interspecific origin. *Agronomy Journal,* 50: 633-63.
3. Babariya, C. A. and Dobariya, K. L. 2012. Correlation coefficient and path coefficient analysis for yield components in Groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding*, 3: 932-938.
4. Burton, G. W. 1952. Quantitative inheritance of grasses. Proceeding 6th International Grassland Congress, 1: 227-283.
5. Fisher, R.A. 1936. The use of multiple measurements in taxonomic problems. *Ann. Eugen.*, 7: 179.
6. Ganvit, R.S. and Jagtap, P.K. 2018. Character association and path co-efficient analysis studies for yield and its contributing traits in groundnut (*Arachis hypogaea* L.). *International Journal of Current Microbiology and Applied Sciences,* 7(11): 3566-3572.
7. Janila, P., Nigam, S. N., Pandey, M. K., Nagesh, P. and Varshney, R. K. (2013). Groundnut improvement: use of genetic and genomic tools. *Front. Plant Sci.*, 4: 23.
8. John. K., Vasanthi, R.P., Sireesha, K. and Giridhara, K.T. 2013. Genetic variability studies in different advanced breeding genotype of Spanish bunch groundnut (*Arachis hypogaea* L.). *Inter. J. Applied Bio. Pharma.Tech.,* 4(2): 55-60.
9. Kumar, C. P., Rekha, R., Venkateswarulu, O. and Vasanthi, R. P. 2014. Correlation and path coefficient analysis in groundnut (*Arachis hypogaea* L.). *Inter. J. Appl. Bio. Pharma. Tech.,* 5 (1): 8-11.
10. Kumar, N., Ajay, B.C., Rathanakumar, A.L., Radhakrishnan, T., Mahatma, M.K., Kona, P. and Chikani, B.M. 2019. Assessment of genetic variability for yield and quality traits in groundnut genotypes. *Electronic Journal of Plant Breeding,* 10(1): 196-206.
11. Kumari, E.A., John, K., Reddy, D.M., and Latha, P. 2019. Studies on genetic variability for yield, yield attributing traits, physiological and quality traits in groundnut (*Arachis*

hypogaea L.) *International Journal of Current Microbiology and Applied Sciences.* 8(7): 2319-7706.

12. Mahalanobis, P.C. (1936). On the generalized distance in statistics. *Proc. Nat. Inst. Sci*. (India), 2: 49-55.
13. Patidar, O.S. and Nadef, H. L. 2017. Assessment of genetic variability and traits association among high oleic advanced breeding lines for yield and quality traits in groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding,* 8 (1): 201-205.
14. Patil, S.K., Shivanna, S., Irappa, B. M. and Shweta 2015. Genetic variability and character yield attributing components in groundnut. *International Journal of Recent Scientific Research,* 6: 4568-4570.
15. Pearson. K. 1926. On the coefficient of racial likeness. Ibid, 18: 105.
16. Ram, T.D. Sharma, H. Kumar, R. and Ram, K. 2017. Correlation and path analysis for yield and its contributing traits in groundnut (*Arachis hypogaea* L.). *Intern. J. Agril. Sci.,* 9 (10): 3997-3999.
17. Rao, V. T., Venkanna, V., Bhadru, D. and Bharathi, D. 2014. Studies on variability, character association and path analysis on groundnut (*Arachis hypogaea* L.). *International Journal of Pure and Applied Bioscience,* 2: 194-197.
18. Shankar, M., Harish, B.N., Gobu, R. and Sheshaiah. 2018. A study of correlation and path analysis in peanut (*Arachis hypogaea* L.). Bulletin of Environment, *Pharmacology and Life Sciences,* 7(12): 111-114.
19. Solanki, S.M., Chaudhari, S.B., Sapovadiya, M.H., and Damor, V. 2019. Genetic variability, correlation and path analysis for yield and it's contributing traits in Virginia groundnut (*Arachis hypogaea* L.). *Ind. J. Pure App. Biosci.* 7 (6): 226-233.
20. Sonone, N. G., Thaware, B.L., Bhave, S.G., Jadhav, B.B., Joshi, G.D. and Dhekale, J.S. 2011. Multivariate studies in groundnut (*Arachis hypogaea* L.). *J. Oilseeds Res.,* 28(1): 24-28.
21. Vasanthi, R.P., Suneetha, N., and Sudhakar, P. 2016. Genetic variability and correlation studies for morphological, yield and yield attributes in groundnut (*Arachis hypogaea* L.). *Legume research*, 38(1):9-15.
22. Vinithashri, G., Manivannan, N., Viswanathan, P.L. and Selvakumar, T. 2019. Genetic variability, heritability and genetic advance of yield and related traits in F_3 generation of groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding,* 10 (3): 1292–1297
23. Vinutha, D.N., Aruna, Y.R., Jagadees, B.N and Savitramma, D.L. 2015. Genetic correlation and path-coefficient analysis of yield and its components in groundnut (*Arachis hypogaea* L.). *Int. J. Agric. Sci. & Res.,* 5(5) : 89-94.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 924-928 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

An Analysis of Consumer Buying Behaviour and Preference for Mango Pulp in Bardoli City of South Gujarat

Paulomee Dhimar and Swati Sharma*
ASPEE Agribusiness Management Institute, Navsari Agricultural University, Navsari, Gujarat
**Email : swatisharma_abm@yahoo.co.in*

Abstract

The Indian food sector has emerged as a high-growth and high-profit sector due to its immense potential for value addition, particularly within the food processing industry. India ranks first among world's mango producing countries accounting for about 50 percent of the world's mango production. In India many processing units are manufacturing mango pulp and marketing it in both domestic and international markets. In this regard, this paper intends to study the consumer buying behaviour towards mango pulp in Bardoli city of South Gujarat. For the fulfilment of the study, 120 respondents were selected as sample size and data were collected through structured questionnaire from both primary and secondary sources. The major findings of the study were that consumers preferred Kesar variety of mango pulp during festival season or any special occasions. And the major factors which influence the consumers for purchasing mango pulp were advertisement, quality, brand name, taste and freshness of mango pulp etc. But the problems faced by consumers while purchasing mango pulp were artificial colour and preservatives, unavailability of desired pack size, high price etc. So, it could be concluded from the study that there is huge scope of mango pulp as it has demand throughout the year. The product is considered a delicacy and a specialty product offered on special occasions. In this regard the demand can be tapped on sustainable basis by setting up proper marketing networks through social media campaigns, introducing expected package size and maintaining desired hygiene standards.

Key words : *mango pulp, buying behaviour, factors influencing, constraints.*

Introduction

The cultivation of mango (*Magnifera indica* L.) accounts for approximately half of all tropical fruits produced worldwide. India occupies the top position amongst the mango growing countries of the world and produces 40.48 per cent of the global mango production from about 22.67 lakh hectares with a production of 196.84 lakh tonnes during Triennium Ending (TE) 2016-17. As of Gujarat is concerned, mango is cultivated in an acreage of 1.52 lakh hectares with a production of 12.41 lakh metric tonnes during TE 2016-17, thereby, producing roughly a share of 6.30 per cent of the country. Gujarat happens to be the fifth largest mango producer in India preceded by Uttar Pradesh, Andhra Pradesh, Karnataka and Bihar during TE 2016-17 (Ramani *et al*. 2019).

South Gujarat is one of the important clusters of mango pulp in the country with a number of processing units in the region with a good backward linkage of Alphonso and Kesar variety of mangoes. Mango pulp is an important value added product of mango. A number of processing units have been manufacturing mango pulp and marketing it in local as well as national and international markets. The growth of mangopulp industries will bring large benefits to the people by way of employment and income (Xavier, 2008). In order to understand the overall current market conditions, consumer demand and consumer behaviour for mango pulp to help the mango pulp processors compete more effectively in an increasingly competitive landscape, the present study was undertaken.

Objective of the study : The main objective of this study was to study consumer buying behaviour and preference for mango pulp in Bardoli city of South Gujarat. With this overall objective the sub objectives of study were as follows :

To study the socio-economic profile of consumers.

To study the consumers buying behaviour towards mango pulp.

To study the factors influencing the selection of mango pulp.

To study the constraints faced by consumers while purchasing mango pulp.

Research Methodology

The nature of the present study was descriptive. The data were gathered from both the primary and secondary sources. The primary data were collected by conducting personal interview of consumers who purchase mango pulp from different locations like supermarket, kirana store, dairy, farsan or sweet shop etc. in the study area. The convenience sampling method was used for the selection of 120 respondents. The primary data were gathered by administering a structured questionnaire with 120 consumers of Bardoli city. The secondary data were

collected through various sources like internet source, journals and other sources. The quantitative approach was used for the data analysis. Simple Statistical tools and tabular analysis was done for the fulfilment of the objectives.

Results and Discussion

Table-1 : Socio-economic profile of respondents. (n=120)

Demographic variables	Parameters	Frequency	Percentage
Gender	Male	74	61.7
	Female	46	38.3
	Total	120	100
Age	Below 18 year	18	15
	18-25 year	29	24.2
	25-40 year	48	40
	40-50 year	23	19.2
	Above 50 year	2	1.7
	Total	120	100
Marital status	Married	63	52.5
	Unmarried	57	47.5
	Total	120	100
Household (Family size)	2 or less than 2	7	5.8
	3-5 members	73	60.8
	More than 5 members	40	33.3
	Total	120	100
Education qualification of respondents	Below SSC	1	0.8
	SSC	9	7.5
	HSC	21	17.5
	Diploma	18	15
	Graduate	45	37.5
	Post graduate	26	21.7
	Illiterate	00	-
	Total	120	100
Occupation of the respondents	Student	44	36.7
	Household	11	9.2
	Employee (private/public)	41	34.2
	Business	13	10.8
	Other	11	9.1
	Total	120	100
Monthly household income of respondents	Less than 10,000	1	0.8
	10.000-20,000	45	37.5
	20,000-30,000	28	23.3
	30,000-40,000	22	18.3
	Above 40,000	24	20
	Total	120	100

The Table-1 shows that among the consumer buying mango pulp from different locations, majority of them were males i.e., 61.7 percent and 38.3 percent were females. From the total sample of 120 consumers, 40 percent were in age-group 25-40 years followed by 24.2 percent were in 18-25 years. Majority of consumers were married i.e., 52.5 percent and rest of other consumers were unmarried. Regarding family or household size of consumers it was found that 60.8 percent consumers had 3-5 members in their family followed by 33.3 percent consumers had more than 5 members in their family. Regarding the educational qualification of the consumers, it was found that 37.5 percent were graduate followed by 21.7 percent were post graduate, 17.5 percent were HSC, 15 percent were diploma and only 7.5 percent who were SSC. Regarding occupations of consumers, it was found that 36.7 percent were students followed by 34.2 percent were employee in private or any public organizations, 10.8 percent were having business. About the monthly household income of consumers, it was found that 37.5 percent had monthly income between 10,000-20,000 Rs. Per month followed by 23.3 percent consumers had monthly income between 20,000-30,000 per month, 18.3 percent had 30,000-40,000 income per month and 20 percent had above 40,000 income per month.

Table-2 : Preferred time for purchasing mango pulp. (n=120)

Time period	No. of Consumers	Percentage of the consumers (%)
Weekly	5	4.2
Monthly	30	25
Quarterly	18	15
Half hourly	5	4.2
Yearly	10	8.3
Only for special occasions	52	43.3
Total	120	100

The Table-2 depicts the preferred time for purchasing mango pulp and it was found that more number of consumers preferred to purchase mango pulp only for special occasions i.e., 43.3 percent, 25 percent consumers preferred to purchase mango pulp monthly, followed by 15 percent preferred to purchase quarterly and 8.3 percent consumers preferred to purchase mango pulp yearly.

Table-3 : Preferred variety of mango pulp. (Multiple selection)

Variety	No. of Consumers	Percentage of the consumers (%)
Ratnagiri Alphonso Mango Pulp	46	38.3
Kesar Mango Pulp	107	89.2

The Table-3 depicts the preferred variety of mango pulp and it was found that 89.2 percent consumers preferred Kesar Mango variety of mango pulp and 38.3 percent consumers preferred Ratnagiri Alphonso variety of mango pulp.

Table-4 : Reasons for purchasing mango pulp. (Multiple selection)

Reason	No. of Consumers	Percentage of the consumers (%)
Quality	96	80
Freshness	75	62.5
Easily availability	72	60
Good packaging	35	28.7
Sugar content	19	15.8
Preservatives	12	10
Hygiene	45	37.5
Quality certification	71	59.2
Taste	56	45.9

The Table-4 depicts the reasons for purchasing mango pulp and it was found that majority of consumers were purchasing mango pulp due to its good quality i.e., 80 percent, freshness of mango i.e., 62.5 percent, easy availability and quality certification i.e., 60 percent and 59.2 percent respectively, good packaging i.e., 28.7 percent etc. So, it can be concluded that majority of consumers were purchasing mango pulp due its good quality, freshness of pulp, easily availability etc.

Table-5 : Occasions for purchasing mango pulp. (Multiple selection)

Occasions	No. of Consumers	Percentage of the consumers (%)
Festival	73	62.4
Picnic	12	10.3
Parties	20	17.1
For Guests	82	70.1
Family functions/ special occasions	91	77.8

The Table-5 depicts the occasions for purchasing mango pulp and it was found that consumers like to purchase mango pulp on special occasions or any family functions i.e., 77.8 percent followed by for guests i.e., 70.1 percent, for festival i.e., 62.4 percent and sometimes consumers were like to purchase mango pulp for picnic and parties i.e., 10.3 percent and 17.1 percent respectively.

Table-6 : Preferred locations for purchasing mango pulp. (Multiple selection)

Location/Place	No. of Consumers	Percentage of the consumers (%)
Supermarket	79	65.8
Farsan/Bakeries	64	53.3
Kirana store	73	60.8
Sweet shop/Dairy	47	39.2
Cooperatives	20	16.7
Prepared by own	2	1.7
Retail outlets	2	1.7

The Table-6 depicts preferred locations for purchasing mango pulp and it was found that majority of consumers were like to purchase mango pulp from supermarket i.e., 65.8 percent followed by kirana store i.e., 60.8 percent, farsan/ bakeries i.e., 53.3 percent, sweet shop/ dairy i.e., 39.2 percent, cooperatives 16.7 percent and consumers least preferred to prepare mango pulp by own.

Table-7 : Most preferred pack size for mango pulp. (n=120)

Pack size	No. of Consumers	Percentage of the consumers (%)
850 gm	74	61.7
3.1 kg	46	38.3
Total	120	100

The Table-7 depicts most preferred pack size for mango pulp and it was found that 61.7 percent consumers preferred to purchase 850 gm pack size of mango pulp and 38.3 percent consumers preferred to purchase 3.1kg pack size of mango pulp.

Table-8 : Preferred type of packaging for mango pulp. (n=120)

Packing type	No. of Consumers	Percentage of the consumers (%)
Tin packing	99	82.5
Plastic packing	12	10
Glass bottle packing	9	7.5
Total	120	100

The Table-8 depicts preferred type of packaging for mango pulp and it was found that 82.5 percent consumers preferred Tin packaging of mango pulp, 10 percent consumers preferred plastic packaging of mango pulp and 7.5 percent consumers preferred to purchase Glass bottle packing of mango pulp.

Table-9 : Preferred mode of consumption of mango pulp. (Multiple selection)

Mode of consumption	No. of Consumers	Percentage of the consumers (%)
As a milk shake	54	45
With ice-cream	64	53.3
Ras-poori	96	80
Mango pulp cake	24	20
Mango pulp sweets (modak)	23	19.2

The Table-9 depicts the preferred mode of consumption for mango pulp and it was found that majority of consumers like to consume mango pulp as ras-poori i.e., 80 percent followed by ice-cream i.e., 53.3 percent, milk shake i.e., 45 percent and some consumers like to consume mango pulp as mango pulp cake and mango pulp sweets (modak).

Table-10 : Source of information for mango pulp. (n=120)

Sources	No. of Consumers	Percentage of the consumers (%)
Print media	14	11.7
Company representative	22	18.3
Online resources	51	42.5
Word of mouth	33	27.5
Total	120	100

Table-11 : Factors which influence the consumer for purchasing mango pulp. (n=120)

Attributes	Always (5)	Mostly (4)	Often (3)	Rarely (2)	Never (1)	Cumulative Score CS*	Mean	Rank
Brand name	89(445)	13 (52)	09(36)	09(18)	00(00)	551	4.59	4
Taste	84(420)	28(112)	06(18)	02(04)	00(00)	554	4.61	2
Quality	86(430)	22 (88)	10(30)	02(04)	00(00)	552	4.60	3
Quantity	67(335)	36(144)	15(45)	01(02)	01(01)	526	4.38	16
Price	77(385)	24 (96)	16(48)	03(06)	00(00)	535	4.45	12
Mango variety	76(380)	32(128)	10(30)	02(04)	00(00)	542	4.52	8
Pack size	73(365)	32(128)	11(33)	04(08)	00(00)	534	4.44	13
Freshness	84(420)	23 (92)	11(33)	02(04)	00(00)	549	4.57	5
Easy availability	82(410)	27(108)	08(24)	02(04)	01(01)	547	4.55	7
Durability	58(290)	34(136)	21(63)	05(10)	02(04)	501	4.17	17
Advertisement	85(425)	27(108)	06(18)	02(04)	00(00)	555	4.62	1
Word of mouth	84(420)	22 (88)	12(36)	02(04)	00(00)	548	4.56	6
Shop display	76(380)	31(124)	10(30)	03(06)	00(00)	540	4.50	10
Attractive packaging	76(380)	23 (92)	18(54)	03(06)	00(00)	532	4.43	14
Discount	77(385)	25(100)	15(45)	03(06)	00(00)	536	4.46	11
Certification	89(445)	13 (52)	08(24)	10(20)	00(00)	541	4.52	9
Labelling	66(330)	37(148)	16(48)	01(02)	00(00)	528	4.40	15

Mean = Cumulative Score (CS)/Total no. of Respondent, Maximum Score = Maximum Scale(5) X Number of Respondents (120) (Always: 5, Mostly: 4, Often: 3, Rarely: 2, Never: 1)

The Table-10 depicts source of information for mango pulp and it was found that 42.7 percent consumers got information about mango pulp through online resources, 18.3 percent consumers got information about mango pulp through company representative, 11.7 percent consumers got information about mango pulp through print media and others got information through word of mouth.

The Table-11 depicts factors which influence the consumer for purchasing mango pulp and it was found that factors like advertisement, taste, quality, brand name, freshness etc. influenced the consumers for purchasing mango pulp.

Table-12 : Constraints faced by consumers while purchasing mango pulp. (Multiple selection)

Constraints	No. of Consumers	Percentage of the consumers (%)	Rank
Poor quality	12	10	5
High price	54	45	3
Lack of availability	16	13.3	4
Poor hygiene	10	8.3	7
No certification	11	9.2	6
Improper packaging	4	3.3	9
Improper labelling	6	5	8
Desired quantity pack not available	63	52.5	2
Use of artificial colour and preservatives	72	60	1
Lack of awareness	2	1.7	10
Freshness	1	0.8	11

The Table-12 depicts constraints faced by consumers while purchasing mango pulp and it was found that desired quality pack not available i.e. 52.5 percent, use of artificial colour and preservatives i.e. 60 percent, poor quality i.e. 10 percent, high price i.e. 45 percent, lack of availability i.e. 13.3 percent, poor qualityi.e. 8.3 percent were major problems while purchasing mango pulp faced by consumers.

Table-13 : Willingness of consumers for purchasing mango pulp in future. (n=120)

Particular	No. of Consumers	Percentage of the consumers (%)
Yes	117	97.5
No	3	2.5
Total	120	100

The table-13 depicts willingness of consumers for purchasing mango pulp in future and it was found that 97.5 percent consumers had willingness for purchasing mango pulp in future and 2.5% respondents had not willingness for purchasing mango pulp in future.

Table-14 : willingness of consumer for suggesting others to purchase mango pulp in future. (n=120)

Particular	No. of Consumers	Percentage of the consumers (%)
Yes	112	93.3
No	8	6.7
Total	120	100

The Table-14 depicts the willingness of consumers for suggesting others to purchase mango pulp in future and it was found that 93.3% respondents had willingness for suggest others to purchase mango pulp in future and

6.7% respondents had not willingness for suggest others to purchase mango pulp in future.

Conclusions

The production and marketing of mango pulp has great potential which presents a good scope and opportunity in domestic as well as international markets. From the above analysis it could be concluded that majority of consumers were aware about mango pulp through online resources, word of mouth and print media. Most of the consumers preferred to purchase kesar mango variety of mango pulp on special occasions, festival and for guests. Majority of consumers preferred purchasing mango pulp from supermarket, kirana stores, bakeries etc. In the study area majority of consumers preferred to purchase 850gm pack size of mango pulp. The major factors influencing the consumers for purchasing mango pulp were advertisements, quality, brand name, freshness of mango pulp and taste of mango pulp etc. The major constraints faced by consumers while purchasing mango pulp were artificial colour and preservatives, unavailability of desired packaging in market etc. So, it could be concluded from the study that there is huge scope of mango pulp as it has demand throughout the year. The product is considered a delicacy and a specialty product offered on special occasions. In this regard the demand can be tapped on sustainable basis by setting up proper marketing networks through social media campaigns, introducing expected package size and maintaining desired hygiene standards.

References

1. Bommy D., and Kavitha Maheswari, S. (2016). Preserved products from mango (*Mangifera indica* L.) and its financial analysis & beneficiaries cost ratio. *International Journal of Current Research and Academic Review* Special Issue, 3: 67-73.
2. Datarkar, S.B.; Darekar, A.S.; Dangore, U.T. and Parshuramkar, K.H. (2014). Economic processing of mango in Gadchiroli district of Maharastra. *International Research Journal of Agricultural Economics and Statistics*, 5(2): 205-210.
3. Karthick, V.; Mani, K. and Anbarassan, A. (2013). Mango pulp processing industry in Tamil Nadu- an economic analysis. *American International Journal of Research in Humanities, Arts and Social Sciences*. 2(1): 48-52
4. Mehta, B.M. and Sonawane, M. (2012). Entrepreneurial behaviour of mango growers of Valsad district of Gujarat state. *Indian Journal of Extension Education*, 12(1):78-82.
5. Ramani, M.; Tarpara, V.D.; Swaminathan, B.; Manasi, P. and Pokiya, N.M. (2019). Cost of cultivation and profitability of Kesar mango cultivation in Saurashtra region of Gujarat, India. *International Journal of Environmental Science and Technology*, 8(6): 1153 – 1160.
6. Reddy, K.V. and Kumar, P. (2010). An economic appraisal of mango processing plants of Chittoor district in Andhra Pradesh. *Indian Journal of Agricultural Economics*. 65(2): 277-297.
7. Shivaraj, G. and Patil, B.L. (2016). Economics of mango cultivation in Dharwad district of Northern Karnataka. *International Journal of Agricultural Sciences*, 8 (55): 2984-2987.
8. Shukla, R., Chaudhari, B. and Joshi, G. (2014). An analysis of consumer behavior and preference for mango pulp in South Gujarat, *Asian Journal of Dairy and Food Research*, 33(2): 98-103.
9. Xavier A S. R. (2008). An economic analysis of mango pulp agro based industry in Krishnagiri District, Tamil Nadu. *Political Economy Journal of India*.
10. V. Karthick et al. (2013). Mango Pulp Processing Industry in Tamil Nadu-An Economic Analysis. *American International Journal of Research in Humanities, Arts and Social Sciences*, 2(1): 48-52.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 929-931 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Assessment of Genetic Diversity for Quantitative Traits in Common Wheat (*Triticum aestivem* L. em Thell) Twenty Genotype

Pradeep Kumar Yadav, Kaushal Singh and S.C. Gaur and P.N. Singh
Corresponding Author Email : scgaur101@gmail.com

Abstract

Determination of genetic diversity is for plant Breeding or accordingly production of more expertise plant species under different conditions correspondingly most common wheat (*Triticum aestivum*) genotypes including 20 winter wheat genotype cultivated in experiment site of B.R.D.P.G College, Deoria (U.P) as a Randomization Block design with three replication. genetic diversity of wheat lines were studied through Mahalanobis'D^2 method and principle component analysis for fourteen characters The intra-cluster group means for 14 characters revealed marked character between the clusters in respects of cluster means for different characters. The 20 genotype was grouped in to 8 different non overlapping clusters. Cluster 1 did not should lowest or highest mean performance for any of the characters under study, these cluster showed in general mean performance. Cluster 2 had The highest mean performance Spike length (13.34), grain per Spike (34.44), test weight (40.46), grain weight per Spike (2.54) and harvest index (41.11).

Key words : *Genetic diversity wheat.*

Introduction

Wheat (*Triticum aestivum*. L.em. Thell, 2n=6x=42) a self -pollinated crop of the graminae family (sub family *Poaceae*) and genus *Triticum* is the worlds.Largest famous energy rich cereal crop. It has been described as the (king of cereals) because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. It is a c^3 type of plant growth form temperate, irrigated to dry area and from warm, humid to dry cold environment Doubtlessly.

The optimum amount of genetic diversity among the parents is required for obtaining broad spectrum for desirable variability in the segregating generations after hybridization. The presence of potential genetic variability in early and advanced generations is an important pre-requisite for the success of selection procedures in attaining objectives of breeding programs. Importance of genetic diversity in plant breeding has been emphasized by several workers (Weinhues, 1960, Moll *et al*., 1962, Depace *et al*., 1978, Arunachalam, 1981 and Hawkes, 1981).

Multivariate analysis bested on Mahalanobis' D2 statistic and canonical variant analysis has been considered as an important tool in quantifying the genetic diversity in different crops (Rao, 1952). These analysis also provide a measurement of relative contribution of different components of diversity both at inter and intracluster level Somayajulu *et al*., 1970, Lee and Kaltsikes, 1973, Chaudhary and Singh, 1975, Sethi *et al*., 1978, Dhonukshe and Rao, 1979, Jatasara and Paroda, 1983). In the past, the degree of genetic diversity was considered to be influence by ecological and geographical diversity. However, Several workers (Lee and Kaltsikes, 1973, Maurya and Singh, 1977, parallelism between and geographical diversity. Several remained almost stable with the change in environments (Somayajulu *et al* 1970, Rana and Murthy, 1971, Lee and Kaltsikes, 1973 and Chaudhary,1975). In contrast Jatasara acnd Paroda (1978) reported instability in the composition of the clusters the varying environments. (1070) examined the relative contribution of different characters.

Materials and Methods

The study of genetic diversity among the 20 genotypes of wheat germplasm was carried out by using 'Mahalanobis' D^2 statistics or described by 'Rao 1952' The field experiment under present investigation was conducted during *Rabi* (2020-21) at Agriculture Research farm of Baba Raghav Das Post Graduate College Deoria (U.P.). Geographically, this College is located in the east part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 3 raw of 2.5m length spaced at 23cm above the mean sea level. Experimental 14 characters- Day To 50% flowering, Plant height (cm), Day to maturity, Number of effective tillers, Length of spike(cm), Number of spikelets per spike, Number of grains per spike, Test Weight 1000 grains (g), Grain yield per plant (g),Flag leaf area (cm^2), Peduncle length(cm), Grain yield per plant(g), Biological yield per plant(g), Harvest index(%).

Results and Discussion

Loss of genetic diversity has become a problem for agriculturally important species. Decrease in genetic

variation affects the productivity and adaptability for improvement of bread wheat (Stoeva *et al*., 2009). Genetic diversity in wheat is becoming narrowed due to modern breeding, which is a problem for adaptation to biotic and abiotic stresses, like salt or drought tolerance (Nasab et al., 2013). The use of molecular markers for the evaluation of genetic diversity is receiving much attention as they allow calculation of genetic distance based on allele frequencies and useful in studying the relationship of closely related lines Huang *et al*., 2002). Availability of superior and diverse alleles/genes form the basis of genetic improvement of crop plants including wheat (Abouzied *et al*., 2013) that can help in identification of new cultivars. Haile *et al*., (2013) reported that SSR markers are more variable than other molecular markers, which are useful tools for the study of genetic diversity of germplasms. The study of genetic diversity among the 20 Genotypes and 3 replication of wheat gremplasm was carried out by using "Mahalanobis" D2 statistics or described by 'Rao (1952).The clustering pattern of the 20 genotypes was grouped in to 8 different non overlapping clusters. cluster 1 had highest number of genotypes (9) followed by cluster 2 with 5 entries, cluster 3,4,5,6,7 and 8 with only 1 entry each. The inter cluster distances range from 0.00 cluster (3,4,5,6,7,8,) to 4.22 (cluster 2). The maximum Inter cluster distances was observed between the clusters 4 and 5(9.38) which suggested that members of these one clusters are genetically very diverse to each other. The inter cluster values between clusters 2 and 6 (9.07) clusters 4 and 7 (8.79), clusters 2and 5 (8.98) clusters 4 and 7 (8.79) were also very high. The minimum inter cluster D2 value (4.15) was recorded in case of clusters 3and 8 followed by clusters 3and 8(5.18). The higher inter cluster distances indicate greater genetic divergence between the genotypes of those clusters while lower Inter cluster values between the clusters suggested that the Genotypes of the clusters were not much genetically diverse form each other.The inter cluster group mean far 14 characters are given in perusal of table should that cluster mean for different traits indicated considerable differences between the clusters. Cluster 1 did not should lowest or highest mean performance for any of the characters under study , these cluster showed in general mean performance. Cluster 2 had the highest mean performance Spike length (13.34), grain per Spike (35.44), test weight (40.46), grain weight per Spike (2.54),and harvest index (41.11). Cluster 3 exhibited highest mean performance for the spike lets per Spike (21.73), days to maturity (132), biological yield (40.41), and Lowest mean values for peduncle length (38.07), grain weight per Spike (2.03). Cluster 4 showed highest mean performance for Spike length (12.41), tillers per plant (4.83) grain yield per plant (14.76), harvest index (39.29) and lowest mean values for lowest mean values for plant height (85.41). Cluster 5 exhibited highest mean values for the character days to 50% flowering (87.67), Spike length (11.41), Spike lets per Spike (20.6), test weight (39.4), biological yield (38.35) and lowest mean values for tillers per plant (4.33), grain weight per Spike (2.07),grain yield per plant (8.65), harvest index (22.95). Cluster 6 exhibited highest mean performance for the peduncle length (153.4), Spike length (10.78), productive tillers/plant (4.77), days to maturity (132), grain weight per Spike (2.49) harvest index (32.71) and lowest mean values for plant height cm (88.38) spike lets per Spike (16.96), grain per Spike (18.87). Cluster 7 exhibited highest mean performance for the days to 50% flowering (88.67), plant height cm (91.57) flag leaf area cm2 (35.34) , Spike length (10.19), grain per Spike (30.23) , biological yield (37.24), grain yield per plant (11.24) and lowest mean peduncle length (39.16), tillers per plant (4.53) spike lets per Spike (19.15), days to maturity (127.67), test weight(30.17). Cluster 8 exhibited highest mean performance for Days to maturity (131.33) and lowest mean flag s leaf area cm2 (23.83), Spike length (9.61) biological yield (28.42) grain yield per plant (9.21).

Table-1 : Names of wheat genotypes used in the study.

S. No.	Name of genotype	S. No.	Name of genotype
1.	DBW-107	11.	SR-303
2.	NW-2036	12.	DBW-71
3.	WL-15	13.	WL-13
4.	PBW-343	14.	WH-1105
5.	HUW-234	15.	WH-711
6.	PBW-154	16.	HUW-318
7.	HUW-468	17.	WL-2
8.	PBW-502	18.	HD-2967
9.	DBW-39	19.	PBW-152
10.	WL-14	20.	HUW-26

Table-2 : Clustering pattern of 20 genotypes on the basis of Mahalanobis D^2 statistics of wheat germplasm.

Cluster number	No. of Genotypes	Number of Genotypes
1	9	PBW-343, DBW-71, SHREERAM-303, PBW-502,HUW-468, HUW 318, DBW-39, WL-141,NW-2036
2	5	WH-1105, WH-711, HUW-206, PBW-152, PBW-154
3	1	WL-2
4	1	DBW-107
5	1	HD-2967
6	1	WL-15
7	1	WL-13
8	1	HUW-234

Table-3 : Estimated of average Inter and intra-cluster distances for 8 clusters in wheat germplasm.

	Inter and intra cluster distance							
	Group.1	**Group.2**	**Group. 3**	**Group.4**	**Group.5**	**Group.6**	**Group.7**	**Group.8**
Group.1	4.15	6.57	5.69	5.22	6.26	5.67	6.75	6.44
Group.2	6.57	4.22	8.13	6.11	8.98	9.07	7.4	6.96
Group.3	5.69	8.13	0	8.05	4.15	5.66	6.59	5.18
Group.4	5.22	6.11	8.05	0	9.38	7.18	8.79	8.78
Group.5	6.26	8.98	4.15	9.38	0	6.62	5.33	6.72
Group.6	5.67	9.07	5.66	7.18	6.62	0	8.1	7.75
Group.7	6.75	7.4	6.59	8.79	5.33	8.1	0	6.66
Group.8	6.44	6.96	5.18	8.78	6.72	7.75	6.66	0

Table-4 : Cluster group mean for 14 characters among 20 wheat Genotypes.

	Cluster mean													
	DFF	**PHT**	**PEDL**	**FLA**	**SL**	**TPP**	**SPS**	**DTM**	**GrPS**	**TW**	**GWPS**	**BY**	**GYPP**	**HI(%)**
Group. 1	85.8	89.2	39.5	28.2	11.3	4.3	19.7	129.5	24.7	37.9	2.34	34.6	11.5	33.9
Group. 2	85.4	90	40.21	27.92	13.34	4.95	21.8	128.8	35.4	40.4	2.54	34.8	14.0	41.1
Group. 3	83	92.49	38.07	26.45	9.89	4.83	21.73	132	28.47	39.2	2.03	40.4	11.0	27.7
Group. 4	84	85.41	40.45	32.94	12.41	4.83	19.6	128.33	24.93	38.8	2.38	37.6	14.7	39.2
Group. 5	87.67	90.52	39.53	31.56	11.41	4.33	20.6	130.33	27.17	39.4	2.07	38.3	8.65	22.9
Group. 6	83.33	88.38	153.4	28.17	10.78	4.77	16.96	132	18.87	36.9	2.49	36.1	10.9	32.7
Group. 7	88.67	91.57	39.16	35.34	10.19	4.53	19.15	127.67	30.23	30.71	2.23	37.2	11.2	30.3
Group. 8	82.33	90.81	39.16	23.83	9.61	4.57	19.37	131.33	29	37.15	2.29	28.42	9.21	31.89

References

1. Abouzied, H.M., Eldemery, S.M. and Abdellatif, K.F. (2013). SSR-Based Genetic Diversity Assessment in Tetraploid and Hexaploid Wheat Populations. British Biotechnology Journal, 3: 390- 404.
2. Arunachalam (1981). Genetic distances in plant breeding. *Indian J. Genet.* 41(21): 226-236.
3. Chaudhary, B.D and singh, V.P. (1975). Genetic diversity in some Indian and exotic barley varieties and their hybrid. *India. J genet.,* 35(3): 409-413. 8: 11 PM 0.2KB/s
4. De-Pace, C., Porceddu, E. and Blanco, A. (1978). Variability of agronomic traits in genetically distant durum wheat. *Proc. Int. Wheat genet. Symp.,* New Delhi, 681-694.
5. Dhonukshe, B.L. and Rao, M.V. (1979). Heterosis in durum wheat. *Indian J. Genet.,* 39: 285291.
6. Haile, J.K., Hammer, K., Badebo, A., Nachit, M.M., and Röder, M.S. (2013). Genetic diversity assessment of Ethiopian tetraploid wheat landraces and improved durum wheat varieties using microsatellites and markers linked with stem rust resistance. *Genetic resources and crop evolution,* 60(2): 513-527.
7. Huang, X., Börner, A., Röder, M. and Ganal, M. (2002). Assessing genetic diversity of wheat (*Triticum aestivum* L.) germplasm using microsatellite markers. *Theoretical and Applied Genetics,* 105(5): 699-707.
8. Hawkes, J.G. (1981). Germplasm collection, preservation and use. Int. plant breeding II. ed. K. J. Frey. Lowe state Unit. Press, low, pp. 57-84.
9. Jatasara, D.S. and Proda, R.S. (1983). Genetic diversity in wheat. *Indian J. Genet.,* 43(1): 6367.
10. Lee, J. and Kaltsikes, P.J. (1973). The application of Mahalanobis' generalized distance to measure genetic diversity in durum wheat, *Euphytica,* 22: 124-131.
11. Moll, R.H.; Sathawana, W.S. and Robinson, H.F. (1962). Heterosis and genetic diversity in verity crosses of maize. *Crop sci.,* 2: 197-198.
12. Maurya, D.M. and Singh, D.P. (1977). Genetic diversity in rice. *India J. Genet,* 37(3): 395402.
13. Nasab, S., Mohammadi Nejad, G. and Nakhoda, B. (2013). Assessing genetic diversity of promising wheat (*Triticum aestivum* L.) lines using microsatellite markers linked with salinity tolerance. *Journal of Plant Molecular Breeding,* 1(2): 28-39.
14. Rana, B.S. and Murty, B.R. (1971). Genetic diversity and phenotypic staibility for some characters in the genus sorghum, *Indian J. Genet.,* 31: 345-356.
15. Rao, C.R (1952). Advance statistical method in biometric research , *Hofner pub. Co.* Darion, pp 371-378.
16. Somyajulu, P.L.N.; Joshi, A.B. and Murty, B.R.(1970). Combining ability in wheat. *Indian J. genet.,* 30: 134-141.
17. Sethi, G. S.; Asana, B. M. and Singh, H. B. (1978). Genetic diversity in triple dwarf wheat. *Indian J. Agric. Sci.,* 48: 445-448.
18. Weinhues F. (1960). Botany and breeding of wheat in progressive wheat production center, etude la azote Geneva.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 932-934 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Assessment of Yield Losses Due to Insect Pests in Mustard

Raj Veer Yadav* and Vipin Kumar
Division of Entomology, Rajasthan Agricultural Research Institute, (SKNAU) Durgapura, Jaipur-302018 Rajasthan
**Corresponding Author Email : rajveertonk@gmail.com*

Abstract

Assessment of yield losses due to insect pests in mustard were conducted during *Rabi*, 2020-21 and 2021-22, at Rajasthan Agricultural Research Institute, Durgapura, Jaipur. Due to insect pests of mustard avoidable losses were calculated over treated yield 40.82 and 41.02 per cent both the year respectively. The pooled avoidable losses obtained 40.92 per cent.

Key words : *Treated and untreated, yield, increase in yield and avoidable loss.*

Introduction

Indian mustard known as *Brassica juncea* (L.) Czern & Coss, belongs to plant family *Brassiceae* (*Cruciferae*) or the mustard family. In the trade, it is commonly referred to as Rapeseed-mustard along with four other closely related cultivated species *viz. Brassica rapa, B. napus, B. carinata and Eruca sativa.*

India is one of the largest producers of oilseeds in the world and it is backbone of agricultural economy of India. In India rapeseed-mustard accounted for an area 6.78 million hectors, production 9.12 million tonnes and yield 1345 kg ha^{-1} with four major producing states are Rajasthan, Haryana, Uttar Pradesh and Madhya Pradesh which had accounted of area 2.95, 0.64, 0.76 and 0.68 million hectors and production 4.22, 1.15, 0.96 and 0.91 million tonnes, yield 1431, 1793, 1260 and 1354 kg ha^{-1}, respectively (Anonymous, 2020). Rajasthan is the leading producing state with the total 4.22 million tonnes production and share of 46.28 per cent compared to all India mustard production. Alwar, Bharatpur, Sri Ganganagar and Tonk are the leading mustard producing district of the Rajasthan which had accounted of area 0.27, 0.25, 0.23 and 0.23 million hectors and production 0.67, 0.53, 0.44 and 0.41 million tonnes, yield 2284, 2115, 1860 and 1740 kg ha^{-1}, respectively (Anonymous, 2021).

There are major threats in mustard production areas attack of various insect-pests. There are major insects which cause damage to mustard crops *viz*., mustard aphid, *Lipaphis erysimi* (Kalt), mustard sawfly, *Athalia lugens proxima* (Klug.), painted bug, *Bagrada hilaris* (Burm.), pea leaf miner, *Chromatomyia horticola* (Gour.), cabbage butter fly, *Pieris brassicae* (Linn.) and bihar hairy caterpillar, *Spilarctia oblique* (Walk.) (Yadav *et al.,* 2018).

Mustard aphid, *Lipaphis erysimi* (Kalt), is the major pest of mustard growing field which are spread all over the mustard cultivated areas. It's accountable to reach from 9 to 96 per cent crop production weight loss and 15 per cent oil diminution in India (Yadav and Singh 2016). Painted bug, *Bagrada hilaris* (Burm.) present in whole the crop growing season seedling stage to till harvest. It is estimated that approximately 26.84 to 70.0 per cent loss in crop grain yield and 2.75 per cent in oil content is occurred in mustard due to heavy attack of mustard painted bug (Kalasariya and Parmar, 2016). Mustard sawfly, *Athalia lugens proxima* (Klug.) is also considered a serious pest which causes large damage to different cruciferous crop plants in India. Decrease in yield from this pest on an average 25 per cent but some time at the favourable condition of this pest population reach to heavy diminution of yield go up to 100 per cent (Patel *et al.,* 2018).

Material and Methods

The experiment was laid out in simple paired plot design (Paired t-test) with two treatments, *viz.,* treated and untreated, each replicated thirteen times. The plot size was measured 4.0 x 3.0 m^2 with row to row and plant to plant distance of 30 cm and 10 cm, respectively.

Method of observations : The plots were treated with alternate sprays of dimethoate 30 EC and malathion 50 EC respectively at weekly interval. The data of the seed yield obtained per plot was converted into quintal per hectare to interpret the results of crop loss inflicted by incidence of insect pests on mustard crop. The avoidable loss and increase in yield over control (untreated) will be calculated for each treatment with the formula given by Pradhan (1964).

$$\text{Avoidable loss (\%)} = \frac{\text{Yield in treated plot - Yield in untreated control plot}}{\text{Yield in treated plot}} \quad 100$$

Table-1 : Assess the yield losses due to insect pests in mustard crop (Pooled, Rabi, 2020-21 and 2021-22).

Treatment	Yield (q ha^{-1})			Increase in yield over untreated (%)			Avoidable loss (%)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Treated plots	13.18	13.48	13.33	68.97	69.56	69.27	40.82	41.02	40.92
Untreated plots	7.80	7.95	7.88	-	-	-	-	-	-
Increase in yield	5.38	5.53	5.46	-	-	-	-	-	-
t. cal.	20.15	17.52	18.84	-	-	-	-	-	-

$$\text{Increase in yield (\%)} = \frac{\text{Yield in treated - Yield in untreated control}}{\text{Yield in untreated control}} \quad 100$$

Result and Discussion

Assessment of the yield losses due to insect pests in mustard crop found that the mean of seed yield 13.33 q ha^{-1} calculated from treated plots and seed yield 7.88q ha^{-1} calculated from untreated plots during pooled *Rabi*, 2020-21 and 2021-22. The increase in yield over untreated control plots was 5.46q ha^{-1} during pooled *Rabi*, 2020-21 and 2021-22. Per cent increase in yield over untreated was 69.27 pooled both the years 2020-21 and 2021-22.

If losses due to insect pests would be avoided by using various pest control management tactics, seed yield be incise in good manner. The pooled data obtained from *Rabi*, 2020-21 and 2021-22 show that avoidable losses were calculated 40.92 per cent from both the years. Dotasara *et al.* (2018) reported 41.14 per cent avoidable losses from insect pests in mustard for two years consecutive studied. Arvind (2021) reported 49.82 per cent avoidable losses from untreated plot. Kumar (2020) reported three mustard varieties for avoidable losses 32.77, 36.91 and 32.09 per cent respectively. Sharma *et al.* (2019) reported assess the yield losses in mustard and found losses ranged from 20.11 to 32.62 per cent. Sahoo (2016) reported avoidable losses from insect pests varied from 34.62 to 59.33%. Mandarwal (2014) reported avoidable losses from three different treatments were found 33.96, 28.68 and 28.30 per cent, respectively. Kular and Kumar (2011) reported maximum yield loss 26.4 per cent insect pests in mustard. Verma and Singh (1987) reported avoidable losses in mustard 90.0-93.2 per cent. Singh et al. (2010) recorded avoidable losses as 88.72 per cent 90.52 per cent during two consecutive years study, Tomar (2017) reported yield losses 84.96, 89.53 and 74.57 per cent, respectively in three year consecutive study. Sharma *et al.* (2019) reported avoidable losses ranged from 20.11 to 32.62 per cent under late sown conditions, which are collaborated present findings.

Conclusion

Avoidable losses were calculated 40.92 per cent from both years' pooled data.

Acknowledgements

The author is grateful to Director RARI, Division of Entomology and Major advisor for providing all necessary facilities.

References

1. Anonymous (2020). Agricultural Statistics at a Glance 2020. (www.agricoop.gov.in).
2. Anonymous (2021). Rajasthan Agricultural Statistics at a Glance 2020-21. (www.agriculture.rajasthan.gov.in)
3. Arvind (2021). Seasonal Abundance and Eco-friendly Management of Major Insect Pests of Mustard, *Brassica juncea* (Linn.) Czern and Coss. *M.Sc. (Ag.) thesis, submitted to SKNAU* Jobner.
4. Dotasara S.K., Kumawat K.C., Swami D., Jat G.C., Choudhary H.S. and Jat S.L. (2018). Assessment of crop loss due to insect pests in Indian mustard in Semi-arid region of Rajasthan. *Journal of Entomology and Zoology Studies,* 6(3): 770-772.
5. Kalasariya R.L. and Parmar K.D. (2016). Effect of abiotic factors on population fluctuations of mustard painted bug (*Bagrada hilaris* Burmeister) using path co-efficient analysis. *Journal of Experimental Zoology India,* 19(1): 1485-1490.
6. Kular J.S. and Kumar S. (2011). Quantification of avoidable yield losses in oilseed brassica caused by insect pests. *Journal of Plant Protection Research,* 51(1): 38-43.
7. Kumar K.P. (2020). Management and assessment of yield loss due to mustard aphid, *Lipaphis erysimi* (Kalt.). *M.Sc. (Ag.) thesis, submitted to RPCAU* Pusa (Bihar).
8. Mandarwal N. (2014). Management of Aphid, *Lipaphis erysimi* (Kalt.) on Mustard [*Brassica juncea* (Linn.) Czern and Coss] in Semi-Arid Region of Rajasthan. *M.Sc. (Ag.) thesis, submitted to SKNAU* Jobner.
9. Patel S., Yadav S.K. and Singh C.P. (2018). Foraging behaviour of mustard sawfly, *Athalia lugens proxima* klug. on rapeseed-mustard. *Journal of Experimental Zoology India,* 21(1): 379-381.
10. Pradhan S. (1964). Assessment of losses by insect pests of

crops and estimation of insect population. *Indian Journal of Entomology,* 15: 17-58.

11. Sahoo S.K. (2016). Estimation of yield losses in *Brassica* due to insect pests. *Indian Journal of Entomology,* 78(4): 317-321.
12. Sharma D., Yadav S. and Yadav S. (2019). Population dynamics of mustard aphid, *Lipaphis Erysimi* Kalt in various *brassica* spp. *International Journal of Current Microbiology and Applied Sciences,* 8(2): 2952-2959.
13. Sharma D., Yadav S.P. and Yadav S. (2019). Assessment of avoidable yield losses due to *Lipaphis erysimi* Kalt in various *Brassica* spp. *International Journal of Current Microbiology and Applied Sciences, 8*(6): 2020-2025.
14. Singh A.P., Singh P.P. and Singh Y.P. (2010). Avoidable yield losses due to mustard aphid, *Lipaphis erysimi* (Kalt.) in Eastern Rajasthan. *Journal of Experimental Zoology,* 2: 377-378.
15. Tomar S.K. 2017. Studies to calculate loss in yield in mustard crop due to infestation of mustard aphid, *Lipaphis erysimi* (Kalt.). *Journal of Experimental Zoology,* 20: 1205-1207.
16. Verma S.N. and Singh O.P. (1987). Estimation of avoidable loss to mustard by the aphid, *Lipaphis erysimi* (Kalt.) in Madhya Pradesh. *Indian Jouranal of Plant Protection,* 15(1): 87-89.
17. Yadav M. and Rana J.S. (2018). Biochemical constituent of *Brassica juncea* genotypes in relation to mustard aphid (*Lipaphis Erysimi* Kalt.) infestation. *Journal of Pharmacognosy and Phytochemistry,* 7(2): 938-943.
18. Yadav S. and Singh S.P. (2016). Bio- efficacy of some new insecticides against mustard aphid, *Lipphis erysimi kalt.* (Hemiptera: Aphididae) on Indian mustard. *The Bioscan* 11(1): 23-26.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 935-936 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Integrated Nutrient Management through Organic Sources on Chickpea in Bundelkhand Reason

Rajnarayan Singh, Abhishek Patel*, Pravesh Shrivashtav and Akansha Gupta
Institute of Agricultural Sciences, Bundelkhand University, Jhansi, U P
**Corresponding Authour Email : apatel181995@gmail.com*

Abstract

The field experiment was conducted during Rabi Season of 2018-19 at karguan ji agriculture farm Bundelkhand University Jhansi (UP) to study on the "effect of integrated nutrient management through organic sources on chick pea in Bundelkhand reason". Experimental units were arranged in Randomized Block Design (RBD) with three replications .Application of phosphorus up to 60 kg/ha prove the best fertility level for growing chickpea variety JG-14 through organic sources used in the field which is as follows–FYM, Poultry Manure and Vermicompost. All of the growth characters viz. number of branches, fresh weight, dry weight at harvest and yield attributes i.e. number of pods/plant, number of seeds plant-^{1} and number of seeds/pod were found to be significantly maximum in application of 100% organic source with PSB seed treatment.

Key words : *Integrated nutrient management, PSB, chickpea, growth and yield.*

Introduction

Chick pea (*Cicer Arietinum* L.) is the third important pulse crop in the world after dry beans (*Phaseolus vulgaris*) and cow pea (*vigna ungiculata*) globally, chickpea is mostly grown between 20^{0} N and 30^{0} N latitude, cultivated over an area of 11.56 Million Hactare with production 9.08 million tons and an average productivity of 810 kg per hectare and share of food legume crop in global area and production is 18% and 22% respectively. The important chick pea growing countries are India, Pakistan, Ethiopia, Burma and Turkey. Chick pea is the important pulse crop of India which account for 47% of total pulse production from 33% of total pulse area. India's productivity in comparison with other countries productivity is low. The reason for low productivity of chickpea in Uttar Pradesh may be due to lack of balance nutrition and their management etc. In Uttar Pradesh, chickpea occupied an area of 5.60 lakh hectares with a production of 3.80 lakh tones with an average productivity of 683 kg/ha , accounts 6.81% and 5.31% area and production of country, respectively (Agri. Statistics at a glance, 2015).

Organic manures modify the soil physical behavior and increase the efficiency of applied nutrients (Pandey *et al*. 2007). Chickpea suffer from insect pests and diseases. Among, these damages, incidence of wilt and pod borer (*Helicoverpa armigera*) in chickpea and powdery mildew as well as rust and stem fly as well as pod borer in field pea are the key enemies. Escalating costs, annihilation of natural enemies and other non-target organisms, development of resistance and in many cases cross resistance are the serious problems associated with the use of synthetic insecticides. Proper management as well as control of diseases and insect pest in combined way can push up the yield of chickpea and field pea to a great extent. In order to arrest the haphazard uses of agro-chemicals like fertilizer. Insecticides and fungicides etc. in the management of various insect pests, diseases attacking on chickpea and field pea and decline soil fertility, it is worthwhile to use organic sources of nutrients. The use of organic manures which were traditionally important nutrient resources declined substantially. Added to this, excessive and continuous use of a few inorganic fertilizers in unbalanced proportion resulted in the deficiency of micronutrients besides diminishing soil fertility and resulting in unsustainable crop yield. Among the various organic manures, the compost produced by earthworms (Vermicompost) and FYM are main sources of macro and micronutrients. Photosynthesis and stomatal conductance are reduced by P deficiency and conversely, increases P increased photosynthesis. Phosphate Solubilizing Bacteria (PSB) is also known to increase phosphorus uptake resulting in better growth and higher yield of chickpea plants. The combined inoculation of phosphate solubilizing bacteria has increased nodulation, growth and yield parameters in chickpea (Guidi *et al,* 1994). The bio fertilizers particularly, PSB for chickpea plays a crucial role in crop production. It also adds plant nutrients to the soil and organic acids during decomposition which act on the insoluble nutrient reserve in the soil and make them available. Biologically, it provides food for the beneficial soil microorganisms the application of neem seed cake at 2.5% gives higher emergence while application of neem seed cake at 5% gives maximum disease reduction and highest shoot and root length (Jibhkate, 2010). Seed treatment of chickpea

Table-1 : Effect of integrated nutrient management through organic sources on chickpea in Bundelkhand reason.

Treatment Formulation	Grain Yield (q/ha)	100 seed weight (g)	Cost of cultivation (Rs.)	Net return (Rs.)	B:C Ratio
RDF (Chemical)	26.1	25.3	30350	96840	3.19
100% through FYM	28.1	24.8	33560	97405	2.90
100% through VC	25.5	25.5	34245	96270	2.81
100% through Poultry Manure	27.8	28.2	32350	95450	2.95
50% through FYM + 50% through VC	27.9	24.1	31560	96560	3.06
50% through FYM + 50% through PM	27.2	26.0	33720	96200	2.85
50% through VC + 50%through PM	22.9	26.2	32510	89540	2.75
1/3FYM + 1/3 VC + 1/3 PM	31.3	26.8	34520	106830	3.09
(1/3FYM + 1/3 VC + 1/3 PM) + PSB	25.4	25.4	34240	95430	2.79
CD 5%	2.46	1.5	-	-	-

with Trichoderma has been reported to ensure optimum initial population of chickpea by controlling the seedling wilt (Sonawarne and Pawar, 2001).

Materials and Methods

The experiment was laid out on Organic Research Farm, Kargunaji, Bundelkhand University, Jhansi during Rabi seasons of 2018-19. The high warmer month is June 26^0-44^0 C and coldest month is January 7^0-24^0C. Total rainfall received during crop growing period was 15.60 mm. The soil of the experimental site was clayey in texture with bulk density of 1.28 g / cc, pH of 7.30, OC of 0.65 %. The soil is low in available N (205.25 kg/ha) and P2 O5 (25.90 kg/ha), and medium in available K_2O (96.54 kg/ha). The experiment was laid out 3×3 factorial in Randomized Block Design (RBD) with nine treatment and three replications. The material used in the experiment was three organic manure viz., FYM, Vermicompost and poultry manure and their uses PSB culture. The crop chickpea variety JG-14 duration of 110 to 120 days was sown on 05-11-2018 with a spacing of 30 cm x 10 cm. All of the growth characters viz. number of branches, fresh weight, dry weight at harvest and yield attributes i.e. number of pods/plant, number of seeds/plant and number of seeds/pod were found to be significantly maximum in application of 100% organic source from.

Results and Discussion

The data on grain yield as affected by organic sources on chickpea under organic condition is presented in Table-1. The data exhibit that among all the combination of organic sources in T_7 enriched with 1/3 through FYM+1/3 through Vermicompost + 1/3 through Poultry manure yielded non-significantly higher grain yield (31.3 q/ha) as compared to other treatment combinations followed by T_1(28.1 q/ha), T_4 (27.9 q/ha) and T_3(27.8 q/ha). Maximum 100 seed weight (28.2 g) were recorded in treatment T_8 (1/3 FYM + 1/3 VC+ 1/3 PM + PSB), followed by T_7 (30.9 g), T_5 (29.9 g) and T_3 (25.1 g). The data exhibit that among all the combination of organic sources in T_7 enriched with 1/3 through FYM + 1/3 through Vermicompost + 1/3 through Poultry manure higher net return and B:C ratio (Rs. 106830 and 3.09) while minimum net return and B:C ratio T_6 50%through VC + 50%through PM (Rs. 89540 and 2.75).

References

1. Deol Harpreet Singh, Singh M.S. and Singh R.P. (2008). Yield, quality and economics of Indian mustard (*Brassica juncea* L.) as affected by nutrient management practices under late sown condition. *Indian J. of Ecology,* 35: 1, 31-34.
2. Nawale SS, AD. Pawar, BM. Lambade and NS. Ugale (2009). Yield maximization of chickpea through INM applied to sorghum-chickpea cropping sequence under irrigated condition. *Legume Research*. 32(4): 282-285.
3. Gaur PM, Tripathi S, Gowda CLL, Ranga Rao GV, Sharma HC, Pande S and Sharma M (2010). Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. Pp 28.
4. Kumpawat (2010) Integrated nutrient management in blackgram (*Vigna mungo*) and its residual effect on succeeding mustard (Brassica juncea) crop. *Indian Journal of Agricultural Sciences.* 80: 1, 76-79.
5. Khambalkar, Priyadarshani. A.; Tomar P.S.; Verma, S.K.(2012). Long-term effects of integrated nutrient management on productivity and soil fertility in pearlmillet (*Pennisetum glaucum*) – mustard (Brassica juncea) cropping sequence. Indian Journal of Agronomy, 57: 3
6. Naik VR, Patel PB, Patel BK. 2014. Study on effect of different organics on yield and quality of organically grown onion. *The Bioscan.* 9(4):1499-1503.
7. Ved Ram, KU. Ali, Mishra and RM. Upadhyay (2008). and Verma, 2017 Studies on sulphur, zinc and biofertilizers on yield, yield attributes and nutrient content at different growth stages in mungbean. *J. Food Legumes*. 21(4): pp. 240-242.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 937-938 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Phytoplasma on Metabolites of Healthy and Diseased Plant of Brinjal (*Solanum melongena* L.)

Reema Upadhyay
Department of Botany, M.M.H., College, Ghaziabad, U.P.

Introduction

Among the vegetable crops grown in India, brinjal is quite popular. The value of brinjal is enhanced as a vegetable during the off season when other vegetables are scare. Out of various pathogens and diseases, the little leaf disease caused by phytoplasma is the most serious disease in India (Anjaneyulu *et al.* 1968, Verma et al. 1969, Srinivasan and Chellish 1978). The assessment of yield losses has been done from time to time .Phytoplasma is phloem invader. They may block channels and cause wilting, utilize food material, and thus weaken the host. This cause chlorosis of various degrees, inducing hormonal imbalance. Thus, they have been found to affect the physico- chemical level of the host.

The purpose of this study is the cause of damage to the yield and for this the level of nitrogen and some metabolites i.e. protein, sugar and starch were studied.

Materials and Methods

To compare the physico-chemical characters of healthy and disease plants leaf, stem and root samples were used. The study included protein, sugar (non reducing and reducing), starch and pigment content of leaves etc. Estimation of protein content of leaf, stem and root from diseased and healthy plant was done for each sample separately from the nitrogen content of the sample. Estimation of reducing and non reducing sugars was done by colorimeter method of Somogi (1952) using Nelson"s chromogenic reagent. Pucher *et.al.* (1948) method described by peach and Tracey was followed to estimate the starch. Chlorophyll estimation was done following the method of Amon (1949). The method of Ikon (1969) was followed for estimation of carotene.

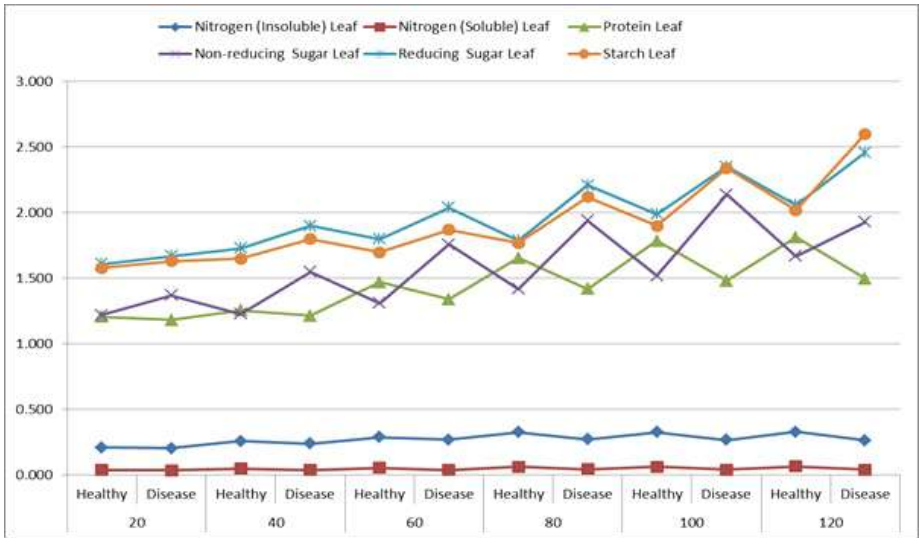
Results and Discussion

The results revealed a decrease in the amount of nitrogen, protein and increase in sugar and starch. In root however, the sugar and starch content showed a decrease (table-1 & graph-1,2 &3). All the three pigments analyzed i.e., chlorophyll a, chlorophyll b and carotene were reduced considerably in phytoplasma infected brinjal plants (table-2 & graph-4).

A decrease in the amount of the total nitrogen in phytoplasma infected brinjal plants have been noticed in the present study. Since most of the amino acids are

Table-1 : Effect of Phytoplasma on metabolites of healthy and diseased plant of brinjal (mg/100g.d.w.)

Parameters	Days after inocu	20		40		60		80		100		120	
	Plant Parts	Healthy	Disease	Healthy	Disease	Healthy	Disease	Healthy	Disease	Healthy	Disease	Healthy	Disease
Nitrogen (Insoluble)	Leaf	0.211	0.204	0.259	0.239	0.289	0.270	0.326	0.274	0.328	0.268	0.331	0.264
	Stem	0.164	0.149	0.204	0.171	0.225	0.179	0.243	0.184	0.257	0.191	0.286	0.198
	Root	0.208	0.207	0.214	0.213	0.224	0.220	0.231	0.225	0.247	0.242	0.252	0.246
Nitrogen (Soluble)	Leaf	0.039	0.037	0.051	0.038	0.056	0.040	0.063	0.045	0.064	0.043	0.066	0.042
	Stem	0.035	0.027	0.047	0.032	0.053	0.035	0.056	0.037	0.060	0.039	0.066	0.043
	Root	0.047	0.048	0.051	0.053	0.054	0.060	0.055	0.072	0.059	0.078	0.064	0.085
Protein	Leaf	1.208	1.182	1.256	1.215	1.472	1.341	1.656	1.420	1.787	1.482	1.813	1.498
	Stem	1.065	0.972	1.156	0.998	1.393	1.103	1.482	1.130	1.603	1.208	1.677	1.235
	Root	1.130	1.115	1.162	1.130	1.261	1.182	1.356	1.251	1.403	1.288	1.472	1.308
Non-reducing Sugar	Leaf	1.220	1.370	1.230	1.550	1.310	1.760	1.420	1.940	1.520	2.140	1.670	1.930
	Stem	1.020	1.040	1.050	1.070	1.140	1.240	1.140	1.270	1.230	1.450	1.260	1.580
	Root	0.930	0.958	0.960	0.990	1.160	0.980	1.270	0.980	1.360	0.920	1.520	0.840
Reducing Sugar	Leaf	1.610	1.670	1.730	1.900	1.800	2.040	1.790	2.210	1.990	2.350	2.060	2.460
	Stem	1.330	1.040	1.470	1.620	1.550	1.730	1.750	2.070	2.050	2.340	2.320	2.510
	Root	1.110	1.050	1.280	1.150	1.380	1.220	1.490	1.270	1.630	1.290	1.740	1.330
Starch	Leaf	1.580	1.630	1.650	1.800	1.700	1.870	1.770	2.120	1.900	2.340	2.020	2.600
	Stem	1.750	1.770	1.900	1.940	1.990	2.120	2.160	2.410	2.240	2.510	2.290	2.650
	Root	1.240	1.160	1.380	1.290	1.530	1.360	1.630	1.430	1.820	1.510	1.920	1.560



synthesized in the leaves and then translocated to other plants, the soluble and insoluble fractions of nitrogen must be affected by any factor that controls translocation. The phytoplasma, the causal agent of the disease is known to occupy phloem and interfere with translocation. This explains why in later stages the diseased tissues have lesser nitrogen than their corresponding healthy tissues. Decrease of total nitrogen in MLO infected plant was reported by Dunlap (1930) in virus infected plants. A decrease in amount of protein content has been reported by Narsimhamurthy (1962) in sandal spike disease os sandal.

The result indicates that there is reduction in protein synthesis and hence carbohydrate are not being utilized and accumulated. The possible reason for reduces protein synthesis may be reduced supply of nitrogen probably due to blockage of translocation. An increase amount of sugar content was noticed by Nagaich (1978) in purple top roll and witche"s broom disease of potato. Blocking of phloem was noticed by Shikata et al. (1969) in sugarcane white leaf disease. Poor development of grana as well as stroma lamellae could be due to the increased action of the enzyme or the interruption of chlorophyll biosynthesis in MLO infected plants Shukla et al. (1984).

Conclusions

It can be argued that therefore that when the phloem is blocked by phytoplasma, translocation of solutes that is prepared for material is greatly affected. Since these substances are translocated in the soluble forms accumulation of starch may be probably inhibitory to their further synthesis. A mechanism stimulating feedback. This probably accounts for the accumulation of insoluble and soluble forms of sugar.

References

1. Anjaneyulu (1968). Identity of tomato big bud virus and eggplant little leaf virus. *Curr. Sci.,* 37: 271-272.
2. Verma A.; Chenlu V.V.; Raychaudhari, S.P.; Prakash, N. and Rao, P.S. (1969). Mycoplasma like bodies in tissues infected with sandal spike and brinjal little leaf. *Ind. Phytopath,* 22: 289-291.
3. Srinivasan, and Chelliah, S. (1978). Presence of the leafhopper Hishimonus phycitis (Distant) for brinjal plants infected with little leaf disease with particular reference to its amino acids composition. *Haryana J. Hort. Sci.* 7(3-4); 203-207.
4. Somogi, M. (1952). Notes on sugar determination. *Jour. Biol. Chem* 195; 19-23.
5. Pucher G.W., Leavenworth, G.S. and Vickory, H.B. (1948). *Anal.Chem.* 20; 850-853.
6. Amon, D.I. (1949). Copper enzymes in isolated chloroplasts, (1) Polyphenol oxidase in Beta vulgaris. *Plant Physiol.* 24; 1-15
7. Ikan, R. (1969) natural products. A laboratory guide. *Academic Press,* London. New York, p 101
8. Dunlap, L.D. (1932). A micromethod for nitrogen in plant material. *Plant Physiol.;* 717-720.
9. Nagaich, B.B. (1978). Investigation on purple top roll and witche's broom diseases of patato, *Final Technical Report,* CPRI, Simla.
10. Shikata , E.; Teng, W.S. and Matsumoto, T. (1969) Mycoplasma or PLT like microorganisms detected in leaves of sugarcane plants infected with white leaf disease and suppression of disease symptoms by antibiotics of tetracycline group. *Jour. Fac. Agric. Hokk Univ.* 56; 79-90.
11. Shukla U.S. and Kishan singh (1984) . Changes in chloroplast ultrastrusture and chlorophyll in relation to mycoplasma infected sugarcane leaves. *Indian J. Plant Pathol.* 2(2) : 114-119.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 939-943 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Consumers' Buying Behaviour towards Online Food and Grocery Shopping from Organized Retailers in Ahmedabad City

Sachin Sutariya and Swati Sharma*
ASPEE Agribusiness Management Institute, Navsari Agricultural University, Navsari, Gujarat
*Email : swatisharma_abm@yahoo.co.in

Abstract

Over the past few years, India's food and grocery shopping pattern is shifting from traditional shopping to online shopping. Today consumers are more inclined towards buying online, when they compare offline vs online and most of them believe that the easier way of shopping for food and grocery is online mode. In this regard, this paper intends to find consumers buying behavior towards online food and grocery shopping from organized retailers in Ahmedabad city. For the fulfilment of the study objectives, 200 respondents were selected as sample size and data were collected through structured questionnaire. The major findings of the study were that consumers preferred to use mobile application for the order and for saving their time and to avoid long queues the consumers were buying online food and grocery. The availability of wide range of products at one place attracts the consumers towards online buying. The major factors influencing the consumers towards buying online food and grocery were security of ID and password, tracking of items and delivery time etc. Also, the major issues faced by consumers while purchasing online food and grocery were security issues, technical issues, delivery time problem and possibility of forgery etc. So, in order to succeed in online organized food and grocery business retailers need to make online buying platform convenient and safe for consumers.

Key words : *Consumers Buying Behavior, Food and Grocery, Organized Retailers, Online Shopping.*

Introduction

The online food and grocery industry is one of the growing industries in India. This particular business model is more popular amongst the people in service profession followed by business class and people retired. Online grocery sales represent less than one percent of total grocery sales in India, this sector is expected to experience tremendous growth in the next decade. India's food and grocery retail sector are considered the third largest in the world and reached sales of $410 billion in 2020, according to Euromonitor International. The sector is dominated by traditional and unorganized retail formats, specifically hawkers and neighbourhood shops called kirana stores (similar to mom & pop stores in the United States), which represent 90 percent of the market in sales. The remaining 10 percent is made up of modern grocery retailers (such as supermarkets and hypermarkets) and e-commerce. In 2020, online food and grocery sales grew by 80 percent to $2.66 billion as COVID-19 compelled consumers to shop more online due to lockdown restrictions and safety concerns. During this period, consumers shifted their attitudes towards grocery e-commerce and began to see it as the most convenient and safest way to procure essential supplies (Patil, U., Sandoval, L., & Sawant, 2021).

Consumers are playing an important role in online shopping. The increasing use of Internet by the younger generation in India provides an emerging prospect for online retailers. It is important for online retailers to have knowledge about the factors affecting consumers' buying behaviour, and constraints faced by online buyers to develop their marketing strategies to convert potential customers into active ones. So, the present study was undertaken to understand the consumers buying behavior towards online food and grocery shopping factors affecting.

Objectives of the Study : The main objective of this study is to study consumers' buying behavior towards online food and grocery shopping from organized retailers in Ahmedabad city of Gujarat. With this overall objective the sub objectives of the study are as follows.

To study the socio-economic profile of consumers buying online food and grocery from organized retailers.

To study the consumer buying behaviour and perception towards online food and grocery shopping.

To determine different parameters and attributes for choosing the particular online shopping platform for food and grocery.

To identify the issues faced by the consumers while online shopping food and grocery.

Research Methodology

The nature of the present study was descriptive. The data were gathered from both the primary and secondary

sources. The primary data were collected by conducting personal interview_of consumers who purchase food and grocery from organized online retailers in the study area. The simple random sampling methodology was used for the selection of 200 respondents. The primary data were gathered by administering a structured questionnaire with 200 consumers of Ahmedabad city of Gujarat. The secondary data were collected through various sources like magazines, internet source, journals and other sources. The quantitative approach was used for the data analysis. Simple statistical tools and tabular analysis was done for the fulfilment of the objectives.

Results and Discussion

Table-1 : Socio-Economic profile of consumers. (n=200)

Demographic Variables	Categories	No. of Consumers	Percentage
Gender	Male	123	61.5
	Female	77	38.5
	Total	200	100
Age Group (in Years)	Below 18 years	10	5
	18 - 25 years	72	36
	26 - 40 years	95	47.5
	41 - 50 years	19	9.5
	Above 50 years	4	2
	Total	200	100
Marital Status	Married	74	37
	Unmarried	126	63
	Total	200	100
Household Size	2 or Less than 2 members	15	7.5
	3 - 5 members	146	73
	More than 5 members	39	19.5
	Total	200	100
Education Qualification	HSC	48	24
	SSC	14	7
	Below SSC	9	4.5
	Diploma	15	7.5
	Graduate	94	47
	Post Graduate	20	10
	Total	200	100
Occupation	Student	25	12.5
	Housewife	72	36
	Employee (Private/Public)	84	42
	Business	19	9.5
	Total	200	100
Monthly Household Income (Rs. /Month)	Less than 10,000	15	7.5
	10,000 - 20,000	58	29
	20,001 - 30,000	72	36
	30,001 - 40,000	32	16
	Above 40,000	23	11.5
	Total	200	100

The Table-1 shows that among the 200 consumers buying food and grocery from organized online retailers, 61.5 percent were male and 38.5 percent were female. From the total sample of 200 consumers, 47.5 percent were in age-group of 26-40 years followed by 36 percent were in age-group 18-25 years. From the study it was found that 63 percent were unmarried and 37 percent were married. The 73 percent of consumers were having 3-5 family members followed by 19.5 percent had more than 5 members and 7.5 percent had two or less than two family members. Regarding the educational qualification of the consumers, it was found that 47 percent of the consumers were graduates followed by 24 percent who were HSC and rest 10 percent were post graduate. Among the consumers buying food and grocery from online organized retailers, 42 percent were employee (Private/Public); 36 percent were housewife; 12.5 percent were student and 9.5 percent were doing business. About the monthly household income, it was found that 36 percent had monthly household income between 20,001 to 30,000 followed by 29 percent consumers having monthly family income between 10,000 to 20,000 and 16 percent consumers were having monthly family income between 30,001 to 40,000.

Table-2 : Easier Mode for Shopping of Food and Grocery. (n=200)

Mode for Shopping	No. of Consumers	Percentage
Online	145	72.5
Offline	55	27.5
Total	200	100

From the Table-2 it could be concluded that 72.5 percent consumers believed that online mode was easier for shopping of food and grocery while 27.5 percent consumers believed that offline mode was easier for shopping of food and grocery in the study area.

Table-3 : Frequency of Consumer buy Food and Grocery from Online Organized Retailers. (n=200)

Frequency of Buy Food and Grocery	No. of Consumers	Percentage
Once in a Week	26	13
Every two week (Fortnightly)	33	16.5
Once in a Month	68	34
For Special Occasions	66	33
During flash sales	7	3.5
Total	200	100

The Table-3 shows that among the consumers buying food and grocery from online organized retailer, 34 percent order once in a month, 33 percent order for special occasions, 16.5 percent order fortnightly 13 percent order once in week and 3.5 percent order only during flash sales.

Table-4 : Monthly Money Spent in Online Food and Grocery Shopping (Rs.). (n=200)

Monthly Money Spent (Rs.)	No. of Consumers	Percentage
Below 500	40	20
501 – 1000	79	39.5
1001 – 5000	59	29.5
Above 5000	22	11
Total	200	100

The Table-4 depicts that among the consumers buying food and grocery from online organized retailer, 39.5 percent consumers spent between Rs. 501-1000 followed by 29.5 percent consumers who spent between Rs.1001-5000; 20 percent consumers spent below Rs.500 and 11 percent consumers spent more than Rs. 5000 in shopping of food and grocery.

Table-5 : Consumers Willing to Pay Money as Delivery Charges (Rs.). (n=200)

Delivery Charges (Rs.)	No. of Consumers	Percentage
Below 50	125	62.5
51 – 100	49	24.5
101 – 150	21	10.5
Above 150	5	2.5
Total	200	100

The Table-5 depicts that among the consumers buying food and grocery from online organized retailer, 62.5 percent consumers were willing to pay below Rs. 50 followed by 24.5 percent who were willing to pay Rs. 51-100; 10.5 percent consumers were willing to pay Rs. 101-150 and only 2.5 percent consumers willing to pay above Rs. 150 as a delivery charges for shopping of food and grocery.

Table-6 : Preferred Online Organized Retailers for buying Food and Grocery. (n=200)

Online Organized Retailers	No. of Consumers	Percentage
Amazon	20	10
Big Bazaar	19	9.5
Big Basket	14	7
D Mart	98	49
Grofers	7	3.5
Flipkart	4	2
Jio Mart	31	15.5
Reliance Fresh	5	2.5
Others	2	1
Total	200	100

The Table-6 shows that 49 percent consumers preferred to order their food and grocery items from the D Mart. So, D Mart was the most preferred organized retailer among the consumers for shopping online food and grocery items in the study area. Followed by 15.5 percent consumers preferred to order their food and grocery items from Jio Mart; 10 percent preferred to order from Amazon, 9.5 percent from Big Bazaar, 7 percent from Big Basket, 3.5 percent from Grofers, 2.5 percent from Reliance Fresh, 2 percent from Flipkart and only 1 percent consumers preferred to order their food and grocery item from other organized retailers.

Table-7 : Preferred Platform for buying Online Food and Grocery. (n=200)

Platform	No. of Consumers	Percentage
Mobile Application	178	89
Website	22	11
Total	200	100

The Table-7 shows that among the consumers buying food and grocery from online organized retailer, 89 percent of consumers' preferred mobile application and rest 11 percent of consumers preferred website for their online shopping of food and grocery.

Table-8 : Need of Buying Online Food and Grocery from Online Organized Retailers (n=200)

Need of Buying	No. of Consumers	Percentage
When I need home delivery	58	29
When I don't have time	71	35.5
When I need to comparative prices	37	18.5
When I want something unique and special	34	17
Total	200	100

The Table-8 depicts the consumers need of buying online food and grocery from online organized retailers, about 35.5 percent consumers were buying food and grocery items when they don't have time, 29 percent consumers were buying food and grocery items when they need home delivery, 18.5 percent consumers were buying food and grocery items when they need comparative prices and 17 percent consumers were buying food and grocery items when they want something unique and special.

Table-9 : Preferred Mode of Payment. (n=200)

Mode of Payment	No. of Consumers	Percentage
Net Banking	35	17.5
Credit Card	42	21
Debit Card	51	25.5
Cash on Delivery	72	36
Total	200	100

The Table-9 shows that among the consumers buying food and grocery from online organized retailers, 36 percent of consumers preferred cash on delivery mode; 25.5 percent consumers preferred debit card mode; 21 percent consumers preferred credit card mode and 17.5 percent consumers preferred net banking mode for making payment for online shopping of food and grocery from online organized retailers.

Table-10 : Reasons for Buying Food and Grocery from Online Organized Retailers. (n=200)

Reason for Buying	No. of Consumers	Percentage
Easy to Order	41	20.5
Discounts & Offers	24	12
Wide range of products at One Shop	31	15.5
Avoid long Queues (line)	42	21
Save Time	62	31
Total	200	100

The Table-10 depicts the reasons for buying food and grocery from online organized retailers and it was found that 31 percent consumers preferred to save time, 21 percent consumers for avoiding long queues (line), 20.5 percent consumers as easy to order, 15.5 percent consumers preferred for availability of wide range of products at one shop and 12 percent for discounts and offers.

Table-11 : Features of Website/App which attracts more for Online Food and Grocery Shopping. (n=200)

Features of Website/Application	No. of Consumers	Percentage
Design of Website	23	11.5
Discount Offered	62	31
Advertisement	24	12
Availability of wide range of Products	91	45.5
Total	200	100

The Table-11 shows that among the consumers buying food and grocery from online organized retailers, availability of wide range of products attracts 45.5 percent consumers, discount offered attracts 31 percent consumers, advertisement attracts 12 percent consumers and design of website attracts 11.5 consumers.

The Table-12 depicts the factors influencing consumers for online food and grocery shopping from online organized retailers and it was found that the major factors were products brand followed by availability of all product range at one place then product quality; free home delivery followed by affordable prices; discounts scheme & offers and services/complain handling.

According to the Table-13 it could be concluded that the major factors affecting the satisfaction of consumers while shopping for online food and grocery were security of ID and password, tracking of items, delivery time followed by others like login facility, cash on delivery, adequate search option, offers and discounts, different payment option, user friendly web design and mobile application, product assortment/ categories and order confirmation screen which gives satisfaction to the consumers while shopping food and grocery items from online organized retailers.

The consumers confront several issues while they do shopping of food and grocery from online organized retailers. According to the Table-14 the major issues faced by the consumers were security issues, technical issues, delivery time possibility of forgery (duplicate item), no guarantee, product highly priced and mode of payment etc.

Conclusions

Online food and grocery industry is one of the growing industries in India. During the COVID-19 pandemic more consumers shifted their perception towards online shopping of food and grocery and began to see it as the most convenient and safest way to buy essential groceries. In this regard, this study focused on finding out the consumers buying behavior towards online food and grocery shopping from online organized retailers in Ahmedabad city. The study reveals that in the study area 61.5 percent of consumers were male, 47.5 percent of consumers were in age group between 26-40 years, 63 percent of consumers were unmarried, 42 percent of consumers were employees (private/public), and 36 percent of consumers had family income between Rs.20, 001-30,000. The study further revealed that D Mart was the most preferred organized retailer in study area and 90 per cent consumers preferred to use mobile application for ordering. For saving the time and avoiding long queues consumers were buying online food and grocery. Availability of variety of products at one place attracts the consumers for online buying. Product brand and quality were the most important factors followed by free home

Table-12 : Factors influencing Consumers for Online Food and Grocery Shopping.

Factors	Always	Mostly	Often	Rarely	Never	CS	Mean	Rank
Product Brand	102 (510)	65 (260)	19 (570	9 (18)	5 (5)	850	4.25	1
Product Quality	84 (420)	91 (364)	15 (45)	5 (10)	5 (5)	844	4.22	3
Affordable Prices	75 (375)	74 (296)	35 (105)	12 (24)	4 (4)	804	4.02	5
Discount Schemes/Offers	61 (305)	83 (332)	38 (114)	11 (22)	7 (7)	780	3.9	6
Availability of all product range at one place	86 (430)	87 (348)	18 (54)	6 (12)	3 (3)	847	4.23	2
Services/Complaint Handling	48 (240)	94 (376)	35 (105)	16 (32)	7 (7)	760	3.8	7
Free Home Delivery	74 (370)	88 (352)	19 (57)	11 (22)	8 (8)	809	4.04	4

Mean = Cumulative Score (CS) / Total No. of Respondent (200)

Table-13 : Factor affecting Satisfaction while Shopping Online Food and Grocery.

Factors	Very Important	Somewhat Important	Neither Important nor Unimportant	Somewhat Unimportant	Very Unimportant	CS	Mean	Rank
User friendly web design and mobile application	71 (355)	44 (176)	63 (189)	18 (36)	4 (4)	760	3.8	9
Login Facility	75 (375)	77 (308)	30 (90)	8 (16)	10 (10)	799	3.99	4
Product assortment/ categories	47 (235)	72 (288)	71 (213)	7 (14)	3 (3)	753	3.76	10
Adequate search option	61 (305)	66 (264)	59 (177)	10 (20)	4 (4)	770	3.85	6
Security of ID and Password	145 (725)	25 (100)	16 (48)	7 (14)	7 (7)	894	4.47	1
Different Payment Option	51 (255)	89 (356)	40 (120)	14 (28)	6 (6)	765	3.82	8
Cash on Delivery	55 (275)	100 (400)	32 (96)	9 (18)	4 (4)	793	3.96	5
Offers and Discount	59 (295)	59 (236)	75 (225)	3 (6)	4 (4)	766	3.83	7
Delivery Time	72 (360)	68 (272)	52 (156)	6 (12)	2 (2)	802	4.01	3
Order Confirmation Screen	44 (220)	80 (320)	60 (180)	12 (24)	4 (4)	748	3.74	11
Tracking of Items	75 (375)	89 (356)	26 (78)	8 (16)	2 (2)	827	4.13	2

Mean = Cumulative Score (CS) / Total No. of Respondent (200)
Score = Maximum Scale × No. of Respondent (Very Important: 5, Somewhat Important: 4, neither Important nor Unimportant: 3, Somewhat Unimportant: 2 Very Unimportant: 1)

Table-14 : Issues faced by Consumers while Online Shopping for Food and Grocery.

Problems	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	CS	Mean	Rank
Product highly priced	46 (230)	61 (244)	64 (192)	13 (26)	16 (16)	708	3.54	6
Possibility of forgery (duplicate item)	35 (175)	98 (392)	48 (144)	14 (28)	5 (5)	744	3.72	4
No Guarantee	41 (205)	60 (240)	76 (228)	17 (34)	6 (6)	713	3.56	5
Security Issues	101 (505)	53 (212)	24 (72)	16 (32)	6 (6)	827	4.13	1
Mode of payment	23 (115)	58 (232)	90 (270)	19 (38)	10 (10)	665	3.32	7
Delivery Time Problem	51 (255)	78 (312)	47 (141)	16 (32)	8 (8)	748	3.74	3
Technical Issues	54 (270)	95 (380)	41 (123)	4 (8)	6 (6)	787	3.93	2

Mean = Cumulative Score (CS) / Total No. of Respondent (200)
Score = Maximum Scale × No. of Respondent (Strongly Agree: 5, Agree: 4, Neutral: 3, Disagree: 2, Strongly Disagree: 1)

delivery option and affordable prices. For consumers' satisfaction, security of ID and password was the very important factor. Most of the consumers were facing the security issues, technical issues, delivery time problem and possibility of forgery (duplicate item), while they were buying online food and grocery. So, in order to succeed in online organized food and grocery business retailers need to make online buying platform convenient and safe for consumers.

References

1. Ali, I., and Naushad, M. (2021). Determinants of customer satisfaction in online grocery shopping. *International Journal of Data and Network Science*, *5*:383–390
2. Das, S. S. and Todmal, A. (2020). Change in Consumers Perception towards Online Grocery Shopping. *International Journal of Management*, *11*(8):1049–1059
3. Kaur, H., and Shukla, K. R. (2016). Consumer's Attitude Towards Online Shopping in Delhi City. *International Journal of Multidisciplinary Approach and Studies*, *03*(2): 29–40.
4. Kaur, H., and Shukla, K. R. (2017). Consumer's Attitude for Acceptance of Online Grocery Shopping in India. *International Journal of Current Research*, *9*(5): 50776–50784.
5. Kothari C. R. (2004). Research Methodology: Methods & Techniques. New Age International Publishers, Second Revised edition, New Delhi.
6. Patil, U., Sandoval, L., and Sawant, A. (2021). COVID-19 Accelerates the Growth of India's Online Grocery Market (Report No. IN2021-0067). United States Department of Agriculture.
7. Prasad, J., and Raghu, Y. (2018). Determinant Attributes of Online Grocery Shopping In India - An Empirical Analysis. *IOSR Journal of Business and Management*, *20*(2):18–31.
8. Prashar, K., and Singhal, S. (2020). Study of Consumer Perception Towards Online Grocery Shopping. *Journal of Xi'an University of Architecture & Technology*, *XII*(III): 5629–5644.
9. Sathiyaraj, S., Kumar, S. A., and Subramani, K. A. (2015). Consumer Perception Towards Online Grocery Stores, Chennai. *ZENITH International Journal of Multidisciplinary Research*, *5*(6): 24–34.
10. Shankar, S., and Kumar, N. (2018). A Descriptive Analysis of Consumer Perception on Online Grocery Shopping. *International Journal of Research and Scientific Innovation*, *V*(iii): 14–18.
11. Suguna, S., and Pooja, V. (2020). A Study on Consumer's Perception Towards Online Grocery Shopping in Coimbatore City. *EPRA International Journal of Research and Development*, *5*(9):8 3–89.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 944-949 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Challenges and Opportunities for Climate Change Education in India : A Critical Review

Sanjay Kumar
Dept. of B.Ed., BRD (PG) College Deoria (U.P.)
Email : baudhsk@gmail.com

Abstract

It is unquestionably telling that climate change is happening in all over world, and its adverse impact could reverse the progress made towards meeting sustainable development goal. The global crisis poses on of the most serious challenges to lowering poverty and existing inequalities, especially in developing countries that are projected to be highly vulnerable to climate convertibility. Thus, the education circle territory provides an unused opportunity for successful climate change adaptation and mitigation through knowledge and skill attainments, and consequently, positive behavior change. Specially, educations can affluent individuals and communities to make informed decisions and take behavioral actions for climate adaptation sustainable development. This study is focused on India. At present time, Indian government is already embedding climate change in its school curriculum. However, it lacks coherent approaches to leverage climate change education as a tool in its adaptation and mitigation strategies. This review, therefore, explores some of the critical barriers and difficulties to climate change education and possible opportunities for effective learning to promote sustainable development in India.

Key words : *Climate change, education, India, sustainable development, health, challenges, opportunity.*

Introduction

Climate change is negotiable one of the most pushing global issues that have long-term implication for all countries sustainable development. From increasing of shifting weather patterns that threaten food security to rising sea level and frequent rain-fall that cause baneful flooding, climate change impacts are wide-ranging and unprecedented in scale. Recent researches warns that such frequent climate-related events could be unpleasant than predicted in the near future. The main cause of the climate change is global warming, main attributed to carbon-intensive industrialization and associated population growth, a prime element in the current capitalist world that opposes green development initiatives. It can be bodily say that developing nations are particularly vulnerable to the impacts of climate change, even though they do not share the same burden of responsibility for global warming.

In response to the climate change challenges mentioned above, nations have signed several global treaties to defeat the adverse impacts of climate change. The first agreement was the United Nations convention on climate change, which was founded during the earth summit in 1992 to prevent dangerous human interference in the climate system. The Kyoto Protocol, which was starting negotiations to strengthen the global response to climate change, followed in 2008 with its implementation period ending in 2012. While the sum of the emission from countries that observed the Kyoto targets reducing significantly. Hence it resulted in improvident and unsubstantial impacts on the climate problem. After this, in 2015 the Paris Agreement on climate change was signed by all nations to accelerate and quicken the previous convention's action. It seeks to enhance ambitious efforts to combat climate change while promoting developing countries financial support to its effects. While it is too soon to assess the new climate alliance effectiveness, a debate on overarching inequality issues, such as carbon caps, climate finance and the level of policy ambition between developed and developing countries was vital. Hence like this inequalities and power play in the climate problem show significant challenges for organized and sustainable strategies against climate change.

Contextual Background

According to world population review, the live data, Indian current population- 2022 is around 140.55 million, after 2030, India is expected to be the most populous country in the world. India is expected to reach its peak population of 1.65 billion people by 2060, after which it will begin to decrease. The number of children in India peaked over a decade ago and is now decreasing. Verburg, et al and Weisser, et al, suggested that such a high population enhances climate variation by causing pressure on the existing natural resources, thus increasing to environmental degradation, increased conflicts, food security and high poverty levels as resources become scarce. Marchant and Lane also points out a strong connection between increased human interventions and the area's ecosystem based on its historical perspectives, which significantly shapes its economic and social

development. The following section will discuss the key wackiness sectors (parts) in India in detail.

Key Sectors Wackiness to Climate Change : This part will discuss the key sector in India that are most wackiness to climate change. They include food security, water resources, biodiversity, human health, agriculture sector, high temperature, and stream weather.

(a) Food Security and Agriculture : One of the most pervasive and destructive impact of climate change in India is food security, with projections of frequent emergencies and famine. According to the United Nations Food and Agriculture Organization (UNFOA) report, there is a strong connection between climate change and food insecurity due to the shifts in growing seasons, interposed with increased floods and droughts, that destroy food crops. There has been a decline in the long rainfall season between June and September and the progressive moisture deficit has resulted in decreased crop yield of long life grains, such as maize, oats, millets etc. so significantly affects the available food supply. Climate change is a major factor to increase in food price. In the last 20 years, food price have risen about 2.6% each year, and it is expected that food price will continue to rise more. Extreme weather affects livestock and crops, and droughts can have impact on the stability and price of food. According to the IPCC report, the yield of crops like wheat and maize is already showing a decline in low attitude areas. Due to the increase in the amount of carbon in the atmosphere, the nutritional quality of crops is decreasing, for example, due to the high carbon environment, the nutritional value of wheat is decreasing from 6% to 13% of protein, zinc from 4% to 7%, and iron from 5% to 8%.

(b) Water Resources : Climate change has impacted the intensity, frequency and predictability of precipitation in India. Intense storms and heavy precipitation can result in the contamination of water resources. In several cities, runoff picks up pollutants from the streets, and can over flow sewage water system, allowing untreated sewage water to enter drinking water supplies system. In rural areas runoff transports animal wastes, pesticides, chemical substances, chemical fertilizers and can enter drinking and recycling waters. Polluted drinking water can cause several types of diseases in human as well as other animals, such as diarrhea, cholera, and legionnaire's disease. It can also cause eye, ear and several types of skin infections. In animals, it can cause several bacterial, fungal, helminthes and viral diseases. In some low lying coastal areas, the sea levels also enhance salt-water intrusion in to river deltas and aquifers, thus threatening the availability of fresh water. In the area where it suffering from droughts, contaminants become more concentrated as water supplies decrease. In addition, algal blooms thrive in warm temperature and can contaminate drinking water.

(c) Human Health : Climate change also affects human health through air pollution, water born diseases such as cholera, diarrhea, typhoid etc. heatstroke and vector born diseases such as filarial, malaria, dengue, sleeping sickness etc. While other factors such as health preparedness and topography effect the spread of several diseases, scientist have established that high temperatures and intense rainfall impart critical breeding environments for the mosquitoes causing malaria, filarial, dengue etc. Consequently, there have been increasingly reported malaria cases, especially in the part of America, Asia and Africa. In India it is most common in Orissa, Maharashtra, Chhattisgarh, Jharkhand and West Bengal. Experts have predicted that diseases like malaria and dengue will increase in future as a result of climate change and it will be difficult to control them. According to data from World Health Organization (WHO) more than 150,000 people have died due to heat waves since the last decade.

(d) Extreme Weather Events : Extreme water events such as flood, droughts and forest fires are now frequent events across India, with their impact varying across the area. In the last few decades, the irregularity of flood, drought and rain etc. has increased significantly. All these are happening as a result of climate change. There is a lot of rain in some places, while in some places there is a possibility of drought due to lack of water. Prolonged heat waves due to climate change have created hot and dry conditions suitable for forest fires. According to the data of National Institute for Space Research-INPE of Brazil, since January 2019, till now, a total of 74,155 have faced forest fire in Amazon Forests of Brazil. Along with this, it has also been revealed that the incidence of fire in the Amazon Forests has increased by 85% since the year 2018.

Rise in temperature and change in vegetation patterns have forced some bird species to become instinct. According to experts, a quarter of the earth's species may become extinct by 2050. In 2008, the polar bear was added to the list of animal that could become extinct due to rise in sea level.

(e) Biodiversity : Biodiversity is the full variety of life on Earth. It includes diversity within several types of species, between species and of ecosystem. Biodiversity play an important role in climate regulation. According to United Nations Conference on Environment and Development (UNCED), biodiversity means the variety among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystem and ecological

complexes of which they are part. India is one of the 12 mega biodiversity countries in the world and divided in to 10 biogeographically sectors. In the present times the biodiversity of India is faced by several threatened. The important cause of threats to biodiversity are the habitat distraction, invasive species, population, population and over exploitation of natural resources. The biodiversity loss has ecological impact (Kumar Ajay et al), and its main cause is climate change. Due to increase in temperature many plant species like, Dandelion, Berberisa sciatica, Jasminum officinale etc. have shifted towards higher attitude in Nainital. According to Gates (1990), three degree centigrade increase in temperature may lead to the forest movement of 2.5 km/year, which is 10 times the rate of natural forest movement. Anonymous (2009), reported that climate change affects the normal life cycle of plants. He also reported that invasive species, like Lantana, Parthenium and Ageratum conizoides are a threat to native species being more tolerant to climate change. Anonymous (2007), also reported that the sex ratio of sea turtle disturbed because as a result of high temperature, more female turtles are produced. Some threatened species like, frogs, toads, tigers and elephants are vulnerable to the impact of climate change like sea level changes and longer drier spells.

Role of Education in Climate Change Management : Educating people on climate change is an important measure to prepare populations at all community levels including school children, college students, farmers and the general public population to play an active role in integration and adaptation action. According to Nikendei, Cranz and Bugai, the importance of empowering school and college students with the right information about global climate change. Ochieng and Koske, emphasize that primary and secondary students also need climate knowledge and its impact as they will have to make climate policy decisions. Thus they need to have an informed aspect. Resulting this, the role of multidisciplinary research in the pressing climate change issue is beyond doubt. It is time to actively consider knowledge creation and skill development by education to tackle climate change rather than addressing it from a policy view point that, completely leaves governments with the only one responsibility of developing strategies to adapt to its influence. Reid, emphasize that research for climate literacy is important for producing peoples who understand the climate system and can utilize that knowledge in their relations and active community members. Wangari Maathai, a famous global climate activist, also emphasize the fact that, “You can’t protect the environment unless you empower people, you inform them and you help them understand that these resources are their own, that they must protect them.” So thus, both formal and informal climate change education plays a critical role in empowering populations to understand actively climate science and the skills to adapt and respond to climate shocks. Beyond this, climate justice movements, which increased attention in all forms of media, also offer much-needed informal education on the pressing issue.

Climate Change Education in India; What to Teach : It is evidentially true that the continued extraction of natural resources for economic development is geographically and socially uneven, and so are the effects of climate change, India is one of the regions that is severely experiencing the adverse influences of ever-changing climate due to its dependence on rain-fed agriculture and tourism as the backbone of its economies, sectors that highly vulnerable to extreme climate variations. From the recurring droughts in Rajasthan, Maharashtra, southern districts of Uttar Pradesh (Drishtiias.com), the floods in Bengal, Orissa, Andhra Pradesh, Kerala, Assam, Bihar, Gujarat, UP, Haryana and Punjab, their climate related events exacerbated food insecurity and human conflicts resulting from a scarcity of natural resources and ultimately forced migrations within the region (m-hindi-wavedunia.com).

Climate change education has to two parts- climate and change. The climate part obviously falls under the umbrella of natural sciences and has traditionally been taught in geography (eg. Climatology) and Earth science (eg. Meteorology). The another part- educating for change- is where the taught provoking discussion on climate change education need to occur. We need to distinguish between educating about change. We posit that educating for change will help citizens or students lessen negative changes, adapt to change and to promote positive change. Educating for change will require engaging social sciences and humanities teachers, as well as others.

There are six components to the change part of climate change education :

Issue analysis

Community and personal decision-making

Political processes

Social justice

Inter-cultural sensitivity and inter-cultural competence, and

Behavior change.

Issue analysis : Climate change is a concept that includes environmental, social, economic and political problems and issues facing communities around the world. Issue analysis guides citizens and students through a process that can be used with any issue. It is a simple

process that can be applied to a wide range of environment, social and economic problems.

Issue analysis gives students, people or groups the background information they need to understand about the subject of issue and to evaluate proposed solution.

Community and personal decision-making : Along with time, in a changing world, the ability of individuals, organization, societies and communities to select the best course of action amongst many options will be critical, viz- where small scale farming is the main occupation, changing temperature and rainfall patterns will threaten the food security and source of income for form families. For choosing new crops to grow, they will have to be able to see at many different factors, such as nutritional values, soil characteristics and market value etc. Such decision making is complex. Both good and bad decisions will affect the well being of many people.

Issue analysis and community decision making are distinctive skill sets. Issue analysis can be the basic inquiry that help societies and communities-learn about their problems from multiple perspective and identity options for change. A community decision making process then uses this information to produce an action plan to address those problems.

Political Process : Community decision making is a powerful tool for change, but it has limitations. For example, in urban areas if people desire changes that involves construction or alteration of major infrastructure, such as public transportations and recycling centers, community decision-making alone will not result in those changes being made. In this, political processes are also involved. In order to change main broad system, the people will have to understand the strength and limitations of the political system- at local level, national level or international level.

Social Justice : The world is far from being just. It is not equitable. The gap between haves and have-nots is growing, increased by the recent global recession as well as climate change. Pupils arrive at school knowing that things are not well in the world. Many pupils want to know why and would like to do something about it. Issue analysis helps pupils to understand why, but it takes more than conceptual awareness to undertake effective action. Political action is one means but other ways for social exist.

Studying social justice helps students put a framework around their feeling of inequity and provides them peaceable way for action. As with other form of educating people for change social justice, is more than just awareness and knowledge. It also includes values and giving opportunities to participate, especially through volunteerism.

Inter-cultural Sensitivity and Competence : If the predictions of planetary change become true, we can estimate nearly 150 million environmental refugees over the incoming 40-45 years (Conisbee and Simms, 2003). They will be leaving submerged coast-lines and regions facing sustained droughts and flooding and will go to the different parts of the neighboring places. But the people of neighboring places will not accept them. To prevent these escalations, part of climate change education should include preparing some people to leave their communities and preparing others to accept the refugees. This will require a high level of inter-cultural skill and competence.

Behavior Change : In present time, it is time to teach elements of behavior change to everyone. Behavior change would then become a international process to both alter people habits and actions and work effectively with other towards a common goal work.

Education for Sustainable Development (ESD); The Best Framework : We reliance that a great deal of effort will placed on defining climate change education. It is best addressed through the education for sustainable development frame work. ESD has four steps- (a) access to and retention in quality basic education, (b) reorienting existing education program to addressed sustainability, (c) increasing people awareness and training, and (d) providing training for employees in all parts of the economy, eg. Public as well as private. Climate change affects pupils access to and retention in basic education as a result of poverty, migration, diseases, and many more factors. It will take good governance and policy implementation to deal with these issues within education system. Teachers of every discipline can contribute to climate change education. Students arrive at school with many different skills and interest and it is the teacher's responsibility to engage different learning styles to teach the mandated content.

Challenges of Climate Change Education : These include the need to ascertaining the role of the educators, grappling with misconceptions, complexities of interdisciplinary and understanding the content of climate change education.

(a) Ascertaining the role of the educators : Climate science teachers lack clear guidance on how and which aspects of climate change pursue. These similar trends are present all over the world. The teachers are not trained on effective way to communicate about climate change.

(b) Grappling with Misconceptions : There are a lot of misconception about the cause and effect of climate change among people, region of local communities and

educators. Afifi et al study on climate change perception among refugees in East Africa showed a lack of awareness, with many refugees blaming bad governance and conflict for the climate problems.

(**c) Understanding the Content of Climate Change Education :** Some climatic and environmental notions are also innumerous and difficult, thus un-specialist teachers and the general citizens may find it challenging to understand all the global problem elements.

Opportunities for Climate Change Education : Irrespective of existing challenges, the literature captures a lot of opportunities in India, which can be maximized for climate change education. Among these are tremendous support from teachers, government's commitments, and presence of indigenous knowledge system.

(i) Tremendous Support from Teachers : Teacher's tremendous support of climate change education, beyond this, the report that very few have received training and lack adequate resources to teach the topic. Present opportunity to empower them with the true and the right knowledge about the case. Ochieng and Koske says that most teachers believe that climate change should be taught in schools/ colleges, including people acts and policies to deal with the climate crisis.

(ii) Government's Commitment : Indian government commitment to creating a favorable regulatory and enabling environment to build resilient communities also gives relevant educational integration opportunity in their established national climate change policies. In India the national action plan on climate change was established in year 2008. Its objective is to educate the public, representations of the public, on various agencies of the government and to make communities aware of the threat posed by climate change and measures to combat it. This action plan includes 8 missions- national solar mission, national mission for developing energy efficiency, national mission at residence, national water mission, national mission for sustainable Himalayan ecosystem, national mission for green India, national mission for save agriculture, national mission on strategic knowledge for climate change.

Conclusions

The literature review undertaken aimed to assess the challenges and opportunities for climate change education in India. It achieved this by first highlighting broader impacts of the crisis and the global responses to this increasingly recognized fact. The research also emphasized the importance of climate change education in managing its effects, especially regarding empowering vulnerable populations with the appropriate skill and knowledge to effectively adapt to extreme climates. Its originality lies in searching whether at how climate change education is happening India while identifying existing opportunities to subside it with the current specific-country climate response plans. In addition to only integrating climate change in educational curriculum as most Indian government currently do, the study identified the need to train educators with accurate climate change information to make such knowledge meaningful to learners and incorporate indigenous knowledge in the learning process. The review process excluded some probable sources on climate change education, as I only took away the literature published in English and Hindi and from Google Scholar and Web of Science Database, with specific search terms.

In conclusion, given the lack of well-defined leadership of climate change education in India, various partnership between government ministries, research groups in universities, colleges and institutions, local schools, museums, and non-profits could create better opportunities and place-based active learning on climate change. These viewpoints may also be necessary and useful outside India, even within regions with clear climate education policies, as the misconceptions about the issue, exclusion of local knowledge, educators' lack of adequate training and definitions of their roles in climate change persist.

References

1. Addeney, M.; Climate change adaptation law and policy in the African Union: Creating legal pathways for adaptation. In proceeding of the 5th International Climate Change Adaptation Conference, Cape Town, South Africa, 18-21 June 2018.
2. Anonymous. Biodiversity and Climate Change: Convention and Biological Diversity: www.biodiv.org (2007). Accessed on July-30, 2010.
3. Anonymous. Impact of climate change on the vegetation of Nainital and its surroundings. NBRI newsletter. 36: 25-31. 2009.
4. Bahuguna, A. Impact of Climate change on Coral Reefs. Indian society of Geomantic ISG) Newsletter, 14, 1-4, December, 2008.
5. Conisbee, Molly and Simms, Andrew. Environmental Refugees: The Case of recognition, London: New economic Foundation. http://www.neweconomics.org/gen/z-sys-Publication. (accessed Oct-27, 2006).
6. De Souza, K. et al; Vulnerability to climate change in three hot spots in Africa and Asia: Key issue for policy-relevant adaptation and resilience-building research. *Reg. Env. Chang.* 2005, 15, 747-753.
7. United Nations. United Nations Climate, 2020. https:// unfccc.int/ process and meetings/ the-convention/ what-is-the-united-nations-framework-convention-on-climate-change (accessed on Feb-23, 2021.

8. United Nations. World Population Prospects, 2019. https:// population.un.org/ wpp/ (access on Feb-22, 2021).
9. Magazines (magazines-activity)/ store-magazine/601-store-2020/3627-jalvayu-parivartan-aur-bharat-ki-chunautiyan)
10. Rosen, A. M.; The wrong Solution at the Right Time. The Failure of the Kyoto Protocol on Climate Change. *Politi Policy* 2015, 43, 30-58.
11. Shanawaj, N. Environmental awareness and Environmental attitude of secondary and Higher education School Teachers and Students, University of Rajasthan, 1990.
12. Verberg, R. 2010. Climate Change in East Africa: Towards a Methodological Framework on Adaptation and Mitigation Strategies of Natural Resources; Alterra: Wageningen, The Netherlands,
13. Weisser, F.; Bolling, M.; Doevenspeck, M.; Muller Mahn, D.: Translating the Adaptation to climate change paradigm: The policies of a travelling idea in Africa. 2014. 180, 111-119.
14. FAO. 2019 Africa regional overview of Food security and Nutrition; FAO: Accra, Ghana, 2020.
15. Mohammed, E. Y.; Uraguchi, Z.B.; Impact of Climate Change on Fisheries: Implication for food security in Sub-Saharan Africa. In Global Food Security; Nova Science Publishers, Inc: New York, NY, USA, 2013, 114-135.
16. IPCC. Regional Climate Projection; IPCC : Geneva, Switzerland, 2018.
17. Orindi, V.A.; Murray, L.A. Adapting to Climate Change in East Africa: A Strategic Approach; International Institute for Environment and Development (IIED): London, UK, 2005.
18. Wachholz, S.; Artz, N.; Chene, D. Warming to the idea: University students' knowledge and attitudes about climate change. *Int. J. Sustain. Higher Education.* 2014, 15, 128-141.
19. Ochieng, M.A.; Koske, J. The of Climate Change Awareness and Perception among Primary School Teacher's in Kisumu Municipality, Kenya. *Int. J. Humanit. Soc. Sci.* 2013, 3, 174-179.
20. Reid, A. Climate Change Education And Research: Possibilities and potentials vs problems and perils. *Environmental Edu. Research.* 2019, 25, 767-790.
21. Zoeller, C. Conservation Hero: Wangari Maathai. 2021. https:// www.oneearth.org/ conservation-hero-wangari-maathai/ (accessed on Feb-23, 2021).
22. Muhirwa,F. Environmental Education profile in Rwanda; Protestant Institute of arts and Social Sciences, Department of Natural Resources and Environmental Management: Huye, Rwanda, 2020.
23. Afifi, T.; govil, R.; Sakdapolrak, P.; Warner, K. Climate Change Vulnerability and Human Mobility: Perspectives of refugees from the East and Horn of Africa; UNHCR: Geneva, Switzerland, 2012.
24. Jalvayu Parivartan: Ek Vaishwik chunauti. https://www.drishtiias.com.
25. Barat ke aise kshetra jahan barh machati hai jyada tabahi. https://m-hindi.webdunia.com.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 950-953 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Estimation of Genetic Variability, Heritability and Genetic Advance for Yield and Yield Related Traits in Bread Wheat (*Triticum aestivum* L.) Genotypes

Shivani Chaudhary, Abhishek Rai and Mahendra
*Choudhary, P.N singh and S.C. Gaur**
Department of Genetics and Plant Breeding, B.R.D P.G College, Deoria (U.P.)
**Corresponding Author Email : scgaur101@gmail.com*

Abstract

Twenty wheat genotypes were tested in three rows of 2.5m length spaced at0.25mRandom block design B.R.D PG college Deoria [U.P.] in Rabi season. The overall objective was to study the extent of genetic variability, heritability and genetic advance. Analysis of variance revealed that there was a significant difference among the twenty genotypes for all the characters studied. The phenotypic coefficients of variation (PCV) values were higher than genotypic coefficients of variation (GCV) values forall the traits studied. Medium phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) were recorded for plant height, number of kernels per spike, thousand kernels weight, grain yield per plot, biological yield per plant and harvest index. Medium phenotypic coefficients of variation (PCV) and low genotypic coefficients of variation (GCV) values were displayed for days to maturity [5.62], grain yield [13.15], peduncle length. Low phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) values were recorded for days to50% maturity, spike length, number of productive tillers and plant height[cm], which suggests the limitation of selection for these traits. High heritability values were observed in all the characters studied. The expected genetic advance as a percent of mean ranged from 2.843 to 21.076. Characters with a high genetic advance as a percent of mean allow the improvement of this character through selection.

Key words : *PCV, GCV, heritability, genetic advance.*

Introduction

Bread wheat (*Triticum aestivum* L. em Thell. 2n=6x=42), a self-pollinating annual plant in the true grass family Gramineae (Poaceae), is largest cereal crop extensively grown as staple food sources in the world (Mollasadeghi et al., 2012). It is one of the most important export and strategic cereal crop in the world and in Ethiopia in terms of production and utilization (Ranjana and Kumar, 2013). It has been described as the 'King of cereals' because of the largest hectare it occupies, high productivity and the observable position it holds in the international food grain trade (Shashikala, 2006). The Food and Agriculture Organization of the United Nations (FAO) gracefully project the worldwide acclaim sticking with wheat as human food and the International Maize and Wheat Improvement Center (CMMYT) have chosen a wheat spike symbol in their logo with the description "Let there be bread." It is a major source of energy, protein and dietary fiber in human nutrition (Rizwana et al., 2010).

Heritability offers an index of the transmissibility of quantify the genetic relationship of a trait in the population, is high it should be fairly easy to improve that trait. Genetic advance gives an idea of improvement in the mean performance of the selected clusters over the base populations in an experiment. Correlation coefficient analysis looks to be quiet Powerful tool to understand the inter relationship in between grain yield and other Attributes and between themselves.

Materials and Methods

Experimental site : The experiment was carried out at the Agricultural Research Farm, Baba Raghav Das Post Graduate College Deoria (U.P.). During Rabi seasons 2020-21. Geographically, this College is located in the east part of Uttar Pradesh, India.

Procedure for recording the experimental data : Five plants from each plot were selected randomly excluding the border plants and tagged before the onset of flowering. The following data from these plants were recorded from all the three replications and averaged. Replication wise averaged data were then used for further analysis.

Days to 50% flowering, Days to maturity, Plant height (cm), Number of effective tillers per plant, Length of spike (cm), Number of spikelets per spike, Number of grains per spike, Weight of 1000 grains (g), Grain yield per plant (g), Flag leaf area per plant (cm2), Peduncle length per plant (cm), Grain yield per spike (g), Biological yield per plant (g), Harvest index (%).

Table-1 : Pedigree.

Sl. No.	Name of Genotype	Parentage / Pedigree	Sources and Year of Release
1.	Jamuni	ALD/COC//URES/HD216 0M/HD2278	IARI, New Delhi (2014)
2.	HD-3003	PBW 343/HD2879	IARI, New Delhi (2017)
3.	Shreeram-303	K0307/K9162	CSAUAT, Kanpur (2018)
4.	PBW-154	K 8101 /K 68	CSAUAT, Kanpur(1996)
5.	HD-3086	PBW343/HP1731	CSAUAT, Kanpur (2014)
6.	Black	PBW343*/KONK	
7.	NW-2036	C306/T.sphaerococcu m//HW 2004	IARI , New Delhi (2006)
8.	PBW-107	ND/VG9144//KAL/BB/3/YACO'S' /4/VEE#5 'S'	PAU, Ludhiana (PB) (1996)
9.	HD-2643	RAJ 3765/PBW343	IIWBR, Karnal (2003)
10.	K-1006	PBW 343/V 1	RARI, Durgapura (RJ) (2009)
11.	HD-2888	WH 594/RAJ 3858//W485	PAU, Ludhiana (PB) (2008)
12.	DBW-14	W 485 /PBW 343// RAJ1482	PAU, Ludhiana (PB) (2004)
13.	RAJ-4120	VEE'S'/ HD2407//HD 2329	IARI , New Delhi (1997)
14.	PBW-550	TUKURU/INQLAB	IIWBR, Karnal (2015)
15.	PBW-502	DBW14/HD2733//HUW468	IARI , New Delhi (2014)
16.	K-9107	PRINIA/UP2425	IIWBR, Karnal (2013)
17.	K-1317	MILAN/S87230//BABAX	CCS HAU, Hisar (2013)
18.	HD-2967	ALONDRA/CUCKOO//URES-81	IIWBR, Karnal
19.	PBW-313	HUW12* 2/CPAN 1666//HUW12	BHU, Varanasi (1986)
20.	HD-3171	HUW 206/HUW202	BHU, Varanasi (2000)

Table-1 : Analysis of variance of randomized block design for 14 characters of wheat germplasm.

Source of variation	d.f.	Plant height (cm)	Days to 50% flowering	Days of maturity	Flag leaf area (cm^2)	Peduncle length (cm)	Spike length plant (cm)	No of productive tillers
Replication	2	1.0750	1.5170	163.1770	17.3350	3.0930	0.0170	0.0190
Treatment	19	21.706*	36.512**	221.150**	236.683**	10.834*	2.237**	0.259**
Error	38	8.967	9.308	54.495	5.78	4.476	0.519	0.07

Table-1 : Contd....

Source of variation	d.f.	Grai n per spike	Grain weight (g)	Spikelets per spike	Test weight	Grain yield kg/plant	Biological yield (g/plant)	Harvest index (%)
Replication	2	0.3970	0.0320	12.3860	1.950	0.0450	1.7710	5.1510
Treatment	19	8.723*	1.0625**	10.0**	35.698**	8.18**	22.737**	65.750**
Error	38	3.604	0.058	4.13	3.127	0.78	3.842	11.722

*,** significant at 5% and 1% level, respectively.

Statistical analysis : Squares due to genotype (Treatment) were highly significant for all the fourteen characters under study. The variance due to replications were significant for days to 50% flowering, days to maturity, spike length, number of spikelet per spike, plant height (cm), flag leaf area, number of productive tillers, number of grain per spike, grain weight leaf spike, peduncle length, 1000 grains weight, biological yield per plan grain yield per plant and harvest index. The genotypic, phenotypic and environmental coefficient of variation were computed to assess the existing variability in the germplasm (table).

Gaur, S.C. (2019) reported that high estimates of genetic advance in percent over mean were found for productive tillers per plant, biological yield per plant, biological yield per plant and flag area. Grain yield per plant, plant weight exhibited moderate (G.A.). The low estimate of genetic advance were observed for harvest index 50% flowering, yield per spike, days to maturity, spikelet's length, number of grain per spikes peduncle length were observed our study.

The means of five plants of each entry in each replication were used for the analysis of data, following the procedure of standard RBD analysis of variance. The data were subjected to following statistical analysis. Analysis of variance, Estimation of heritability, Genetic advance as percent overmean, Analysis of genetic parameter.

All the statistical analysis were carried out by using Windostat Version 9.2 from indostat services, Hyderabad

Table-3 : Estimate of coefficient of variation for 14 characters in wheat germplasm.

S. No.	Source	Range mean			?^{2}e var environment	?^{2}e var genotypical	Var phenotypical	GCV	PCV	ECV	h^2 broad sense	Genetic Advancement 5%	Gen. Advas % of Mean 5%
		Minimum	Maximum	Mean									
1.	Day to 50% flowering	70.00	82.00	76.2 7	9.308	9.068	18.376	3.948	5.621	4	49.347	4.358	5.714
2.	Flag leaf area (cm)^2	22.14	64.26	35.32	5.78	76.968	82.748	24.837	25.753	6.806	93.015	17.43	49.346
3.	Length of spike (cm)	10.40	13.47	12.01	0.519	0.573	1.092	6.303	8.702	6	52.462	1.129	9.404
4.	Peduncle length (cm)	40.22	46.75	44.98	4.476	2.119	6.595	3.273	5.773	4.756	32.134	1.7	3.822
5.	No. of pod tillage	3.63	5.20	4.42	0.07	0.063	0.133	5.675	8.259	6	47.219	0.355	8.033
6.	Plant height (cm)	78.12	88.90	84.64	8.967	4.246	13.214	2.434	4.294	3.538	32.134	2.406	2.843
7.	Maturity date (days)	81.33	125.67	114.47	54.495	56.553	111.048	6.57	9.206	6.449	50.927	11.055	9.658
8.	Biological yield (g)	20.22	28.65	24.20	3.842	6.298	10.141	10.37	13.159	8.1	62.109	4.074	16.836
9.	No of spikelet per spike	17.23	25.41	19.18	4.13	1.957	6.087	7.295	12.865	10.597	32.15	1.634	8.52
10.	Grains per spike	35.27	11.37	37.7 8	3.604	1.706	5.31	3.457	6.099	5.024	32.134	1.525	4.037
11.	Grain weight (g)	1.60	3.47	2.58	0.058	0.336	0.394	22.444	24.295	9.3	85.346	1.103	42.713
12.	Test weight	37.67	48.33	99.20	3.127	10.857	13.984	7.455	8.46	4	77.642	5.981	13.532
13.	Grain yield per plant (g)	10.90	16.30	13.38	0.78	2.467	3.247	11.738	13.466	6.6	75.978	2.82	21.076
14.	Harvest index (%)	47.93	66.75	57.0 7	11.722	18.009	29.731	7.436	9.555	5.999	60.574	6.804	11.923

Licensed to Dept. of Plant Breeding and Genetics Punjab Agricultural University Ludhiana.

Randomized block design : To test the variation present among the parents and the hybrids the ANOVA is carried out from the randomized block data separately for all the characters.

Estimation of heritability : Estimation of Heritability in broad sense $(h)^2$ was calculated using the formula suggested by Hanson *et al.* (1956).

Genetic advance as per cent over mean (GA) : Expected genetic advance (GA) was estimated by the method suggested by Johnson *et al.* (1955).

Results and Discussion

Analysis of variance : The results of analysis of variance for Randomized block design in respect of germplasm evaluation experiment have been presented in table. The mean.

Mean performance of genotypes for 14 characters of wheat : The mean performance of genotypes for fourteen characters is presented in Table 4.2(b). The general mean and range for all the traits, studies are given in the table 4.2(b).

Days to 50% flowering : A perusal of data revealed that days of flowering of different ranged from 70.00 days to 82.00 days with a ranged mean value of 76.27 days.

Plant height (cm) : The plant height ranged from 78.03 cm to 88.90 cm with a grand mean value of 84.64 cm. the tallest variety observed was black (88.90 cm). the genotype different was PBW-107 (78.12 cm). The coefficient of variation was estimated as 3.59%.

Peduncle length (cm) : The peduncle length ranged from 40.22 to 46.75 respectively of mean value 94.48.

Flag leaf area (cm^2) : The mean values for number of flag leaf are arranged from (22.14 cm2 (PBW-313) to 64.26 cm2 (PBW-107)2.2.6 Spike length per plant (cm) Large extent of variation was observed for spike length and mean value ranged from HD-288 (10.40 cm) to HD-3003 (13.47cm).

No. of effective tillers per plant : Large extent of variation was observed for number of tillers per plant and mean values ranged from 3.63 (K-1317) to 5.20, HD-30032.2.8 No. of

Spikelets per spike : Number of spikelets per spike ranged from HD3003 (17.23) to HD-3171 (25.41).The coefficient variation was estimated as 10.60%.

Biological yield (g/plant) : Mean values of biological yield per plant ranged from (20.22) to (28.65) and the grant mean was registered 24.20. 2.2.10 Grain yield per plant (g). Grain yield per plant ranged from (10.90 g) to (16.30 g) and the grant mean value was registered (13.38g).

No. of grain per spike : Grain per spike ranged from 35.27 to 41.37 with grand mean of 19.18.

2.2.12 Grain weight per spike (g) : Grain weight per spike ranged from (1.60 g) to 3.47g) with grant mean of spikelet leng.

1000 grain weight (g) : Ranged from 37.67 g to 48.33 g with grand mean value of 44.20 g followed by shreeram-303 (37.67 g), HDWhile highest grains of PBW-343 (48.33g). The coefficient variation was estimated to be 4.00%.

Harvest index (%) : The data presented table 4.2b indicated that there is considerable variation of harvest index ranging from 47.83% to 66.75%

Gaur, S.C. (2016) reported that general mean for peduncle length was 36.08 cm the lowest and highest mean performance showed amole (31.41) and (Pbw65*2) (44.48) respectively the top non-significant group of comprised for 40 entries out of 72. The no. of tillers per plant had general mean of 8.25 with arrange of 4.75 TUKURU to 12.77 TRACH. The grain yield per plant range for CNO79 in case of 15.38 (TRACH) with general mean of 9.32 germplasm thirty-three producing significantly higher yielding per plant.

Coefficient of variation : The estimates of genotype of phonotypic and environmental coefficient of variation for 14 characters of wheat germplasm collection are present in table-3. The magnitude if phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient (GCV) for all characters. The high magnitude PCV (25.73%) was observed yield for grain weight g), No. of spikelet per spike, grain yield per plant had high PCV were recorded for harvest index, flag leaf area (cm2). Moderate PCV was exhibited by grain yield per plant no. of (13.15g) spikelet, peduncle length, maturity days PCV (5.62) low for days to 50% flowering, peduncle length, No. of tillage, grain per spike test weight.

The genotypic coefficient of variation (GCV) was found to high (24.83%) for flag leaf area (cm^2) grain weight, grain yield per plant, and moderate (10.37%), for biological yield, harvest index. Test weight, and low (3.94g) for days to 50% flowering, peduncle length (cm), length of spike, No. of pod tillage, plant height (cm) the estimate of GCV were low for rest of characters.

Heritability and genetic advance : Heritability and genetic advance are important selection parameters. Heritability estimated along with genetic advance are normally more helpful in predicting the grain under selection than heritability estimates due to alone. The estimate of heritability can be utilized for the prediction of genetic gain which indicates the genetic improvement that would result from the selection of best individual. Hence estimate of heritability is an essential pre-requisite of heritability (>80%) were observed for flag leaf area (cm^2) (93.017), grain weight (85.396) moderate heritability (60-80%) was recorded for test weight (77.642), grain yield per plant (g) (75.978), number of spikelets per spike (62.109). Low heritability (10-60%) length of spike (52.462), maturity date (days) (50.927), number of productive tillers (47.219) indicating that a plant breeder can concentrate on these traits to exploit effective selection for genetic improvement genetic advance is the improvement in mean genotypic value (21.076) of selected individual over parental population.

References

1. Abu Tefera, 2012. Grain and feed annual report. Grain report number: ET1201, Addis Ababa, Ethiopia.
2. Ali, N.; F. Javidfer and A.A. Attatry (2002). Genetic variability correlation and path analysis of yield and its components in wheat (*Triticum aestivum* L.). *Pak. J. Bot*, 34: 145-750.
3. Arya, V.D.; Pawar, I.S. and Lamba, R.A.S. (2005). Genetic variability and correlation for yield and quality traits in bread wheat. *Haryana Agriculture University Journal of Research,* 35 (1): 59-63.
4. B.A. Monpara, 2011. Grain filling period as a measure of yield improvement in bread wheat, *Crop Improv.* (2011) 38(1): 1-5.
5. Daniel Hailegiorgis, Mebrahtom Mesfin and Tsige Genet, 2011. Genetic Divergence Analysis on some Bread Wheat Genotypes Grown in Ethiopia, 2Bahir Dar University, Amhara, Ethiopia. 1Global Journal of Science Frontier Research Volume XVI Issue erosion l V VII Year 2016 15 (D) © 2016 Global Journals Inc. (US) Genetic Variability, Heritability and Genetic Advance for Yield and Yield Related Traits in Bread Wheat (*Triticum aestivum* L.) Genotypes.
6. Faris Hailu, 2011. Genetic Diversity and Grain Protein Composition of Tetraploid Wheat (*Triticum durum* Desf.) Germplasm from Ethiopia. Doctoral (Agri.) Thesis University of Agricultural Sciences. Alnarp, Sweden.
7. Gaur, S.C.; Sharma, S.K. and Gaur, L.B. (2014). Study of heritability and genetic advance with correlation response in F_1 and F_2 generations of bread wheat (*Triticum aestivum* L. emThell.) Progressive Research, 9 (769-772.
8. Gautam, Gaur, S.C.; Gaur, A.K. and Gaur, L.B. (2017). Genetic hariability for quantitative character and their association with grain yield and its component in bread wheat (*Triticum aestivum* L. em. Thell). *International Journal Society for Scientific Development in Agriculture and Technology*, 12 (4): 2581-2586.
9. Johnson, H.W., H.E. Robinson and R. E. Comstock. (1955). Estimates of genetic and environmental variability in soybean. *Agron. J.,* 47: 314-318.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 954-956 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Eco-Friendly Management of Chilli Leaf Curl Disease Complex under Field Condition

Smriti Akodiya[1], Shaik Munnysha[1], Mamta[1], Ramavath Abhi[2] and Manisha[2]
[1]*Department of Plant Pathology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*
[2]*Department of Nematology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*
Corresponding Author Email : smritiakodiya869@gmail.com

Abstract

Chilli (*Capsicum annuum* L.) is popularly known as "wonder spice" and is an important cash crop and remunerative vegetable crop of India and is grown both for home market and export. Chilli leaf curl complex disease is one of the major limiting factors in chilli production. In our present investigation attempt was taken to manage the chilli leaf curl by eco-friendly approaches. Foliar application of Imidachloprid was found most effective as this treatment give minimum PDI (36.29) followed by Raw cow milk @ 25% (49.62 %), NSKE @ 10% (54.07 %), Cow urine @10% (54.80 %), Potassium PDI (59.25 %),Two week butter milk @ 20%, (59.25 %), Neem leaf extract @ 20% (62.21 %), and Cow dung +Jaggery @ 2% (76.28 %), while the maximum PDI was recorded in control. Imidachloprid was significantly superior over all other treatments. Next to Imidachloprid foliar application of Cow milk @ 25% + Turmeric powder @ 2% was found effective and it was superior to cow dung, Neem leaf extract and control but it was statistically at far with cow urine 10%, NSKE@10%, potassium@1.5% and buttermilk @ 20%. Foliar application of cow urine @10% also shows increasing result and it was superior over cow dung +Jaggery and control. While it was statistically at par with NSKE, Potassium, Raw cow milk, butter milk and neem leaf extract. The maximum percentage disease is controlled by Imidachloprid (57.39 %) followed by Raw cow milk @ 25% + turmericurine @ 10% PDC (35.65 %), Potassium @ 1.5% PDC (30.43%), Two week butter milk @ 20% (30.43%) and Cowdung+Jaggery @ 2%(10.43%).

Key words : *Chilli leaf curl, wonder spice, bio-friendly approach, per cent disease index.***Introduction**

Introduction

Capsicum annuum L. is an important spice crop that is grown all over the world. Chilli belongs to the genus *Capsicum,* family Solanaceae. It was originated in Mexico, Southern Peru and Bolivia (Villalon, 1981). Chilli is a spice crop and vegetable crop of India that is grown for both home market and export. Chilli is famous for its pleasing aromatic flavour pungency and high colouring substance. The pungency in Chilli is due to the alkaloid capsaicin contained in the pericarp and placenta of fruits Chilli has become an essential part of Indian cuisine and is valued for its characteristic pungency, colour and aroma. In Indian home, chilli is used by the poor and rich. The plant of chilli is herbaceous and annual in nature. It consist of terminal group of leaves. The leaves that are developed are generally alternate to oppose. Out crossing in chilli generally ranges from 7 to 90%. So it is a facultative cross pollinating species. The largest producer consumer and exporter of chilli in the world is India.

Chilli was first introduced in India by Portuguese at the end of 15th century. The top ten chilli producing countries are India, China, Ethiopia, Thailand, Pakistan, Bangladesh, Myanmar, Ghana and Vietnam accounted for more than 80% of the world production in 2018; Maximum share is taken by India with 43% share in global production, followed by China (8 %), Ethiopia (7 %), Thailand (6 %), Pakistan (4%), Bangladesh (3%) and Myanmar (3%) (Anonymous, 2018). India contributes one-fourth of the total quantity of chilli exported in the world (Geetha and Selvarani, 2017).

Cultivated species of chilli (*Capsicum). viz*., *C. annuum, C. baccatum, C. chinense, C. frutescens* and *C. pubescens.* Among these, *C. annuum* L. is the most grown species all over the world. India is rich source of chilli varities with different nutritional quality. Main use of chilli as vegetable, spices, sauce and pickles . Instead of this, it is also used in Ayurvedic medicine, beauty product and beverage. Out of the twenty four viruses reported to occur naturally on chilli, eleven viruses have been reported from India, *viz* tobacco leaf curl virus, cucumber mosaic virus (Hussain, 1932). Indian chilli mosaic virus, potato virus X, potato virus Y, tobacco ring spot virus, pepper veinal mottle virus and pepper vein bending virus, chilli leaf curl virus, tomato leaf curl New Delhi virus (Khan *et al.,* 2006).

Leaf curl of chilli has been reported by several investigators from India and abroad (Husain, 1932). The emerging threat of the viruses belonging to the genus *Gemini* virus has been substantially addressed earlier. The extent of yield loss caused by some *Gemini* viruses has been estimated as high as 100% and in some areas infection with viruses has rendered the growing of peppers uneconomical, causing whole fields to be abandoned prior to harvest (Greenleaf, 1986) Up to 96%

losses in yield has been reported by Bhendi yellow vein mosaic.

Management of viral diseases is much more difficult than that of diseased caused by other group of pathogen due to their complex disease cycle, efficient vector transmission and non-availability of an effective viricide.

Khan *et al.* (2006) has been characterized in India. Ambiguous measures, such as pesticide sprays to control vectors, removal of diseased plants and agronomic interventions, have been tried without much success.

Northern region of M.P comprising Murena, Bhind, Gwalior is the hot spot of virus disease of crop like yellow mosaic, mosaic of pulses, cucurbits, yellow vein mosaic of okra, leaf curl of chilli. Chilli leaf curl complex is one of the most important constraints in the cultivation of chilli particularly for the commercial chilli growers, the disease is responsible for the quantitative and qualitative lossess. Due to this the disease drastically decrease the farmer's income. The disease can be managed by foliar application of insecticides. But spraying and their after picking of chillies may cause harmful effect to the consumers. The non-chemical management specially using plant extract and animal waste possessing fungicidal properties may act as an alternative way for the management and same consumption of chilli.

Materials and Methods

Management of chilli leaf curl complex under field condition : An experiment was conducted at college of Agriculture, Gwalior during Rabi 2019. The Experimental field was prepared by ploughing thrice with Cultivator followed by planking of making a good soil texture fine tilt and smooth soil surface. Recommended doses of FYM (1t/ ha) were mixed thoroughly in soil. After 35 days transplanting of seedling is done and Nitrogen (100kg/ ha), Phosphorous (50 kg/ha) and Potash (50kg/ha) were drilled and mixed thoroughly in soil by light harrowing before transplanting Thirty five days old seedling of Local variety that is chilli raised in nursery under insect proof conditions were planted in each plot in 3-4 cm. Six irrigations were given and weeding was done regularly to keep plots weed free. Nine Treatments *viz*, NSKE @ 10%, Cow urine @ 10%, Cow dung @ 20% + Jaggery @ 2%, Potassium (K_2O) @ 1.5%, Foliar application of raw cow milk @ 20% + Turmeric powder @ 2% , Neem Leaf extract @ 20%, Two week old butter milk @ 20%.

Statistical Analysis : The statistical model design in single environment could be defined below :

Yijk = + ti + bij + rijk

K = the general

Ti = the effect of i^{th} treatment

Bij = the effect of j^{th} replication in i^{th} treatments

Eijk = the error associated with each observation.

The skeleton for analysis of variance for randomised complete block design is given below :

Source of variance	Degree of freedom	MSS	Expected MSS
Replication	r-1	MSR	2ei+2tri
Treatment	t-1	MST	2ei+rri
Error	(r-1)(t-1)	MSE	2ei
Total	rt-1		

Standard error of mean (S.E(m)) : It was calculated as formula given below

$$S.E.(m) = \frac{\sqrt{MSE}}{r}$$

Where,

MSE = Mean sum of squares due to error

R = number of replications

Critical difference (C.D) : It was mean used as formula mentioned below

$$CD = (\text{at } 5\%) = SE(m)^* \ t_5$$

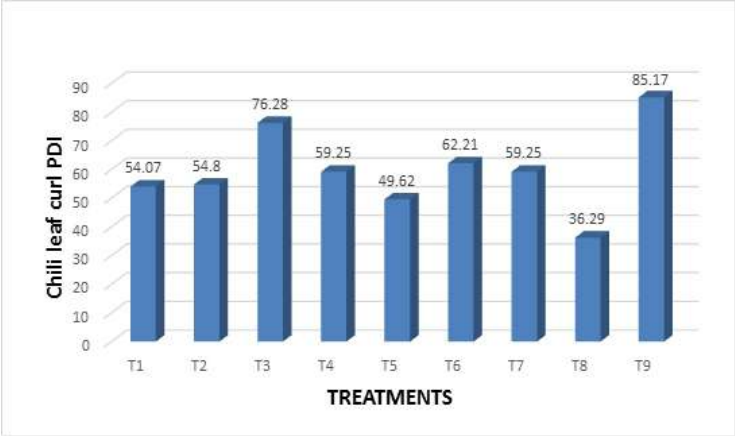
Results and Discussion

Management of chilli cultivars through bio-friendly approach : A set of nine treatments consisted of NSKE @ 10%, Cow urine @ 10%, Cow dung + Jaggery @ 2%, potassium @ 1.5 % , Raw cow milk @ 25% + turmeric powder @ 2%, Neem leaf extract @ 20%, Two week butter milk @ 20%, Imidachloroprid and control were evaluated for the management of chilli leaf curl complex.

Foliar application of Imidachloprid was found most effective as this treatment give minimum PDI (36.29) followed by Raw cow milk @ 25% (49.62 %), NSKE @ 10% (54.07 %), Cow urine @10% (54.80 %), Potassium PDI (59.25 %),Two week butter milk @ 20%, (59.25 %), Neem leaf extract @ 20% (62.21 %), and Cow dung + Jaggery @ 2% (76.28 %), while the maximum PDI was recorded in control. Imidachloprid was significantly superior over all other treatments. Next to Imidachloprid foliar application of Cow milk @ 25% + Turmeric powder @ 2% was found effective and it was superior to cow dung, Neem leaf extract and control but it was statistically at far with cow urine 10%, NSKE@10%, potassium @ 1.5% and buttermilk @ 20%. Foliar application of cow urine @10% also shows increasing result and it was superior over cow dung +Jaggery and control. While it was statistically at par with NSKE, Potassium, Raw cow milk, butter milk and neem leaf extract.

Table-1 : Field evaluation of selected chemicals and non–chemical for management of chilli leaf curl.

Treatments	PDI%	PDC (Per cent disease control)
NSKE @ 10%	54.07(47.34)	36.51
Cow urine @ 10%	54.80(47.77)	35.65
Cow dung + Jaggery @ 2%	76.28(60.90)	10.43
Potassium @1.5%	59.25(50.37)	30.43
Raw cow milk @ 25% + Turmaric Powder @ 2%	49.62(44.78)	41.74
Neem leaf extract @ 20%	62.21(52.10)	26.95
Two week butter milk @ 20%	59.25(50.37)	30.43
Imidachloroprid @ 0.03%	36.29(37.03)	57.39
Control	85.17(67.51)	7.61
S.E (m)	1.94	
C.D at 5%	5.82	



T_1 = NSKE@10% T_2 = Cow urine @10%
T_3 = Cow dung+ Jaggery @ 2% T_4 = Potassium@ 1.5 %
T_5 = Raw cow milk @ 25 %+ Turmeric Powder@2%
T_6 = Neem leaf extract@ 20% T_7 = Two week butter milk@ 20%
T_8 = Imidachloprid @0.03% T_9 = Control

Fig.-1 : Percentage disease incidence of chilli leaf curl by application of different Treatments.

The maximum percentage disease is controlled by Imidachloprid (57.39%) followed by Raw cow milk @ 25% + turmericurine @ 10% PDC (35.65%), Potassium @ 1.5% PDC (30.43%) week butter milk @ 20% (30.43%) and Cowdung + Jaggery @ 2% (10.43%).

Conclusions

All the treatments significantly checked the disease. But the chemical Imidachloprid @ 0.03% was found most effective and significantly superior over other treatments. However Some other treatments like Foliar application of cow milk @ 25% + turmeric Powder @ 2%, NSKE @ 10%, Cow urine @ 10%, two week old butter milk @ 20%and potassium @ 20% significantly checked the disease. In the Light of safe and Environment Friendly management.

Suggestion for Future Work

Foliar application of Raw cow milk @ 25% + Turmeric powder @ 2%, Cow urine @ 10. Two week old butter milk @ 20%, NSKE @ 10% and potassium @ 1.5% were found effective for the management of the leaf curl complex. Now there is a need to test these effective treatments under different concentration and combination to develop an alternative to the chemical for an environment and consume safe management of the disease, a large no of cultivars should be evaluated against the disease.

References

1. Ahmad, A.A. and Raghav, R.M. (2016). Medicinal plant extracts for the management of leaf curl disease of chilli (*Capsicum annuum* L) . *World J. Pharma. Sci*, 5 (1): 1916 -1924.
2. Husain, M.A. (1932) Leaf curl in cotton and other plants. *Nature*, 130: 312.
3. Khan, M.S. Raj, S.K. and Singh, R. (2006). First report of tomato leaf curl New Delhi virus infecting chilli in *India. Pl. Pathol,* 55(2): 256.
4. Geeta, R. and Selvarani, K. (2017). A study of chilli production and export from Imia IJARIIE-ISSNO-2395-4396.
5. Greenleaf, W.H. (1986). Pepper Breeding. In: Basseett M J (Ed) Breeding Vegetable Crops. pp: 67-134. AVI Publishing Co., Westport CT.
6. Villalon, B. (1981). Breeding peppers to resist virus diseases. *Pl Dis,* 65: 557-561.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 957-963 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

To Study on Correlation Coefficient and Path Analysis for Yield and its Components in Bread Wheat (*Triticum aestivum* L. em. Thell) Genotypes

Sonal Kumari and S.C. Gaur
Department of Genetics and Plant Breeding, Baba Raghav Das P. G. College, Deoria–274001 (U.P.)
Corresponding Author Email: scgaur101@gmail.com

Abstract

The present investigation was carried out using 20 bread wheat genotypes at Agriculture Research Farm of B.R.D. P. G. College Deoria, (U.P.). during *Rabi,* 2020-2021 in Randomized Block Design (RBD) with Three replication. The data were recorded form five randomly selected plants for 14 Quantitative traits *Viz*., Days to 50% flowering, Days to maturity, Plant height (cm), Number of productive tillers per plant, Length of spike (cm), Number of spikelets per spike, Number of grains per spike, 1000-grain weight (g), Grain yield per plant (g), Flag leaf area per plant (cm^2), peduncle length per plant (cm), Grain yield per spike (g), Biological yield per plant (g), Harvest index (%).The correlation of different traits with grain yield was examined both at phenotypic and genotypic levels and the study showed that genotypic correlation coefficient values were higher than the phenotypic values. The grain yield per plant was positive and significant peduncle length, flag leaf area, number of productive tillers per plant, ear length, number of spikelets per spike, number of grains per spike and grain weight per spike at genotypic and phenotypic levels while it showed positive and significant with biological yield per plant and harvest index at phenotypic level only. The results of path coefficient based on genotypic coefficient and phenotypic coefficient taking grain yield per plant as dependent variable indicated that at genotypic level, positive direct effect on grain yield per plant was observed for biological yield per plant harvest index, ear length, flag leaf area, plant height and days of 50% flowering whereas, the negative direct effect was observed for grain weight per spike, days to maturity, 1000-grains weight, number of grains per spike, number of spikelets per spike, number of productive tillers per plant and peduncle length. At phenotypic level, positive direct effect on grain yield per plant was observed for biological yield per plant, harvest index, number of spikelets per spike, flag leaf area, 1000-grains weight, days of 50% flowering and ear length whereas, the negative direct effect was observed for number of grains per spike, grain weight per spike, plant height, peduncle length, days to maturity and number of productive tillers per plant. Both at phenotypic and genotypic level flag leaf area, ear length, number of spikelets per spike and biological yield per plant was established high positive direct effects on grain yield per plant.

Key words : *Correlation coefficient, path analysis, wheat*

Introduction

About wheat [*Triticum aestivum* (L.) em. Thell]; 2n = 6x = 42] is a cereal crop of the member of Gramineae (Poaceae) family and one of the most leading cereals of many countries of the world including India. It is one of the world's most common staple foods. It covers 17 per cent (one-sixth) of global cropland, feeds about 40% of the world's population and accounts for 20% of overall food calories and protein in human nutrition. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. It is grown in temperate, irrigated areas and in warm, humid to dry, cold environments (Bhushan, 2013). Wheat is a self-pollinated, monocotyledonous plant that had originated from South West Asia. There are different species of wheat, out of which only three *Triticum* species are mostly cultivated throughout the world. These are *Triticum aestivum* (bread wheat), *Triticum durum* (macaroni wheat) and *Triticum dicoccum* (emmer wheat). The bread wheat is an allohexaploid species (2n=6x=42) having AABBDD with A, B and D genome. The genetic origin of wheat is of interest; since it is a classic example of how closely related species may be combined in nature into a polyploid series. The species of *Triticum* and their close relatives can be divided into diploid, tetraploid and hexaploidy groups, with chromosome numbers of 2n = 14, 28 and 42, respectively, in which the basic chromosome number of Wheat is x = 7. *Triticum durum* originated thousands of years ago from a hybridization between the wild diploid *Triticum monococcum* (A genome donor) and the donor of the B genome which, according to morphological, geographical and cytological evidence, has been recognized as *Triticum speltoides* or a closely related species (Fikre, 2015). Globally, wheat (*Triticum* species.) is grown in about 224.09 million hectares holding the position of highest acreage among all crops with annual production hovering around 794.44 million metric tons (USDA, 2021). In India, it is grown in an area of 31.76 million hectares (14.17% of the global area) with a production of 108.75 million metric tons (13.68% of world production) and productivity of 3424 kg/ha. (Anonymous, 2020). The nutritional value of wheat is extremely important as it takes

on important place among the few crop species being extensively grown as staple food sources. Correlation coefficient analysis appears to be a very useful approach for determining how various yield variables interact. This parameter also provides estimates of the interdependencies between grain yield and other qualities, as well as amongst themselves. This would make it easier for breeders to adopt successful selection techniques for increasing yield. By separating the correlation coefficient of grain yield and the concerned trait, path coefficient analysis determines the level of direct and indirect effect of independent variables on a dependent variable. As a result, path coefficient analysis has become the most widely used and useful statistical method for this purpose, and it can also be used to estimate the quantitative impact of direct and indirect effects caused by one or more components of grain yield, as well as the relationship between these components.

Materials and Methods

The field experiment under present investigation was conducted during *rabi* 2021-22 at Agriculture Research Farm of Baba Raghav Das Post Graduate College Deoria (U.P.). Geographically, this College is situated in the east part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 68 meter (223 feet) above the mean sea level. The climate of district Deoria is semi-arid with hot summer and cold winter nearly 80% of total rain fall is received during the monsoon (only up to September) with a few showers in the winter. The experiment was laid out in Randomized Block Design (RBD) with 3 replications, each replication and each genotype sown in two rows of five meters length spaced at 2.5m from row to row and 10 cm form plant to plant. The recommended package of practices was adopted for raising the healthy crop. Observations for all the traits were recorded on five randomly selected plants of each entry in reach replication while observation for days to 50 per cent heading and days to maturity were recorded on plot basis. Statistical analysis: - Correlation Coefficient Analysis: To determine the degree of association of characters with yield and also among the yield components, the correlation coefficients were calculated. Both genotypic and phenotypic coefficients of correlation between two characters were determined by using the variance and covariance components as suggested by Al-Jibouri *et al.,* (1958). Path coefficient analysis was carried out using phenotypic correlation values of yield components on yield as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

Results and Discussion

Correlation coefficient at phenotypic and genotypic levels were estimated using fourteen characters in twenty genotypes of wheat to study the degree of mutual relationship between yields and its component traits. The estimates genotypic correlation coefficients and phenotypic correlation coefficients are present in Table-1 and Table-2 respectively. Perusal of the results revealed that the estimates of genotypic correlation coefficients were higher in magnitude than their corresponding correlation coefficient at phenotypic level. Days to 50 % flowering exhibited positive and significant correlation coefficient with days to maturity (rg = 0.841** and rp = 0.670**) at both genotypic and phenotypic levels. It showed positive and significant correlations with plant height (rg = 0.280**), peduncle length (rg = 0.375**) and flag leaf area (rg = 0.414**) at genotypic level and also showed positive and significant correlation coefficient with 1000-grains weight (rp = 0.270**) at phenotypic level. Days to maturity exhibited positive and significant correlation coefficient with plant height (rg = 0.296**), peduncle length (rg = 0.265**) and flag leaf area (rg = 0.356**) at genotypic level. Plant height established positive and significant correlation coefficient with peduncle length (rg = 0.854** and rp = 0.498**) and flag leaf area (rg = 0.500** and rp = 0.287*) at both genotypic and phenotypic level while it showed positive and significant correlation with number of spikelets per spike (rg = 0.441**), number of grains per spike (rg = 0.374**) grain weight per spike (rg = 0.375**) 1000- grains weight (rg = 0.277*) biological yield per plant (rg = 0.528**) and harvest index (rg = 0.561**) at genotypic level only. Peduncle length established positive and significant correlation coefficient with flag leaf area (rg = 0.647** and rp = 0.397**), number of spikelets per spike (rg = 0.428** and rp = 0.293*), grain weight per spike (rg = 0.440** and rp = 0.301*), biological yield per plant (rg = 0.495** and rp = 0.322*) and grain yield per plant (rg = 0.449** and rp = 0.317*) at both genotypic and phenotypic level while it showed positive and significant correlation with number of productive tillers per plant (rg = 0.332**), number of grains per spike (rg = 0.790**), 1000- grains weight (rg = 0.449**) and harvest index (rg = 0.625**) at genotypic level only. Flag leaf area exhibited positive and significant correlation coefficient with number of productive tillers per plant (rg = 0.709** and rp = 0.527**), ear lengh (rg = 0.723** and rp = 0.371**), grain weight per spike (rg = 0.639** and rp = 0.469 **), 1000- grains weight (rg = 0.499** and rp = 0.322*), biological yield per plant (rg = 0.310* and rp = 0.264*) and grain yield per plant (rg = 0.466** and rp = 0.356**) at both genotypic and phenotypic level while it showed positive and significant

Table-1 : Estimates of Genotypic correlation coefficients between 14 characters of wheat.

Characters	Days of 50% Flowering	Days to maturity	Plant height (cm)	Peduncle length (cm)	Flag leaf area (cm^2)	Number of productive tillers per plant	Ear length (cm)	Number of spikelets per spike	Number of grains per spike	Grain weight per spike (g)	1000-grains weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
Days of 50% Flowering	1.0000	0.841**	0.280*	0.375**	0.414**	-0.0891	0.2085	0.0426	-0.0884	-0.0451	-0.1303	0.0090	-0.1262	-0.2486
Days to maturity		1.0000	0.296*	0.265*	0.356**	-0.0394	0.2363	0.0191	0.1365	-0.0456	0.1183	-0.0208	-0.1407	-0.2391
Plant height (cm)			1.0000	0.854**	0.500**	0.0979	0.0256	0.441**	0.374**	0.375**	0.277*	0.528**	0.561**	0.1591
Peduncle length (cm				1.0000	0.647**	0.332**	0.1238	0.428**	0.790**	0.440**	0.449**	0.495**	0.625**	0.449**
Flag leaf area (cm^2)					1.0000	0.709**	0.723**	0.601**	0.523**	0.639**	0.499**	0.310*	0.482**	0.466**
No. of productive tillers per plant						1.0000	0.729**	0.891**	0.847**	0.530**	-0.1415	0.401**	0.598**	0.518**
Ear length (cm)							1.0000	0.798**	0.905**	0.805**	0.1897	0.546**	0.737**	0.481**
Number of spikelets per spike								1.0000	0.824**	0.633**	-0.349**	0.367**	0.674**	0.859**
Number of grains per spike									1.0000	0.606**	-0.445**	0.380**	0.663**	0.723**
Grain weight per spike (g)										1.0000	0.651**	0.783**	0.821**	0.558**
1000-grains weight (g))											1.0000	0.469**	0.443**	-0.1083
Biological yield per plant (g)												1.0000	0.956**	-0.0975
Harvest index (%)													1.0000	0.2414

* Significant at P = 0.05%** Significant at P = 0.01%

Table-2 : Estimates of Phenotypic correlation coefficients between 14 characters of wheat.

Characters	Days of 50% Flowering	Days to maturity	Plant height (cm)	Peduncle length (cm)	Flag leaf area (cm^2)	Number of productive tillers per plant	Ear length (cm)	Number of spikelets per spike	Number of grains per spike	Grain weight per spike (g)	1000-grains weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
Days of 50% Flowering	1.0000	0.670**	0.1583	0.1079	0.1827	-0.0596	0.1600	-0.0409	0.0379	-0.0750	0.270*	-0.0372	-0.1215	-0.1134
Days to maturity		1.0000	0.1550	0.1736	0.2329	-0.0627	0.1810	-0.0265	-0.1194	-0.0675	0.0738	0.0250	-0.1467	-0.0733
Plant height (cm)			1.0000	0.498**	0.287*	0.0351	0.0105	0.1009	0.1424	0.2112	0.2050	0.2172	0.1386	0.2409
Peduncle length (cm				1.0000	0.397**	0.0768	0.0816	0.293*	0.0109	0.301*	0.1319	0.322*	0.0540	0.317*
Flag leaf area (cm^2)					1.0000	0.527**	0.371**	0.1723	0.2368	0.469**	0.322*	0.264*	0.1545	0.356**
Number of productive tillers per plant						1.0000	0.399**	0.341**	0.360**	0.2445	-0.0815	0.314*	0.1554	0.404**
Ear length (cm)							1.0000	0.364**	0.276*	0.510**	0.0430	0.295*	0.1038	0.348**
Number of spikelets per spike								1.0000	0.651**	0.282*	-0.2541	0.1857	0.306*	0.356**
Number of grains per spike									1.0000	0.293*	-0.1703	0.1613	0.390**	0.350**
Grain weight per spike (g)										1.0000	0.377**	0.577**	0.2288	0.681**
1000-grains weight (g))											1.0000	0.338**	-0.2013	0.2200
Biological yield per plant (g)												1.0000	-0.302*	0.767**
Harvest index (%)													1.0000	0.342**

*Significant at P = 0.05% **Significant at P = 0.01%

Table-3 : Genotypic path coefficients for grain yield per plant in wheat.

Characters	Days of 50% Flowering	Days to maturity	Plant height (cm)	Peduncle length (cm)	Flag leaf area (cm^2)	Number of productive tillers per plant	Ear length (cm)	Number of spikelets per spike	Number of grains per spike	Grain weight per spike (g)	1000-grains weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
Days of 50% Flowering	0.0298	0.0453	0.0083	0.0112	0.0124	-0.0027	0.0062	0.0013	-0.0026	-0.0013	-0.0039	0.0003	-0.0074	-0.2486
Days to maturity	-0.3263	-0.2151	-0.0636	-0.0569	-0.0766	0.0085	-0.0508	-0.0041	-0.0294	0.0098	-0.0255	0.0045	0.0514	-0.2391
Plant height (cm)	0.0206	0.0218	0.0738	0.1138	0.0369	0.0072	0.0019	0.0325	0.0276	0.0277	0.0205	0.039	0.0117	0.1591
Peduncle length (cm)	-0.0024	-0.0017	-0.0097	-0.0063	-0.0041	-0.0021	-0.0008	-0.0027	-0.005	-0.0028	-0.0028	-0.0031	-0.0028	0.449**
Flag leaf area (cm^2)	0.1105	0.0949	0.1333	0.1725	0.2666	0.1889	0.1927	0.1602	0.1393	0.1704	0.1331	0.0825	0.1241	0.466**
Number of productive tillers per plant	0.0268	0.0118	-0.0294	-0.0999	-0.2132	-0.3008	-0.2193	-0.2681	-0.2546	-0.1593	0.0426	-0.1206	-0.1558	0.518**
Ear length (cm)	0.1008	0.1143	0.0124	0.0599	0.3495	0.3525	0.4835	0.386	0.4374	0.3893	0.0917	0.2641	0.2326	0.481**
Number of spikelets per spike	-0.0068	-0.0031	-0.0703	-0.0683	-0.0959	-0.1422	-0.1274	-0.1595	-0.2396	-0.1009	0.0557	-0.0585	-0.137	0.859**
Number of grains per spike	0.0169	-0.0261	-0.0714	-0.1508	-0.0997	-0.1615	-0.1726	-0.2865	-0.1908	-0.1156	0.0849	-0.0725	-0.138	0.723**
Grain weight per spike (g)	0.0211	0.0214	-0.1758	-0.2062	-0.2993	-0.248	-0.3771	-0.2962	-0.2837	-0.4683	-0.3048	-0.3668	-0.2611	0.558**
1000-grains weight (g))	0.0277	-0.0252	-0.059	-0.0955	-0.1062	0.0301	-0.0403	0.0743	0.0947	-0.1384	-0.2127	-0.0998	0.023	-0.1083
Biological yield per plant (g)	0.0121	-0.028	0.7121	0.6672	0.4175	0.5407	0.7366	0.4943	0.5127	1.0563	0.633	1.3486	-0.1315	-0.0975
Harvest index (%)	-0.1571	-0.1511	0.1005	0.2838	0.2942	0.3273	0.3041	0.5427	0.4572	0.3524	-0.0685	-0.0616	0.6321	0.2414

Table-4 : Phenotypic path coefficients for grain yield per plant in wheat.

Characters	Days of 50% Flowering	Days to maturity	Plant height (cm)	Peduncle length (cm)	Flag leaf area (cm^2)	Number of productive tillers per plant	Ear length (cm)	Number of spikelets per spike	Number of grains per spike	Grain weight per spike (g)	1000-grains weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
Days of 50% Flowering	0.0261	0.0175	0.0041	0.0028	0.0048	-0.0016	0.0042	-0.0011	0.001	-0.002	0.007	-0.001	-0.0032	-0.1134
Days to maturity	-0.0213	-0.0317	-0.0049	-0.0055	-0.0074	0.002	-0.0057	0.0008	0.0038	0.0021	-0.0023	-0.0008	0.0047	-0.0733
Plant height (cm)	-0.0088	-0.0086	-0.0558	-0.0278	-0.016	-0.002	-0.0006	-0.0056	-0.0079	-0.0118	-0.0114	-0.0121	-0.0077	0.2409
Peduncle length (cm	-0.0049	-0.0078	-0.0224	-0.045	-0.0178	-0.0035	-0.0037	-0.0132	-0.0005	-0.0135	-0.0059	-0.0145	-0.0024	0.317**
Flag leaf area (cm^2)	0.011	0.014	0.0173	0.0238	0.0601	0.0317	0.0223	0.0104	0.0142	0.0282	0.0193	0.0159	0.0093	0.356**
Number of productive tillers per plant	0.0012	0.0013	-0.0007	-0.0016	-0.011	-0.0208	-0.0083	-0.0071	-0.0075	-0.0051	0.0017	-0.0066	-0.0032	0.404**
Ear length (cm)	0.0008	0.0009	0.0001	0.0004	0.0018	0.002	0.0049	0.0018	0.0014	0.0025	0.0002	0.0014	0.0005	0.348**
Number of spikelets per spike	-0.0025	-0.0016	0.0062	0.0179	0.0105	0.0208	0.0222	0.0611	0.0397	0.0172	-0.0155	0.0113	0.0187	0.356**
Number of grains per spike	-0.0041	0.013	-0.0155	-0.0012	-0.0258	-0.0392	-0.03	-0.0708	-0.1088	-0.0319	0.0185	-0.0176	-0.0424	0.350**
Grain weight per spike (g)	0.0056	0.005	-0.0157	-0.0223	-0.0347	-0.0181	-0.0378	-0.0209	-0.0217	-0.0741	-0.0279	-0.0428	-0.017	0.681**
1000-grains weight (g))	0.0076	0.0021	0.0057	0.0037	0.009	-0.0023	0.0012	-0.0071	-0.0048	0.0106	0.028	0.0095	-0.0056	0.2200
Biological yield per plant (g)	-0.0386	0.026	0.2251	0.3337	0.2739	0.3257	0.306	0.1925	0.1671	0.5977	0.3499	1.0364	-0.3129	0.767**
Harvest index (%)	-0.0854	-0.1032	0.0975	0.038	0.1086	0.1093	0.073	0.2151	0.2742	0.1609	-0.1416	-0.2123	0.7032	0.342**

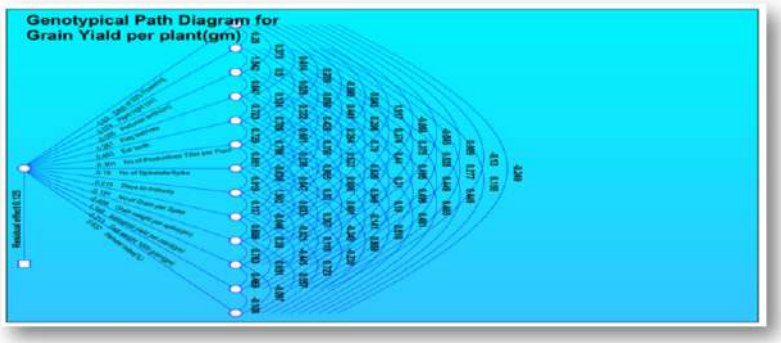


Fig.-1: Genotypic path diagram for grain yield per plant in wheat.

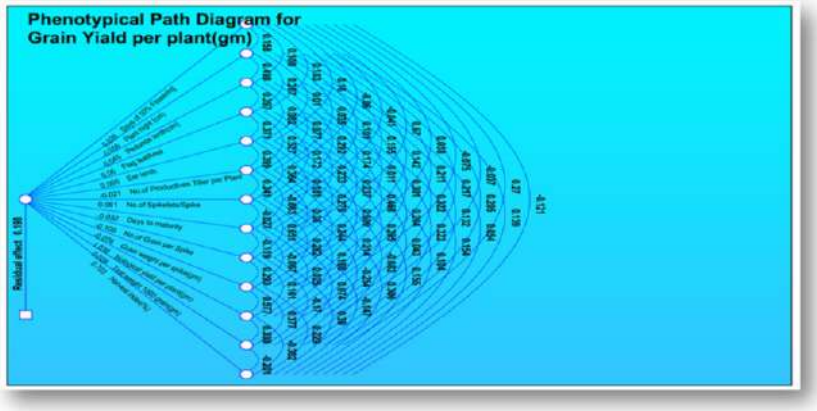


Fig.-2 : Phenotypic path diagram for grain yield per plant in wheat.

correlation with number of spikelets per spike (rg = 0.601**), number of grains per spike (rg = 0.523**) and harvest index (rg = 0.482**) at genotypic level only. Number of productive tillers per plant exhibited positive and significant correlation coefficient with ear length (rg = 0.729** and rp = 0.399**), number of spikelets per spike (rg = 0.891** and rp = 0.341 **), number of grains per spike (rg = 0.847** and rp = 0.360 **), biological yield per plant (rg = 0.401** and rp = 0.314*) and grain yield per plant (rg = 0.518** and rp = 0.404**) at both genotypic and phenotypic level while it showed positive and significant correlation with grain weight per spike (rg = 0.530**) and harvest index (rg = 0.598**) at genotypic level only. Ear length exhibited positive and significant correlation coefficient with number of spikelets per spike (rg = 0.798** and rp = 0.364 **), number of grains per spike (rg = 0.905** and rp = 0.376 **), grain weight per spike(rg = 0.805** and rp = 0.510 **), biological yield per plant (rg = 0.546** and rp = 0.295*) and grain yield per plant (rg = 0.481** and rp = 0.348**) at both genotypic and phenotypic level while it showed positive and significant correlation with harvest index (rg = 0.737**) at genotypic level only. Number of spikelets per spike exhibited positive and significant correlation coefficient with number of grains per spike (rg = 0.824** and rp = 0.651 **), grain weight per spike (rg = 0.633** and rp = 0.282*), harvest index (rg = 0.674** and rp = 0.306*) and grain yield per plant (rg = 0.859** and rp = 0.356**) at both genotypic and phenotypic level while it showed positive and significant correlation with biological yield per plant (rg = 0.367**) at genotypic level only. It showed negative and significant correlation with 1000-grains weight (rg = -0.349**) at genotypic level only. Number of grains per spike exhibited positive and significant correlation coefficient with grain weight per spike (rg = 0.606** and rp = 0.293*), harvest index (rg = 0.663** and rp = 0.390**) and grain yield per plant (rg = 0.723** and rp = 0.350**) at both genotypic and phenotypic level while it showed positive and significant correlation with biological yield per plant (rg = 0.380**) at genotypic level only. It showed negative and significant correlation with 1000- grains weight (rg = -0.445**) at genotypic level only. Grain weight per spike exhibited positive and significant correlation coefficient with 1000-grains weight (rg = 0.651** and rp = 0.377**), biological yield per plant (rg = 0.783** and rp = 0.577**) and grain yield per plant (rg = 0.558** and rp = 0.681**) at both genotypic and phenotypic level while it showed positive and significant correlation with harvest index (rg = 0.821**) at genotypic level only. 1000-grains weight exhibited positive and significant correlation coefficient

with biological yield per plant (rg = 0.469** and rp = 0.338**) at both genotypic and phenotypic level while it showed positive and significant correlation with harvest index (rg = 0.443**) at genotypic level only. Biological yield per plant exhibited positive and significant correlation coefficient with harvest index (rg = 0.956**) at both genotypic level while it showed positive and significant correlation with grain yield per plant (rp = 0.767**) at phenotypic level only. It showed negative and significant correlation with harvest index (rp = -0.302**) at phenotypic level only. Harvest index exhibited positive and significant correlation coefficient with grain yield per plant (rp = 0.342**) at phenotypic level only. The analysis of correlation coefficient revealed that the degree of association between yield and its components given the mutual relationship between the yield components. The correlation of different traits with grain yield was examined both at phenotypic and genotypic levels and the study showed that genotypic correlation coefficient values were higher than the phenotypic values. This indicated that how much of phenotypic correlation coefficient are influenced by environment. The grain yield per plant was positive and significant peduncle length, flag leaf area, number of productive tillers per plant, ear length, number of spikelets per spike, number of grains per spike and grain weight per spike at genotypic and phenotypic levels while it showed positive and significant with biological yield per plant and harvest index at phenotypic level only. Similar results also reported by (Kotal *et al*. (2010), Ali and Shakor (2012), Nukasani *et al.* (2013), Kumar *et al.* (2014), Avinashe *et al*. (2015), Parnaliya *et al*. (2015), Chitralekha *et al*. (2018) and Sharma *et al*. (2018), Tarkeshwar *et al*., (2020), Kumari *et al*., (2020), Gautam *et al*., (2021)).

Path coefficient analysis was conducted to assess the magnitude of contribution of various yield contributing traits to yield in the form of cause and effect. Grain yield per plant was taken as dependent variable and days to 50 per cent flowering, days to maturity, plant height, peduncle length, flag leaf area, number of productive tillers per plant, ear length, number of spikelets per spike, number of grains per spike, grain weight per spike, 1000-grains weight, biological yield per plant and harvest index were treated as independent variables. It revealed whether the association of these independent characters with yield is due to their direct effect on yield or is consequence of their indirect effect *via* other component characters. The genotypic and phenotypic correlation coefficients of grain yield per plant with its contributing characters were partitioned into direct and indirect effect through path coefficient analysis is presented in table-3 and Table-4 and also depicted in diagrammatically Fig.-3 and Fig.-4. At genotypic level, highest positive direct effect on grain yield per plant was observed for biological yield per plant (1.3486) followed by harvest index (0.6321), ear length (0.4835), flag leaf area (0.2666), plant height (0.0738) and days of 50% flowering (0.0298); whereas, the highest negative direct effect was observed for grain weight per spike (-0.4683), days to maturity (-0.2151), 1000-grains weight (-0.2127), number of grains per spike (-0.1908), number of spikelets per spike (-0.1595), number of productive tillers per plant (-0.3008) and peduncle length (-0.0063). At phenotypic level, highest positive direct effect on grain yield per plant was observed for biological yield per plant (1.0364) followed by harvest index (0.7032), number of spikelets per spike (0.0611), flag leaf area (0.0601), 1000-grains weight (0.028), days of 50% flowering (0.0261) and ear length (0.0049); whereas, the highest negative direct effect was observed for number of grains per spike(-0.1088), grain weight per spike (-0.0741), plant height (-0.0558), peduncle length (-0.045), days to maturity (-0.0317) and number of productive tillers per plant (-0.0208). Both at phenotypic and genotypic level flag leaf area, ear length, number of spikelets per spike and biological yield per plant was established high positive direct effects on grain yield per plant. In the present study path coefficient was calculated for grain yield per plant at genotypic and phenotypic level taking grain yield as a dependent variable. The results of path coefficient based on genotypic coefficient and phenotypic coefficient taking grain yield per plant as dependent variable indicated that at genotypic level, positive direct effect on grain yield per plant was observed for biological yield per plant harvest index, ear length, flag leaf area, plant height and days of 50% flowering whereas, the negative direct effect was observed for grain weight per spike, days to maturity, 1000-grains weight, number of grains per spike, number of spikelets per spike, number of productive tillers per plant and peduncle length. At phenotypic level, positive direct effect on grain yield per plant was observed for biological yield per plant, harvest index, number of spikelets per spike, flag leaf area, 1000-grains weight, days of 50% flowering and ear length whereas, the negative direct effect was observed for number of grains per spike, grain weight per spike, plant height, peduncle length, days to maturity and number of productive tillers per plant. Similar finding also reported by Ahmad *et al.* (2018). Both at phenotypic and genotypic level flag leaf area, ear length, number of spikelets per spike and biological yield per plant was established high positive direct effects on grain yield per plant. These traits were also correlated positively with grain yield per plant. Therefore, direct selection for these characters will be effective in improving grain yield in the genotypes studied. The information could be utilized in formulating a sound selection criterion in wheat breeding programme for

genetic improvement of high yield potential genotypes. Similar finding had also been reported by (Ayer *et al*. (2017), Pooja *et al*. (2018), Rajput (2018), Tarkeshwar *et al*., (2020), Kumari *et al.,* (2021), Muhammad *et al*., (2021), Gautam *et al.,* (2021).

References

1. Anonymous, (2020). Director's Report of AICRP on wheat and barley, 2019-20, Ed: G.P. Singh, ICAR-IIWBR, Karnal, Haryana, India, pp.1-3.
2. Ahmad, T.; Kumar, A.; Pandey, D. and Prasad, B. (2018). Correlation and path coefficient analysis for yield and its attributing traits in bread wheat (Triticum aestivum L. em Thell). *Journal of Applied and Natural Science,* 10(4): 1078-1084.
3. Ali, I.H. and Shakor, E.F., (2012). Heritability, variability, genetic correlation and path analysis for quantitative traits in durum and bread wheat (Triticum aestivum L. em. Thell) under dry farming conditions. *Mesoptamia Journal of Agriculture*, 40(4): 27-39.
4. Al-Jibouri H.A.; Miller, A. R. and Robinson H.F. (1958). Genotypic and environmental variances and co variance in upland cotton crosses of interspecific origin. *Journal of Agronomy* 50: 633-637.
5. Avinashe, H.A.; Shukla, R.S.; Dubey, N. and Jaiwar, S. (2015). Correlation and path analysis for yield and yield contributing characters in bread wheat (Triticum aestivum L. em. Thell). *Electronic Journal of Plant Breeding,* 6(2): 555-559.
6. Ayer, D.K.; Sharma, A.; Ojha, B.R.; Paudel, A.; and Dhakal, K. (2017). Correlation and path coefficient analysis in advanced wheat (*Triticum aestivum* L. em. Thell) genotypes. *SAARC Journal of Agriculture,* 15(1): 1-12.
7. Bhushan, B.; Bharti, S.; Ojha, A.; Pandey, M.; Gaurav, S.S.; Tyagi, B.S. and Singh, G. (2013). Genetic variability, correlation coefficient and path analysis of some quantitative traits in bread wheat (*Triticum aestivum* L. em. Thell.). *Journal of Wheat Research,* 5(1): 21-26.
8. Chitralekha, S.; Chandrakar, P.K.; Rastogi, N.K.; Banjare, V. and Densena, M. (2018). Estimation of correlation coefficient study of some quantitative traits in wheat (*Triticum aestivum* L. em. Thell). *Annals of Plant Sciences,* 7(2): 2078-2081.
9. Dewey, O.R. and Lu, K.H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*, 57: 515-518.
10. Fikre, G.; Alamerew, S.; and Tadesse, Z. (2015). Genetic variability studies in bread wheat (*Triticum aestivum* L.) genotypes at kulumsa agricultural research center, South east Ethiopia. *Journal of Biology, Agriculture and Healthcare,* 5(7): 89-98.
11. Gautam.; Soni Singh.; Kumar, Kamlesh and S.C. Gaur (2021). Studies on correlation and path analysis of quantitative traits in different wheat (*Triticum aestivum* L. em. Thell.) genotypes under Alluvial soil condition. *Frontiers in Crop Improvement,* Vol. 9 (Special-VI): 2677-2680.
12. Kumar, R.; Bhushan, B.; Pal, R. and Gaurav, S.S. (2014). Correlation and path coefficient analysis for quantitative traits in wheat (*Triticum aestivum* L. em. Thell) under normal condition. *Annals of Agri Bio Research,* 19(3): 447-450.
13. Kumari, P.; De, N. and Kumari, A. K. A. (2020). Genetic Variability, Correlation and Path coefficient analysis for Yield and Quality traits in Wheat (*Triticum aestivum* L. em. Thell). *International Journal Current Microbiology Applied Science,* 9(1), 826-832.
14. Kotal, B.D.; Das, A. and Choudhary, B.K. (2010). Genetic variability and association of characters in wheat (*Triticum aestivum* L. em. Thell) *Asian Journal of Crop Science*, 2(3): 155-160.
15. Muhammad I. U.; Shahzadi M. Rehana B.; Rahmat U. S.; Rehmat U.; Sibtain A.; Muhammad I. U.; Aziza M. H.; Ahmed M. El-Shehawi; Marian B.; Marek Z. and Muhamad I. K. (2021). Grain yield and correlated traits of bread wheat (*Triticum aestivum* L. em.Thell) lines: Implications for yield improvement. *Saudi Journal of Biological Sciences,* 28: 5714–5719.
16. Nukasani, V.; Potdukhe, N.R.; Bharad, S.; Deshmukh, S. and Shinde, S.M. (2013). Genetic variability, correlation and path analysis in wheat (*Triticum aestivum* L. em. Thell). *Journal of Wheat Research,* 5(2): 48-51.
17. Parnaliya, J.B.; Raiyani, G.D.; Patel K.; Dabhi, K.H. and Bhatiya, V.J. (2015). Genetic variability, correlation and path analysis in bread wheat (*Triticum aestivum* L. em. Thell) genotypes under limited water for timely sown condition. *An International e-Journal,* pp. 301-308.
18. Pooja, Chawla, V.; Singh, V. and Yadav, S. (2018). Path coefficient and correlation studies of yield and yield associated traits in diverse genotypes of bread wheat (*Triticum aestivum* L. em. Thell). *International Journal of Chemical Studies*, 6(3): 73-76.
19. Rajput, R.S. (2018). Correlation, path analysis, heritability and genetic advance for morpho-physiological character on bread wheat (*Triticum aestivum* L. em. Thell). *Journal of Pharmacognosy and Phytochemistry*, 7(2): 107-112.
20. Sharma, P.; Kamboj, M.C.; Singh, N.; Mehar Chand and Yadava, R.K. (2018). Path coefficient and correlation studies of yield and yield associated traits in advanced homozygous lines of bread wheat (*Triticum aestivum* L. em. Thell) germplasm. *International Journal of Current Microbiology and Applied Sciences,* 7(2): 51-63.
21. Tarkeshwar.; Kamlesh Kumar.; Yadav, Mohit.; Gaur, S.C.; Ravi Prakash Chaudhary and Mishra, Govind (2020). Studied on Correlation and Path Coefficient for yield and its component Traits in bread wheat (*Triticum aestivum* L. em. Thell.). *International Journal of Current Microbiology and Applied Sciences Special*, 11: 688-696.
22. USDA (2021). United States Department of Agriculture. https:// apps.fas.usda.gov/psdonline/circulars/ production. pdf.
23. Wright, S. (1921). Correlation and causation. *Journal of Agricultural Research*, 20: 555-586.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 964-968 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

To Estimate Genetic Divergence in Bread Wheat (*Triticum aestivum* L. em. Thell) Genotypes

Sonal Kumari and S.C. Gaur
Department of Genetics and Plant Breeding, Baba Raghav Das P.G. College, Deoria–274001 (U.P.) India.
Corresponding Author Email: scgaur101@gmail.com

Abstract

The present investigation was carried out using 20 bread wheat genotypes at Agriculture Research Farm of B.R.D. P. G. College Deoria, (U.P.). during Rabi, 2020-2021 in Randomized Block Design (RBD) with Three replication. The data were recorded form five randomly selected plants for 14 Quantitative traits Viz., Days to 50% flowering, Days to maturity, Plant height (cm), Number of productive tillers per plant, Length of spike (cm), Number of spikelets per spike, Number of grains per spike, 1000-grain weight (g), Grain yield per plant (g), Flag leaf area per plant (cm2), peduncle length per plant (cm), Grain yield per spike (g), Biological yield per plant (g), Harvest index (%).The twenty wheat genotypes grouped into five clusters on the basis of their relative magnitude of D2 values. Cluster I was the largest one with 11 genotypes followed by cluster III having 5 genotypes, cluster V with 2 genotypes and remaining clusters viz., II and IV with a single genotype. The mean intra-cluster distance ranged from 0.00 (II cluster and IV cluster) to 12.92 (cluster V). The cluster V had maximum intra-cluster distance (12.92) followed by cluster I (9.91) and cluster III (9.03). Maximum inter-cluster distance showed by cluster IV and V (164.82) followed by cluster II and V (120.63), cluster III and IV (108.72), cluster I and V (70.84) and cluster II and III (61.67). Minimum inter-cluster distance was observed between cluster I and IV (38.18), cluster III and V (35.48), cluster I and III (31.27), cluster I and II (16.08) and cluster II and IV (10.12). The variation in days to 50% flowering ranged from 71.67 (cluster III) to 86.11 (cluster V), for days to maturity from 120.11 (cluster III) to 129.72 (cluster IV), for plant height from 94.76 cm (cluster III) to 102.40 cm (cluster IV), for peduncle length from 8.14 cm (cluster IV) to 10.11 cm (cluster II), for flag leaf area from 16.86 cm2 (cluster III) to 19.88 cm2 (cluster IV), for number of productive tillers per plant from 8.88 (cluster III) to 10.99 (cluster IV), for ear length from 53.74 cm (cluster V) to 72.67 cm (cluster IV), for number of spikelets per spike from 3.00 (cluster V) to 3.91 (cluster II), for number of grains per spike from 41.23 (cluster IV) to 47.43 (cluster II), for grain weight per spike from 13.06 g (cluster V) to 19.49g (cluster II), for 1000-grains weight from 36.42 g (cluster III) to 54.49 g (cluster II), for biological yield per plant from 33.22 g (cluster V) to 37.16g (cluster III), for harvest index 34.70 % (cluster III) to 41.22 % (cluster V) and for grain yield per plant from 9.96 g (cluster III) to 11.08 g (cluster V).

Key words : *Wheat, genetic divergence, D2 analysis.*Introduction

Introduction

About wheat [*Triticum aestivum* (L.) em. Thell]; 2n = 6x = 42] is a cereal crop of the member of Gramineae (Poaceae) family and one of the most leading cereals of many countries of the world including India. It is one of the world's most common staple foods. It covers 17 per cent (one-sixth) of global cropland, feeds about 40% of the world's population and accounts for 20% of overall food calories and protein in human nutrition. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. It is grown in temperate, irrigated areas and in warm, humid to dry, cold environments. Wheat is a self-pollinated, monocotyledonous plant that had originated from South West Asia. There are different species of wheat, out of which only three *Triticum* species are mostly cultivated throughout the world. These are *Triticum aestivum* (bread wheat), *Triticum durum* (macaroni wheat) and *Triticum dicoccum* (emmer wheat). The bread wheat is an allohexaploid species (2n=6x=42) having AABBDD with A, B and D genome. The genetic origin of wheat is of interest; since it is a classic example of how closely related species may be combined in nature into a polyploid series. The species of *Triticum* and their close relatives can be divided into diploid, tetraploid and hexaploidy groups, with chromosome numbers of 2n = 14, 28 and 42, respectively, in which the basic chromosome number of Wheat is x = 7. *Triticum durum* originated thousands of years ago from a hybridization between the wild diploid *Triticum monococcum* (A genome donor) and the donor of the B genome which, according to morphological, geographical and cytological evidence, has been recognized as *Triticum speltoides* or a closely related species (Fikre, 2015). Globally, wheat (*Triticum* species.) is grown in about 224.09 million hectares holding the position of highest acreage among all crops with annual production hovering around 794.44 million metric tons (USDA, 2021). Genetic diversity refers to the variation that exists among the species genotypes. Mahalanobis (1936) proposed an excellent method known as "Mahalanobis D^2 statistics" or

Table-1 : Grouping of 20 wheat genotypes into five clusters (by Tocher's method).

Cluster No.	Name of genotype	Number of Genotype
I	WL-1, WL-2, PBW 343, WL-15, HD 3086, WL-11, Jamuni, Black, PBW 502, PBW 154, WL-4	11
II	WL-10	1
III	WL-5, WL-12, WL-7, WL-6, GW 322	5
IV	WL-16	1
V	WL-9, HD3003	2

Table-2 : Estimate of Average inter and intra cluster distance for 5 clusters in wheat Germplasm.

Cluster	I	II	III	IV	V
I	9.91	16.08	31.27	38.18	70.84
II		0.00	61.67	10.12	120.63
III			9.03	108.72	35.48
IV				0.00	164.82
V					12.92

Table-3 : Intra and Inter Cluster group means for 14 characters among wheat genotypes.

Cluster	Days of 50% Flowering	Days to maturity	Plant height (cm)	Peduncle length (cm)	Flag leaf area (cm^2)	Number of productive tillers per plant	Ear length (cm)	Number of spikelets per spike	Number of grains per spike	Grain weight per spike (g)	1000-grains weight (g)	Biological yield per plant (g)	Harvest index (%)	Grain yield per plant (g)
I	82.21	129.38	98.61	9.20	19.47	10.74	64.31	3.32	45.76	16.19	43.83	37.06	37.14	10.57
II	79.80	128.00	97.73	10.11	19.78	10.39	67.65	3.91	47.43	19.49	54.49	35.78	36.82	10.56
III	71.67	120.11	94.76	9.02	16.86	8.88	54.98	3.04	43.42	13.46	36.42	37.16	34.70	9.96
IV	84.44	129.72	102.40	8.14	19.88	10.99	72.67	3.63	41.23	14.43	41.87	34.51	40.89	10.58
V	86.11	129.44	99.76	8.84	17.49	10.39	53.74	3.00	46.02	13.06	39.32	33.22	41.22	11.08

"D^2 methodology" that is extensively used to determine genetic diversity in germplasm. This technique assesses the forces of differentiation at the intra-cluster and inter-cluster levels, assisting in the selection of genetically distinct parents for use in hybridization programs. The D^2 statistics also determines the proportion of each component character to the total divergence and quantifies the degree of diversification. In plant breeding, genetic diversity is vital for exploiting heterosis or generating productive recombinants. In a breeding programme, choosing the right parents is crucial.

Materials and Methods

The field experiment under present investigation was conducted during *rabi* 2021-22 at Agriculture Research Farm of Baba Raghav Das Post Graduate College Deoria (U.P.). Geographically, this College is situated in the east part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 68 meter (223 feet) above the mean sea level. The climate of district Deoria is semi-arid with hot summer and cold winter nearly 80% of total rain fall is received during the monsoon (only up to September) with a few showers in the winter. The experiment was laid out in Randomized Block Design (RBD) with 3 replications, each replication and each genotype sown in two rows of five meters length spaced at 2.5m from row to row and 10 cm form plant to plant. The recommended package of practices was adopted for raising the healthy crop. Observations for all the traits were recorded on five randomly selected plants of each entry in reach replication while observation for days to 50 per cent heading and days to maturity were recorded on plot basis. the Mahalonobis' D^2 statistics (1936) as described by Rao (1952) used and grouping of genotypes into different clusters done by Tocher's method (Rao, 1952). The intra cluster distances and inter cluster distances were calculated by the formula given by Singh and Choudhary (1977).

Results and Discussion

The twenty wheat genotypes grouped into five clusters on the basis of their relative magnitude of D^2 values. The result of the genotypes grouping into clusters is presented in Table-1 also depicted in Fig.-1. Cluster I was the largest one with 11 genotypes followed by cluster III having 5 genotypes, cluster V with 2 genotypes and remaining clusters *viz.,* II and IV with a single genotype.

Average inter and intra-cluster distances among five clusters were presented in the Table-2 and also depicted in Fig.2. The mean intra-cluster distance ranged from 0.00 (II cluster and IV cluster) to 12.92 (cluster V). The cluster V had maximum intra-cluster distance (12.92) followed by cluster I (9.91) and cluster III (9.03). Maximum inter-cluster distance showed by cluster IV and V (164.82)

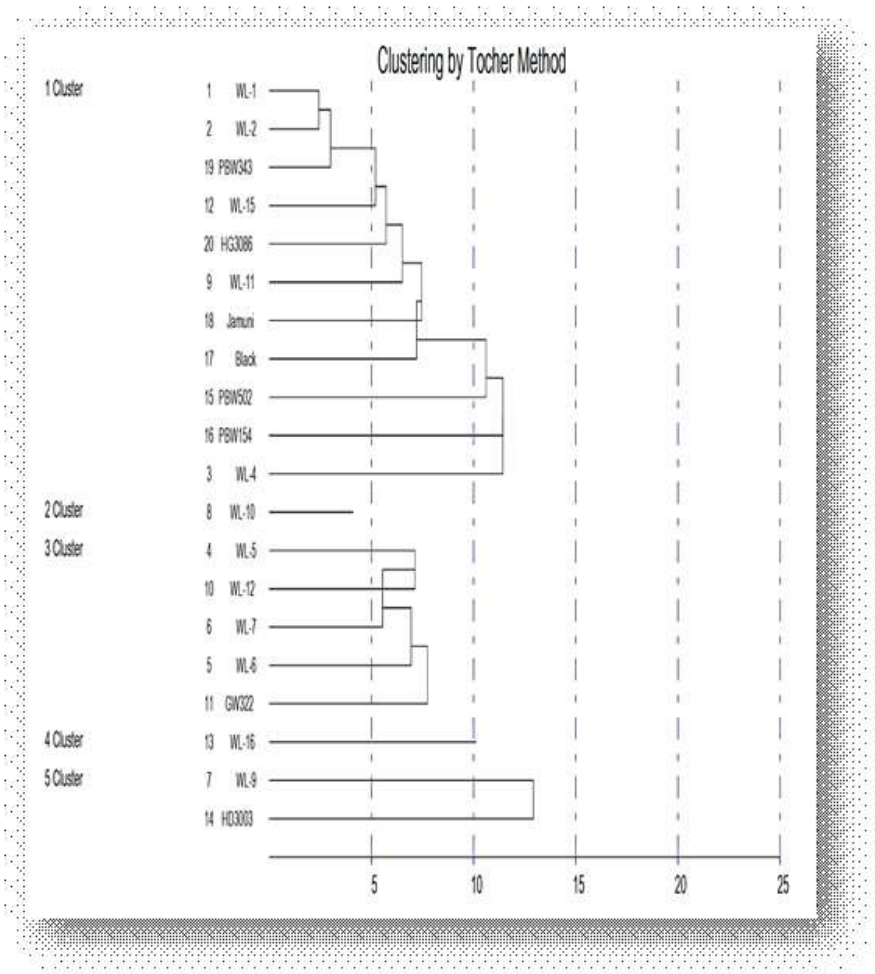


Fig.-1 : Grouping of 20 wheat genotypes into five clusters (by Tocher's method).

followed by cluster II and V (120.63), cluster III and IV (108.72), cluster I and V (70.84) and cluster II and III (61.67). Minimum inter-cluster distance was observed between cluster I and IV (38.18), cluster III and V (35.48), cluster I and III (31.27), cluster I and II (16.08) and cluster II and IV (10.12).

The cluster means of different characters have been presented in Table 3. It was observed that the magnitude of difference among cluster means for different characters was prominent. The variation in days to 50% flowering ranged from 71.67 (cluster III) to 86.11 (cluster V), for days to maturity from 120.11 (cluster III) to 129.72 (cluster IV), for plant height from 94.76 cm (cluster III) to 102.40 cm (cluster IV), for peduncle length from 8.14 cm (cluster IV) to 10.11 cm (cluster II), for flag leaf area from 16.86 cm2 (cluster III) to 19.88 cm2 (cluster IV), for number of productive tillers per plant from 8.88 (cluster III) to 10.99 (cluster IV), for ear length from 53.74 cm (cluster V) to 72.67 cm (cluster IV), for number of spikelets per spike from 3.00 (cluster V) to 3.91 (cluster II), for number of grains per spike from 41.23 (cluster IV) to 47.43 (cluster II), for grain weight per spike from 13.06 g (cluster V) to 19.49g (cluster II), for 1000-grains weight from 36.42 g (cluster III) to 54.49 g (cluster II), for biological yield per plant from 33.22 g (cluster V) to 37.16g (cluster III), for harvest index 34.70 % (cluster III) to 41.22 % (cluster V) and for grain yield per plant from 9.96 g (cluster III) to 11.08 g (cluster V).

Genetic diversity present in the available germplasm, one of potent technique of measuring genetic diversity is the D^2 statistic proposed by Mahalanobis in 1936. D^2 statistic measures the degree of diversification and determines the relative importance of each character to total divergence. Based on multivariate analysis as per Mahalanobis D^2 statistic, 20 wheat genotypes were grouped into 5 clusters. Cluster I was the largest one with 11 genotypes followed by cluster III having 5 genotypes, cluster V with 2 genotypes and remaining clusters *viz.,* II and IV with a single genotype. Similar grouping was also done by Singh *et al*., (2014) and Ali and Bharadwaj (2015). Magnitude of inter-cluster distance measures the genetic distance between two clusters while intra-cluster

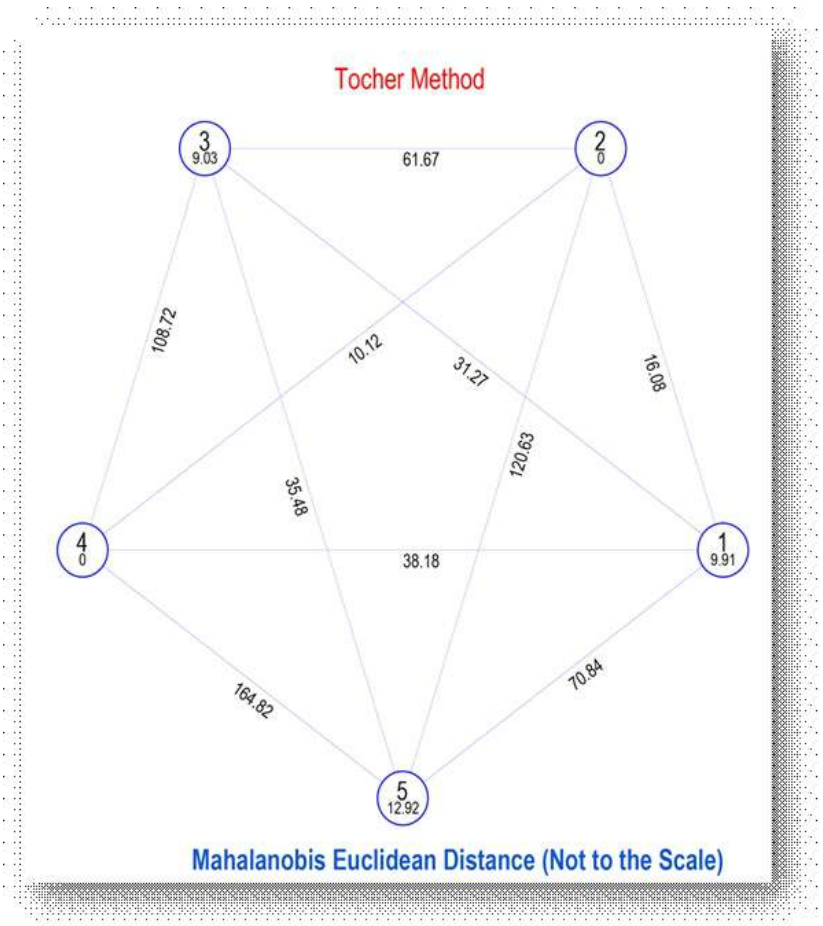


Fig.-2: Relative disposition of clusters showing average intra and inter distance in genetic divergence.

distance measures the extant of genetic diversity between the genotypes of same cluster. The value of intra-cluster distance values was lower than that of inter-cluster distances, indicating wide genetic diversity among the genotypes. The inter-cluster distance varied from 10.12 (cluster II and IV) to 164.82 (cluster IV and V). Some other notable inter-cluster distances were recorded between cluster that showed the genotypes concerned with these clusters have wide genetic diversity and thus genotypes of these clusters can be used in wheat hybridization programme for improvement in grain yield. Similar findings had also been reported by Ali *et al*. (2017) and Singh *et al.* (2018). The maximum intra-cluster distance was indicated by cluster V followed by cluster I and cluster III. The highest intra-cluster distance among the genotypes of these clusters was mainly due to wide genetic diversity in the genotypes. The result found in present investigation was in agreement with the results of Zarna *et al.* (2017) and Preeti *et al.* (2018). Cluster V had genotypes having higher mean values for grain yield per plant, harvest index and harvest index, cluster IV had high value for days to maturity, plant height, flag leaf area, number of productive tillers per plant and ear length, cluster II had highest value for peduncle length, number of spikelets per spike, number of grains per spike, grain weight per spike and 1000-grains weight, cluster III had highest value for biological yield per plant. Therefore, hybridization between the selected genotypes from divergent clusters is essential to judiciously combine all the targeted traits Kumar et al., (2018), mohammad et al., (2018), Tarkeshwar *et al*., (2019), Hossain *et al.* (2021).

References

1. Ali, T. and Bharadwaj, D.N. (2015). Study of genetic divergence in Wheat (*Triticum aestivum* L. em thell). *Agricultural Communications*, 3(2), pp.1-6.
2. Ali, T.; Singh, M.K. and Bharadwaj, D.N. (2017). Analysis of genetic divergence in wheat (*Triticum aestivum* L. em thell). Environment and Ecology, 35(3B): 2081-2083.
3. Fikre, G.; Alamerew, S.; and Tadesse, Z. (2015). Genetic variability studies in bread wheat (*Triticum aestivum* L. em thell) genotypes at kulumsa agricultural research center, South east Ethiopia. Journal of Biology, *Agriculture and Healthcare*, 5(7): 89-98.
4. Hossain, M.; Azad, M.; Eaton, T. and Siddquie, M. (2021). Assessment of Different Traits to Evaluate Genetic Divergence in Some Wheat (*Triticum aestivum* L. em thell) Genotypes under Late Sowing Condition. *American Journal of Plant Sciences,* 12, 734-747.

5. Kumar, Kamlesh; Gaur, S.C.; Gaur, L.B.; Gaur, A.K.; and Singh, S.P. (2018). Genetic Diversity studies in Wheat (*Triticum aestivum* L.) for grain yield and related traits. *Frontiers in crop Improvement*, 6(2): 131-133.
6. Lal, B.K.; Ruching, M. and Upadhyay, A. (2009). Genetic variability, diversity and association of quantitative traits with grain yield in bread wheat (*Triticum aestivum* L.). Asiam Journal of Agricultural Science, 1(1): 4-6.
7. Mahalanobis, P.C. (1936). On the generalized distance in statistics. *Proceedings of National Academic Science,* 2: 55-79.
8. Mohammad, Phool; Gaur, S.C.; Gaur, A.K.; and Singh, S.P. (2018). Study of Genetic Diversity of Quantitative traits with grain yield in bread wheat (*Triticum aestivum* L.). *Frontiers in Crop Improvement*, 6(2): 124-126.
9. Nimbalkar, C.A., Navale, P.A. and Biradar, A.B. (2002). Generalized D^2 and genetic diversity in wheat. *Journal of Maharashtra Agricultural Universities*, 27(1): 43-45.
10. Preeti, Panwar, I.S. and Singh, V. (2018). Genetic divergence analysis for grain yield, its components and quality traits under normal and heat stress environments in Bread Wheat (*Triticum aestivum* L. em. Thell). *International Journal of Pure and Applied Bioscience,* 6(3): 686-693.
11. Rao, C. H. (1952). Advanced Statisti'cal Methods in Biometic Research. John Wiley & Sons, New York.
12. Singh, G.; Kumar, P.; Kumar, R. and Gangwar, L.K. (2018). Genetic diversity analysis for various morphological and quality traits in bread wheat (*Triticum aestivum* L. em thell). Journal of Applied and Natural Science, 10(1): 24-29.
13. Singh, P.; Singh, A.K.; Sharma, M. and Salgotra, S.K. (2014). Genetic divergence study in improved bread wheat varieties (*Triticum aestivum* L. em thell). *African Journal of Agricultural Research,* 9(4): 507-512.
14. Singh, R. K. and Choudhary, B. D. (1977). Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
15. Tarkeshwar; Gaur, S.C.; Singh, S.P.; Sahu, R.K.; Kumar, K.; Yadav, M. and Yadav, G. (2019). Genetic divergence analysis on some bread wheat (*Triticum aestivum* L. em. Thell) genotypes. *Frontiers in Crop Improvement*, Vol, 7(2): 103-105.
16. USDA (2021). United States Department of Agriculture. https:// apps.fas.usda.gov/psdonline/circulars/production.pdf.
17. Zarna, V.N.; Patel, J.B.; and Pansuriya, A.G. (2017). Genetic divergence analysis in bread wheat (*Triticum aestivum* L. em thell). *Research in Environment and Life Sciences,* 10(3): 291-294.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 969-976 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Influence of Insecticides on the Development of Pest Resistance of Diamondback Moth (*Plutella Xylostella*)

Taheera Ansari and Sushil Kumar*
Department of Zoology, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur-273009
Corresponding Author (Sushil Kumar) Email : sushilk731@gmail.com

Abstract

Plutella xylostella (family: Lepidoptera), the diamondback moth (DBM), is a damaging insect pest of cruciferous crops with a worldwide distribution. Environment factors, natural predators, overwintering populations, and migrations all influence the magnitude of the infestation from the geographical area and annual variation. Synthetic pesticides used to control of this pest, are hazardous to the ecosystem because of their high toxicity, which affects not only the target pest but also beneficial species. The usage of these insecticides has aided the creation of generations of more resistant insects and resulted in crop contamination with hazardous residues, putting human health at risk. It has gained resistance to virtually every insecticide used in the field due to its genetic plasticity. Integrated pest management (IPM) methods include host plant resistance as a key component for pest control. Synthetic pesticides, in combination with other IPM methods, may be critical in building a successful pest control management against DBM. We compiled the evidenced on pest biochemical and morphological parameters that have been investigated to improve DBM resistance in its host plants and suggestions for laboratories and field trials for their management.

Key words : *Integrated pest management, biopesticides, synthetic insecticides, cruciferous infestation*

Introduction

Plutella xylostella (Linnaeus) has an extensive global distribution recognised as a Diamondback moth (DBM) or cabbage moth. Immature stages of *Plutella xylostella* (*P. xylostella)* could be dispersed through seedling transplants, agricultural residues, and multinational cruciferous vegetable trades (Shelton and Wyman, 1992, Chua and Lim, 1977). It feeds on plants in the family Cruciferae, including almost all cruciferous crops such as cauliflower, broccoli, cabbage, mustard, radish and turnip etc. its natural host range is limited to cultivated and wild Brassicaceae that are characterized by having glucosinolates, sulfur-containing secondary plant compounds. Plant damage is caused by larval feeding. Individual larvae can only cause limited damage but many larvae may infest a single plant and many of the cruciferous crops that infests can only be marketed if they are essentially undamaged. It is a highly mobile species, capable of long migratory flights, and also is dispersed through human movement of infested crucifer seedlings and vegetables (Talekar and Shelton, 1993). *P. xylostella* can infest crops year-round and farmers may apply insecticides weekly throughout the year.

This lepidopteran pest is the most destructive for crucifers in the approximately more than 100 countries including India. It causes major loss of yield upto 50-80% annually in India especially cabbage (*Brassica oleracea*) in the states like Uttar Pradesh (Kalia et al, 2018). The initial *P. xylostella* may have been identified in Europe, but depending on the vast complex and sexual forms of its parasitoids and host plants discovered in South Africa, it is thought to have originated there and then spread to Europe and East Asia. (Hardy 1938, Kfir 1998, Liu et al. 2000). However, widespread distribution of *P. xylostella* has been observed in British Columbia (Mason PG et. al. 2022). This crucifer specialist has spread throughout the world and therefore is considered to be the most commonly occurring of all Lepidoptera (Shelton, 2004).

This pest was first noticed in the 1970s, and it was thought to be driven in part by insecticide resistance (Talekar and Shelton, 1993). Resistance to pyrethroids was discovered in the 1980s, followed by resistance to additional pesticide classes. Many wide spectrum insecticides used by farmers to manage *P. xylostella* infestations have been severely reduced due to pest resistance and cross resistance. However, due to cross resistance instances caused by *P. xylostella* exposure to several pesticide groups, the situation can deteriorate. A large number of modes of action are available for the control of susceptible *P. Xylostella.* This species has the distinction of being the only known pest species to evolve resistance to *Bacillus thuringiensis* (Bt) insecticidal proteins used under field conditions, and has done so in multiple world areas (Tabashnik et al., 2003). Its resistance issues also showed frequently greatest in cropping areas especially Southeast Asia, Indian subcontinent, tropical Africa, and the Hawaiian Islands.

In this review, we considered the life cycle of *P.*

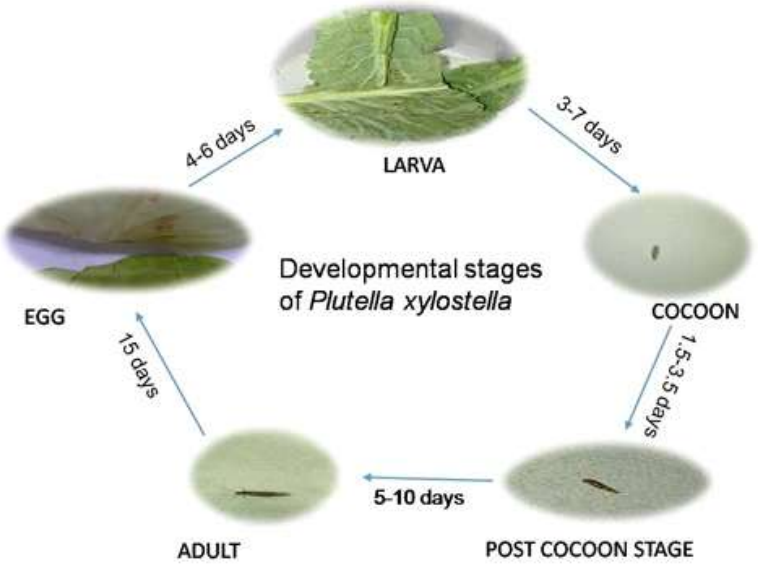


Fig.-1: Life cycle of *P. xylostella* : The average development days observed and the pictures of stages is also taken by our research study.

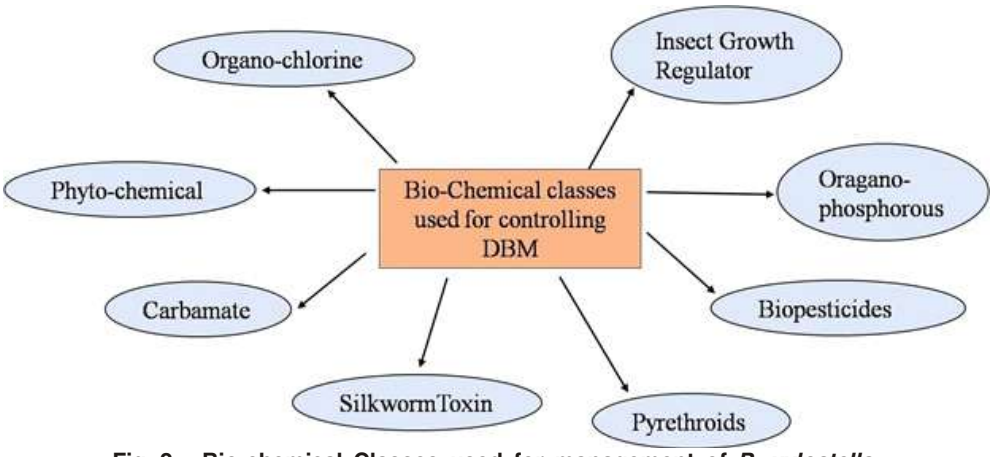


Fig.-2 : Bio-chemical Classes used for management of *P. xylostella*.

Xylostella and in which an improved understanding of their biochemical resistance mechanisms created by the insect and cross- resistance pattern were discussed. Such information is required to check the co-resistance of the aforementioned pest and our experience with the Indian scenario.

Ecology and life cycle of *P. xylostella* : *P. xylostella* is the world's most cosmopolitan pest, having spread to every section of the globe where crucifers are farmed as crops or exist as wild plants, in part naturally and in part by man's hand. It develops between 8 to 32°C, with the best survival at 14°C and a generation time of 41 days (Liu et al. 2002). Its adult moths emerge at dusk and remain active until late at night. Most adults emerge during the first 8 hours of photophase, and mating happens at dusk the same day. Developmental stages of this pest showed egg, larva (first instar to fourth instar), pupa, cocoon and adult moth are described here and mentioned in figure-1.

Egg : A hand lens can easily observe the little (0.44 x 0.26 mm) whitish eggs in the field (Harcourt, 1961). Temperature affects the incubation period of P. xylostella eggs. Approximately it took 4-8 days with an average of 5.6 days (Ooi and Kelderman, 1979). Single eggs or clusters of two to eight eggs are placed singly or in groups of two to eight in depressions on the surface of leaves, with 60% of the eggs on the upper surface (Lasota and Kok 1989). The rate of hatching is inversely proportional to the temperature (Yamada and Kawasaki 1983).

Larva : There are four different instars of larva. Normally, the first instar mines the leaf tissue. The larvae are surface feeders after the first instar and consume voraciously. Caterpillars are green and 10-12 mm long when fully grown. Temperature affects the pace of development of larvae. The larval stage lasted 15-21 days in Ontario (Harcourt, 1957), 10-30 days in New South Wales, Australia and only 6 days in Malaysia (first instar, 4.0-5.5;

second instar, 3.5-4.5; third instar, 3.4-5.0; and fourth instar, 4.2-5.6) (Ooi and Kelderman, 1979). The laboratory study found that larval time ranged from 7.8 to 19.5 days at temperatures of 32.5-17.5°C (Yamada and Kawasaki, 1983). They came to the conclusion that this was due to changes in field conditions such as climate, food source, and so on. When estimating the growth of P. xylostella larvae populations and selecting when to sample, differences in populations and temperature conditions should be taken into account. The developmental times of P. xylostella larvae were radically impacted by feeding on several cultivated and wild food plants (Idris, 1998 and Sarfraz et al. 2007, 2011). Larval development times are also affected by the nutritional content of host plants (Sarfraz et al., 2009).

Pupa : Pupae are enveloped in loosely woven cocoons that are commonly attached to plant components (mainly leaves) and buried in crevices around the bud. The pre-pupal stage begins with the fully grown larvae spinning the cocoon, followed by one or two days of quiescence. Temperature affects the time it takes for a cocoon to spin into a pupa; maximal development occurs at 27.5°C (Yamada and Kawasaki, 1983). The pre-pupal stage is ranged from 7 to 10 days and the pupal stage from 5 to 15 days (Harcourt, 1957), with an average of 8.5 days, however the pupal stage in New South Wales, Australia was reported to be 1-2 weeks. The temperature threshold for pupal development is 9.8°C, and the pupal stage's effective thermal total (day-degrees) is predicted to be 61. Within the temperature range of 17.5-27.5°C, the rate of adult emergence is 42-53.4% and reduces above this temperature (Yamada and Kawasaki, 1983).

Adult : The sex ratio is approximately 1:1. On the day of emergence, mating begins at dusk. Oviposition begins immediately after nightfall and peaks around 2 hours later; after midnight, few eggs are deposited. Females and males have average life spans of 16 and 12 days, respectively. Over 95% of females begin laying eggs on the day of emergence; the process takes 10 days, and the number of eggs laid per female varies from 159-288 (Ooi and Kelderman, 1979). Sivapragasam and Heong (1984) discovered that temperature had a significant effect on adult survival, oviposition rates, and generation, and that the temperature most suited for P. xylostella was around 30°C, based on the intrinsic rate of increase.

Generations *P. xylostella* has a wide ecological tolerance, allowing it to reproduce in a wide range of environmental circumstances. Temperature has an impact on its life history, thus the generation time varies accordingly. The life cycle takes around 3 weeks in warm conditions, while it might take as short as 16 days in extreme weather. It can be extended up to 6 weeks or longer in more moderate locations (Bright 1976, Harcourt, 1957). Wu (1968) calculated that one generation might take 13-34 days at room temperature (23°C), 13-37 days in the field, and 17-20 days at a constant temperature of 23°C. As a result, there could be up to 19 generations of this pest per year in laboratory. In the tropics, however, 10-14 generations have been observed in the wild. (Hardy, 1938; Koshihara and Yamada, 1981)

Seasonality : *P. xylostella* breeds whole year in the tropics, although it has been reported to hibernate in the adult form in colder latitudes, though these reports have not been confirmed by others (Harcourt, 1954; Razumov, 1970). Adults migrate from warmer regions in the spring to sites where the moth can't even hibernate, resulting in annual infestations (Putnam, 1978; Butts and McEwen, 1981). In any given year, the abundance of P. xylostella is determined by two major factors: overwintering populations in the United States and southern spring winds that transport the moths north into Manitoba, central Saskatchewan, and eastern Alberta (Canola Council of Canada, 2014),

Several researches have looked at the seasonal abundance of DBM and how it relates to different meteorological situations (Harcourt, 1957; Wu, 1968). In tropical areas, the moth breeds all year and infests cruciferous crops like Chinese cabbage and common cabbage during the cool and dry seasons, along with many other leaf-feeding insects. Infestation appears to be hampered by heavy rain (Talekar and Lee, 1985). The rates of development (e.g. hatching, pupation, adult emergence) of *P. xylostella* were not impacted by humidity, according to Yamada and Kawasaki (1983). As proven in life tables and other ecological studies (Iga, 1985), rainfall, along with other limiting factors (e.g. food scarcity, natural enemies), influences population density.

Natural Enemies : Various parasites and predators attack all stages of P. xylostella. Approximately 60 parasite species out of over 90 that attack P. xylostella appear to be relevant as well as six species prey on eggs, 38 species prey on larvae, and 13 species prey on pupae (Lim, 1986). Trichogramma and Trichogrammatoidea, polyphagous egg parasites, contribute little to natural control and require repeated bulk releases. The most common and effective parasites are larvae. Diadegma and Cotesia are two of the most successful larval parasite genera; a few Diadromus spp., most of which are pupal parasites, also exercise significant control. The bulk of these species are thought to have originated in Europe, where P. xylostella is thought to have originated.

Prevention and Control of *P. xylostella* with resistance mechanism : At present, the mainstay of control in all tropical to subtropical developing countries is

the frequent use of insecticides. *P. xylostella* can have up to 20 generations each year in tropical countries where crucifers are produced all year. As a result of this circumstance, pesticide resistance develops quickly. Farmers frequently raise pesticide doses, employ mixes of many chemicals, and spray more frequently, sometimes once every two days, to combat resistance. *P. xylostella* has developed resistance to virtually all pesticides as a result of the high levels of use in several countries. Here, we discussed the major methods especially cultural, biological and chemical control and biochemical classes to reduce the load of *P. Xylostella* (Figure-2).

Cultural Control (Field Management) : Spray irrigation, trap cropping, inter-cropping, rotation, and clean cultivation are some of the traditional field management strategies which have been used including some effectiveness. Host-plant resistance work also revolves around incorporating one or more novel pesticide genes into oilseed rape and Brassica vegetables. Transgenic canola carrying the cry1Ac gene was developed and tested for P. xylostella control in field and glasshouse trials in the USA (Ramachandran et al., 1998) but no such transgenic crops are registered yet. There is increasing interest in getting this type of resistance registered in Australia (Canola Council of Canada, 2014). Bt-cabbage and Bt-cauliflower plants were also developed and tested against P. xylostella, but due to regulatory and liability issues the transgenic vegetables were not field released and the project ceased in 2010 (Russell et al., 2011).

American scientists have identified two varieties of resistance : Nnormal-flower cabbage and glossy-leaf cabbage (Dickson *et al.,* 1990). There are cabbage and cauliflower hybrid lines bred from these resistant sources that have a high level of resistance to *P. xylostella*. However, because of the thick leaves in the normal-bloom type and dark green glossy leaves in other lines, these hybrids have not yet been commercially exploited due to consumer dissatisfaction. In three cauliflower lines, high protein content, orthodihydroxy phenols, and low sugar amounts were important for resistance, but Ramachandran et al. (1998) proposed different leaf features.

Biological Control : This involves both the biological control and the conservation of endemic natural enemies. Exotic parasite introduction has been used to manage unwanted insects for decades. This method holds a lot of potential for controlling P. xylostella, but it has only been used occasionally in the last 50 years. Insecticide use has been hampered by widespread and frequently indiscriminate use, which has slowed the establishment of parasites and their beneficial benefits.

In one of the earliest parasite introductions, *Diadegma semiclausum* (D. *Semiclausum)* and *Diadro muscollaris* were introduced in New Zealand from England, continue to suppress *P. Xylostella* populations until now (Hardy, 1938, Thomas and Ferguson, 1989). Prior to the advent of effective foreign parasites, *P. Xylostella* caused significant damage in Australia (Wilson, 1960).

D. semiclausum, one of the introduced parasitoids, spread throughout Australia, including Tasmania. *Cotesia plutellae* was found in the Australian Capital Territory, New South Wales, and Queensland. *Diadro muscollaris* was found in Queensland, New South Wales, Victoria, and Tasmania. These introductions resulted in heavy parasitism of *C. plutellae* (72-90%) and marked reduction in damage to crucifers (Goodwin, 1979; Hamilton, 1979). The favourable effects of this parasite in the field management of *P. Xylostella* were not noticed until the mid-1980s due to overuse of insecticides (Sastrosiswojo and Sastrodihardjo, 1986). The parasite spread rapidly after chemical pesticides were replaced by *Bacillus thuringiensis (Bt)* in the early 1980s. In discussing natural enemies, the important role of predators in the management of *P. xylostella* should also be emphasised as has been suggested in various studies based on population dynamics and the indirect effects of insecticides (Baur, 1995; Sivapragasam et al., 1988). In India, Bt active ingredients Cry1Aa and HD73 were become resistance in 1998 (Mohan and Gujar 2003). The combined parasitism has drastically reduced the need for insecticide applications especially in the area of increase production of cabbage.

Insect pathogens such Beauveria bassiana (Jun et al., 1999), Metarhiziumanisopliae (Amiri et al., 1999), Zoopthoraradicans (Furlong and Pell, 1997), baculoviruses (Kariuki and McIntosh, 1999), and entomopathogenic nematodes (Kaya et al., 2006) have recently sparked interest. The efficiency of entomopathogen delivery systems is one of the primary limiting aspects in the use of these natural enemies in the control of *P. xylostella*, and studies have been conducted to try to improve this feature to permit fuller use of these natural enemies (Wright and Mason, 1997). Environmental factors, as well as their interaction with other control techniques like sex pheromones, are critical for these pathogens' effectiveness (Furlong and Pell, 1997). Because of the severity of the P. xylostella problem and the global relevance of cruciferous vegetables, researchers are testing new potential control agents such as genetically enhanced Bt, neem, macrocyclic lactones, baculoviruses, and fungi. The long-term effectiveness of these agents, as with other previously utilised techniques, remains to be seen.

Chemical Control : P. xylostella larvae feed on cruciferous vegetables, which usually have high cosmetic standards, effective control is necessary. Historically, the mainstay of control has been the use of synthetic insecticides. General use patterns of insecticides vary widely over geographic locations and decades in figure-2. The discovery of new, more powerful insecticides, as well as the loss of utility of older pesticides due to resistance, are the primary reasons behind these shifting trends. The most spectacular patterns have been seen in South-East Asia, where P. xylostella is the major problem.

P. xylostella is regarded as one of the most difficult pests to eradicate. It was the first insect to gain resistance to Bt, a bacterial insecticide, in the field (Kirsch and Schmutterer, 1988; Groeter *et al.,* 1994). It now possesses resistance to practically every insecticide used in the field, including novel insecticide families like diamide (Ridland and Endersby, 2011; Gong et al., 2014). This emphasises the importance of developing and implementing comprehensive insecticide resistance management (IRM) programmes in order to maintain the efficacy of viable pesticides.

Integrated Pest Management (IPM) against *P. xylostella* : IPM is a method for resolving pest problems while reducing threats to people and the environment. It can be significantly used to control P. xylostella in a variety of settings, including urban, agricultural, and natural areas. Farmers have relied almost entirely on pesticides to manage P. xylostella for the past 30-40 years, but resistance to currently available insecticides and a lack of new insecticides has prompted study into alternate control methods. These alternatives are, in some cases, essentially the same ones that were abandoned in favour of synthetic insecticides. Because parasites are so critical in controlling P. xylostella population expansion, parasite introduction and conservation will be essential to any long-term IPM strategy. Farmers must coordinate their efforts to apply IPM because one farmer's activities influence those of his or her neighbour. This is true for IRM development and the introduction and conservation of natural enemies. Small-scale agriculture, where farms are frequently less than 0.1 hectare and where several farms in a given area are held by various growers, will require the most cooperation.

The severity of *P. xylostella* control failures, as well as demand to reduce pesticide inputs in small- and large-scale agriculture, both biological and predators systems must be open to insecticide alternatives. Trap cropping, adult capturing, and pheromone disruption were thought to be more suitable for small-scale agriculture, but this is no longer the case. Researchers in India have demonstrated the benefits of using an Indian mustard trap crop to attract *P. xylostella* and *C. binotalis* away from important crops (Srinivasan and Krishna Moorthy, 1992), reducing the need for insecticides to just two sprays per season, compared to ten or more for traditional control methods. Yellow sticky traps have been shown to be effective in capturing *P. xylostella* adults, minimising their oviposition and subsequent larval harm, according to a team of Thai and Japanese scientists (Rushtapakornchai et al., 1992). Using a combination of mustard trap cropping and yellow sticky traps could further reduce the demand for insecticides. In field testing using pheromones to interrupt mating, the population of *P. xylostella* was reduced by 95% when compared to control fields in Japan (Ohano *et al.,* 1992).

IPM is based on the principle of surveying populations and treating when thresholds are surpassed, and it has been pushed in both industrialised and developing countries in the tropics. This strategy's implementation has been hampered by the fact that it necessitates regular scouting by skilled persons who may not always be accessible. In order to make decision-making easier, a few breakthroughs have been achieved in this area. Okadome (1997) proposed a simulation approach for forecasting *P. xylostella* population variations. To account for the complexity of pests included in the crucifer choice process, Jusoh (1997) proposed a *Plutella* comparable action level. This is a significant change because earlier standards were solely based on *P. xylostella*, which is in contrast to the reality in the field, where farmers cultivating crucifers must make judgments based on a variety of pests. Many farmers in developing countries, including India, are unable to distinguish between pests and beneficial insects, other farmers have difficulties counting due to illiteracy, and resistance to numerous pesticides renders most insecticide applications worthless. Thus, community-wide management in the tropics and subtropics is most likely based on the release and establishment of as many parasites as feasible, combined with cultural behaviours.

Conclusions

Although insecticides are easy to use and generally cost-effective, they remain the primary management approach for *P. xylostella.* But it has evolved resistance to nearly every synthetic insecticide used against it in the field. Newer pesticides are being marketed as being gentler on natural enemies and could be used in IPM systems. Although these insecticides are used in the field to control *P. xylostella* populations, they may be harmful to natural enemies. Natural plant products could be a viable option for long-term management of this pest. Alternative botanical pesticides for the treatment of this pest are

urgently needed as source of environmentally and human welfare favourable. The agro-climatic conditions of India including Utter Pradesh are ideal for effective cabbage growing; this has yet to transfer into increased yields, owing to insect pests, particularly the *P. xylostella*. Despite the fact that the pest has become a major economic threat, little research has been done, and the material that is now available is sparse and irrelevant. A new strategic condition looks at the dynamics of DBM movement between India, crucifer vegetable, and pastures crops, as well as compliance with new drift legislation and improved application technology to limit spray drift and boost spray efficacy.

Acknowledgement : Honorable Vice Chancellor and Head of the Department, Zoology, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur (U.P.) is thanked by the authors for providing a better research environment.

References

1. Shelton AM, Wyman JA, 1992. Insecticide resistance of diamondback moth in North America. In: Talekar NS, ed. Diamondback Moth and Other Crucifer Pests: Proceedings of the Second International Workshop. *Shanhua, Taiwan: Asian Vegetable Research and Development Center,* 447-454.
2. Chua, T.H., & Lim, B. H. (1977). Effect of interplant distance on the distribution pattern of diamondback moth, *Plutella xylostella* (L.) among host plants. *Malaysian Applied Biology*, *6*(1), 19-23.
3. Talekar NS, Shelton AM, (1993). Biology, ecology and management of the diamondback moth. Annual Review of Entomology, 38:275-301
4. Kalia, P., Aminedi, R., Golz, J., Russell, D., Choudhary, P., Rawat, S., ... & Bhatacharya, R. (2018, August). Development of diamondback moth resistant transgenic cabbage and cauliflower by stacking Cry1B and Cry1C Bt genes. In *XXX International Horticultural Congress IHC2018: II International Symposium on Plant Breeding in Horticulture 1282* (pp. 237-246).
5. Hardy JE, 1938. Plutella maculipennis, Curt., its Natural and Biological Control in England. Bulletin of Entomological Research, 29(pt. 4):343-372 pp.
6. Kfir R, (1998). Origin of the diamondback moth (Lepidoptera: Plutellidae). Annals of the Entomological Society of America, 91(2):164-167; 36.
7. Liu S, Wang X, Guo S, He J, Shi Z, 2000. Seasonal abundance of the parasitoid complex associated with the diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) in Hangzhou, China. *Bulletin of Entomological Research*, 90: 221-231.
8. Mason, P.G., Dancau, T., Abram, P.K., Noronha, C., Dixon, P.L., Parsons, C.K., & Haye, T. (2022). The parasitoid complex of diamondback moth, Plutella xylostella (Linnaeus)(Lepidoptera: Plutellidae), in Canada: impact and status. *The Canadian Entomologist*, *154*.
9. Shelton AM, 2004. Management of the diamondback moth: déjà vu all over again? I. In: The Management of Diamondback Moth and Other Crucifer Pests. Proceedings of the Fourth International Workshop, 26-29 November 2001, Melbourne. Melbourne, Australia: Department of Natural Resources and Environment, 3-8.
10. Tabashnik, B.E., Carrière, Y., Dennehy, T.J., Morin, S., Sisterson, M.S., Roush, R.T., & Zhao, J. Z. (2003). Insect resistance to transgenic Bt crops: lessons from the laboratory and field. *Journal of economic entomology*, *96*(4), 1031-1038.
11. Liu, S.S., Gebremeskel, F.B., & Shi, Z.H. (2002). Reproductive compatibility and variation in survival and sex ratio between two geographic populations of Diadromus collaris, a pupal parasitoid of the diamondback moth, *Plutella xylostella*. *Biocontrol*, *47*(6), 625-643.
12. Harcourt DG, 1961. Design of a sampling plan for studies on the population dynamics of the diamondback moth, Plutella maculipennis (Curt.) (Lepidoptera: Plutellidae). *Canadian Entomologist* 93: 820-831.
13. Ooi PAC, Keldesman W. (1979). The biology of three common pests of cabbages in Cameron Highlands, Malayisa. Malaysian Agricultural Journal, 52:85-101.
14. Lasota, J.A., & Kok, L.T. (1989). Seasonal abundance of imported cabbageworm (Lepidoptera: Pieridae), cabbage looper (Lepidoptera: Noctuidae), and diamondback moth (Lepidoptera: Plutellidae) on cabbage in southwestern Virginia. *Journal of economic entomology,* 82(3), 811-818.
15. Yamada H, Kawasaki K, (1983). The effect of temperature and humidity on the development, fecundity and multiplication of the diamondback moth, Plutella xylostella (L.). Japanese Journal of Applied Entomology and Zoology, 27(1): 17-21.
16. Harcourt DG, (1957). Biology of the diamondback moth, Plutella maculipennis (Curt.) (Lepidoptera: Plutellidae), in eastern Ontario, II. Life history, behaviour and host relationships. *Canadian Entomologist* 89: 554-564.
17. Idris AB, (1998). Differential effects of food plants on the development, egg production and feeding behaviour of the diamondback moth (*Plutella xylostella L.*). *Pertanika Journal of Tropical Agricultural Science,* 21(2): 93-98.
18. Sarfraz, M., Dosdall, L.M., & Keddie, B.A. (2007). Resistance of some cultivated Brassicaceae to infestations by *Plutella xylostella* (Lepidoptera: Plutellidae). *Journal of Economic Entomology*, *100*(1), 215-224.
19. Sarfraz, R.M., Dosdall, L.M., Keddie, A.B., & Myers, J.H. (2011). Larval survival, host plant preferences and developmental responses of the diamondback moth *Plutella xylostella* (Lepidoptera: Plutellidae) on wild brassicaceous species. *Entomological Science*, *14*(1), 20-30.
20. Sarfraz, R.M., Dosdall, L.M., & Keddie, A.B. (2009). Bottom-up effects of host plant nutritional quality on *Plutella xylostella* (Lepidoptera: Plutellidae) and top-down effects of herbivore attack on plant compensatory ability. *European Journal of Entomology*, *106*(4).
21. Sivapragasam A, Heong KL, (1984). The effects of temperature on adult survival, oviposition and the intrinsic

rate of increase of Plutella xylostella (L). MARDI Research Bulletin, 12(3): 341- 347.

22. Bright Jr, D. E. (1976). The insects and arachnids of Canada. Part 2. The bark beetles of Canada and Alaska. Coleoptera: Scolytidae. The insects and arachnids of Canada. Part 2. The bark beetles of Canada and Alaska. Coleoptera: Scolytidae.
23. Wu KC, (1968). Bionomic studies of Plutella maculipennis Curtis. Journal of Taiwan Agricultural Research, 17:51-63.
24. Koshihara T, Yamada H, (1981). Female sex pheromone of the diamondback moth, Plutella xylostella. Japan Agricultural Research Quarterly, 15(1): 22-28.
25. Razumov, V. P. (1970). How the diamond-back moth overwinters. *Zashchita Rastenii*, *15*(10).
26. Putnam, L. G. (1978). Diapause and cold hardiness in Microplitis plutellae, a parasite of the larvae of the diamondback moth. *Canadian Journal of Plant Science,* 58(3), 915-916.
27. Butts, R.A., & McEwen, F.L. (1981). Seasonal populations of the diamondback moth, Plutella xylostella (Lepidoptera: Plutellidae) in relation to day-degree accumulation. *The Canadian Entomologist*, *113*(2), 127-131.
28. Iga, M. (1985). The seasonal incidence and life tables of the diamondback moth, *Plutella xylostella(L.)* (Lepidoptera: Yponomeutidae). *Japanese Journal of Applied Entomology and Zoology*, *29*(2), 119-125.
29. Lim, G. S. (1986). Biological control of diamondback moth. In Diamondback moth management: Proceedings of the first international workshop (pp. 159-171). *Asian Vegetable Research and Development Center, Shanhua,* Taiwan.
30. Ramachandran S, Buntin GD, All JN, Raymer PL, Stewart CN Jr, 1998. Greenhouse and field evaluations of transgenic canola against diamondback moth, Plutella xylostella, and corn earworm, Helicoverpa zea. Entomologia Experimentalis et Applicata, 88(1):17-24.
31. Canola Council of Canada. (2014). Flea beetles. Canola encyclopedia. Canola Council of Canada [online]. Available from http://www.canolacouncil.org/canola-encyclopedia/insects/flea- beetles [accessed 10 December 2015].
32. Russell DA, Uijtewaal B, Dhawan V, Grzywacz D, Kaliaperumal R, (2011). Progress and challenges in the Bt Brassica CIMBAA public/private partnership. In: Proceedings of the Sixth International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests. Shanhua, Taiwan: AVRDC, 19-27.
33. Dickson, M.H., Shelton, A.M., Eigenbrode, S.D., Vamosy, M.L., & Mora, M. (1990). Selection for resistance to diamondback moth (*Plutella xylostella*) in cabbage. *Hort. Science*, *25*(12), 1643-1646.
34. Thomas, W.P., & Ferguson, A.M. (1989). *Plutella xylostella (L.)*, diamondback moth (Lepidoptera: Yponomeutidae). Technical communication (Commonwealth Institute of Biological Control).
35. Wilson F, (1960). A review of the biological control of insects and weeds in Australia and Australian New Guinea. Vestnik sel'sko-khozyaistvennoi Nauki, 5+102 pp. [Commonwealth Agricultural Bureaux.
36. Goodwin S, 1979. Changes in the numbers in the parasitoid complex associated with the diamondback moth, *Plutella xylostella (L.)* (Lepidoptera) in Victoria. *Australian Journal of Zoology.* 21:981-989.
37. Hamilton JT, 1979. Seasonal abundance of Pieris rapae (L.), Plutella xylostella (L.) and their diseases and parasites. *General and Applied Entomology.* 11: 59-66.
38. Sastrosiswojo S, Sastrodihardjo S, 1986. Status of biological control of diamondback moth by introduction of parasitoid Diadegma eucerophaga in Indonesia. Diamondback Moth Management. Proceedings of the First International Workshop, Tainan, Taiwan, 11-15 March, 1985., 185-194.
39. Baur, M.E., Kaya, H.K., & Thurston, G.S. (1995). Factors affecting entomopathogenic nematode infection of Plutella xylostella on a leaf surface. *Entomologia Experimentalis et Applicata,* 77(3), 239-250.
40. Sivapragasam A, Ito Y, Saito T, (1988). Population fluctuations of the diamondback moth, *Plutella xylostella* (L.) on cabbages in Bacillus thuringiensis sprayed and non-sprayed plots and factors affecting within-generation survival of immatures. *Researches on Population Ecology,* 30(2): 329-342.
41. Mohan, M., & Gujar, G. T. (2003). Local variation in susceptibility of the diamondback moth, *Plutella xylostella* (Linnaeus) to insecticides and role of detoxification enzymes. *Crop protection*, *22*(3), 495-504.
42. Jun, L., & Xing-yao, Z. (2005). Ecological control of forest pest: a new strategy for forest pest control. *Journal of Forestry Research*, *16*(4), 339-342.
43. Amiri, B., Ibrahim, L., & Butt, T. M. (1999). Antifeedant properties of destruxins and their potential use with the entomogenous fungus *Metarhizium anisopliae* for improved control of crucifer pests. *Biocontrol Science and Technology*, *9*(4), 487-498.
44. Furlong MJ, Pell JK, 1997. Integration of Zoopthora radicans and synthetic female sex pheromone for the control of diamondback moth. In: Sivapragasam A., eds. Proceedings of the Third International Workshop on the Management of Diamondback Moth and other Crucifer Pests. Malaysia: MARDI, Ministry of Agriculture, 123-129.
45. Kariuki, C. W., & McIntosh, A. H. (1999). Infectivity studies of a new baculovirus isolate for the control of the diamondback moth (Plutellidae: Lepidoptera). *Journal of Economic Entomology,* 92(5), 1093-1098.
46. Kaya, H. K., Aguillera, M. M., Alumai, A., Choo, H. Y., De la Torre, M., Fodor, A., ... & Ehlers, R. U. (2006). Status of entomopathogenic nematodes and their symbiotic bacteria from selected countries or regions of the world. *Biological control*, *38*(1), 134-155.
47. Wright DJ, Mason JM, 1997. Entomopathogenic nematodes as bioinsecticides against foliar pests of field crops: what are the key factors for successful application? Proceedings of the 49th international symposium on crop protection, Gent, Belgium, 6 May 1997. Part II. Mededelingen Faculteit Landbouwkundige en

Toegepaste Biologische Wetenschappen, Universiteit Gent, 62(2b): 425-428.

48. Kirsch, K., & Schmutterer, H. (1988). Low efficacy of a Bacillus thuringiensis (Berl.) formulation in controlling the diamondback moth, *Plutella xylostella (L.)*, in the Philippines. *Journal of Applied Entomology,* 105(1-5), 249-255.
49. Groeters, F. R., Tabashnik, B. E., Finson, N., & Johnson, M. W. (1994). Fitness costs of resistance to Bacillus thuringiensis in the diamondback moth (*Plutella xylostella). Evolution*, 197- 201.
50. Ridland PM, Endersby NM, 2011. Some Australian populations of diamondback moth, *Plutella xylostella* (L.) show reduced susceptibility to fipronil. In: Proceedings of the Sixth International Workshop on Management of the Diamondback Moth and Other Crucifer Insect Pests. Shanhua, Taiwan: AVRDC, 21-25.
51. Gong W, Yan HH, Gao L, Guo YY, Xue CB, (2014). Chlorantraniliprole Resistance in the Diamondback Moth (Lepidoptera: Plutellidae). *Journal of Economic Entomology,* 107: 806-814.
52. Rushtapakornchai W, Vattanatangum A, Saito T, (1992). Development and implementation of sticky trap for diamondback moth control in Thailand. In: Talekar NS, ed. Diamondback Moth and Other Crucifer Pests: Proceedings of the Second International Workshop. Shanhua, Taiwan: Asian Vegetable Research and Development Center, 523-528.
53. Ohno T, Asayama T, Ichikawa K, 1992. Evaluation of communication disruption method for suppressing diamondback moth infestations at two different areas using synthetic sex pheromone. In: Talekar NS, ed. Diamondback Moth and Other Crucifer Pests: Proceedings of the SecondInternational Workshop. Shanhua, Taiwan: Asian Vegetable Research and Development Center, 109-114.
54. Okadome K, 1997. Simulation model for forecasting population fluctuations of the diamondback moth in cabbage fields. In: Sivapragasam A et al., eds. Proceedings of the Third International Workshop on the Management of Diamondback Moth and other Crucifer Pests. Malaysia: MARDI, Ministry of Agriculture, 145-152.
55. Jusoh MM, 1997. Plutella equivalent action threshold for insect pests of crucifers using Chinese kale as model. In: Sivapragasam A et al., eds. Proceedings of the Third International Workshop on the Management of Diamondback Moth and other Crucifer Pests. Malaysia: MARDI, Ministry of Agriculture, 158-161.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 977-984 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Evaluation of Various Strain of Button Mushroom for their Cultural, Morphological and Yield Attributes

Vijay Kumar[1], Lakhanapuram Hemanth Kumar[1] and Sonal[1]
[1]*Department of Plant Pathology, College of Horticulture, VCSGUUHF Bharsar Pauri Garhwal*

Abstract

The button mushroom is a eatable mushroom and is saprophytic basidiomycetes, which have been successfully, cultivated at commercial level worldwide using lignocellulose waste as substrates for their cultivation. In the present investigation seven strains of button mushroom including check (Belgium-2) were undertaken to characterized and study effect of culture media, temperature, and pH range on radial growth of different strain, spawn preparation, production efficiency and growth behaviour. Five different culture media namely malt extract agar media, potato dextrose agar media, wheat extract agar media, corn meal agar media and oatmeal agar media were tested and measured the maximum radial on malt extract agar media (70.72mm) after 21 days of inoculation. Maximum radial growth of different strain like Delta-D, Delta-N, A-15, U-3, MC-465, S-11 and Belgium-2 of button mushroom were recorded at temperature 25? and at pH 6.5 after 21 days of inoculation. Among various strain of button mushroom, strain U-3 produced maximum yield (15.80kg/q of compost) with maximum number of fruiting body (1,287.98/q of compost) as compared to Delta-N, having yield (11.78kg/q of compost) with (1,129.18/q of compost) number of fruiting body and minimum yield was observed in Belgium-2 (5.63kg of compost) and significantly higher body weight was observed in strain U-3(12.25g). Growth behaviour like spawn run, case run, and pinhead formation were observed in strain S-11 and gave significantly best performance followed by the other strains. Best desirable morphological characteristics like length of stalk, width of stalk, width of mushroom cap and length of mushroom cap were observed in strain A-15 and minimum in strain Bel-2.

Key words **:** *Saprophytic, basidiomycetes, lignocellulose, mushroom*

Introduction

Button mushroom is an edible fungus belongs to phylum Basidiomycota, class Basidiomycetes, order Agaricales and family Agaricaceae. *Agaricus bisporus* also known as khumbi and European mushroom. They comprise delicious, nutritionally rich, medicinally important, non-conventional source of human food. Mushrooms are fleshy edible fungi which are good source of vegetable protein, containing most of the essential amino acids, minerals and vitamins. Their use as food and drugs recorded in the ancient Indian literature, like the Vedas, dates back to 3000 BC. While Greeks regarded as the "Food of God", Chinese called it as "Elixir of life" which means a substance believed to cure all ills (Singh *et al.,* 2000). The white button mushroom *Agaricus bisporus* is now being cultivated in more than 100 countries of the world and is mostly confined to Europe 55 per cent, North America 27 per cent and Eastern Asia 14 per cent, (Verma, 2002).

Mushroom have significant important due to their nutritive and medicinal value. Mushrooms are the good source of quality protein with 70-80% digestibility and having all essential amino acid *i.e.,* lysine and methionine which are lacking in cereals and pulses.

They contain high amount of fiber. Besides that, they are also good sources of vitamin C, B complex, B-12, Thiamine, Riboflavin, Niacin and folic acid and also contain high amount of Potassium, Copper, Phosphorus and low in Sodium and Iron. Near about 80 species of mushrooms have been cultivated experimentally on various substrates of which few are commercially cultivated in different part of the world. The annual production of commercially cultivated mushrooms are about 10 million tones /annum and India contributes 70,000 tones/annum (Singh and Mishra, 2010).

The numbers of recognized mushroom species have been reported to be 14,000, Out of these, about 7,000 species are considered to possess varying degree of edibility and almost 3,000 species of 31 genera are regarded as prime edible. To date, only 200 of them are experimentally grown, 100 economically cultivated, about 60 commercially cultivated and about 10 have reached to industrial scale production in many countries (Sharma *et al*., 2007). Among these, *Agaricus bisporus* ranks first contributing almost 1/3 rd of total world mushroom production which has been estimated to be over 34, 12,392 tones now (Wakchaure, 2016).

Though, mushroom cultivation, both in the east and west started many centuries ago, yet its cultivation in India is of recent origin, having been initiated in Sloan, Himachal Pradesh in year 1961, when scheme entitled "Development of mushroom cultivation in Himachal

Pradesh" was started by Department of Agriculture, Himachal Pradesh in collaboration with ICAR, New Delhi. It was during 90's that there was significant increase in production, from 4,000 tons in 1985 to 38,000 tons in 1997, which at present is estimated to be around 1,13,315 tones/annum (Wakchaure, 2016).

Mainly four types of edible mushroom are cultivated in India on commercial scale. These are white button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus ostreatus*), tropical paddy mushroom (*Volvariella volvacea*) and milky mushroom (*Calocybe indica*). Majority of the seasonal, commercial and all exportoriented units grow white button mushroom. This mushroom is having maximum acceptability in domestic markets, both in fresh and canned form. Himachal Pradesh is one of the leading state, growing *Agaricus bisporus* with annual production of more than 7,400 metric tons per annum (Anonymous, 2011).

Button mushroom is the most important commercially cultivated mushroom in the world and at present, *Agaricus bisporus* contributes 35 to 45% of total worldwide production of mushroom.

Button mushroom is cultivated on the compost prepared by the traditional methods known as "Long method of composting" (Nair *et al*., 1991) or short method of composting (Sinden *et al*., 1970) or compost prepared by an accelerated method also known as "Rapid composting method" (indoor compost). Preparation of compost by these methods is an old concept and has been abounded in most parts of the world except in few countries in Asia. Compost prepared by such method besides taking more time (around one month) given low yield as it is prone to be attacked by many pests and diseases (Vijay *et al*., 1995).

However, preparation of productive compost in lesser duration has also been reported by several workers (Vijay *et a*l., 1994-95). Yields obtained using such compost ranges between 8-12 kg. mushroom per 100 kg. of compost. However, higher yield to the tune of 18-22 kg. have also been demonstrated by some growers using high yielding strains compost by this method is prepared on clean cemented platform. If this facility is not available than a simple brick platform can be used for this purpose.

Near about 80 species of mushrooms have been cultivated experimentally on various substrates of which few are commercially cultivated in different part of the world. The annual production of commercially cultivated mushrooms is about 10 million tones /annum and India contributes 70,000 tones /annum (Singh and Mishra, 2010).

The three major mushroom producing countries are China, USA and Netherland which account for more than 60% of total world production. The cultivation of white button mushroom in India was started at Sloan (H.P) in 1961. Later on, it was cultivated experimentally at Shrinagar (JK) The first commercially production unit of button mushroom was established at Chail (H.P) during 1966 by maharaja of Patiala. Punjab has become one of leading states in button mushroom production with 58000 tons per annum (Singh *et al*., 2011).

Materials and Methods

The research work on Evaluation of Various Strain of Button Mushroom for their Cultural, Morphological and Yield Attributes were conducted in the laboratory, Department of Plant Pathology, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar. The present investigations were carried out during 2017-18. Seven strains of *Agaricus bisporus* viz. Delta-D, Delta-N, A-15, U-3, MC-465, S-11 and Belgium-2 (check) were evaluated. The details of Materials and Methods for carrying out the present studies are given below under the following heads.

Maintenance of Culture : The culture of *Agaricus bisporus* viz. strain Delta-D, Delta-N, A-15, U-3, MC-465, S-11 and Belgium-2 were stored at 4°C and subcultured regularly at an interval of three weeks. The mycelia agar bits of approximately 5-6 mm diameter were sliced and picked from mother culture slants and transferred to fresh agar slants.

Culture medium : The following g composition and procedure were adopted for the preparation of potato dextrose agar medium

Potatoes: 250 g

Dextrose: 20 g

Agar: 20 g

Distilled water : 1000 ml

pH : 5.5-6.0

About 250 g potatoes were washed with tap water, peeled off, cut into small pieces and boiled in 500-600 ml of water for 25-30 min till they were tender. The boiled potatoes were mashed, and the extract was obtained on filtering through a muslin cloth. Dextrose was dissolved, the volume was made to 1 liter and the pH was adjusted to 5.5-6.0. Solidifying agent agar-agar was dissolved in the filtrate at 80°C. The medium was dispensed in test tubes to 1/4th of the capacity, plugged with nonabsorbent cotton and autoclaved at 15 psi for 20 min.

Sterilization : Sterilization of different media was done in autoclave at 15 psi for 20 minutes and all the glass wares were sterilized at 180^0 C for 2 hours in an electric oven. The cork borer and inoculation needle were initially dipped

in ethyl alcohol and finally flame sterilized and used after a complete cool down.

Incubation : Petri plates containing basal medium and inoculums of different test strains of *Agaricus bisporus* were incubated for 21 days at 25°C in B.O.D incubator.

Selection of solid medium : Five solid media were used to select suitable medium for growth of mycelium. The composition and methods of preparation of various solid media were the same as described by Tutie (1969). The solidification of different solid media was obtained by adding two per cent agar. The best solid medium obtained was used for further studies. The data were recorded for average statistical analysis to draw conclusions.

Effect of temperature : Petri plates containing malt extract agar medium along with inoculums of different test strain viz. MC-465, A-15, S-11, U3, Delta-N, Delta-D and Belgium-2 were incubated at various temperatures viz. 10, 15, 20, 25, 30 and 35^{0}C in different incubators. Each treatment was replicated four times and data analyzed statistically.

Effect of hydrogen ion concentration : In this experiment malt extract agar medium with inoculums of different test strains was adjusted at different pH levels of 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5 and 10 and incubated at temperature of 25°C for 21 days. Each treatment was replicated four times. The data obtained was subjected to statistical analysis.

Cultural characteristics of various strain

Preparation of mother or stock culture from pure culture : Pure culture raised from different test strain of *Agaricus bisporus* was inoculated on the sterilized substrate containing boiled wheat grains properly mixed with $CaCO_3$ and $CaSO_4$, which provide base as well as nutrition to the mycelium. Mother or stock cultures of all test strains were prepared on boiled wheat grains. Wheat grains were boiled in tap water for 30 minutes or till they became soft, but did not rupture and allowed to remain in the same hot water for another 20 minutes. Excess water was then drained off, by putting over wire net sieve to keep moisture level below 45 per cent. Next day, 1.33 per cent gypsum and 0.33 per cent lime was added by wet weight of boiled grains and mixed thoroughly. Gypsum prevents the sticking of grains together and lime was added for maintaining proper pH i.e., 6.5-7.0. Properly mixed grains were filled into glass milk bottles (half liter) up to 2/3rd of their capacity (250 g) plugged with nonabsorbent cotton and autoclaved at 22 psi for 2 hours. Sterilized bottles were taken out from the autoclave, while still hot, and were shaken vigorously to avoid clump formation of the grains. These bottles were immediately shifted to inoculation room and allowed to cool down.

The sterilized bottles were surface disinfected by dipping in 2 per cent formalin solution in such a manner that the cotton plug did not get wet. These bottles were then kept under UV light in laminar air flow chamber for at least one hour and then inoculated with pure culture. The inoculation was accomplished by placing two bits of agar medium colonized with mycelium of pure culture just opposite to each other in the inner side of glass bottles and incubated at 24±1°C.

After 7-8 days, these bottles were shaken properly, so that mycelia threads are broken and mixed with grains for further fast spreading of mycelium. After 20 to 22 days, the mycelium covered the entire grains and stock culture was ready for further multiplication. One bottle of stock culture was used to multiply about 25 bottles/bags.

Preparation of Spawn : Wheat grains were used as substrates. The wheat grains were washed thoroughly and then soaked overnight. Dead grains or those floating on the surface of water were removed. The following day, the grains were washed again and boiled in tap water for at least 30 minutes. Care was taken not to over boil the grains so that they may not rupture. Excess water was drained off and the grains were allowed to cool. Calcium carbonate and gypsum in the ratio 1:3 was added to the grains and then filled in glass milk bottles up to 2/3rd of their capacity. These bottles were properly plugged with nonabsorbent cotton and autoclaved at 22 psi pressure for two hours. After cooling down, these bottles were immediately transferred to inoculation chamber and kept under UV light for one hour for surface disinfestations. One bottle of mother culture was used for the inoculation of 25 bottles of spawn and incubated at 25°C for 15-20 days or till such time; the grains were fully impregnated with mycelium of test strains. The bottles were stored at 2-4^{0}C in the refrigerator for further use.

Preparation of compost : *Agaricus bisporus* require a selective medium for its growth; therefore, synthetic compost was prepared according to the long method of composting. The composition formula and method of preparation were the same as described by Garcha (1984). Wheat straw-based composts of different periods of termination and turning schedules were prepared by long method of composting. The wheatstraw based formulation of the compost included.

Ingredients	Quantity
Wheat straw	600 kg
Wheat bran	60 kg
Urea	6 kg
Gypsum	60 kg
Calcium ammonium nitrate	18 kg
Single super phosphate	12 kg
Molasses	10 litre

Wheat straw spread over the cemented platform. Water sprinkled over the straw by pipe and frequently turned by forks till sufficient moisture absorbed. Wetting of straw continued up to 48 hours. After two days, required quantities of different materials viz., urea and wheat bran except gypsum were thoroughly moistened with water and heap was made. The prepared mixture will be filled in the rectangular blocks. While filling the blocks materials slightly pressed on the sides and kept loose in the center. The compost decomposed by totals eight turning and each turning will be done at 3 days interval. Gypsum mixed during 3rd turning and at each turning, water should be sprinkled to make up the loss of moisture content due to evaporation.

Preparation of casing soil : A layer of casing material is necessary for inducing fructification in the spawn run compost. A mixture of garden soil and twoyear old spent compost (1:1) used as the casing material. The casing soil treated prior to use by following way. The required quantity of casing soil placed on polypropylene sheet thereafter, 2% formalin sprinkled till saturation and covered with another polypropylene sheet for 48 hours and thereafter 2% formalin+ 0.1% bavistin spread on casing soil, and thereafter steaming under 15 lbs pressure for 15 min. and its hydrogen ion concentration (pH) was adjusted to around 8.0 by adding calcium carbonate ($CaCO_3$) after steaming. The casing material was used for casing the growing bags after a period of 12 days from the day of spawning.

The moisture level of casing was adjusted to 60 per cent before placing it on the spawn run compost. After 10-12 days of casing, the bags were shifted to cropping room having 14-18°C temperature with 80-90 per cent relative humidity, which was maintained till the crop was over. For maintaining the humidity, water was sprayed on the walls and floor of the growing chamber and cropping bags were also sprayed with water whenever required.

Evaluation of test strain in terms of production efficiency and other morphological traits of fruiting bodies.

Spawning and Filling : Seven kg of fresh compost was filled in each polythene bag (18?x 18?). Through spawning was done @ 0.8 per cent of wheat grain-based spawn. These spawned bags were covered with newspaper sheets and immediately sprayed with formalin (2%) on these newspapers. Moisture content, pH and temperature of the compost were recorded at the time of spawning.

Spawn Run : The spawn running period was 12-15 days; temperatures as well as relative humidity were maintained around 25°C and 85 per cent, respectively. Little or no fresh air was supplied during this period (Kneebone, 1965).

Casing and Crop Management : Fully spawn run bags were cased with 4 cm thick casing soil, properly sterilized and moist and made from two to three years old farmyard manure and garden soil in the ratio of (1:1) v/v. Relative humidity was maintained at about 85-90 per cent until pin head formation, at which time, the bags were generously watered to initiate the flush. The temperature was gradually lowered down and maintained at 14-18°C throughout the cropping period and the amount of fresh air permitted to enter was also gradually increased.

Picking : Mushrooms were picked in the early hours of the day by a light twist so that the broken stumps were not left over in the beds and the small developing mushrooms were not damaged. Mushrooms were cut at the soil level to avoid soil adhering to the mushrooms. Mushrooms were picked, trimmed off, counted and weighed from each bag, at every harvest. Mushrooms were picked at a medium stage of maturity with the veil still intact, but thin. Yield was recorded up to sixty days after first harvest. Morphological characteristics of closed fruit bodies of every strain were recorded based on twenty fruit bodies in each replication, according to the method given by Fritsche (1981).

Sanitation : Before spawning, cropping bags were thoroughly sterilized/disinfected with 2 per cent formalin solution to avoid any surface contamination. Equipment's as well as other articles were cleaned/disinfected with 2 per cent formalin solution before taking them to the cropping room. Use of clean water for spraying purposes, was a daily practice.

Results and Discussion

Effect of culture media, pH and temperature on mycelium growth of various strain : These studies were taken up to understand in detail the effect of different media, pH and temperature on various test strain viz. Delta-D, Delta-N, A-15, MC-465, U-3, S-11 and Belgium-2 of *Agaricus bisporus.*

Basal medium selection : Seven test strains of *Agaricus bisporus* were employed in the present studies and grown on five different solid media. Four replications were kept for each treatment and radial growth of different test strain was recorded after 21 days of inoculation. Data recorded in Table-1 revealed that all the test strains significantly increase the mycelium growth on different media as compared with check. Malt extract agar medium supported maximum (70.72 mm) colony diameter of all strains including check (Belgium-2), followed by Potato dextrose agar medium (63.99 mm) and Wheat extract agar medium (61.22 mm). Oat meal agar medium

Table-1 : Mycelium growth (mm) of different test strain of *Agaricus bisporus* on various solid media.

Sr. No.	Strains (S)	Colony diameter (mm) of different strains after 21 days (M)					Mean
		Malt extract agar	Potato dextrose agar	Wheat extract agar	Corn meal agar	Oat Meal agar	
T_1	Delta-D	70.60	55.50	60.93	39.60	35.55	52.44
T_2	Delta-N	69.85	68.30	49.68	38.63	30.65	51.42
T_3	A-15	83.45	71.35	81.25	50.60	38.05	64.94
T_4	U-3	80.35	69.50	75.88	55.40	40.55	64.34
T_5	MC-465	65.83	60.45	46.85	35.63	28.78	47.54
T_6	S-11	74.20	73.58	68.35	45.45	37.08	59.73
T_7	Bel-2 (check)	50.73	49.20	45.60	34.13	26.55	41.31
	Mean	70.72	63.99	61.22	43.63	33.89	
						S.E.(d)	CD (0.05)
Strains (S)						0.38	1.10
Medium (M)						0.29	0.83
S×M						0.77	2.27

Table-2 : Mycelium growth (mm) of different test strain of *Agaricus bisporus* at different temperature on malt extract agar medium.

Sr. No.	Strains (S)	Colony diameter (mm) of different strains after 21 days (T)						Mean
		10°C	15°C	20°C	25°C	30°C	35°C	
T_1	Delta-D	13.20	42.08	50.30	60.15	19.13	10.15	31.98
T_2	Delta-N	14.00	46.30	53.10	72.05	27.25	12.00	37.45
T_3	A-15	19.50	52.60	56.05	81.20	30.08	14.13	42.26
T_4	U-3	16.38	47.28	57.30	80.18	28.10	12.10	40.23
T_5	MC-465	15.13	46.18	55.10	69.03	25.10	11.03	36.93
T_6	S-11	15.03	43.13	53.08	68.15	20.10	13.05	35.43
T_7	Bel-2 (check)	13.05	41.20	50.15	59.15	18.05	10.08	31.94
	Mean	15.37	45.54	54.14	69.56	24.68	11.79	
							S.E.(d)	CD (0.05)
Strains (S)							0.24	0.43
Temperature (T)							0.12	0.20
S×T							0.48	1.73

Table-3 : Mycelium growth (mm) of different test strain of *Agaricus bisporus* at various pH levels on malt extract agar medium.

Sr. No.	Strains (S)	Colony diameter (mm) of different strains after 21 days (pH)												Mean
		4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	
T_1	Delta-D	25.05	27.25	33.15	35.15	58.15	70.15	55.18	53.10	26.18	20.00	11.05	2.03	1.15	32.13
T_2	Delta-N	24.05	26.13	37.08	35.23	58.03	71.13	59.13	56.08	25.03	19.13	16.03	3.08	2.69	34.29
T_3	A-15	27.28	28.10	38.13	40.10	61.18	74.10	60.03	61.18	31.10	24.05	17.10	8.13	3.41	36.46
T_4	U-3	25.08	27.08	35.03	37.13	63.08	72.05	63.18	60.13	27.08	21.18	14.18	6.15	2.58	34.92
T_5	MC-465	23.05	22.35	34.08	35.20	55.13	70.15	56.03	53.05	24.13	16.10	13.08	2.05	1.33	31.00
T_6	S-11	22.00	25.25	37.98	36.08	60.05	69.13	56.15	56.08	28.10	20.10	15.07	5.10	2.23	33.33
T_7	Bel-2 (check)	21.15	22.18	32.10	33.18	54.05	65.13	54.25	52.15	20.15	13.03	10.08	1.10	1.00	29.63
	Mean	23.95	25.48	35.37	36.00	58.53	70.27	57.70	56.39	25.97	19.09	13.79	3.95	2.06	
													S.E.(d)		CD (0.05)
					Strains (S)								0.38		0.75
					pH								0.20		0.52
					S×pH								0.34		0.87

supported the minimum (33.89 mm) colony diameter after 21 days in comparison to other media.

As far as in different media, strain A-15 recorded maximum (64.94 mm) colony diameter which was statistically at par with strain U-3 (64.34 mm) and minimum colony diameter was recorded in strain Bel-2 (41.31mm).

Mycelium growth (mm) of different test strain of *Agaricus bisporus* on various solid media : The interaction of different solid media with various test strain

Table-4 : Time taken by the mycelium to cover the entire grains in days and types of mycelium growth on wheat grain substrate.

Sr. No.	Strains (S)	Time taken by the mycelium to cover the entire grains (days) ± S.E.(m)	Type of growth
T_1	Delta-D	16.65*±0.56	Strady, less dense
T_2	Delta-N	18.75*±0.86	Strady, not dense
T_3	A-15	15.05*±0.62	Strady, less dense
T_4	U-3	17.23*±0.79	Strady, not dense
T_5	MC-465	20.38*±0.89	Strady, not dense
T_6	S-11	19.28*±0.70	Strady, not dense
T_7	Bel-2 (check)	14.25±0.99	Strady, less dense
	S.E.(d)	1.11	
	CD (0.05)	2.3	

*Significant at 5% level of significance compared with check

Table-5 : Growth behavior of the different strain of *Agaricus bisporus* on wheat strawbased compost (days).

Strains (S)		Spawn run± S.E.(m)	Case run± S.E.(m)	Pinhead Formation± S.E.(m)	First Harvest± S.E.(m)	Second Harvest± S.E.(m)	Third Harvest± S.E.(m)
T_1	Delta-D	17.74*±0.88	17.92*±1.10	20.05±0.55	21.23*±0.33	32.55*±0.67	43.65±0.54
T_2	Delta-N	16.08*±0.75	17.20*±0.46	17.35*±0.69	20.30*±0.35	30.80*±0.47	41.50±0.68
T_3	A-15	18.08±0.48	19.38±0.95	21.88±0.59	22.60*±0.68	33.33*±0.96	40.65*±0.58
T_4	U-3	15.13*±0.48	16.45*±0.69	18.13*±0.23	19.80*±0.54	29.60*±0.63	39.85*±1.59
T_5	MC-465	17.25*±0.24	18.58±0.64	20.60±0.29	21.33*±0.59	31.78*±0.67	43.23±1.52
T_6	S-11	14.188±0.75	15.50*±0.58	16.65*±0.85	18.28*±0.79	28.48*±0.56	34.43*±1.52
T_7	Bel-2 (check)	19.60±0.35	20.28±0.26	21.20±0.67	24.25±0.48	35.65±0.62	44.00±0.59
	S.E.(d)	0.85	1.02	0.84	0.79	0.95	1.40
	CD (0.05)	1.77	2.13	1.75	1.66	1.97	2.93

*Significant at 5% level of significance compared with check

showed that maximum (83.45 mm) colony diameter was produced by strain A-15 on malt extract agar medium, followed by strain U-3 (80.35 mm) on the same medium. Minimum (26.55 mm) colony diameter was recorded by strain Belgium-2 (check) on Oatmeal agar medium. All the test strains, including check (Belgium-2) of *Agaricus bisporus* grew well on malt extract agar medium followed by the potato dextrose agar medium.

Mycelium growth (mm) of different test strain of *Agaricus bisporus* at different temperature on malt extract agar medium : The treatments at different range of temperature significantly increase the mycelium growth as compared with check. Maximum growth of all the test strains including check (Belgium-2) was recorded at 25^{o}C (69.56 mm) followed by 20^{o}C and 15^{o}C. Minimum growth of all the test strain including check (Belgium-2) was recorded at 35^{0}C (11.79 mm). Temperature of 25^{o}C was found the best for the growth of all the test strains.

Strain A-15 at different range of temperature recorded the highest (42.26 mm) colony diameter after 21 days followed by strain U-3 (40.23 mm). Minimum mycelium growth was recorded in strain Belgium-2 (31.94 mm). The interaction study revealed that strain A-15 recorded maximum (81.20 mm) colony diameter at 25^{o}C, followed by strain U-3 (80.18 mm) at 25^{0}C. Minimum mycelium growth resulted in strain Belgium-2 (10.08 mm) at 35^{0}C.

Mycelium growth (mm) of different test strain of *Agaricus bisporus* at various pH levels on malt extract agar medium : The treatments significantly increase the mycelium growth at different range of pH as compared with check. Maximum (70.27 mm) colony diameter was recorded at pH 6.5, followed by pH 6.0 (58.53 mm) after 21 days. Minimum (2.06 mm) colony diameter was recorded by all the test strains including check (Bel-2) at pH 10.

Time taken by the mycelium to cover the entire grains in days and types of mycelium growth on wheat grain substrate : Type of growth in all the test strains was strandy type with pronounced variation in their density. Minimum time (14.25 days) for colonization of entire substrate was taken by strain Belgium-2 (check). Maximum time to cover the entire grains was recorded by strain MC-465 (20.38 days). The types of growth of mycelium on wheat grain substrate are depicted in (Plate-8 and plate-9).

Growth behavior of the different strain of *Agaricus bisporus* on wheat strawbased compost (days) : Minimum time for spawn run on compost was taken by strain S-11 (14.18 days). Maximum time was observed in strain

Table-6 : Yield performance of different strain of *Agaricus bisporus.*

Sr. No.	Strains (S)	Length of stalk (cm) ± S.E. (m)	Width of stalk (cm) ± S.E. (m)	Width of mushroom cap (cm) ± S.E.(m)	Length of (cm) ± mushroom cap S.E. (m)
T_1	Delta-D	2.33*±0.284	1.38*±0.175	3.33*±0.180	3.78*±0.295
T_2	Delta-N	2.80*±0.225	2.38*±0.210	3.68*±0.345	4.05*±0.155
T_3	A-15	3.45*±0.236	3.03*±0.354	4.73*±0.423	5.03*±0.388
T_4	U-3	3.00*±0.245	2.78*±0.419	4.43±0.335	4.78*±0.304
T_5	MC-465	2.00*±0.354	1.68*±0.403	2.90*±0.268	3.38*±0.253
T_6	S-11	2.28*±0.328	2.05*±0.240	4.05*±0.507	4.28*±0.250
T_7	Bel-2 (check)	1.90±0.168	1.25±0.296	2.60±0.420	3.15±0.253
	S.E.(d)	0.37	0.45	0.53	0.39
	CD (0.05)	0.75	0.93	1.09	0.83

*Significant at 5% level of significance compared with check.

Table-7 : Morphological characteristics of different strain of *Agaricus bisporus.*

Sr. No.	Strains (S)	Mushroom yield (Kg/q of compost) ± S.E.(m)	Number of fruiting body/q of compost ± S.E.(m)	Individual fruit body weight± S.E.(m)
T_1	Delta-D	8.43*±0.60	909.68*±29.72	9.25*±0.83
T_2	Delta-N	11.78*±0.46	1,129.18±36.62	10.40*±0.58
T_3	A-15	11.55*±0.38	1,210.45*±17.12	9.83*±0.69
T_4	U-3	15.80*±0.525	1,287.98*±17.48	12.25*±0.74
T_5	MC-465	7.45*±0.366	896.90*±7.98	8.18*±0.34
T_6	S-11	10.30*±0.426	974.28*±45.54	11.03*±0.23
T_7	Bel-2 (check)	5.63±0.333	643.88±22.48	7.88±0.72
	S.E.(d)	0.64	39.51	0.88
	CD (0.05)	1.33	82.73	1.84

*Significant at 5% level of significance compared with check.

Belgium-2(check) (19.60 days) followed by strain A-15 (18.08 days) and MC-465 (17.25 days).

That significantly minimum time was taken from spawning, case run and pinhead formation to the first harvest (18.28 days), second harvest (28.48 days) and third harvest (34.43 days) by strain S-11 and significantly maximum time for first harvest (24.25 days), second harvest (35.65 days) and in third harvest (44.00 days) was taken by the strain Belgium-2.

Yield performance of different strain of *Agaricus bisporus* : The yield efficiency of different strains of *Agaricus bisporus* was statistically analyzed and revealed that all the treatments were found significant as compared with the check. Maximum yield was recorded in strain U-3 (15.80 kg/q of compost) followed by the strain Delta-N (11.78 kg/q of compost) and strain A-15 (11.55 kg/q of compost). Minimum yield was recorded in strains Bel-2 (check) (5.63 kg/q of compost). Maximum number of fruitingbody were produced by the strain U-3 (1,287.98/q of compost) followed by strains A-15(1,210.45/q of compost) and strain Delta-N (1,129.18/q of compost), however minimum number of fruiting body was produced by the strain Belgium-2 (check) (643.88/q of compost). The fruiting body weight was observed to be significantly higher in case of strain U-3 (12.25 g) followed by strains S-11 (11.03 g) and Delta-N (10.40 g), however minimum in case of strain Bel-2 (check) (7.88 g).

Morphological characteristics of different strain of *Agaricus bisporus* : The maximum length of cap was observed in strain A-15 (5.05 cm) followed by strain U-3 (4.78 cm), S-11 (4.28 cm) and Delta-N (4.05 cm) and minimum was taken in strain Belgium-2 (check) (3.15 cm).

Effect of culture media, pH and temperature on mycelium growth : Among the solid media, malt extract agar medium supported maximum (70.72 mm) colony diameter of all test strains including the check (Bel-2). Oat meal agar medium supported the poorest (33.89 mm) colony diameter in 21 days in comparison to other media. These results are in the agreement with the work of Prakasam and Singh (2008) reported that glucose asparagine solution favoured maximum growth of *Agaricus bisporus.* Gapniski *et al.* (1988) investigated mycelium growth of four strains of *Agaricus bisporus* on six synthetic and natural media and reported best growth on Hansen medium.

Six different temperature ranges, from 10 to 35^{o}C were tested for determining the effect of low and high

temperature range and optimum temperature requirement of different strains including check. While the temperature of 25°C was found as optimum temperature for maximum colony diameter and mycelial growth of all the test strains including check (Bel-2), followed by the temperature with 20°C.

Seven strains were also tested for their tolerance to low and high pH range and for determining the optimum pH level. The pH ranges varying from 4.0 to 10.0 were adjusted in basal medium. The best mycelial growth and colony diameter of all the test strains, including check was recorded at pH of 6.5. This was followed by a pH of 6.0 for mycelial growth and colony diameter. Suman *et al.* (2011) who adjusted the pH of the basal medium to 6.5 for maximum mycelial growth and colony diameter. However, there are contradictory reports on the pH requirements. Manjul *et al,* (2003) reported maximum mycelial growth at pH 6.0, whereas no growth was observed at pH 8.5.

Evaluation of strains in terms of production efficiency: These observations are in agreement with the descriptions made by Suman (2001 and 2005) and Yadav (2003). evaluated strains of *Agaricus bisporus* for yield potential. Strain P1 gave the highest yield with a mean yield of 3310g / tray. Strain S310 & S11 produced mean yield of 2793 & 1975g / tray, respectively.

Morphological Characteristics and qualities of *Agaricus bisporus* : This observation is in agreement with the findings of Suman and Sharma (2005) and Singh and Kamal (2011). The fruit bodies of strains DMRA-7, DMRA-37 and DMRA-102, were observed to be round in shape with slightly raised cap at the centre, pure white in colour with short and stout stipe. These qualitative and quantitative traits determine the quality and quantity of mushroom produced. These results are in agreement with the works of Suman (2001), Yadav *et al*. (2002) and Singh and Kamal (2011).

Conclusions

The Malt extract agar medium was found to be the best suitable medium for mycelia growth of different strain of *Agaricus bisporus* followed by potato dextrose agar medium and the suitable Temperature of 25°C was found to be the best for the growth of various test strains of *Agaricus bisporus* on malt extract agar medium and the best growth of different test strains of *Agaricus bisporus* on malt extract agar media was recorded at pH of 6.5. Minimum time was taken by the strain Belgium-2 (14.25 days) to cover the entire wheat grains substrate with strand type of growth. Strain S-11 was found fast growing in compost and take 14.18 days in spawn run, 13.50 days in case run, 15.65 days in pinhead formation and took minimum days for first harvest and second harvest after spawning. Among the various test strains U-3 yielded maximum 15.08 kg/100 kg of compost. Strain A-15 having best desirable morphological characteristics with highest length of stalk3.45 cm, width of stalk 3.03cm width of mushroom cap 4.73cm and length of mushroom cap 5.03 cm.

References

1. Singh, K., Kumar, V. and Singh, M. (2000). Production of mushroom. *Indian Food Packer* 47**(2)**: 29-31.
2. Verma, R.N. (2002). The science and scope of mushroom cultivation. In: Recent Advances in the Cultivation Technology of Edible Mushroom Nirmal Vijay Press, New Delhi, India, pp. 1-10.
3. Singh, R.P. and K.K.Mishra (2010). Status and propectus of edible and medicinal mushroom.Production and Postharvest development from Jan 09-18, Organized by ICAR and IGKV, Raipur pp1-9
4. Wakchaure, G.C. 2016. Production and marketing of mushroom: Global and national scenario. In: *Mushrooms Cultivation, Marketting and Consumption*, M Singh, B Vijay, S Kamal and GC Wakchaure (eds). Directorate of Mushroom Research (ICAR), Solan, India, pp. 15-22.
5. Anonymous. (2011). Vision 2030. Directorate of Mushroom Research (ICAR), Solan (H.P.), India. p 25.
6. Nair, M. G. (1991). Observation of virus disease of the cultivated mushroom, *Agaricus bisporus* in Australia. *Mushroom Science* 17(8): 155-170.
7. Vijay B, Gupta Y and Upadhaya R C. (1995). Effect of casing thickness on yield of *Agaricus bisporus*. *Indian Journal of Mycology and Plant Pathology* 18(2): 209-210.
8. Sinden, J. W. and Hause,r E. (1970). The nature of composting process and its relation to the short composting. *Mushroom Science* 33(2): 123-130.
9. Singh, R.P. and K.K.Mishra (2010). Status and propectus of edible and medicinal mushroom.Production and Postharvest development from Jan 09-18, Organized by ICAR and IGKV, Raipur pp1-9.
10. Singh, M. and Kamal, S. (2011). Conventional and molecular approaches for breeding button mushroom. *Proceedings of the 7th International Conference on Mushroom Biology and Mushroom Products (ICMBMP7) 2011,* pp. 35-42.
11. Kneebone, L.R. 1965. Spawn research at the Pennsylvania State University. *Mushroom Science*, 6(3): 679-681.
12. Fritsche, G. 1981. Some remarks on the breeding, maintenance of strains and spawns of *Agaricus bisporus* and *A. bitorquis*. *Mushroom Science* 11(4): 367-385.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 985-990 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

To Study on Correlation Coefficient and Path Analysis for Yield and its Components in Wheat (*Triticum aestivum* L. em. Thell)

Vimlesh Kumar, Aditya Kumar, P.N. Singh and S.C. Gaur
Department of Genetics and Plant Breeding, Baba Raghav Das P.G. College, Deoria–274001 (U.P.)
Corresponding Author Email : scgaur101@gmail.com

Abstract

A study was undertaken to estimate the correlation coefficient and path analysis of yield and yield contributing traits in 20 wheat cultivars grown in Randomized Block Design with three replications at Research farm, B.R.D.P.G. college Deoria, U.P, during rabi season 2020-21. The 14 characters studied were days to 50% flowering, flag leaf area (cm^2), plant height (cm), days to maturity, spike length (cm), number of spikelets per spike, number of productive tillers per plant, peduncle length, number of grains per spike, Test weight (1000 grain) (g), biological yield per plant (g), grain yield per plant (g), grain yield per spike (g) and harvest index (%). The correlation coefficient estimate show At phenotypic level. Plant height has exhibited highly significant and positive correlation with no of grain per spike while positive correlation with numbers of spikelet per spike, Test weight**.** The genotypic correlation was generally similar in nature and higher in magnitude then the corresponding phenotypic correlation. Plant height (cm) had highly significant and positive correlation with spike length, and of productive tiller was found significant and negative correlation with biological yield, days to maturity exhibited significant and positive correlation with harvest index, Peduncle length exhibited highly significant and negative correlation with spike length. The path coefficient analysis, carried out at genotypic as phenotypic level identified, biological yield, harvest index made a very positive contribution towards expression of grain yield per plant, while direct effect of rest of the character was low. High order positive indirect on grain yield via biological yield were showed by spike length. the most important indirect yield component.

Introduction

Wheat *(Triticum aestivum* L. em. Thell.; 2n=42), a self-pollinated crop of the *Gramineae* family (Sub-family *Poaceae*) and genus *Triticum*, is the world's largest famous energy rich cereal crop. It has been described as the 'King of cereals' because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. It is a C3 type of plant grown from temperate, irrigated to dry area and from warm, humid to dry cold environment. Doubtlessly, this wide adaptation has been possible due to the complex nature of the plant's genome, which provides great plasticity to the crop. Wheat has been bred for a wide array of specific end-use quality traits and various adaptive characteristics, resulting in the development of distinct cultivar tailored to specialized end uses and specific production environment. The origin place of wheat is believed to be in Asia Minor. Some 8000 year ago the people of Asia Minor found a new way of living in course of civilization through the cultivation of general Triticum and Hordeum. The majority of the cultivated wheat varieties belong to three main species of the genus Triticum, these are the hexaploidy (2n=6x=42), *T. aestivum* L. (bread wheat), the tetraploid (2n=4x=28), T. durum Desi and the diploid (2n=2x=14) (Sleper and Poehlman, 2006). Correlation coefficient analysis appears to be a very useful approach for determining how various yield variables interact. This parameter also provides estimates of the interdependencies between grain yield and other qualities, as well as amongst themselves. This would make it easier for breeders to adopt successful selection techniques for increasing yield. By separating the correlation coefficient of grain yield and the concerned trait, path coefficient analysis determines the level of direct and indirect effect of independent variables on a dependent variable. As a result, path coefficient analysis has become the most widely used and useful statistical method for this purpose, and it can also be used to estimate the quantitative impact of direct and indirect effects caused by one or more components of grain yield, as well as the relationship between these components.

Materials and Methods

The field experiment under present investigation was conducted during *Rabi* 2020-21 at Agriculture Research farm of Baba Raghav Das Post Graduate College Deoria (U.P.). Geographically, this College is located in the east part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 68 meter (223 feet) above the mean sea level. The climate of district Deoria is semi-arid with hot summer and cold winter nearly 80% of total rain fall is received during the monsoon (only up to September) with a few showers in the winter. 20 different genotypes of wheat were sown during Rabi season 2020-21 in Randomized Block Design with 3 Replications. The row-to-row distance was maintained at 23cm. Estimation of correlation coefficient between

Table-1 : Estimates of phenotypic correlation coefficient computed between 14 characters of indigenous lines of wheat.

Character Name	DFF	PHT (CM)	FLA (CM)	TPP	DTM	PL (CM)	SL (CM)	SPP (CM)	GPS	GWPS (GM)	TW (1000) GRA IN (GM)	BY (GM)	GY (GM)
Days to 50% flowering	1000	0.3052	0.3515**	0.399**	0.0357**	0.2157**	00.459	0.1236**	0.4748	0.2165	0.1563	0.4181	0.0147
Plant height (cm)		1000	0.0374	-0.3234**	0.3536	0.0561	0.1111	0.4864**	0.6604**	0.2071	0.4784**	0.1707	0.2458
Flag leaf area (cm)			1000	0.0924**	0.3268	0.1230**	0.1324	0.1347	0.1487	0.4281	0.1946	0.3759**	0.2286
Tiller per plant (cm)				1000	0.0793	-0.0015	0.2271	-0.1006	0.4106	0.0635	0.1148	0.0930	0.2121**
Days to maturity					1000	-0.0249	0.1752	0.0095	0.2504	0.1115	0.2543	0.2091	0.0981
Peduncle length (cm)						1000	0.0163	0.2486	0.2477**	0.1931	0.3858	0.0848	0.5218
Spike length (cm)							1000	-0.5029**	-0.0732	0.3624**	0.3808	0.4394**	0.1173
No of spike lets per spike								1000	0.2758	0.2388	0.6188	0.3391**	0.5773**
No of grain per spike									1000	0.2956	0.3515**	0.3282	0.0467**
Grain weight per spike (g)										1000	0.5452	0.5789	-0.1664**
Test weight (g)											1000	0.5326	0.2469
Biological yield per plant (g)												1000	0.0883
Grain yield per plant (g)													1000
Harvest index (%)	0.1884	-0.2760	0.0147	-0.1843	0.0651	0.5289	0.3385	0.6927	0.2173	0.1756	0.5272	0.4837	0.8194

Table-2 : Estimate of genotypic correlation matrix computed between 14 character of indigenous lines of wheat.

Character name	Day to 50% flow ering	Plant height (cm)	Flag leaf area (cm)	Tiller per plant	Days to maturity	Peduncle length (cm)	Spike length (cm)	No of spikelet per spike	No of grains per spike	Grain weight per spike (g)	Test weight 1000 grain (g)	Biological yield (g)	Grain yield per plant (g)
DFF	1000	0.7098	0.7057	0.7803	0.0921	0.441	0.0442	0.0603	1.0746	1.0008	0.1707	1.0088	1.0300
PHT (CM)		1000	0.0229	0.5880	0.5808	0.0123	0.1492	0.9803	0.8840	0.6703	0.7963	0.3537	1.0077
FLA(CM)			1000	0.1832	0.3774	0.1583	0.1152	0.2404	0.2578	0.5859	0.2805	0.7307	0.5571
TPP				1000	0.0916	0.0201	0.2822	0.2514	0.6801	0.4177	0.3472	0.5815	1.0005
DTM					1000	0.0131	0.2254	0.0981	0.4205	0.2130	0.2855	0.4384	0.5331
PL(CM)						1000	0.0116	0.4536	0.3406	0.8236	0.5550	0.1789	-1.0007
SL(CM)							1000	-0.7909	0.1162	-0.2687	0.6196	0.8690	0.5219
SPP								1000	0.4849	1.0076	0.7492	1.2031	0.9427
GPS									1000	0.6131	0.3601	0.8020	-0.4398
GWPS										1000	5.1637	0.4898	0.9316
TW (G)											1000	1.0097	0.5948
BY (G)												1000	1.8368
GY (G)													1000
HI (%)	0.0936	-0.8281	0.0608	-0.3187	0.0199	0.8599	-0.6151	1.0042	0.5461	0.6536	0.9466	1.0094	0.7567

Table-3 : Direct and indirect effect of differents character on grain yield per plant in wheat germplasm.

Character name	Day to 50% flowering	Plant height (cm)	Flag leaf area (cm)	Tiller per plant	Days to maturity	Peduncle length (cm)	Spike length (cm)	No of spikelet per spike	No of grains per spike	Grain weight per spike (g)	Test weight 1000 grain (g)	Biological yield (g)	Grain yield per plant (g)
DFF	-0.0697	0.0213	0.0245	-0.0278	0.0025	-0.0150	-0.0032	-0.0086	-0.0331	-0.0109	-0.0109	-0.0291	-0.0010
PHT(CM)	-0.0356	-0.1167	-0.0044	-0.378	-0.0413	-0.0065	-0.0130	-0.0568	-0.0771	-0.0242	-0.0559	-0.0199	-0.0287
FLA(CM)	-0.0059	-0.0066	0.0168	0.0016	0.0055	0.0021	0.0022	-0.0023	-0.0025	-0.0072	-0.0033	-0.0063	0.0038
TPP	-0.0175	0.0142	-0.0041	-0.0439	-0.0035	0.0001	-0.0100	0.0044	-0.0180	-0.0028	0.0050	-0.0041	0.0093
DTM	-0.0007	-0.0072	0.0067	0.0016	0.205	-0.0005	0.0036	0.0002	0.0051	-0.0023	0.0052	0.0043	-0.0020
PL (CM)	0.0012	-0.0003	0.0007	0.0000	-0.0001	0.0057	-0.0001	0.0014	0.0014	0.0011	0.0022	0.0005	0.0030
SL(CM)	0.0041	-0.0100	0.0119	0.0204	0.0157	-0.0015	0.0896	-0.0451	-0.0066	-0.0325	-0.0341	-0.0394	-0.0105
SPP	0.0081	-0.0320	0.0089	-0.0066	0.0006	0.0164	-0.0331	0.0659	0.0182	0.0154	0.0408	0.0223	0.0380
GPS	0.0418	-0.0582	-0.0131	0.362	0.0221	0.0218	-0.0064	0.0243	0.0881	0.0260	0.0310	0.0289	0.0041
GWPS(G)	0.0019	-0.0018	-0.0037	0.0006	-0.0010	0.0017	-0.0031	0.0020	0.0026	0.0087	0.0047	0.0050	-0.0014
TW(G)	0.0031	-0.0096	-0.0039	-0.0023	0.0051	0.0077	-0.0076	0.0124	0.0071	0.0109	0.0201	0.0107	0.0050
BY (GM)	0.2450	-0.1000	-0.2203	0,0545	0.1225	0.0497	-0.2575	0.1987	0.1923	0.3392	0.3121	0.5860	-0.0517
GY (GM)	0.0125	-0.2093	0.1947	-0.1807	-0.0835	0.4443	-0.0999	0.4416	0.0398	-0.1417	0.2102	-0.0752	0.8516
HI (%)	0.1884	-0.2769	0.0147	-0.1843	0.0651	0.5259	-0.3385	0.6927	0.2173	0.1756	0.5272	0.4837	08194
PARTIAL R^2	-0.0131	-0.0328	0.0002	0.0081	0.0030	0.0030	0.0303	0.0456	0.0191	0.0015	0.0106	0.2834	0.6977

Table-4 : Direct and indirect effect of differents character on grain yield per plant in wheat germplasm.

Character name	Day to 50% flowering	Plant height (cm)	Flag leaf area (cm)	Tiller per plant	Days to maturity	Peduncle length (cm)	Spike length (cm)	No of spikelet per spike	No of grains per spike	Grain weight per spike (g)	Test weight 1000 grain (g)	Biological yield (g)	Grain yield per plant (g)
DFF	0.2810	2.388	-2.3153	-2.5602	0.3022	-1.4571	-0.1452	0.1978	-3.5259	-5.3505	-0.5600	-4.5895	-3.3795
PHT (CM)	1.2990	0.8301	0.0419	1.0762	1.0630	-0.0226	0.2731	1.7941	1-6179	1.2267	1.4574	0.6473	-2.9605
FLA (CM)	0.3346	0.0109	0.4742	-0.0869	-0.1789	-0.0751	0.0546	-0.1140	0.1222	2.1747	0.1330	0.3465	0.2642
TPP	0.3394	0.2558	-0.0797	-0.4350	-0.0398	0.0088	-0.1227	0.1094	-0.2958	0.6167	0.1510	-0.2530	-0.5352
DTM	0.2498	1.5755	-1.0236	-0.2484	0.7126	0.0356	-0.6113	-0.2662	-1.1406	3.2903	-0.7746	-1.1891	-1.4462
PL (CM)	1.2805	0.0355	0.4565	-0.0580	0.0378	0.8834	-0.0333	1.3079	0.9821	5.2582	1.6003	0.5158	-4.4671
SL (CM)	-0.1132	0.3816	-0.2997	-0.7217	-0.5764	0.0296	0.5574	2.0226	0.2972	8.3594	1.5846	2.2224	-1.3346
SPP	-0.0929	-1.5113	0.3706	-0.3876	-0.1513	0.6993	-1.2193	0.5417	0.7476	2.2009	1.1550	1.8848	-1.4534
GPS	7.9951	-6.5770	1.9177	5.0598	3.1282	2.5341	-0.8647	3.6077	0.4399	19.4408	2.6789	5.9669	-3.2720
GWPS	0.7095	-0.3444	-2.3562	0.7284	-0.6232	0.9370	-1.6795	0.7355	1.3426	0.5138	2.6531	3.8483	0.4787
TW (GM)	1.0487	-4.8927	-1.7233	-2.1334	1.7544	3.4100	-3.8069	4.6030	2.2123	31.7261	0.1440	8.4772	-3.6547
BY(GM)	-13.0906	3.3102	6.8385	-5.4423	-4.1023	-1.6742	8.1328	-11.2589	-7.5055	-70.0928	-12.9122	0.3584	17.1894
GY (GM)	4.0936	6.4291	-2.2142	4.8904	2.1188	-6.3776	2.0740	-3.7467	-1.7479	3.7026	-2.3641	-7.2999	0.9743
HI (%)	0.0936	-0.8281	-0.0608	-0.3187	0.0199	0.8599	-0.6151	1.0642	0.5461	2.6536	0.9466	1.1894	-0.7567
PARTIAL R^2	-0.3072	1.5155	0.0288	0.1386	-0.0541	2.4795	1.5730	1.6406	4.0632	1.3634	5.8159	-11.1311	-3.0075

different characters were estimated according to Searle (1961). Path coefficient analysis was carried out according to Dewey and Lu (1959).

Results and Discussion

The estimation of phenotypic, genotypic and environmental correlation coefficients is compound among 14 characters of indigenous line of wheat under study are presented in Table 1 And Table-2. At phenotypic level plant height has exhibited highly significant and positive correlation with no of grain per spike (0.6604) While positive correlation with number of Spikelet per spike (0.4864) and Test weight (0.4784) where high significant and negative correlation with number of productive tiller (-0.3234) highly significant (39.90). Days to 50% flowering has shown highly significant and positive correlation with days to maturity (0.0357) and Number of Spikelet per spike (0.1236) while highly significant and positive correlation with flag leaf area (0.3515) and Number of Productive tiller (0.3990). Days to maturity has shown significant and positive correlation with Flag leaf area (0.3268), No of productive tiller (0.793), Biological yield per plant (0.2091) While significant positive correlation with grain weight per spike (0.1115 and Test weight (1000 grain) (0.2543), Harvest index (0.065).Flag leaf area Has denoted low significant and positive correlation with peduncle length (0.1230), No. of productive tiller (0.924), Biological yield per plant (0.3759) and Grain yield per plant (0.2289) while significant and positive correlation with number of grain per spike (0.1487) No of spikelet per spike (0.1347) Peduncle length has shown moderate significant and positive correlation with number of grain per spike (0.2477) While significant and positive correlation with test weight (0.3858). Spike length per plant has shown highly significant and positive correlation with grain weight per spike (0.3624) Biological yield per plant (0.4394) Grain yield per plant (0.1173) while significant and negative correlation with number of productive tiller (-0.2271) while show highly significant and negative correlation with no of spikelet per spike (-0.5029). No of productive tiller has exhibited highly significant and positive correlation Coefficient with biological yield per plant (0.0930). highly significant and negative correlation with number of spikelet (-0.1006). No of grain per spike has shown highly significant and positive correlation with grain weight per spike (0.2956) no of spikelet per spike (0.2758) harvest index (0.2173) and grain yield per plant (0.0467) while moderate significant and positive correlation with test weight (0.3515). There is no negative significant. Grain weight per spike has shown highly significant and positive correlation with number of spikelets per spike (0.2338) harvest index (0.1756) test weight (0.5455) and significant and negative correlation (-0.1664) with grain weight per spike, No of spikelet per spike has shown highly significant and positive correlation with grain yield per plant (0.5773) while significant and positive correlation with test weight (0.6188). There is no negative correlation. Test weight show significant and positive correlation with biological yield per plant (0.5326) Harvest index (0.5272) and grain yield per plant (0.2469) while there is no negative correlation. Biological yield per plant has shown significant .and positive correlation with grain yield per plant (0.0883) while significant and positive correlation and harvest index (0.4837) there is no negative correlation. Harvest index has shown highly significant and positive correlation with grain yield per plant (0.8194) while negative correlation in not availed. At phenotypic days to 50% flowering exhibited highly significant and positive correlation with days to maturity, number of spikelets per spike and harvest index, plant height exhibited highly significant and positive correlation with spike length, number of productive tillers per plant and test weight, flag leaf area (cm^2), had highly significant and positive correlation with days to maturity, biological yield and spike length, number of productive tillers per plant showed highly significant and positive correlation with number of spikelet per spike and biological yield, days to maturity exhibited highly significant and positive correlation with harvest index. Biological yield and spike length, peduncle length exhibited highly significant and positive correlation with test weight and number of spikelet grain per spike and biological yield, number of spikelet per spike exhibited highly significant and positive correlation with grain weight per spike and harvest index, number of grains per spike exhibited highly significant and positive correlation with biological yield, the grain weight per spike exhibited highly significant and positive correlation with harvest index, Test weight (1000 grain) exhibited highly significant and positive correlation with harvest index and biological yield per plant (g) exhibited highly significant and positive correlation with harvest index. Thus. harvest index and grain yield per plant emerged as closely correlated yield attributes. The strong positive association of grain yield with one or more of the above traits has also been observed by previous workers (Bergale *et al.,* (2002); Ayceek and Yildirim (2006); Chaitali and Bini, (2007); Singh *et al.,* (2008); Anwar *et al*., (2009); Zaeifizdeh *et al.,* (2011); Soni *et al*., (2011); singh *et al*., (2012); Vimal, S.C. *et al.,* (2016); Sidhu and Gill., (2019); Tarkeshwar *et al.,* (2020); Gautam *et., al* (2021); Sahu *et., al* (2021).

The path coefficients analysis was carried out by using genotypic as well as phenotypic correlation coefficient between fourteen characters to direct and indirect of various characters on grain yield per plant. The estimate of direct and indirect effect of different character

on grain yield per plant at phenotypic and genotypic level are presented on Table 3. biological yield per plant (0.5860) followed by harvest index (0.4837) exerted high order positive direct effect on grain yield. however, the direct effect of rest character was too low to be considered of any consequence. flag leaf area (0.0168), spike length per plant (0.0896), no of productive tiller per plant (-0.0439), no of spikelet per spike (0.0659), days of maturity (0.205), days of 50% flowering (-0.0697), 1000 grain weight (0.0087), grain weight per spike (0.0087), made substantial indirect positive contribution of grain yield via biological yield. The indirect contribution of harvest index through biological yield on grain yield was order positive number of grains per spike (0.881), grain weight per spike (0.0087), plant height (-0.1167) and indirect contribution of harvest index through biological yield on grain yield was order positive biological yield (0.5860), no of productive tillers per plant (-0.0439), days to maturity (0.205).and made considerable indirect negative contribution on grain yield through harvest index. The contribution of residual factors towards variation in grain yield very low (0.8516) At genotypic level the path-coefficient analysis carried out by using genotype path coefficient table 4 revealed that biological yield (0.3584) followed by harvest index (0.0936) made very high positive contribution towards grain yield while direct effect of rest of the character was low. High order positive indirect effects on grain yield via biological yield were showed by spike length per spike (8.1328), flag leaf area (-00.4742) no of productive tiller per plant (-00.4350), number of spikelets per spike (0.323), days to maturity (0.7126) days of 50% flowering (0.2810), test weight 1000 grain (0.1440), grain weight per spike (0.5138), peduncle length (0.8834). the indirect effect of harvest index via grain yield per plant was order positive number of grains per spike (0.5461) grain weight per spike (2.6536) and plant height (0.8301) And made considerable indirect negative contribution on grain yield through harvest index with number of productive tillers per plant (-0.3187) number of spikelets per spike (-7.2999 gm. the contribution of residual factors towards variation in grain yield was low (0.9743). At phenotypic level yield per spike, flag leaf area, tiller per plant, peduncle length, no of Spikelet per spike, no of grain per spike, grain yield per plant, and harvest index exerted positive direct effect on grain yield. However, rest of the traits exerted negative direct effect on the days to 50% flowering, plant height, days to maturity, spike length, grain weight per spike, biological yield, as most important direct contributors towards grain yield per plant. (Sachan and singh, (2003); Asif *et al* (2004); Muhammad and Ishan, (2004); Chaitali and Bini, (2007); singh *et al*., (2008); Khokhar *et al.,* (2010); singh *et al.,* (2010); khan *et al.,* (2010); singh *et al*., (2012); Gaur S.C. *et al.,* (2015); P.N. Singh*, et al.,* (2017); Kumar *et al*., (2020); Gautam *et al*., (2021). In the present study, path analysis identified by harvest index. followed by biological yield. plant height and spike length. The characters mentioned above, merit due to consideration at the time of devising selection aimed at developing high yielding varieties in wheat.

References

1. Anwar, J.; Ali, M.A.; Hussain, M.; Sabir, W.; Khan, M.A.; M, Zulkiffal and M, Abdullah (2009). Assessment of yield criteria in bread wheat through correlation and path-analysis. *The Journal of Animal & Plant Sciences,* 19(4) (2009).
2. Asif, M Ahmad, I. (2004). Heritability, genetic variability and path–coefficient of some traits inspiring wheat. *Sarhad Journal of Agric. Pakistan*, 20(1): 87-91.
3. Ayccek, M. and Yildirim, T. (2006). Path coefficient analysis of yield and yield components in bread wheat *(T. aestivum L.). Pakistan J. of Botany,* 38(2): 417-424.
4. Bergale, S.; and Prasad, V.S. (2002). Pattern of variability, character association and path-analysis in wheat (*Triticum aestivum* L.). *Agricultural Science Digest.*, 22(4): 258-260.
5. Chaitali, S. and Bini, T. (2007). Variability, character association and component analysis in wheat *(T. aestivum* L.). *Crop Research,* 34(1-3): 166-170.
6. Dewey and Lu. (1959). Correlation and path-coefficient analysis of crested wheat grass seed production. *Agron. J.,* 51: 515-518.
7. Gaur, S.C.; Gaur, A.K.; Gaur, L.B.; Singh, P.N. and Verma, S.B. (2015). Correlation and path-coefficient studies in wheat (*Triticum aestivum L.). Frontiers in crop Improvement journal* 3(1): 41-43.
8. Gautam.; Singh, Soni.; Kumar, Kamlesh and Gaur, S.C. (2021). Studies on correlation and path analysis of quantitative traits in different wheat *(Triticum aestivum* L. em. Thell.) genotypes under Alluvial soil condition. *Frontiers in Crop Improvement*, Vol. 9(special-VI): 2677-2680.
9. Khokhar, M.; Hussain, M.; Javed, Anear.; Zulkiffal, M.; Iqbal, M.M.; Khan, S.B.; Khan, MA.; Abdul, Qayyum.; Sabir, W. and Shahid, Mehmood. (2010). Correlation and path-analysis for yield and yield contributing charcters in wheat *(Triticum aestivum L.). Acta Agriculture Serbica*. 15(29): 19-24.
10. Khan, MA.; Abdul, Qayyum.; Sabir, W. and Shahid, Mehmood. (2010). Correlation and path-analysis for yield and yield contributing characters in wheat *(Triticum aestivum* L.*). Acta Agriculture Serbia*. 15(29): 19-24.
11. Kumar, Kamlesh.; Tarkeshwar.; Singh, Mukesh.; Gupta, Avinash.; Singh,Soni and Gaur, S.C. (2020) Character association for correlation and Path coefficient studied in bread wheat (*Triticum aestivum* L. em. Thell). *International Journal of Current Microbiology and Applied Sciences* Special-11: 1323-1330.
12. Muhammad, K. and Ishan, K. (2004). Heritability, correlation and path-coefficient analysis for some metric traits in wheat. *International Journal of Agric. And Biology, Pakistan,* 6(1): 138-142.

13. Sachan, M.S. and Singh, S.P. (2003). Genetics of yield and its components in durum wheat *(T. durum Desf). Journal of Inter. Academicia,* 7(2): 140-143.
14. Searle, S. R.; (1961), Phenotypic, genotypic and environmental correlation. *Biometrics*, 17: 474-775.
15. Sidhu, S.K. and Gill, D.S. ;(2019). Correlation and Path Coefficient Analysis of traits associated to Grain Protein Concentration and Yield in Wheat (*Triticum aestivum* L.) Cultivars. *Int. J. Pure App. Biosci.* 6(5): 937-942 (2018).
16. Singh, S.K.; Singh, B.N.; Singh, P.K. and Sharma, C.L. (2008). Correlation and path analysis in some exotic lines in wheat *(Triticum aestivum L.). New Botanist,* 35(1/4): 89-94.
17. Singh, A.K.; Singh, S.B.; Singh, A.P. and Sharma, A.K. (2012). Genetic variability, character association and path analysis for seed and its component in wheat (*Triticum aestivum* L.) under rainfed environment. *Indian Journal of Agricultural Research, 46*(1): 48-53.
18. Sleper John M. Poehlman (2006). Blackwell Publishing professinol, 2121 State Avenue, Ames, lowa 50014. pp424.
19. Soni, Kumar, Sandeep; Yadav, A.K.; Singh, B.N. and Yadav, V.K. (2011). Character association and path analysis in exotic and indigenous lines of bread wheat (*Triticum aestivum* L.) under reclaimed and salt affected soil. *Progressive Research*, 6(2): 221-223.
20. Tarkeshwar.; Kumar, Kamlesh.; Yadav Mohit.; Gaur, S.C.; Choudhary, Ravi Prakash and Mishra, Govind (2020). Studied on Correlation and Path Coefficient for yield and its component Traits in bread wheat *(Triticum aestivum*L. em. Thell.). *International Journal of Current Microbiology and Applied Sciences*Special-11: 688-696.
21. Vimal, S.C.; Sarvjeet; Gaur, S.C. and Kumar, Pankaj (2016). Relations of yield and its Characters in mungbean [vigna radiata. (L) Wilczek]. *Progressive research: An International journal,* 11(Special- VI): *3779-3781(2016).*
22. Zaeifizadeh, Khayatnezhad, M.; Ghasemi, M.; Azimi.; Vahabzadeh, J.M. (2011). Path analysis of yield components in synthetic bread wheat (*Triticum aestivum* L. em.Thell.) genotypes. *Advances in Environment Biology*, 5(1): 98-10.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 991-996 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Screening of Guava (*Psidium guajava* L.) Cultivars for the Kymore Plateau of Madhya Pradesh

Deepak Singh, D.P. Sharma, S.K. Pandey N.R. Rangare* and Gourav Gupta
*Jawaharlal Nehru Krishi Vishwa Vidyalaya, Adharatal, Jabalpur, Madhya Pradesh-482004 *Corresponding Author Email : nrrangare@gmail.com*

Abstract

An investigation was carried out to assess the "Identify the best cultivar of guava fruits (*psidium guajava* L.) for the kymore plateau zone of Madhya Pradesh" was carried out during 2020-21 on Fruit Research Station, Imaliya, Department of Horticulture, JNKVV, Jabalpur. The experiment was laid out in Randomized Block Design (RBD) with seventeen genotypes. Among the different genotypes, Jawahar Guava-12 with creamy pulp colour was shown superior to other genotypes with respect of fruit weight (242.63 g), fruit diameter (7.20 cm), fruit length (7.30), number of fruits (258) and yield per tree (62.83 kg/plant), however acidity was at par in Jawahar Guava- 12 (0.35). In comparison to the other genotypes Jawahar Guava-5 with white pulp colour performed superior in several quality parameters with respect of Total sugar content (12.19%) and reducing sugar content (5.98%) however TSS- Acid ratio found at par (36.59). Finally, promising genotypes such as Jawahar Guava-12, and Jawahar Guava-5 were found in this research work.

Key words *: Guava, TSS, acidity, yield.*

Introduction

The Guava (*Psidium guajava* L.) is the most important tropical fruit next to major fruit crops namely mango, banana, citrus and also the fourth most widely consumed tropical fruit. It is a member of the Myrtaceae family having the native of Central America and commonly grown in South Africa, Hawaii, India Mexico etc. It is available round the year, except during the summer season. It's also called "the apple of the tropics" because of its versatility (Hayes, 1970). Morphologically guava fruits are round, ovoid, or pyriform shaped, with tough dark leaves which are opposite, simple, elliptic to ovate and 5-15 cm long. It produces white colour flower. It has a high nutritional value and a pleasant flavour. Vitamin C and pectin are abundant in this fruit. As far as biochemical parameters, guava has a content of 82.50% water, 2.45% acid, 4.45% reducing sugar, 5.23% non-reducing sugar, 9.73% TSS, 0.48% ash and 260 mg of vitamin C per 100 grams of fruit. Salads and puddings can be made with the shells of ripe fruits. (Phandis, 1970) During the ripening of guava fruits, the level of fructose increased which later reduced in overripe fruits (Le-Riche, 1951). Jam, Jelly, Marmalade, Canning and Nectar are important products which is prepared by fully matured guava fruits. Plant growth, yield, and physio-chemical composition differ amongst guava cultivars. Cultivars differed in terms of skin form, colour, size and smoothness, as well as origin, bushy or erect tree, acidic nature, blooming, fruiting and fruit quality. The bloom arises on the axis of new leaves in guava and the bearing happens on current season growth (Alves *et al.* 2020). Guava is successfully grown all over the country with area 2.64 Lakh ha, production 40.53 lakh MT and productivity 15.3 MT per ha. The most important guava growing states are Utter Pradesh, Madhya Pradesh and Bihar. Madhya Pradesh is holding an area of 35.08 thousand ha with production of 686.70 thousand MT (Anonymous 2018). Guava fruits are consumed either fresh or processed. Only 0.05% of the output is exported as guava fruits having such a limited shelf life due to this it is difficult to transport in distance market without compromising the quality. To expand the lifespan of fruits during long-distance transit, refrigerated shipping is necessary, as well as suitable packing and cushioning material.

Materials and Methods

The current research, titled "Identify the best cultivar of guava fruits (*Psidium guajava* L.) for the kymore plateau zone of Madhya Pradesh," was carried out The present experiment was carried out at the Fruit Research Station, Imaliya, Department of Horticulture, JNKVV, Jabalpur (M.P.) during the year 2020-21. During the study only 17 genotypes were selected for detailed study on the basis of fruiting behavior and size of fruits. Selected genotypes were tagged to study their production and biochemical characteristics of fruits :

Three different lots of five fruits each were taken for physical and chemical analysis from each tree. Observation on traits *viz.,* Physical parameters Fruit diameter (cm), Fruit length (cm), Seed weight (g) per fruit, Number of seeds per Fruit, Seed weight (%), Seed ball diameter (cm), Pulp weight (%), Peel pulp ratio, Pulp

Table-1 : Details of genotypes and varieties used in the study.

Sr. No.	Genotypes	Sr. No.	Genotypes
1.	Jawahar Guava-1	10.	Jawahar Guava-10
2.	Jawahar Guava-2	11.	Jawahar Guava-11
3.	Jawahar Guava-3	12.	Jawahar Guava-12
4.	Jawahar Guava-4	13.	Jawahar Guava-13
5.	Jawahar Guava-5	14.	Jawahar Guava-14
6.	Jawahar Guava-6	15.	Jawahar Guava-15
7.	Jawahar Guava-7	16.	Lucknow-49
8.	Jawahar Guava-8	17.	Allahabad Safeda
9.	Jawahar Guava-9		

Seed ratio, Pulp Colour, Quality Parameters-TSS (^{o}Brix), Acidity (%), TSS-Acid ratio, Reducing sugar (%), Non – reducing sugar (%), Total sugar (%), Ascorbic Acid (mg /100g) Yield Parameters - Fruit weight (g), Number of fruits per plant, At each picking, the number of fruits per plant was independently recorded and the weight of the fruit was taken with the help of electronic weighing machine and the average weight or fruit yield (kg) per plant were recorded from randomly selected fruits from accession. The fruit size, is measured in terms of length and width. Fruit length was measured from the tip of the fruits to other end using digital Vernier-caliper. Fruit width was taken at the middle of the fruit across the fruit length using digital Vernier- caliper. The weight of a selected sample of fruits was determined by digital electronic balance having. Seed weight was measured using electrical balance, it was expressed in grams. Pulp weight or the weight of consumable part was measured using the following formula :

Pulp weight (g) = Weight of fruit (g) – seed weight (g)

The percent consumable part of the fruit i.e. pulp was measured using the following formula :

$$\text{Pulp \%} \quad \frac{\text{Weight pulp (g)}}{\text{Weight of the fruit (g)}} \quad 100$$

The percent non-edible part of the fruit i.e. seed was measured using the following formula :

$$\text{Seed \%} \quad \frac{\text{Weight seed (g)}}{\text{Weight of the fruit (g)}} \quad 100$$

Pulp to seed ratio was calculated using formula :

$$\text{Pulp of seed ratio} \quad \frac{\text{Pulp weight (g)}}{\text{Seed weight (g)}} \quad 100$$

Visual observations were made for determination of fruit colour and pulp colour. Total soluble solids were estimated in term of percent with the help of hand refractometer. Titrable acidity was estimated by titrating 10 ml juice against 0.1 N NaOH using phenolphthalein as indicator. The acidity was determined in terms of lactic acid. The volume of alkali used was noted and calculated using the following formula :

$$\text{\% Titrable acidity} = \frac{\text{Normality of NaOH} \quad 0.009}{\text{Weight of sample (g)}} \quad 100$$

Ascorbic acid content of fruits was determined using standardized 2,6-dichlorophenol indophenol dye and expressed in mg per 100 g of pulp. The data collected on all the quantitative characters were subjected to basic Randomized Block Design analysis and following different statistical parameters were worked out using OP Sheoran Programmer, SPSS statistical software.

Results and Discussion

An investigation of the selected genotypes was carried out, with a focus on the relationship between physicochemical and yield characteristics of fruits. The results are discussed in light of prior studies conducted in India and elsewhere with proper justifications. Intensive scanning of the current seedling populations and phenotypic diversity in the large population is one of the most important requirements for any crop improvement programme. The maximum genetic potential and possibilities is required for creating a desired type. Seventeen genotypes were chosen for the investigation on the basis of various vital factors.

Physical parameters of fruits : At the harvest stage, as shown in (Tables-2 and 3) there was great extent of variance in fruit diameter and length. The genetic diversity in fruit diameter varied from 4.23 cm to 7.20 cm across the different genotypes. Fruit lengths varied from 4.97 cm to 7.30 cm, revealed significant variations across the genotypes. The availability and quantity of auxins, which are translocated from pollen grains to developing ovules, is another element that controls fruit development. Although fruit size is a varietal trait, it may be controlled to some extent by the total number of fruits produced on the tree, soil moisture, and the source-sink relationship. Varietal variations for physical characters have also been reported by Sharma *et al*. (2010), Singh *et al*. (2015) and Karanjalker and Kumar (2015). The overall seed weight per fruit was considerably different, ranging from 1.61 g to 4.25 g. Jawahar Guava-9 genotype has the smallest seed weight per fruit (1.61 g). The quantity of seeds per fruit ranged from 122.67 to 328.67. whereas Jawahar Guava-4 (122.67) has the lowest number of seeds per fruit and Jawahar Guava-10 has the highest number of seeds per fruit (328.67) whereas, maximum seed weight percentage recorded in Jawahar Guava-10 (2.85%) and minimum seed weight percentage found in Allahabad Safeda (1.16%) depends upon total number of seeds per fruit and their weight. The fruit of nine genotypes had tiny seeds and a low weight. Khan *et al*. (2019), Verma and Singh

Table-2 : Mean performance of different physical parameters of Fruit of Guava genotype with respect of Fruit diameter (cm), Fruit length (cm), Seeds weight (g), Number of seeds per fruit and seed weight percentage.

S. No.	Genotypes	Fruit diameter (cm)	Fruit length (cm)	Seed weight (g)/per fruit	Number of seeds per fruit	Seed weight %
1.	Jawahar Guava-1	4.97	5.97	3.49	259.33	2.16
2.	Jawahar Guava-2	5.13	5.83	2.84	212.33	1.86
3.	Jawahar Guava-3	5.00	6.00	2.61	315.00	1.57
4.	Jawahar Guava-4	4.83	6.60	2.01	122.67	1.22
5.	Jawahar Guava-5	4.27	5.80	2.91	264.67	1.69
6.	Jawahar Guava-6	4.23	5.53	2.32	160.00	1.31
7.	Jawahar Guava-7	4.53	4.97	2.36	210.33	1.69
8.	Jawahar Guava-8	4.67	6.20	2.65	295.67	1.64
9.	Jawahar Guava-9	5.83	5.93	1.61	179.00	1.18
10.	Jawahar Guava-10	5.83	6.33	4.25	328.67	2.85
11.	Jawahar Guava-11	6.07	6.77	3.83	309.67	2.16
12.	Jawahar Guava-12	7.20	7.30	3.90	267.67	1.64
13.	Jawahar Guava-13	5.43	6.40	4.21	282.67	2.39
14.	Jawahar Guava-14	4.33	5.17	2.05	197.67	1.73
15.	Jawahar Guava-15	6.57	5.53	1.74	141.67	1.32
16.	Lucknow-49	7.07	6.67	2.72	257.67	1.21
17.	Allahabad Safeda	7.00	7.10	2.21	225.67	1.16
	S.E(m) ±	0.321	0.338	0.371	20.380	0.294
	CD at 5 % level	0.924	0.974	1.069	58.708	0.846

Table-3 : Mean performance of different physical parameters of Fruit of Guava genotype with respect of Seed ball diameter (cm), Pulp weight %, Peel-Pulp ratio, Pulp-Seed ratio and Pulp colour.

S. No.	Genotypes	Seed ball diameter (cm)	Pulp weight %	Peel-Pulp ratio	Pulp-Seed ratio	Pulp colour
1.	Jawahar Guava-1	3.87	93.08	0.051	45.58	White
2.	Jawahar Guava-2	4.03	94.90	0.034	52.49	Creamy
3.	Jawahar Guava-3	3.73	93.87	0.049	60.27	Creamy
4.	Jawahar Guava-4	4.07	95.13	0.038	78.54	White
5.	Jawahar Guava-5	3.33	92.40	0.064	57.88	White
6.	Jawahar Guava-6	3.13	94.26	0.047	76.90	Creamy
7.	Jawahar Guava-7	3.83	93.69	0.049	57.33	White
8.	Jawahar Guava-8	3.83	93.87	0.048	57.34	White
9.	Jawahar Guava-9	4.23	94.21	0.049	80.04	White
10.	Jawahar Guava-10	4.27	92.09	0.055	36.96	Creamy
11.	Jawahar Guava-11	4.90	94.06	0.040	48.60	White
12.	Jawahar Guava-12	4.60	95.21	0.033	61.83	Creamy
13.	Jawahar Guava-13	4.07	93.34	0.046	39.23	White
14.	Jawahar Guava-14	3.20	94.35	0.042	63.31	White
15.	Jawahar Guava-15	4.03	94.34	0.046	75.14	White
16.	Lucknow-49	4.57	97.02	0.018	83.59	Creamy
17.	Allahabad Safeda	4.33	96.87	0.020	85.99	Creamy
	S.E(m) ±	0.225	0.571	0.004	9.597	—
	CD at 5 % level	0.648	1.643	0.013	27.645	

(2015) and Singh *et al*. (2015) found similar findings. In different genotypes seed ball diameter differ between 3.13 cm to 4.90 cm whereas Jawahar Guava-6 had minimum seed ball diameter (3.13 cm) and genotype Jawahar Guava-11 had maximum seed ball diameter (4.90 cm). This study was in close conformity with the findings of Singh *et al.* (2015) and Patel *et al*. (2005). The pulp weight percentage extended the range from 92.09 per cent to 97.02 per cent amongst the selected genotypes. Genotypes L-49 exhibited highest pulp weight percentage (97.02%) followed by Allahabad Safeda (96.87%) while, Jawahar Guava-10 exhibited the minimum (92.09%) pulp weight percentage respectively. The pulp seed ratio ranged from 36.96 to 85.99 in all the genotypes. The maximum and minimum pulp seed ratio was depicted by Allahabad Safeda (85.99) and Jawahar Guava-10 (36.96) respectively. Pulp weight percentage depends upon availability of pulp weight against total fruit weight and

Table-4 : Mean performance of different quality parameters of Fruit of Guava genotype with respect of Total soluble solids (°Brix), Acidity % and TSS-Acid ratio.

S. No.	Genotypes	TSS °Brix	Acidity (%)	TSS : Acid ratio
1.	Jawahar Guava-1	12.53	0.38	34.59
2.	Jawahar Guava-2	12.07	0.34	36.12
3.	Jawahar Guava-3	10.40	0.35	30.01
4.	Jawahar Guava-4	12.20	0.36	34.08
5.	Jawahar Guava-5	12.17	0.33	36.59
6.	Jawahar Guava-6	10.07	0.36	27.72
7.	Jawahar Guava-7	11.17	0.36	31.02
8.	Jawahar Guava-8	9.70	0.35	27.66
9.	Jawahar Guava-9	8.77	0.37	23.90
10.	Jawahar Guava-10	13.17	0.34	39.12
11.	Jawahar Guava-11	12.07	0.34	35.21
12.	Jawahar Guava-12	12.20	0.35	34.50
13.	Jawahar Guava-13	9.77	0.29	34.09
14.	Jawahar Guava-14	10.70	0.36	30.16
15.	Jawahar Guava-15	11.67	0.31	38.15
16.	Lucknow-49	10.27	0.35	29.46
17.	Allahabad Safeda	13.15	0.32	40.99
	S.E(m) ±	0.320	0.014	1.689
	CD at 5 % level	0.922	0.042	4.864

Table-5 : Mean performance of different physical parameters of Fruit of Guava genotype with respect of Reducing sugar %, Non-reducing sugar %, Total sugar % and Ascorbic acid content.

S. No.	Genotypes	Reducing Sugar (%)	Non reducing Sugar (%)	Total Sugar (%)	Ascorbic acid (mg/100 g)
1.	Jawahar Guava-1	5.05	5.74	10.79	187.14
2.	Jawahar Guava-2	5.49	6.00	11.49	183.66
3.	Jawahar Guava-3	5.39	5.94	11.33	169.13
4.	Jawahar Guava-4	5.47	6.06	11.53	189.18
5.	Jawahar Guava-5	5.98	6.21	12.19	164.52
6.	Jawahar Guava-6	4.49	6.06	10.55	156.27
7.	Jawahar Guava-7	5.55	6.04	11.59	166.63
8.	Jawahar Guava-8	5.03	6.21	11.24	179.28
9.	Jawahar Guava-9	5.15	6.23	11.38	232.25
10.	Jawahar Guava-10	5.19	6.20	11.39	241.73
11.	Jawahar Guava-11	5.15	6.35	11.50	171.63
12.	Jawahar Guava-12	4.69	5.54	10.23	155.79
13.	Jawahar Guava-13	5.56	6.49	12.05	249.66
14.	Jawahar Guava-14	5.11	6.29	11.39	168.22
15.	Jawahar Guava-15	5.38	6.35	11.72	144.72
16.	Lucknow-49	5.39	5.45	10.83	245.67
17.	Allahabad Safeda	4.85	5.41	10.26	243.16
	S.E(m) ±	0.218	0.198	0.260	4.011
	CD at 5% level	0.629	0.569	0.748	11.554

decreased numbers of seed and their weight. These findings are confirmed by Rajore *et al*. (2021), Pandey *et al.* (2016) and Sahoo *et al.* (2017). Pulp seed ratios varied from 36.96 to 85.99, with Allahabad Safeda having the greatest pulp seed ratio and Jawahar Guava-10 having the lowest. These findings are also reported by Patel *et al.* (2011). Peel pulp ratio varied substantially between genotypes, ranging from 0.018 to 0.064. The genotype L-49 had the lowest peel pulp ratio, whereas Jawahar Guava-5 had the greatest peel pulp ratio. Among the different genotypes Allahabad Safeda, L-49 (Sardar), Jawahar Guava-2, Jawahar Guava-3, Jawahar Guava-6, Jawahar Guava-10 and Jawahar Guava-12 had Creamy pulp colour, while genotypes Jawahar Guava-1, Jawahar Guava-4, Jawahar Guava-5, Jawahar Guava-7, Jawahar Guava-8, Jawahar Guava-9, Jawahar Guava-11, Jawahar Guava-13, Jawahar Guava-14 and Jawahar Guava-15 had white pulp

Table-6 : Mean performance of different yield parameters of Fruit of Guava genotype with respect of Fruit weight (g), Number of fruits per plant and yield per plant (kg).

S. No.	Genotypes	Fruit Weight (g)	Number of fruits per plant	Yield per plant (kg)
1.	Jawahar Guava-1	165.00	149.67	24.85
2.	Jawahar Guava-2	156.00	119.00	18.11
3.	Jawahar Guava-3	166.20	172.33	28.59
4.	Jawahar Guava-4	165.19	89.00	14.38
5.	Jawahar Guava-5	174.27	159.67	28.23
6.	Jawahar Guava-6	177.41	202.00	35.74
7.	Jawahar Guava-7	139.13	196.67	27.59
8.	Jawahar Guava-8	161.98	123.67	20.28
9.	Jawahar Guava-9	136.67	171.67	23.53
10.	Jawahar Guava-10	161.50	165.00	27.74
11.	Jawahar Guava-11	179.95	130.67	23.42
12.	Jawahar Guava-12	242.63	258.00	62.83
13.	Jawahar Guava-13	176.83	115.00	20.42
14.	Jawahar Guava-14	120.27	139.00	16.49
15.	Jawahar Guava-15	133.17	92.67	12.49
16.	Lucknow-49	231.73	223.33	52.45
17.	Allahabad Safeda	191.35	240.33	45.89
	S.E(m) ±	13.424	17.483	4.625
	CD at 5 % level	38.671	50.364	13.324

Quality parameters of fruits : Significant variation in quality parameters observed in (Tables-4 and 5) all guava genotypes. Jawahar Guava-10 had the maximum total soluble solids (13.17 °Brix) while Jawahar Guava-9 had the minimum total soluble solids (8.77 °Brix). Ran *et al.* (2017), Sharma *et al.* (2010) and Kumar *et al.* (2017) found comparable findings. Within the genotypes, acidity percentages ranged from 0.29 percent to 0.38 percent, with the highest acidity (0.38 percent) found in genotype Jawahar Guava-1 and the lowest acidity found in genotype Jawahar Guava-13 (0.29 percent). The ascorbic acid concentration ranged from 144.72 mg/100 g (Jawahar Guava-15) to 249.66 mg/100 g (Jawahar Guava-13), indicating a wide range for genotype selection. Variation in TSS, acidity, and ascorbic acid may have arisen as a result of genotypic diversity, inheritance, and the effect of agro-climatic circumstances. Similar finding about acidity was confirmed by Pandey *et al.* (2016) where he found out that cultivars CISH-G 31 had maximum acidity (0.36%) and lowest acidity percentage reported under Cultivar Hisar Safeda (0.26%), whereas, similar values also confirmed by Patel *et al.* (2011) where he investigated and stated that Ascorbic acid ranged between 149.13 mg/ 100g (RCG-3) and 246 mg/100g (RCGH-1). Transgressive segregation was evident in the higher and lower values for all of these characteristics, which is very useful in identifying the appropriate elite types for the requirement. TSS acidity ratio ranged from 23.90 to 40.99 in which genotype Allahabad Safeda had reported highest TSS acid ratio (40.99) and Jawahar Guava-9 found to be lowest TSS acid ratio (23.90). Similar findings had been reported by Gosh *et al.* (2013), Patel *et al.* (2015) and Sahoo *et al.* (2017). In this study, the highest reducing sugar was found in genotype Jawahar Guava-5 (5.98%), while the highest non-reducing sugar and total sugars were found in genotype Jawahar Guava-13 (6.49%, 12.19% respectively). The lowest reducing sugar values were found in genotype Jawahar Guava-6 (4.49%), non-reducing sugar in Allahabad Safeda (5.41%), and total sugar in Jawahar Guava-12 (10.23%). In terms of quality characteristics, genotypes Jawahar Guava-13, Allahabad Safeda, and Jawahar Guava-5 were shown to be better. The differences in chemical components across varieties were due to genetic characteristics as well as environmental variables such as temperature and humidity during the time of development. Similar varietal variation had been reported by Singh *et al.* (2002), Choudhary *et al.* (2008) and Pandey *et al.* (2016).

Yield parameters of fruits : The mean weight of fruit during harvesting showed a substantial amount of variance, as indicated in Tables-6. The fact that mean fruit weight varied from 120.27 g to 242.63 g among genotypes might be related to intrinsic characteristics and environmental adaptation in a specific location, which could be a significant diagnostic trait for genotype selection. The genotype Jawahar Guava-12 had mean fruit weight 242.63 g which is comparable to L-49, produced the largest mean fruit (234.73 g). Verma and Singh (2015), Gupta *et al.* (2017) and Verma and Singh (2015) reported similar findings. No. of fruits per tree ranged from 89 (Jawahar Guava-4) to 258 (Jawahar

Guava-12). It revealed significant variation among chosen genotypes. The yield of per tree ranged from 12.49 kg in Jawahar Guava-15 to 62.83 kg in Jawahar Guava-12. The differences in fruit number and yield across genotypes might be attributed to intrinsic characteristics and environmental adaptation in a certain location, which could be a useful diagnostic character for genotype selection in further breeding programme. The quantity of fruits grows in several genotypes, but the weight of the fruits was dropped due to small size. This might be owing to the increased distribution and diversion of available food materials into development of additional fruits. Climate factors might be the reasons that influenced size and quality of fruit in guava as also reported by Thimmappaih and Suman (1986). Similar findings were also reported by Singh *et al.* (2002) and Kumar *et al.* (2015).

References

1. Alves LB, Passos AB, Noia LR, Canal GB, Ferreira A and Ferreira MFS. 2020. Epigenetic variation in guava (Psidium guajava) genotypes during the vegetative and reproductive phases of the production cycle. *Genetics and Molecular Research* 19(2): 1-14.
2. Anonymous 2018. Horticultural Statistics at a Glance, Database (www. Agricoop. nic.in).
3. Choudhary ML, Dikshit SN, Shukla N and Saxena RR. 2008. Evaluation of Guava (*Psidium guajava* L.) varieties and standardization of recipe for nectar preparation. *Journal of Horticulture Science* 3(2): 161-163.
4. Ghosh SN, Roy S and Bera B. 2013. Study on performance of twenty-one guava cultivars in red and laterite soil of West Bengal under irrigated condition. *Journal of Crop and Weed* 9(2): 81-83.
5. Gupta N, Gill MIS and Arora NK. 2017. Evaluation of guava genotypes genotypes based on morphological and physico-chemical characteristic. The Bioscan 12(3): 1607-1610.
6. Karanjalker GR and Kumar P. 2015. Comparative physico-chemical and sensory evaluation of fruits of guava (*Psidium guajava* L.) cultivars. *Progressive Horticulture* 47(1): 170-172.
7. Khan AA, Das A and Sarkar SK. 2019. Profiling of fruit physico-chemical attributes of some promising guava (*Psidium guajava* L.) cultivars under the new alluvial zone of West Bengal. *Journal of Pharmacognosy and Phytochemistry* 8(5): 588-592.
8. Kumar J, Kumar R, Tripathi S and Singh VP. 2017. Physico-chemical and morphological evaluation of guava (*Psidium guajava* L.) genotype under Tarai conditions. *HortFlora Research Spectrum* 6(2): 97-101.
9. Kumar P, Ulemale H and Tambe BT. 2015. Performance of guava genotype to qualitative and yield attributes. *Supplement on Genetics and Plant Breeding* 10(2): 781-784.
10. Le-Riche F. 1951. Chemical changes during the development of guava varieties. *Union of South African Department of Agriculture, Bulletin* no. 21.
11. Pandey D, Pandey AK and Yadav SK. 2016. Evaluation of newly developed guava cultivars & selections under Lucknow conditions. *Indian Journal of Horticulture* 73(3): 334-338.
12. Patel RK, Maiti CS, Deka BC, Deshmukh NA, Verma VK and Nath A. 2011. Variability Studies in Guava (*Psidium guajava* L.) Genotypes for Growth, Yield and Quality Attributes at mid-hills of Meghalaya. I*ndian Journal of Hill Farming* 24(1&2): 24-28.
13. Patel RK, Maiti CS, Deka BC, Deshmukh NA, Verma VK and Nath A. 2015. Physical and biochemical changes in guava (*Psidium Guajava* L.) during various stages of fruit growth and development. *International Journal of Agriculture, Environment & Biotechnology* 8(1): 63-70.
14. Patel RM, Pandey A, Dwivedi SK and Sharma G. 2005. Studies on physicochemical properties of guava (*Psidium guajava* L.) cultivars grown in Rewa. *Plant Archives* 5(2): 597-600.
15. Phadnis NA. 1970. Improvement of guava (*Psidium guajava* L.) by selection in Maharastra. Indian Journal of Horticulture 27: 99–105.
16. Rajore M, Kanwar J, Rathore GPS and Kachouli B. 2021. Evaluation of guava (*Psidium guajava* L.) cultivars for morphological, yield and quality attributes under Malwa plateau conditions. *Journal of Pharmacognosy and Phytochemistry* 10(2): 483-485.
17. Ran S, Sharma JR and Jakhar MS. 2017. Assessment of genetic diversity and diversity relationship in different varieties of guava using morphological characterization. *Plant Archives* 17(1): 307-311.
18. Sahoo J, Tarai RK, Swain SC, Sethy BK and Dash D. 2017. Physico-chemical analysis some guava genotypes during rainy and winter season under east and south east coastal plain zone of Odisha. *International Journal of Chemical Studies* 5(6): 527-531.
19. Sharma A, Sehrawat SK, Singhrot RS and Tele A. 2010. Morphological and Chemical Characterization of Psidium Species. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca Journal* 38(1): 28-32.
20. Singh D, Gill MIS, Boora RS and Arora NK. 2015. Genetic diversity analysis in guava (*Psidium guajava*) on the basis of morphological and physico-chemical traits. *Indian Journal of Agricultural Sciences* 85(5): 678–83.
21. Singh S, Singh J and Hoda MN. 2002. Evaluation of guava germ plasm under Sabour (Bihar) conditions. *Indian Journal of Agricultural Sciences* 72(7): 393-395.
22. Thimmappaiah and Suman CL. 1986. Seasonal effect on fruit quality in guava (*Psidium guajava* L.). *South Indian Horticulture Journal* 34(2): 64-69.
23. Verma A and Singh SP. 2015. Studies on physico-chemical attributes of guava (*Psidium guajava*) cultivars. *Progressive Horticulture* 47(1): 53-56.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 997-1000 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Performance of Growth and Flowering Response of Marigold on Rice Bund Condition in Chhattisgarh Plains

Gunjan Jha[1]* and L.S. Verma[2]
[1]*IGKV-Krishi Vigyan Kendra, Rajnadgaon, Chhattisgarh*
[2]*Department of Floriculture and landscape Indira Gandhi Krishi Vishwavidyalya, Raipur, Chhattisgarh*
**Corresponding Authour Email : gunsoon183@gmail.com*

Abstract

The main objective of investigation was to utilize the rice bunds through selection of best crops and evaluate the suitable flower crops under bund condition. the main objective of this investigation was selection of superior flower crops and its variety to utilize the rice bund. The present investigation was undertaken in the field of Krishi Vigyan Kendra Rajnandgaon, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during winter season of 2018-20. The experiment was carried out in Randomized Block Design with four replications. The treatment comprised of four varieties of marigold flower crops. Under this investigation the growth attributes plant height (108.24 cm., 110.0 cm) and plant spread (63.0, 65.8 cm) were shown significantly maximum in variety Pusa arpita but in flowering characters Pusa deep shown maximum number of flowers (156, 163 No.) due to more number of branches and it was show statistically superior from others.

Key words *: Flowering characters. growth characters, marigold, rice bund.*

Introduction

The demand for flowers is increasing tremendously with the changing scenario of progressive economy, changing life style and changes in social values of people of the country.Marigold, a member of the family Asteraceae, is a potential commercial flower that is gaining popularity on account of its easy culture, wide adaptability and short-term lucrative return and increasing demand in the subcontinent. It is native of Central and South America especially Mexico. Genus Tagetes consists of 33 species, out of these species, *Tagetes erecta L*., commonly called African marigold and *Tagetes patula L*. popular as French marigold are of great horticultural importance and is grown commercially for exquisite blooms. Both the species of marigold are suitable for garden display and grown commercially for use as cut flowers and loose flowers. It is highly suitable as a bedding plant in an herbaceous border and is also ideal for newly planted shrubberies to provide color and to fill the space. It has attracted the attention of flower growers due to its wide spectrum of attractive colors, shape, size and good keeping quality.

The situation of Floriculture crops in Chhattisgarh state has been taken up on area in about 13200 ha with a production of 47500 MT (mainly loose flowers) with productivity of 3.60 MT/ha. With sixth rank, contribution of this state in the national floriculture (loose flowers) is about 8.15 % (Anonymous 2018) whereas, marigold production is 33288 MT and area is 4692 ha in the year of 2017-18 (Anonymous 2017-18).

Rice is staple food of the state and it is grown in 3.7 million ha. area, which is 68.8 % of the total agricultural land of the state *i.e.,* state is known as a “Rice bowl” of central India but productivity is low in Chhattisgarh due to more than 55.40 % farmers are marginal and 21.96% are small farmers (Anonymous, 2018), they have very small and scattered land holdings. These small holdings are further surrounded by *med (*bund) and it occupies a significant portion of the arable rice production area it plays a critical role in retaining moisture/water on sloped ground, providing access to fields, and delineating ownership but bunds may, serve as sources of weed propagules if poorly managed, on the other hand, well-managed bunds may provide a source of income through the production of cash crops. The estimated area of bund is approximately 3, 79, 250 ha. this area is almost wasted which reduces the net cropped area which further reduce the average productivity of the State (Singh *et al.* 2016). To overcome aforesaid problems selection of suitable remunerative crop is important for the state, the flower crops especially marigold is most suitable crops. Therefore, marigold should be evaluated under rice bund conditions on different parameters and recommended to farmers for adopting flower on bund plantation technology to increase the production level of area. Keeping in view, a study was conducted to assess the performance of four marigold varieties under rice bund condition of Chhattisgarh plains.

Materials and Methods

The present investigation was conducted during winter season of 2018-19 and 2019-20 at Krishi Vigyan Kendra Rajnandgaon. Indira Gandhi Krishi Vishwavidyalaya,

Raipur (C.G.), Chhattisgarh is situated between 17°14N 24°45'N latitude and 79°30E 84°15'E longitude. Rajnandgaon situated on the bank of Shivnath river and falls between 21°06'N latitude and 81°02' E longitude at an altitude of 307 meter above the mean sea level. It having tropical and dry spell throughout the year. The materials utilized for the present study consisted of four varieties Pusa deep, Pusa Arpita, Pusa bahar, and Calcutta marigold. The experimental field was laid out in Randomized Block Design with four replications. The experimental field was rice bund area, ploughed well with the help of mould board plough and experiment was laid out in the field as per layout plan with the help of measuring tape, rope and bamboo pegs and then ridges and furrows was prepared between 45 cm distance of RxR and used 30-micron poly mulching with drip line. A recommended dose of F.Y.M. @ 10 kg/m2 was applied to all the plots before planting. Marigold seedlings were transplanted after 27 days of sowing. The light irrigation was done immediately after transplanting. Marigold seedlings are generally soft, tender and susceptible to damping off. Hence, in case of mortality gap filling was done after two weeks of transplanting. Observations on important characters viz., plant height, plant spread, total number of branches plant-1, and flowering attributes; Number of days for first bud appearance (Days), Number of days for 50 % flowering (Days), Number of flowers per plant (No.).

Treatment details :

Treatment	Name of variety
CV1	Pusa Deep
CV2	Pusa Arpita
CV3	PusaBahar
CV4	Calcutta marigold

Results and Discussion

The analysis of variance revealed that all the genotypes differed significantly from each other for the growth attributes. The mean performance of the genotypes for growth and flowering attributes have been presented in table-1.

Plant height (cm) : Under the rice bund condition significantly maximum plant height (108.24 cm., 110.0 cm) was obtained in Pusa arpita, followed by Pusa bahar (93.05cm, 94.3 cm), Pusa arpita was at par with others and it was statistically superior to all other varieties whereas, it was recorded minimum in Calcutta marigold (54.45 cm, 57.9 cm) in both of the years.Plant height is attributed to be an important varietal character that depends upon the genetic constitution. The variation in plant height among the various genotypes might be due to genotypic differences in phenotypic expression of plant height and variations in different genotype-environmental interaction effects on plant height (Bharathi and Jawaharlal, 2014). Similar variation in plant height due to genotypes was also reported by Rao *et al.* (2005), Singh & Singh (2006) and Khanvilkar *et al.* (2003) in marigold.

Plant spread (cm) : The plant spread was measured in the five randomly selected plants with the help of meter scale in the North- South and East-West direction. The average value was then worked out. At 90 DAT, Plant spread varied significantly in different genotypes of marigold and it ranged from 24.1 to 63.0 cm. & 27.6 to 65.8 cm. The significantly maximum plant spread observed in variety Pusa arpita (63.0, 65.8 cm) followed by Pusa deep (58.0, 65.1 cm), Pusa arpita was at par with others and show superior from other varieties in first year but in second year it was at par with varieties Pusa bahar (29.8, 33.2 cm) and Calcutta marigold (24.1, 27.6 cm) whereas, it was calculated minimum in Calcutta marigold (24.1, 27.6 cm). The difference in plant spread might be due to the characters which are inherited by the genotypes. Variation in plant spread has been attributed to the additive gene effects. Similar variations in plant spread have also been observed by earlier workers (Beniwal *et al.* 2012, Narsude 2010 b, Raghuvanshi *et al.* 2011, Choudhary *et al*. (2014), Nandkishor and Raghav (2001) in marigold germplasm. The observations are in line with the finding of Singh *et al.* (2003), Narsude *et al.* (2010), Raghuvanshi and Sharma (2011) and Choudhary *et al.* (2014) in marigold, who also observed variation in plant spread in different genotypes of marigold due to the inherent character of marigold genotypes.

Total Number of branches/plant : All the branches which came out from the main stem and secondary branches were counted and recorded at 90 DAT. This was done on all the five tagged plants in each treatment and then average worked out. At 90 DAT, the maximum numbers of primary branches plant^{-1} were noticed in Pusa deep (117, 120.5 No.) followed by variety Pusa arpita (77.2, 79.5 No.), Pusa deep at par with others whereas, it was observed minimum in Pusa bahar (32.8, 36.5 No.) in both of the years. The variation in number of primary branches plant^{-1} might be due to the difference in their genetic composition and varied growth rate among the genotypes of marigold (Narsude *et al*., 2010). Further, the individual genetic makeup of the genotypes may also have been influenced by the environmental conditions. Similar variations for number of branches were also observed by Rao *et al*. (2005), Narsude *et al*. (2010 a) in marigold and Munikrishnappa *et al*. (2013) in China aster. The numbers of secondary branches plant^{-1} may have increased due to pinching of plant which might have forced the auxiliary buds to thrive well (Kelly and Harbaugh, 2002). Similar results have also been reported by Khanvilkar *et al.* (2003)

Table-1 : Performance of Growth and flowering attributes of marigold varieties at 90 (DAT).

Treatments	Plant height (cm)		Total number of branches /plant (No.)		Plant spread (cm)		Number of days for first bud appearance (Days)		Number of days for 50 % flowering (Days)		Number of flowers per plant (No.)	
	Years											
	I	II	I	II	I	II	I	II	I	II	I	II
Pusa Deep	78.65	80.8	58	65.1	117	120.5	54.6	51.3	74.1	76.7	156.0	163.0
Pusa Arpita	108.24	110	63	65.8	77.2	79.5	54.9	52.8	69.6	68.1	93.8	114.0
Pusa Bahar	93.05	94.3	29.8	33.2	32.8	36.5	52.9	54.6	73.5	75.6	93.5	99.1
Calcutta marigold	54.45	57.9	24.1	27.6	61.1	63.7	45.5	46.2	65.9	66.4	23.5	26.0
SEm±	0.67	0.55	0.52	0.99	0.57	0.65	0.56	0.55	0.45	0.53	3.62	2.36
CD @ 5%	2.13	1.76	1.67	3.16	1.85	2.08	1.85	1.76	1.44	1.69	11.58	7.58

in marigold and Munikrishnappa *et al.* (2013) in China aster.

Number of days for first bud appearance (Days) : First bud appearance was observed in variety Calcutta marigold (45.5, 46.2 days) but maximum time was taken for first bud appearance in variety Pusa arpita, Pusa deep (54.9, 54.6 days) in both years respectively. This could be due to absorption of more nutrients and nutrient uptake in addition to prevailing favorable environment, i.e., low night temperature and short-day lengths Rao *et al.* (2005). The genetic control of all these characters and modification in their expression due to environmental conditions might be the possible causes of observed variation reported by Panwar *et al.* (2013). Naik *et al.* (2005) stated that the variation in the appearance of first bud might be the genetic makeup and varied growth behavior of the genotype. Similar reports were given by Bhaskaran *et al.* (2016) in Gaillardia.

Number of days for 50 % flowering (Days) : Pusa deep was required more number of days (74.1, 76.7 days) for 50% flowering in both the years and it was at par with Pusa bahar and Calcutta marigold in first year while, in second year it was at par with Pusa arpita (68.1 days) and Calcutta marigold (66.4 days) whereas, it was obtained minimum in Calcutta marigold (65.9, 66.4 days) in both the years. Based on the genetic makeup, different genotypes might also take different time period for flowering (Singh & Singh, 2006). The similar findings were reported by Nair *et al.* (2003) in gerbera and Singh & Mishra (2008) in marigold.

Number of flowers per plant (No.) : The significantly maximum number of flowers (156, 163 No.) was obtained in Pusa deep cultivar and it was show statistically superior from others, while it was calculated minimum in Calcutta marigold (23.5, 26.0 No.) in both the years. The variation might be due to the hereditary characters of the genotypes. The variation might be due to increased or decreased number of branches. Moreover, photo-synthesis efficacy might also be responsible as it helps in enhancing food accumulation which results in better growth of the plant resulting higher number of flowers. Under this investigation total number of branches per plant also observed in Pusa deep variety. Singh & Mishra (2008), Sunitha *et al.* (2007), Narsude *et al.* (2010), Beniwal & Dahiya (2012) in marigold and Singh & Sangama (2000) in China aster reported similar findings.

Conclusion

The estimated area of bund is approximately 3, 79,250 ha. this area is almost wasted which reduces the net cropped area which further reduce the average productivity of the State (Singh *et al.* 2016). In some parts of Chhattisgarh bund is utilized by farmers for pulse production especially pigeon pea in kharif @ 1.5 tones/ha productivity, which would add to pulse production of the state by 3.75 lakh tones (Anonymous, 2007) but pigeon pea is long duration crop generally damaged by monkey, infested by many insect pest and grazing after rice harvest, to overcome aforesaid problems marigold is one of the best option to grow on bund condition of rice.

References

1. Anonymous, Horticultural Statistics at a Glance. (2018). Anonymous, CG Hort data (2017-18).
2. Aditya, D. K. (1992). Floriculture in national economy. *Proceedings of the 6th National Horticultural Conference and Symposium*, BSHS, pp 30-35.
3. Baskaran V., Abirami K. (2016). Effect of growth substances on growth, flowering and corm production in gladiolus (Gladiolus grandiflorus) cv White Prosperity under Bay Island conditions. *Indian Journal of Agricultural Sciences* 86: 216–219.
4. Beniwal, B.S. and Dahiya, S.S., (2012). Variability studies in marigold (*Tagetes* spp.). In: Abstracts of National Seminar on Sustainable Agriculture and Food Security: Challenges in Changing Climate, held at CCS Haryana Agricultural University, Hisar, Haryana, March 27-28, p. 298.
5. Bharathi T.U., Jawaharla M., Kannan M., Manivannan N., and Raveendran M. (2014). Correlation and Path Analysis In African Marigold (*Tagetes Erecta* L.). The Bioscan: *An International Quarterly Journal of Life Sciences*. 9(4): 1673-1676.

6. Choudhary, M., Beniwal, B. S. and Kumari, A. (2014). Evaluation of marigold genotypes under semi-arid conditions of Haryana. *Annals of Hort*., 7(1): 30-35.
7. Dadlani, N. K. (2003). Global positioning of Bangladesh floriculture. A paper presented on a seminar held on 6th November, 2003, BARC, Famgate, Dhaka.
8. Khanvilkar, M.H. (2003). Performance of African marigold (*Tagetes erecta*) in north Konkan coastal zone of Maharashtra. *Journal of Maharashtra Agriculture University*, 28(3): 333-334.
9. Mohanty CR, DK Sena and RC Das. (1994). Studies on effect of corm size and pre-planting chemical treatments of corms on growth and flowering of Gladiolus. *Orissa Journal of Horticulture* 22(1/2): 1-4.
10. Munikrishnappa, P. M., Patil, A.A., Patil, V.S., Patil, B.N., Channappagoudar, B.B. and Alloli, T.B. (2013). Studies on the growth and yield parameters of different genotypes of China aster (*Callistephus chinensis*L. Ness). Karnataka. *Journal of Agriculture Sciences*, 26(1): 107-111.
11. Naik, B.H., Patil, A.A. and Basavaraj, N. 92005). Stability Analysis in African marigold (*Tagetes erecta* L.) Genotypes for Growth and Flower Yield. *Karnataka Journal Agriclture. Sciences.* 18(3): 758-763.
12. Nair, S. A. and Shiva, K.N. (2003). Genetic variability, correlation and path coefficient analysis in gerbera. *Journal of Ornamental Horticulture*, 6 (3): 180-187.
13. Nandkishore, Raghva, S.P.S. (2001). Variability studies in African marigold. *Journal of Ornamental Horticulture*, 4(2):124-125.
14. Naresh, S., Rao, A. V. Bhaskar, D. D., Krishna, V. V., Uma. K. and Rao, M.P. (2015). Evaluation of Gladiolus (*Gladiolus hybrida* L.). *Plant Archives.*15 (1): 451-454.
15. Narsude, P.B., Kadam, A.S. and Patil, V.K. (2010). Studies on the growth and yield attributes of different African marigold (*Tagetes erecta* L.) genotypes under Marathwada conditions. *The Asian Journal of Horticulture*, 5(2): 284-286.
16. Panwar S, Singh KP, Janakiram T, Namita 2013. Genetic variability, heritability and genetic advance in African marigold (*Tagetes erecta* L.) genotypes. *Progressive Horticulture*; 45: 135-139.
17. Raghuvanshi, A. and Sharma, B.P. 2011. Varietal evaluation of French marigold (*Tagetes patula* Ninn.) under mid-hill zone of Himachal Pradesh. *Progressive Agriculture.* 11(1): 123-126.
18. Rao, C.C., Goud, P.V., Reddy, K. M. and Padmaja, G. (2005). Screening of African marigold (*Tagetes erecta* L.) cultivars for flower yield and carotenoid pigments. *Indian Journal of Horticulture*, 62(3): 276-279.
19. Singh, D. and Singh, A.K. (2006). Characterization of African marigold (*Tagetes erecta* Linn.). *Journal of Ornamental Horticulture*. 9(1): 40-42.
20. Singh, D and Mishra, K. K. 2008. Comparative performance of different genotypes of marigold (*Tagetes spp*.). *Indian Journal of Agricultural Sciences*, 78(4): 308-317.
21. Singh K.P. & Sangama. 2000. Effect of graded level of N and P on China aster (*Callistephus chinensis*) cultivar Karnini. *Indian-Journal-of-Horticulture*, 57(1): 87- 89.
22. Singh, S.P., Solanki R.S Singh M.K. Singh K. (2016). Development of tractor operated bund former-cum-packer for increasing resource productivity. *Indian Journal of Agricultural Sciences*, 86(9): 1121-1127.
23. Sunitha, H.M., Hunje, Ravi, Vyakaranahal, B.S. and Bablad, H.B. (2007). Effect of pinching and growth regulators on plant growth, flowering and seed yield in African marigold (*Tagetes erecta* Linn.). *Journal of Ornamental Horticulture*, 10(2): 91-95.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1001-1009 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Different Pre-Sowing Seed Treatments on Seed Germination and Seedling Growth of Fruit Crops : A Review

Manish Kumar[1], Sushil Sharma[2], Hardeep[2]*, Deepak Sangwan[1] and Asheesh Kumar[2]
[1]*Department of Horticulture, Maharana Pratap Horticultural University, Karnal, Haryana*
[2]*Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana*
[*]*Corresponding Author's Email : hardeepsangwan13@gmail.com*

Abstract

Seed germination is the resumption of active growth of embryo that results in the emergence of the young plant. In many fruits, seeds do not germinate even under favourable conditions because of presence of dormancy. Such dormancy in seeds may be caused due to presence of hard seed coat, impermeability to water and gases, germination inhibitors or improper development of embryo. For overcoming dormancy in such seeds, pre-sowing treatments like mechanical scarification, soaking in water, growth regulators (IAA, IBA, GA_3 and NAA) and chemical treatments (H_2SO_4, HCl, KNO_3 and KOH) etc. are required, thus improve germination and seedling growth. These treatments improve seed germination by creating a balance between hormonal ratios in seed and reduce the growth preventing hormones like ABA. Plant growth regulators improve seed germination by activating the enzymes involved in carbohydrate metabolism. Pre-sowing treatments decrease the time required for seed germination, improve germination percentage and seedling growth to meet the growing demand of rootstocks. Pre-sowing seed treatments enhance germination and seedling growth even in biotic and abiotic stressed conditions. This review summarized the effect of different pre-sowing seed treatment on seed germination and seedling growth of different fruits crops.

Introduction

Seed germination is the resumption of active growth of embryo of a mature seed that results in the emergence of young plant. It is a physiologically complex process depends on same environment conditions on which vegetative growth depends. Water, oxygen, light, nitrate and other factors must be available and there should be no inhibitory substances present (Duval *et al*., 2012, Chachalis and Reddy., 2000). Majority of horticultural crops particularly fruit plants like karonda, jamun, papaya, kagzi lime, guava, phalsa is propagated through seeds. For growing plants from seed, it is crucial to have an in-depth knowledge of seed viability, storage, sowing timing and factors responsible for germination.

Nowadays, the demand for budded and grafted plants is increasing but this demand is not fulfilled because of the paucity of superior seedling rootstock. To accomplish the increasing demand for quality rootstock, seedlings need to be raised from seeds, while most fruit seeds take a long time to germinate because seeds suffer from physical dormancy due to hard seed coat and impermeability to water and gases (Singh, 1967). Seed coat (testa) of many fruit species contains significant amount of germination inhibitor *viz*., benzoic acid, cinnamic acid, coumarin, naringenin, jasmonic acid and abscisic acid (ABA), which prevent their seed germination (Arora and Bhojwani, 1989). In several fruit species, it has been shown that pre-sowing treatments boost seed germination and subsequent seedling growth. Therefore, pre-sowing seed treatments are very important and can be done by different methods like cold stratification, hot water soaking, mechanical scarification and chemical treatments using GA_3, thiourea, KNO_3, KOH, urea, panchagavya, cow dung slurry, NAA, H_2SO_4, HCl are employed for breaking dormancy, increasing permeability and also to improve germination. KNO_3 improve the seed germination by creating a balance between hormonal ratios in seed and reducing the growth preventing hormones like ABA (Ali *et al*., 2010).

Application of plant growth regulators like GA_3, IBA, NAA and IAA in appropriate concentration along with scarification treatment may modulate growth behaviour and leads to enhanced germination, growth and survival of seedlings. Exogenously applied GA overcomes seed dormancy in several species (Hassan and Fardous, 2003; Hradilik and Cisarova, 1975). Many experiments have been conducted in order to find a suitable treatment for improving seed germination and seedling growth vigour. As germination and growth of seedlings in fruit crops is significantly impacted by variety of pre-sowing seed treatments. Seed treatment of fruit seeds is crucial for uniform germination, preventing the issue of uneven and irregular germination, and to produce saplings either for planting or to be used as rootstock.

In this aspect, there is need for finding the best pre-sowing seed treatment for different fruit crops. Many researchers had conducted experiments to identify a

suitable treatment for getting better seed germination and seedling growth vigour. Hence, the literature pertaining to their work in different fruit crops has been reviewed here.

Effect of different pre-sowing treatments on seed germination of different fruit crops

Guava : Manthri *et al.* (2014) carried out an experiment on guava to study the effect of various pre-sowing seed treatments like water soaking, gibberellic acid, thiourea, hot water and acid treatments on germination percentage. They observed that the highest germination 83.79 and 80.30 % was obtained with GA_3 (1000 ppm) and (500 ppm) respectively, which were superior over other treatments. Hejazi *et al.* (2018) reported that guava seeds treated with 300 ppm GA_3 for 24 hours stimulated quick emergence and assured highest germination percentage (40 %). Similarly, Guava seeds soaked in GA_3 @150 mg/l for 24 hours improved germination percentage (80.77%) and took minimum number of days for germination (16.73) (Boricha *et al*., 2020). Dinesh *et al.* (2019) carried out a study on different physical and chemical methods of seed treatment on germination and seedling growth attributes of guava (*Psidium guajava* L.) and revealed that maximum germination percentage (88.56%) was observed when seeds treated with GA_3 1000 ppm for 24 hours (T5). Sikhondze *et al*. (2020) investigated the effects of pre-germination treatments on seed germination and growth of wild guavas and stated that seed treated with sulphuric acid showed the highest germination percentage (93.3%) followed by seeds treated with hot water. Similarly, maximum germination performance (72 %) and comparatively higher seed viability resulted from scarification of guava seeds with 30% concentrated sulphuric acid for 5 seconds (Sourabh *et al.,* 2020). Masilamani *et al*. (2015) found that highest germination (41 %) in guava was reported in seeds treated with $CaOCl_2$ for 12 hours.

Jamun : Stephen *et al*. (2012) concluded that acid (H_2SO_4) scarification of seeds for 10 min results in maximum germination percentage both in diffused light and dark conditions in *Syzygium cumini*. Gaikwad and Borkar (2018) concluded that seed soaked in 10% KOH and 10% NaOH for 10 min was the excellent pre-sowing treatment that promotes maximum seed germination in *Syzygium cumini*.

Papaya : In papaya, the maximum seed germination (60.4%) was obtained in GA_3 @ 200 ppm followed by GA_3 100 ppm (Ramteke *et al*., 2015). Similarly, minimum days taken for germination (12.33 days) and maximum germination percentage (88.89) was found when seeds were treated with 300 ppm GA_3 for 24 hours (Pratibha *et al.,* 2015). Seed soaked with 150 ppm GA_3 + 12 hours + azotobacter induced early germination, rate of emergence, germination percentage as well as seed vigour index-I and vigour index-II in papaya (Lanjhiyana *et al.,* 2020). Similarly, GA_3 @150 mg/l dipping for 12 hours took minimum days for first germination (7.55) and 50 % germination (9.44). Maximum germination percentage (77% and 87% at 10 and 20 DAS, respectively) also reported in same treatment (Desai *et al.,* 2017). Seed treatment with Gibberelic acid (@ 500 ppm showed maximum seed germination (47.50 %) (Mali *et al*., 2015). Anjanawe *et al*. (2013) concluded that in papaya maximum (60.4%) seed germination was obtained in 100 ppm GA_3 followed by 200ppm GA_3, 50ppm NAA and 50ppm BA. Sharma *et al*. (2018) revealed that seeds treated with 400 ppm NAA took minimum number of days for first germination (12.00 days) and maximum germination percentage (77.78%). Bagul *et al*. (2018) reported that among various treatments, panchgavya was most effective for improving germination percent (90.03%) and took minimum days for germination (10.16). Owino and Ouma (2011) reported that potassium solutions improve germination of papaya seeds. Dayeswari *et al*. (2018) reported that seed treated with KNO_3 1.0% increased germination percentage (96.66%) of papaya as compared to control (89.56 %).

Tamarind : Vasantha *et al*. (2014) found that tamarind seeds subjected to mechanical scarification and GA_3 200 ppm result in an increase in germination percentage (97.78%), rate of germination (2.12) and decrease the number of days taken to initiation of germination (5.33 days). Muhammad and Amusa (2003) reported that seeds of tamarind when treated with 50 % sulphuric acid concentration for 60 minutes recorded the highest germination. Azad *et al*. (2013) found that pre-sowing treatments of cold water (40 ^{o}C for 24 h) and scarification with sand paper performed better than other treatments in seed germination, germination percentage and other seedling growth attributes of Tamarindus.

Ber : Saied *et al.* (2008) examined the impact of different scarification methods on germination of *Ziziphus spina-christi* seeds and found that seeds soaked for one hour in concentrated sulphuric acid was a suitable method for encouraging emergence with easy application. Jamwal *et al.* (2013) revealed that seed soaked in water for 48 hours followed by 6 days storage in moist gunny bags enhanced germination percentage (50 %) as compared to control (0 %). Sodimu *et al*. (2020) concluded that among the different seed priming methods, mechanical scarification was the best dormancy breaking method in *Z. mauritiana* with a germination percentage of 95.20. Dorji *et al*. (2015) found that the best pre-sowing treatment for overcoming seed dormancy and seedling emergence of the rare *Ziziphus budhensis* was complete removal of hard seed stone by cracking or scarification of stone with sand

paper (sanding). Data showed that seed germination and seedling emergence was highest (90% ± 7.3 SE) when the hard seed coat was cracked and sown, followed by sanding of the seed stone to a thin layer (76.7 % ± 5.3 SE).

Aonla : Chiranjeevi *et al*. (2017) studied the impact of growth regulators and biofertilizers on seed germination behaviour and seedling growth of aonla (*Emblica officinalis* Gaertn) and concluded that aonla seeds soaked in GA_3 200 ppm solution for 12 hours followed by 12 hours shade drying reported earliest germination (8.33 days), highest germination percentage (88.88) and faster rate of germination (1.07). Similarly, GA_3 @ 500 mg/l for 24 hours minimized days required for initiation of germination (6.20 days) as well as ameliorate germination percentage (67.89) and maximize survival percentage (72.12) at 180 DAS (Lalitha *et al.,* 2020). Barathkumar (2019) found that aonla seed treated with 2 % KNO_3 for 24 hours significantly increased the seed germination percentage (87.49) as compared to control (38.69 %) whereas the minimum days taken for 50 % germination (7.51 days) was noticed GA_3 500 ppm. Sharma *et al*. (2021) scrutinized the effect of different treatments on breaking seed dormancy in aonla (*Phyllanthus emblica* L.) and found that aonla seed scarified with acid for 30 sec significantly improved seed germination (80.39 %) and also helps in breaking seed dormancy.

Citrus : Joshi *et al.* (2015) found that for inducing germination and better seedling performance in acid lime the best seed treatment was GA_3 200 ppm. The germination was found maximum in treatment GA_3 @ 200 ppm (81.63 %) which was found at par with NAA @ 40 ppm (79.36 %) whereas minimum germination % was found in control (67.46 %). Similarly, in Rangpur lime, GA_3 100 ppm was the best treatment for germination under laboratory (88.86%) as well as field conditions (69.88%) and it was significantly superior over rest of the treatments followed by NAA 100 ppm (85.62%) and KNO3 1.0% (83.15%) whereas lowest germination (73.24%) was recorded in control (Jadhav and Deshmukh, 2019). Panda *et al*. (2018) revealed that gibberellic acid at 100 ppm recorded minimum days taken to germination (26.00), germination percentage (55.24%), Seedling vigour index-I (1436.94 cm) and seedling vigour index-II (104.07 gm) in kagzi lime. Similarly, seed treatment with GA_3 80 ppm for 12 hours was the most beneficial treatment for improving seed germination (90 %) in rangpur lime (Dilip *et al*., 2017). Khopkar *et al*. (2017) studied the influence of GA_3 solution on rate of seed germination of pummelo and found that among various pre-sowing treatments the best results for seed germination were shown by GA_3 50 ppm solution for 24 hours. Chaudhary *et al.* (2019) investigated the effect of gibberellic acid on germination and vigour of Kagzi lime Seedlings and concluded that freshly extracted kagzi lime seeds soaked in an aqueous solution of 500 ppm GA_3 for 12 hours induced early germination, higher seedling vigour index and survival percentage.

Other fruits : Caliskan *et al*. (2012) investigated the effect of different pre-sowing treatments on the seed germination and emergence of fig seeds (*Ficus carica* L.) and concluded that seed treated with GA_3 significantly increased the germination and emergence of fig seeds. Rostami and Shasavar (2009) reported that scarification treatments increased germination and early growth. Sulphuric acid treatment was better over mechanical scarification in removing the hard endocarp surrounding the olive seeds. Mabundza *et al*. (2010) found that passion fruit seeds treated with H_2SO_4 prior to sowing improved germination (94 %). Ito *et al.* (2011) found that in seed propagation type of F_1 hybrid strawberry the seed germination performance enhanced by scarification with concentrated sulphuric acid and matric priming. These treatments improved strawberry seed germination performance even under unfavourable temperature conditions. Shah *et al.* (2013) found that maximum germination in plum (75.33 %), peach (31.33 %) and apricot (73.33 %) was obtained when seeds soaked in water for 9 days followed by GA_3 2000 ppm for 24 hours treatment. Adekunle (2014) found that seed soaking in cold water enhanced better seed germination percentage, time of germination and seedling vigour in soursop than other treatments. Samir *et al.* (2015) revealed that seed treated with 100 ppm GA_3 showed best results for germination percentage (85.80), germination index (4.39), and germination value (12.25) in khirni. Results for earliest seedling emergence (7 days) was noticed in 2% KNO_3 seed treatment. Parameters like mean daily germination (3.48), seed vigour (88.64) and germination energy (68.50) were observed maximum when khirni seeds treated with 200 ppm GA_3. Bhavya *et al.* (2017) concluded that germination (83.30 %) and morphological characters of karonda seedlings improved with water soaking treatments for 8 hours. Ghosh *et al*. (2017) found that pre-germination treatment with H_2SO_4 for 4 minutes improved germination percentage (89.50) of yellow passion fruit. In chironji, seeds dipped in water for 24 hours followed by soaking in GA_3 at 200 ppm for 24 hours results in early germination (22.19 days), maximum germination percentage (71.27) and maximum survival percentage (64.13) which was at par with mechanical scarification and dipping in H_2SO_4 @ 5 % (Joshi *et al*., 2017). Palepad *et al*. (2017) reported that GA_3 1000 ppm solution improve the germination percentage (83.33%) and minimized the days (10.27) taken for germination over other treatments in custard apple. Singh and Maheswari (2017) found that pre-sowing seed treatment with GA_3 500 ppm for 24 hours was the most promising treatment for

seed germination (100 %) followed by GA_3 250 ppm for 24 hours (96.73 %) in soursop seedlings. Lata *et al*. (2018) revealed that seed scarified with H_2SO_4 36 N recorded the highest in vitro strawberry seed germination (94.33 %) and it was statistically at par with H_2S0_4 30N (94.00 %). Overnight water-soaked seeds resulted in early and complete germination while GA_3 treated seeds resulted in maximum germination percentage, survivability percentage and seedling growth in Surinam cherry (Patil and Halesh, 2018). Reshma and Simi (2019) found that the freshly extracted mango stones when treated with 200 ppm GA_3 solution and sown in stalk-end up position resulted in minimum number of days for initiation of germination (13 days), and 50% germination (23 days), highest rate of germination (0.74) whereas, the stones soaked in 100 ppm GA_3 solution recorded the highest germination (82.22 %), seedling vigour index-I (2142.03 cm) and seedling vigour index-II (791.48 gm). Sau *et al*. (2019) found GA_3 100 ppm as the best seed priming treatment for wood apple, as it increased germination percentage by 96.01 % over control besides improved vegetative growth (85.21 % longer seedlings than control), leaf chlorophyll content and leaf mineral composition, to procure seedlings with vigorous growth. In peach, maximum germination percentage (68.60) was recorded when peach stones soaked in tap water for 36 hours (Rab *et al*., 2017). Lal *et al.* (2020) studied the effect of soaking and placement of seed on germination and seedling emergence in litchi and found that seed germination (92.58 %) improved when seeds were soaked in water as compared to without soaking. Mistry and Sitapara (2020) concluded that karonda seeds soaked with GA_3 100mg/l for 24 hours took minimum number of days (21.00) for germination. Thounaojam and Dhaduk (2020) reported that, in chironji higher germination percentage was observed when treated with alternate wetting (24 hours) and drying (24 hours) followed by 3 days dipping in tap water, scarification with H_2SO_4 5% for 5 minutes and with sand paper. Zoubi (2020) found that scarification treatments enhance the germination rate and early growth of seedlings in date palm. Sulphuric acid more efficiently removes the hard endocarp of seeds than mechanical scarification. In passion fruit, maximum germination percentage (84%) and germination index (2.02) was observed in seeds treated with thiourea 1 % (Gurung *et al*., 2014). Olmez *et al*. (2007) concluded that *Punica granatum* seeds soaked in H_2SO_4 for 15 minutes with cold stratification for 60 days resulted in better germination rate and maximum germination percentage (84.8%).

Effect of different pre-sowing treatment on seedling growth of different fruit crops

Jamun : Patil *et al*. (2017) investigated the role of different seed treatment and foliar spray of chemical substances on seedling growth of *Syzygium cuminii* L. seeds and found that the maximum seedling height (82.60 cm), number of leaves (42.63), stem diameter (7.90 mm), number of shoots/seedling (2.95), leaf area (86.30 cm_2), root: shoot ratio (3.21), primary root length (43.04 cm) was recorded when seeds treated with GA_3 @ 200 mg/l for 10 min. Gaikwad and Borkar (2018) reported maximum shoot length was noted at 10% KOH (30.21 cm) and 10 % NaOH (30.63 cm). On the other hand, root length was maximum at 10% KOH (32.33 cm) and 5% NaOH (32.52 cm).

Guava : Brijwal and Kumar (2014) found that from the different pre-sowing treatments, scraping of seed coat with sand paper + seeds soaked in GA_3 50 ppm for 24 hours (T_4) was the most beneficial treatment for enhancing seedling height, stem girth, number of leaves per seedling, fresh and dry weight of stems, leaves and roots of guava rootstock. Seedling growth parameters such as seedling length (65.73 cm), girth of the seedling (2.42 mm) was found superior in GA_3 1000 ppm for 24 hours (Dinesh *et al.,* 2019). Similarly, Vegetative growth parameters such as number of leaves (7.80, 14.33, 17.93), the height of seedling (7.28, 15.07, 28.18 cm), stem diameter (0.87, 2.22, 2.75 mm), fresh weight of shoot (14.21 g), dry weight of shoot (5.97 g), fresh weight of root (1.94 g), dry weight of root (1.12 g), shoot: root ratio (7.32) and survival percentage (75.00%) were found best when guava seeds soaked in GA_3 @ 150 mg/l for 24 hours (Boricha *et al*., 2020). Sikhondze *et al*. (2020) reported that highest plant height (44 cm), stem girth (3.73 cm) was recorded in seeds treated with sulphuric acid. Sourabh *et al.* (2020) investigated the effect of scarification treatments on seedling growth of guava (*Psidium guajava*) and found that hot water soaking at 80ºC for 1-minute leads to maximum seedling length (6.03 cm).

Papaya : Pratibha *et al*. (2015) concluded that maximum root length (15.30 cm) and root dry weight (0.32g) were recorded in GA_3 200 ppm for 24 hours. Parab *et al*. (2017) revealed that the maximum girth of seedling (5.77 mm), leaf area (56.00 cm^2) and total fresh weight (17.02 g) were observed when seeds treated with GA_3 200 ppm at 60 DAS. Similarly, maximum plant height (11.08 cm), number of leaves per plant (9.78), girth of seedling (3.58 mm) and largest average leaf area (37.50 cm2) in papaya were found in GA_3 200 ppm (Choudhary *et al*., 2018). Anjanawe *et al*. (2013) observed maximum plant height, diameter of the stem and primary roots per plant in 200ppm GA_3. Similarly, the maximum seedling height (7.58 cm and 12.60 cm), number of leaves per plant (6.67 cm and 9.78 cm) and stem diameter (0.253 cm and 0.323 cm) at 20 and 30 days respectively was observed when treated with gibberelic acid @ 500 ppm (Mali *et al*., 2015). Sharma *et al*. (2018) observed that maximum height of seedling (19.90cm), number of leaves per seedling (18), fresh

weight of seedling (7.71g), number of roots per seedling (28.00), dry weight of seedling (1.68g) were found in when seed soaked with NAA 400 ppm. Seed treatment with panchgavya showed maximum height of seedling (4.20cm), number of leaves (4.56), stem girth (15.65 mm), leaf area (46.00 cm^2), length of tap root (10.77 cm), number of roots per seedling (18.58), root/shoot ratio (1.92), fresh weight of seedling (6.69 g), dry weight of seedling (1.58 g) in papaya (Bagul *et al*., 2018).

Ber : Kumar *et al*. (2020) found that GA_3 @ 400 ppm significantly reduce plant mortality and also enhance diameter of tap root (0.68mm) and survival percentage (72.33%) of seedling at 120 days in ber. Singh *et al*. (2004) found that, all treatments significantly enhanced root and shoot growth and seedling survival of ber. Seed treatment with 600 ppm GA_3 + 6% sucrose resulted in the greatest seedling survival at 90 days after sowing (90.98%), seedling height (80.63 cm), girth of seedling at ground level (1.72 cm), buddable stage (1.48 cm), root length (26.05 cm), root fresh (4.35 g) and dry (1.55 g) weights. Foliar spray of 50 ppm GA_3 on seedlings obtained from different seed soaking treatments accelerated seedling vigour. GA_3 gave maximum plant height (56.29 cm), plant girth (2.75 cm) and internode length (2.69 cm). Foliar spray of 50 ppm MH reduced plant height and internode length (Rajwar *et al*., 2007)

Aonla : Mawalagedera *et al*. (2014) found that in *Phyllanthus emblica* the seed dormancy was broken by the pre-treatment where the seed coat was scarified and treated with 1% gibberellin. Chiranjeevi *et al*. (2017) noticed that the maximum height of seedling (28.47 cm), seedling girth (1.26 cm), seedling biomass (2.28 g) was observed when seeds are treated with GA_3 200 ppm solution for 12 hours followed by 12 hours shade drying. Similarly, seed treatment with GA_3 @ 500 mg/l resulted in maximum number of leaves (25.46, 71.93, 106.26 and 119.26), seedling diameter (3.48, 6.40, 7.84 and 8.76 mm) and seedling height (48.60, 90.36, 106.40 and 114.60 cm) at 60, 90, 120 and 180 days after sowing in aonla (Lalitha *et al.,* 2020). Seedling growth parameters like seedling length (15.23 cm) and root length (7.68 cm) was found higher in seeds treated with GA_3 500 ppm for 24 hours (Sharma *et al*., 2021).

Citrus : Joshi *et al.* (2015) reported that maximum number of leaves per plant (34.93), fresh weight (20.72g) at 165 days after germination were found in treatment GA_3 200 ppm. Jadhav *et al*. (2019) revealed that maximum height of seedling (60.90 cm), highest number of seedlings per seed (2.67), highest % seedlings attain buddable stem diameter (82.57 %), length of roots i.e., primary and secondary (45.20 and 16.43 cm) was obtained by the application of GA_3 100 ppm. Similarly, seed treatment with gibberellic acid at 100 ppm in kagzi lime reported maximum shoot length (11.36 cm), number of leaves (19.26), seedling length (21.67 cm), root length (11.36 cm) and fresh weight of seedling (2.09%) (Panda *et al*., 2018). Sanaullah *et al*. (2020) studied the influence of plant growth regulators and chemicals on seedling growth of rough lemon (*Citrus jambhiri* L.) under hydroponic condition and concluded that the best results for most of the growth parameters was shown by GA_3 150 ppm solution for 12 hours and this treatment was at par with KNO_3 at 1.5%. Dilip *et al*. (2017) observed that maximum height of plant (11.97 cm), number of leaves (18.89), fresh and dry weight of shoot (13.65 g and 6.81 g), length of tap root (16.17 cm), number of secondary and fibrous roots (6.24 and 86.86), fresh and dry weight of roots (5.92 g and 4.06 g) was found in GA_3 80 ppm for 12 hours in rangpur lime.

Other fruits : Joshi *et al*. (2017) found that maximum seedling height (36.78 cm), seedling diameter (0.45 cm), number of leaves per plant (14.63 cm) and leaf area (48.47 cm^2) was found in seeds treated with GA3 200 ppm treatment at 180 DAS. Pre-sowing treatment such as GA_3 200 ppm, mechanical scarification and H_2SO_4 @ 5 % found equally better for growth parameters of Chironji seedlings at 180 days after sowing. Similarly, Dadhaniya *et al*. (2020) conducted an experiment in which six different chemical treatments were applied on custard apple seeds to study the effect on seedling growth. Results revealed that maximum height of seedling (20.2, 39.01 and 50.01 cm), stem girth (2.39, 3.20 and 4.10 mm), number of leaves (5.26, 11.32 and 17.51), shoot length (36.83 cm), root length (16.99 cm), number of roots (11.57) and fresh weight of shoot (6.55 gm) was observed in seeds treated with GA_3 200 ppm at 60, 90 and 120 DAS. Similarly, seed treated with GA_3 1000 ppm resulted in maximum seedlings height (23.33, 37.54 and 48.31 cm), girth of plant (0.46, 0.62 and 0.93 cm), number of leaves (17.37, 28.60 and 32.64) and leaf area (76.42 cm2) at 60, 90 and 120 DAS in custard apple (Palepad *et al*., 2017). Seeds soaked in water for 9 days followed by treatment with GA_3 2000 ppm for 24 hours reported maximum height and girth in plum (90.94 cm, 8.04 mm), peach (83.96 cm, 6.63 mm) and apricot (93.80 cm, 8.12 mm) (Shah *et al.,* 2013). Patel *et al*. (2017) conducted an experiment to study the influence of pre-sowing treatments on survival percentage and growth of mango rootstock and reported that mango stones treated with 100 ppm GA_3 for 24 hours had better growth and survival percentage (64.17). Rajput and Sharma (2020) carried out an experiment in which seeds of *Annona squamosa* L. were treated with 13 different organic and inorganic sources. The result revealed that the maximum plant height (12.91 cm), number of leaves (13.75), Stem girth (4.01 mm), length of

seedling (24.27 cm), root length (11.56 cm), maximum chlorophyll content index (19.49) and maximum mean survival percentage of seedlings (85.00%) were recorded when seeds soaked in 200 ppm GA_3. Maximum seedling height (35.42 cm), number of leaves (11.20) and vigour index (3170.57) were observed superior in seeds treated with sulphuric acid for 4 minutes in yellow passion fruit (Ghosh *et al*., 2017). Patel *et al*. (2017) observed that mango stones when treated with Thiourea at 1 % had the maximum shoot length (49.93 cm), root length (34.38 cm), shoot dry weight (21.08 g) and total dry weight (26.36 g). Passion fruit seeds treated with GA_3 500 ppm results in maximum seedling height (16.23cm, 19.62cm and 20.91cm) and number of leaves (10.25, 11.35 and 14.25) at 30, 60 and 90 day after sowing (Gurung *et al*., 2014). Vasantha *et al*. (2014) found that GA_3 200 ppm resulted in maximum plant height (40.57cm), seedling girth (1.99 cm), number of leaves (30.47), fresh and dry weight of shoots (23.99 g and 8.07g, respectively), fresh and dry weight of roots (7.90 g and 4.80g, respectively) at 150 days after sowing as compared to control.

Conclusions

The nursery industry must create more rootstocks with graftable sizes in less time in order to meet the rising demand for planting material (grafts). Pre-sowing treatments are therefore crucial to accelerating seed germination and seedling growth so that they can reach graftable size sooner. As a result, improving seed germination is crucial for breeding programmes, germplasm testing, and propagation. In many fruit species, pre-sowing treatments appear to be the most promising in this regard. Therefore, it can be said that pre-sowing treatments particularly GA_3 at different concentrations is successful in increasing fruit crop seed germination and improving seedling growth in different fruit crops.

References

1. Adekunle, T.T., 2014. Influence of seed treatments on germination and seedling growth of soursop-*Annona muricata*. *Journal of Biology, Agriculture and Healthcare*, 4(21): 1-6.
2. Ali, T., Hossein, P., Asghar, F., Salman, Z. and Ali, Z.C.M., 2010. The effect of different treatments on improving seed germination characteristics in medicinal species of Desurainia sophia and Plantago ovate. *African Journal of Biotechnology,* 9(39): 6588-593.
3. Anjanawe, S.R., Kanpure, R.N., Kachouli, B.K. and Mandloi, D.S., 2013. Effect of plant growth regulators and growth media on seed germination and growth vigour of papaya. *Annals of Plant and Soil Research*, 15(1): 31-34.
4. Arora, R. and Bhojwani, S.S., 1989. In vitro propagation and low temperature storage of Saussurea lappa C.B. Clarke–an endangered medicinal plant. *Plant Cell Report,* 8: 44–47.
5. Azad, M.S., Nahar, N. and Matin, M.A., 2013. Effects of variation in seed sources and pre-sowing treatments on seed germination of *Tamarindus indica:* a multi-purpose tree species in Bangladesh. *Forest Science and Practice,* 15(2): 121-129.
6. Bagul, H.B., Parmar, A.B., Parmar, B.R., Pandey, A.K. and Jnanendra, M., 2018. Effect of pre-sowing seed treatments on germination and growth of papaya (*Carica papaya* L.) seedlings cv. red lady. *The Pharma Innovation Journal,* 7(1): 95-97.
7. Barathkumar, T.R., 2019. Studies on influence of different seed treatments on dormancy breaking in aonla (*Phyllanthus embolic* L.). *Journal of Pharmacognosy and Phytochemistry*, 2: 131-133.
8. Bhavya, N., Naik, N., Kantharaju, V. and Nataraj, K.H., 2017. Studies on effect of different pre-sowing treatments on germination of karonda (*Carissa carandas* L.) seeds. *Journal of Pharmacognosy and Phytochemistry*, 6(6): 352-354.
9. Boricha, U.K., Parmar, B.R., Parmar, A.B., Rathod, S.D., Patel, M.V. and Pandey, A.K., 2020. Effect of pre-sowing treatments on seed germination and seedling growth of guava. *The Pharma Innovation Journal*, 9(9): 431-433
10. Brijwal, M. and Kumar, R., 2014. Influence of pre-sowing treatments on vegetative growth parameters of seedling rootstock of guava (*Psidium guajava* L.). *Asian Journal of Horticulture*, 9(1): 120-123.
10. Çaliºkan, O., Mavi, K. and Polat, A., 2012. Influences of pre sowing treatments on the germination and emergence of fig seeds (*Ficus carica* L.). *Acta Scientiarum. Agronomy*, 34(3): 293-297.
11. Chachalis, D. and Reddy, K.N., 2000. Factors affecting Campsis radicans seed germination and seedling emergence. *Weed Science*, 48:212–216.
12. Chaudhary, A., Ahlawat, T.R., Kumar, S., Jena, S. and Patel, D., 2019. Effect of gibberellic acid on germination and vigour of kagzi lime seedlings. *Current Journal of Applied Science and Technology*, 38(6): 1-8.
13. Chiranjeevi, M.R., Muralidhara, B.M., Sneha, M.K. and Hongal, S., 2017. Effect of growth regulators and biofertilizers on germination and seedling growth of aonla (*Emblica officinalis* Gaertn). *International Journal of Current Microbiology and Applied Sciences*, 6(12): 1320-1326.
14. Choudhary, R.C., Kanwar, J., Chouhan, G.S., Singh, P. and Tanwar, D.R., 2018. Effect of GA_3 and growing media on seedling growth of papaya (*Carica papaya* L.) cv. Pusa Nanha. *International Journal of Chemical Studies,* 6(6): 1008-1012.
15. Dadhaniya, D.B., Kanzaria, D.R., Sejal, B., Dhara, T. and Varuti, P., 2020. Effect of time of sowing and chemical treatments on seedling growth of custard apple (*Annona squamosa* L.) cv. Sindhan. *Chemical Sciences Review Letter*, 9(33): 19-23.
16. Dayeswari, D., Auxcilia, J., Malarkodi, K. and Vijayakumar, R.M., 2018. Effect of Chemicals and bio-inoculants on seedling growth and vigour of TNAU papaya CO. 8 (*Carica*

papaya L.). *International Journal of Current Microbiology and Applied Sciences*, 7(3), 3007-3014.

17. Desai, A., Panchal, B., Trivedi, A. and Prajapati, D., 2017. Studies on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Madhu bindu as influenced by media, GA_3 and cow urine under net house condition. *Journal of Pharmacognosy and Phytochemistry*, 6(4): 1448-1451.
18. Dilip, W.S., Singh, D., Moharana, D., Rout, S. and Patra, S.S., 2017. Effect of gibberellic acid (GA_3) different concentrations at different time intervals on seed germination and seedling growth of rangpur lime. *Journal of Agroecology and Natural Resource Management*, 4(2): 157-165.
19. Dinesh, A., Padmapriya, S., Kavino, M., Raja, K. and Sujatha, K.B., 2019. Effect of different physical and chemical methods of seed treatment on germination and seedling growth attributes of guava (*Psidium guajava* L.). *Journal of Pharmacognosy and Phytochemistry*, 8(3): 4373-4377.
20. Dorji, T., Lama, M.K. and Namgyal, D., 2015. Breaking the stone: overcoming seed dormancy and seedling emergence of the rare *Ziziphus budhensis* in bhutan himalayas. *Indian Journal of Plant Sciences*, 4(3): 47-54.
21. Duval, M., Gallardo, K., Catusse, J. and Bally, J., 2012. Seed germination and vigor. *Annual Review of Plant Biology*, 63(1), 507-533.
22. Gaikwad, R.S. and Borkar, S.U., 2018. Effect of pre-sowing treatments on seed germination and plant growth of *syzygium cumuni* (L.) skeels. *International Journal of Research and Analytical Review,* 5(4): 186-189
23. Gaikwad, R.S., and Borkar, S.U., 2018. Effect of pre-sowing treatments on seed germination and plant growth of *Syzygium cumuni* (l.) skeels. *International Journal of Research and Analytical Reviews*, 5(4): 186-189.
24. Ghosh, A., Dey, K., Bauri, F.K. and Dey, A.N., 2017. Effects of different pre-germination treatment methods on the germination and seedling growth of yellow passion fruit (*Passiflora edulis* var. flavicarpa). *International Journal of Current Microbiology and Applied Sciences*, 6(4): 630-636.
25. Gurung, N., Swamy, G.S.K., Sarkar, S.K. and Ubale, N.B., 2014. Effect of chemicals and growth regulators on germination, vigour and growth of passion fruit (*Passiflora edulis* Sims.). *The Bioscan*, 9(1), 155-157.
26. Hassan, M.A. and Fardous, Z., 2003. Seed germination, pollination and phenology of Gloriosa superba L. (Liliaceae). *Bangladesh Journal of Plant taxonomy,* 10(1): 95–97.
27 Hejazi, Z., Sadat, M., Raghib, M., Zerak, A. and Fitrat, K., 2018. Effect of different concentrations of GA_3, H_2O_2 and bleach solutions on seed germination of guava (*Psidium guajava* L). *International Journal of Chemical Studies, New Delhi*, 6(5): 2679-2681.
28. Hradilik, J. and Cisarova, H., 1975. Studies on the dormancy of caraway (Carum carvi) achenes. *Rostlinna vyroba,* 21: 351–364.
29. Ito, Y., Maruo, T., Ishikawa, M. and Shinohara, Y., 2011. Effects of scarification with sulfuric acid and matric priming on seed germination of seed propagation type of f1 hybrid strawberry (*Fragaria× ananassa* Duch.). *Journal of the Japanese Society for Horticultural Science*, 80(1): 32-37.
30. Jadhav, N.G. and Deshmukh, H.S., 2019. Effect of growth regulators, chemical and organic wastes on the seed germination and seedling diameter of Rangpur lime. *Journal of Pharmacognosy and Phytochemistry*, 8(3), 448-451.
31. Jadhav, N.G., Tapkeer, P.B. and Deshmukh, H.S., 2019. Effect of growth regulators, chemical and organic wastes on height of seedling, number of seedlings per seed (extent of polyembryony), % seedling attain buddable diameter and root length (primary and secondary) of rangpur lime seedlings. *International Journal of Chemical Studies*, 7(3): 3596-3600.
32. Jamwal, M., Hussain, S., Sharma, N., Kumar, R., Sharma, R.M., Wali, V.K. and Parmar, A.M., 2013. Pre-sowing seed treatments affect germination and quality of rootstock in indian ber (*Zizyphus mauritiana* Lam.). *World Journal of Agricultural Sciences*, 9(2): 116-122.
33. Joshi, C.J., Sharma, D.K., Gotur, M. and Rajan, R., 2017. Effect of different chemicals on germination and seedling growth of chironji (*Buchanania lanzanspreng.). Plant Archives*, 17(2): 1483-1486.
34. Joshi, P.S., Sahoo, A.K., Bhoyar, R.K. and Meshram, P.C., 2015. Effect of various plant growth promoting substances on seedling growth of acid lime. *Trends in Biosciences*, 8(19): 5222-5225.
35. Khopkar, R.R., Nagaharshitha, D., Haldavanekar, P.C. and Parulekar, Y.R., 2017. Studies on seed germination of pummelo (*Citrus grandis* L. Osbeck). *International Journal of Agricultural Science and Research*, 7(5): 257-264.
36. Kumar, A., Gurjar, P.K.S., Kureel, M.K. and Asre, A., 2020. Effect of Pre-sowing seed treatments on root growth and survival of ber (Zizyphus mauritiana L.). *Journal of Pharmacognosy and Phytochemistry*, 9(2): 1883-1885.
37. Lal, N., Marboh, E.S., Gupta, A.K., Kumar, A. and Nath, V., 2020. Effect of soaking and placement of seed on germination and seedling emergence in litchi. *Journal of Plant Development Science*, 12(5): 317-320
38. Lalitha, K.R., Tank, R.V., Chawla, S.L. and Jena, S., 2020. Effect of chemicals on seed germination and seedling growth of aonla (*Emblica officinalis* Gaertn.). *The Pharma Innovation Journal*, 9(12): 239-243
39. Lanjhiyana, R., Sahu, G.D., Panigrahi, H.K. and Katiyar, P., 2020. Role of pre-sowing seed treatment on germination behavior and seedling vigour of papaya (*Carica papaya* L.). *Journal of Pharmacognosy and Phytochemistry*, 9(5): 3039-3042.
40. Lata, S., Sharma, G., Garg, S. and Joshi, M., 2018. Effect of different chemical treatments on germination of strawberry seeds. *International Journal of Current Microbiology and Applied Sciences*, 7(3): 1270-1274.
41. Mabundza, R.M., Wahome, P.K. and Masarirambi, M., 2010. Effects of different pre-germination treatment methods on the germination of passion (*Passiflora edulis*) seeds. *Journal of Agriculture and Social Sciences*, 6(3): 57-60.
42. Mali, D.S., Nikumbhe, P.H., Kharde, R.P. and Sonavane,

P.N., 2015. Effect of Pre-Sowing seed treatment with plant growth regulators on germination and growth of Papaya (*Carica Papaya* L.). *Bioinfolet-A Quarterly Journal of Life Sciences*, 12(3b): 768-774.

43. Manthri, K., Bharad, S.G. and Parameshwar, P., 2014. Effect of growth regulators on seed germination in guava. *International Journal of Biological Sciences*, 5(2): 81-91
44. Masilamani, P., Nagaraja, A., Yadav, M.P. and Srivastava, D.K., 2015. Influence of different pre-sowing treatments on germination and seedling vigour of guava (*Psidium guajava* L.) seeds. *Journal of Non-Timber Forest Products*, 22(1): 7-9.
45. Mawalagedera, S.M.U.P., Perera, G.A.D. and Sooriyapathirana, S.D.S.S., 2014. Prolonged seed dormancy in *Phyllanthus emblica* L. can be overturned by seed scarification and gibberellin pre-treatment. *Open Journal of Forestry*, 4(1): 38.
46. Mistry, J.M. and Sitapara, H.H., 2020. Effect of seed treatments on germination of karoda (*Carissa carandas* L.) cv. Local. *International Journal of Chemical Studies*, 8(4): 3174-3176.
47. Muhammad, S. and Amusa, N.A., 2003. Effects of sulphuric acid and hot water treatments on seed germination of tamarind (*Tamarindus indica* L). *African journal of biotechnology*, 2(9): 376-279.
48. Olmez, Z., Temel, F., Gokturk, A. and Yahyaoglu, Z., 2007. Effects of sulphuric acid and cold stratification pretreatments on germination of pomegranate (*Punica granatum* L.) seeds. *Asian Journal of Plant Sciences*. 6(2): 427-430.
49. Owino, D.O. and Ouma, G., 2011. Effect of potassium priming on papaya (*Carica papaya* var. Kamiya). *Journal of Animal & Plant Sciences*, 11(2): 1418-1423.
50. Palepad, K.B., Bharad, S.G. and Bansode, G.S., 2017. Effect of seed treatments on germination, seedling vigour and growth rate of custard apple (*Annona squamosa*). *Journal of Pharmacognosy and Phytochemistry*, 6(5): 20-23.
51. Panda, P.A., Karna, A.K. and Sinha, K., 2018. Effect of gibberellic (GA_3) acid on seed germination and growth of kagzi lime (*Citrus aurantifolia* Swingle). *International Journal of Chemical Studies*, *6*(5): 2803-2805.
52. Parab, A.M., Mathad, J.C. and Malshe, K.V., 2017. Effect of pre-soaking chemicals on germination and subsequent seedling growth of papaya (*Carica papaya*) Cv. Solo. *International Journal of Chemical Studies*, 5(4): 1812-1816.
53. Patel, R.J., Ahlawat, T.R., Patel, A.I., Amarcholi, J.J., Patel, B.B. and Sharma, K., 2017. Growth of mango (*Mangifera indica* L.) rootstocks as influenced by pre-sowing treatments. *Journal of Applied and Natural Science*, 9(1): 582-586.
54. Patil, H., Tank, R.V., Bennurmath, P. and Gotur, M., 2017. Effect of seed treatment and foliar spray of chemical substances on seedling growth of jamun (*Syzygium cuminii* L.). *International Journal of Chemical Studies,* 5(5): 1676-1680
55. Patil, S.V. and Halesh, G.K., 2018. Effect of growth regulators and chemicals on germination of Surinam cherry (*Eugenia uniflora* L.) seeds. *International Journal of Current Microbiology and Applied Sciences*, 7(9): 546-551.
56. Pratibha, C., Teja, T. and Krishna, P.M., 2015. Effect of chemical treatments on the germination and subsequent seedlings growth of papaya (*Carica papaya* L.) seeds cv. Pusa Nanha. *Journal of Agricultural Engineering and Food Technology*, 2(3): 189-191.
57. Rab, A., Rahman, J., Jehangir, M., Ilyas, M. and Khan, A.A., 2017. Effect of soaking durations and sowing dates on the germination and seedlings growth of peach stones. *International Journal of Agricultural and Environmental Research*, 3(1): 106-111.
58. Rajput, K. and Sharma, T.R., 2020. Effect of organic and inorganic sources on seed germination, growth and survival of custard apple (*Annona squamosa* L.) seedlings. *Journal of Pharmacognosy and Phytochemistry*, 9(6): 552-556.
59. Rajwar, D.K., Shanker, R, Singh S.K. and Bhagat, B.K., 2007. Seed germination and seedling growth of wild ber (*Ziziphus rotundifolia* L.). *Journal of Research*, Birsa Agricultural University, 19: 107-109.
60. Ramteke, V., Paithankar, D.H., Kamatyanatti, M., Baghel, M.M., Chauhan, J. and Kurrey, V., 2015. Seed germination and seedling growth of papaya as influenced by GA_3 and propagation media. *International Journal of Farm Sciences*, 5(3), 74-81.
61. Reshma, U. R. and Simi, S., 2019. Effect of pre-sowing treatments, sowing positions and age of stones after extraction on germination of mango. *International Journal of Current Microbiology and Applied Sciences*, 8(4): 2565-2573.
62. Rostami, A.A. and Shasavar, A., 2009. Effects of seed scarification on seed germination and early growth of olive seedlings. *Journal of Biological Sciences*, 9(8): 825-828.
63. Saied, A. S., Gebauer, J. and Buerkert, A., 2008. Effects of different scarification methods on germination of *Ziziphus spina-christi* seeds. *Seed Science and Technology*, 36(1): 201-205.
64. Samir, M., Rai, R. and Prasad, B., 2015. Seed germination behaviour as influenced by pre-sowing treatments in khirni. *Journal of Hill Agriculture*, 6(1): 132-135.
65. Sanaullah, A., Hazarika, B.N., Wangchu, L. and Sarma, P., 2020. Effect of plant growth regulators and chemicals on seedling growth of rough lemon (*Citrus jambhiri* L.) under hydroponic condition. *International Journal of Current Microbiology and Applied Sciences,* 9(9): 2353-2358.
66. Sau, S., Pal, B., Sarkar, S. and Sarkar, T., 2019. Influence of seed priming on germination and seedling vigour of wood apple (*Feronia Limonia* Swingle). *International Journal of Bio-resource and Stress Management*, 10(2): 128-36.
67. Shah, R.A., Sharma, A., Wali, V.K., Jasrotia, A. and Plathia, M., 2013. Effect of seed priming on peach, plum and apricot germination and subsequent seedling growth. *Indian Journal of Horticulture*, 70(4): 591-594.
68. Sharma, K., Singh, S.K., Mangal, S. and Sahu, K., 2021. Effect of different treatments on breaking seed dormancy

in aonla (*Phyllanthus emblica* L.). *The Pharma Innovation Journal*, 10(1): 705-708

69. Sharma, T., Tanuja, D.K. and Naithani, D.C., 2018. Effect of bioregulators and chemical on seed germination and seedling growth in papaya (*Carica papaya* L.) cv. Pusa Nanha under valley condition of garhwal Himalaya. *International Journal of Pure and Applied Biosciences*, 6(1), 1116-1121.
70. Sikhondze, T., Nxumalo, K.A., Masarirambi, M.T., Wahome, P.K. and Zwane, M.G., 2020. The Effects of pre-germination treatments on seed germination and growth of wild guavas in the kingdom of eswatini, southern africa. *Asian Journal of Agricultural and Horticultural Research*, 5(1): 28-36.
71. Singh R., 1967. Fruits. National Book Trust of India, New Delhi, 87-88.
72. Singh, D.K., Singh, B. and Sen, S.K., 2004. Role of pre-sowing seed treatment with different chemicals and seed sizes on the germination behavior and seedling growth of ber (*Zizyphus mauritiana* L.). *Environment and Ecology,* 22:439-442.
73. Singh, S.J. and Maheswari, T.U., 2017. Influence of pre-sowing seed treatments on the performance of soursop (*Annona muricata* L.) seedlings. *Plant Archives*, 17(2): 1215-1218.
74. Sodimu, A.I., Usman, M.B., Osunsina, O., Lapkat, G.L., Likita, M.S. and Okechalu, S.O., 2020. Effect of seed priming methods on germination of indian jujube (*Ziziphus mauritiana.* LAM) in northern guinea savanna ecological zone of nigeria. *South Asian Research Journal of Agriculture and Fisheries*, 2(4): 132-136.
75. Sourabh, P., Sharma, J.R. and Bhukar, A., 2020. Effect of scarification treatments on seed germination of guava (*Psidium guajava*). *Indian Journal of Agricultural Sciences*, 90(7): 1333-1337.
76. Stephen, A., Reddy, C.D. and Christopher, P.J., 2012. Effect of pre-sowing treatments on seed germination of *Syzygium cumini* (L.) Skeels. *Advances in Plant Sciences*, 25(1): 297-299.
77. Thounaojam, A.S. and Dhaduk, H.L., 2020. Enhancement of seed germination in chironji (*Buchanania lanzan* Spreng) through physical and chemical treatments. *Journal of Pharmacognosy and Phytochemistry*, 9(1): 1354-1359.
78. Vasantha, P.T., Vijendrakumar, R.C., Guruprasad, T.R., Mahadevamma, M. and Santhosh, K.V., 2014. Studies on effect of regulators and biofertilizers on seed germination and seedling growth of tamarind (*Tamarindus indica* L.). *Plant Archives*, 14(1): 155-160.
79. Zoubi, O.M., 2020. Effect of mechanical and chemical scarifications of date palm seeds (*Phoenix dactylifera* L.) on invitro germination. *Bulgarian Journal of Agricultural Science*, 26(1): 105-113.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1010-1016 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Study on Marketing Trends of Rice and Maize of Pan Seed Company in Ramanujganj and Daltonganj Blocks

Manjeet Singh* and Md. I.A. Ansari

Centre for Agribusiness Management, Faculty of Agriculture, Birsa Agricultural University, Kanke, Ranchi Jharkhand-834006

**Corresponding Author Email : manjeet.singh914@gmail.com*

Abstract

The study was conducted at Daltonganj and Ramanujganj to know the socio-economic conditions of farmers, to analyse the marketing trends of Pan Seeds. 50 farmers and 5 retailers were selected equally from both places for the study. Based on survey result, it was found that 26% of total farmers were illiterate, 64% of total farmers were having nuclear families, 40% of total farmers were having family size of 5-7 members, 44% of total farmers were having land holding of 1-2 ha, and 44% of farmers were having annual income up to 1 lakh in Daltonganj. Based on survey result, it was found that 30% of total farmers were illiterate, 74% of total farmers were having nuclear families, 52% of total farmers had family size of 5-7 members, 48% of total farmers were having small land holding of 1-2 ha, and 50% of farmers were having income up to 1 lakh in Ramanujganj. The sale of rice in Daltonganj increased from 14 MT in 2014 to 21.11 MT in 2017, showed 50% of increase in sale of maize increased from 0 MT to 9.8 MT in Daltonganj. The sales of rice in Ramanujganj increased from 0 MT in 2014 to 22.98 MT in 2017 and sales of maize increased from 0 MT in 2014 to 8.98 in 2017. The purchase preference of Pan Seeds increased from 10% in 2014 to 38% in 2017 in Daltonganj and purchase preference increased from10% in 2014 to 50% in 2017 in Ramanujganj. 50% of retailers were distributors of Bayer Seed Company and distributors of Pan Seeds were 40%. The study concluded that Pan Seeds Pvt. Ltd. had good hold and positive growth in the both areas and the socio-economic condition of farmers can be analysed to plan marketing strategy to increase company's market share.

Key words : *Chi-square test, socio-economic condition, marketing trends, rice and maize.*

Introduction

Daltonganj is the block, main town and headquarter of Palamau district of Jharkhand. It is also the subdivision of Palamau. Daltonganj has a population of 3, 89,307 with male literacy rate of 81% and female literacy rate of 80% (Wikipedia). Ramanujganj is a tehsil and blocks in Balrampur district of Chhattisgarh. Ramanujganj has a population of 168,066 with male population of 82,442 male and female populations of 82,442. The literacy rate of male is 56.78% and female literacy rate of 40.05% (census India). It is the tribal dominated area in which more than 60% of population comprising of Scheduled tribes. The total area of Daltonganj block is 38891.22 acres out of which agricultural land is about 2039.82 acres. The average annual rainfall of Daltonganj is 964.4mm with monsoon rainfall of about 892.2mm. The average annual rainfall of Ramanujganj is 1172mm with highest average rainfall of 350mm in month of august. Agriculture is the main source of their livelihood, rural development and food security in both the block. Rice and maize are the main crops of farmers of these places besides other crops. Rice is grown mainly as kharif crop in rainfall areas that receive heavy rainfall. Maize is the third most important cereal crop in India after wheat and rice. The production of rice in India has increased to 3.5 times in last 60 years making country second largest producer of rice with 21% of global share. The present average yield of rice in India is around 2.2Mt/ha which is less that world rice productivity. Maize is grown in 4% of the net areas sown in the country. Major Rice producing states are West Bengal, Uttar-Pradesh, Andhra-Pradesh, Punjab, Orissa, Chhattisgarh etc. The production of maize increased from 1.7 million MT in 1950-51 to 23 million MT in 2013-14. The country per hectare yield of maize is 2.5 MT as compared to world production of 5.5MT. Agriculture productivity depends to a great extent on the use of quality seeds, which are capable of producing higher yields, provided other associated factors are available in proper combination. Improved varieties of seeds are one of the most important components of strategic inputs. The farmers of these regions use local seeds as well as hybrid seeds. The total sale of hybrid rice in Palamau is about 400 tonnes and for maize is 340 tonnes. The total sale of hybrid rice seeds is 165 tonnes and of maize is 150 tonnes in Ramanujganj. The main seed companies involved in marketing of rice and maize are Pan Seeds, Bayer, Syngenta, Pioneer, Tata, Aadvanta, Shree-Ram, Mahyco, Ankur etc. Pan Seeds is one of leading Seed Company of Daltonganj and Ramanujganj, whose headquarter is in Kolkata. The company promotes it seeds under Brand name "PAN" and the commitment to provide quality. It is the leading rice seeds company in Eastern India. Pan Seeds earns 65% of its profit from rice seed varieties and

rest 35% from wheat, vegetables and oil seeds. Sustainable availability of good quality seed and well-functioning seed marketing system is vital development issue, without which attaining the required agricultural production and productivity is impossible. The companies need not only produce goods quality goods but also inform consumers about their product benefits which can be only achieved by advertisement. The socioeconomic condition of farmers and marketing trends of rice and maize of Pan Seeds in Daltonganj and Ramanujganj are unexplored.

Materials and Methods

To study the socio-economic condition of farmers, marketing trends of pan seeds two questionnaires, one for farmers and one for retailers were developed. A total of 100 farmers were selected and interviewed for data collection as questionnaires for farmers. Five villages were taken from both Daltonganj and Ramanujganj and 10 farmers from each village were selected constituting a total sample size of 100 farmers. A total of 10 retailers were selected and interviewed as per questionnaire designed for retailers. Five retailers were taken from Daltonganj and Ramanujganj constituting a sample size of 10 retailers. The collected data were analysed in a systematic manner and interpreted with simple method. The data were analysed and presented as bar charts, pie charts, line chart etc. to know the socio-economic conditions of farmers, marketing trends of rice and maize seeds of Pan Seeds.

Result and Discussion

The survey result on socio-economic conditions of farmers includes the Education level, Family type, Size of family, Housing pattern, Land holding, Animal husbandry assets, Annual income of respondents of Daltonganj and Ramanujganj.

It is clear from the table-1 that in case of Daltonganj, 26% respondents where illiterate, respondents with education up to middle were 24% and there were no respondents with post graduate qualification. In case of Ramanujganj, 30% respondents where illiterate and respondents with education up to middle were 18% and there were only 2% of respondents having post graduate qualification. The result from the above table explains that illiteracy among the farmers of Daltonganj and Ramanujganj is most common as table shows illiteracy of 28% respondents. The result of only 01% Post graduate practising agriculture shows that with increase in educational qualifications people leave agriculture practise. The illiteracy might be due to lack of awareness about education and poverty. Similar finding on education level have been also reported by *Roy et al.* (2011-12) and *Bihari et al. (2012*).The result of the study revealed that illiteracy in the farmer was still on the higher side with 26% responded in Daltonganj and 30% respondent in Ramanujganj were illiterate.

It is clear from the table-2 that in case of Daltonganj most of the respondents (64%) had nuclear type of family and only 36% of the respondents had joint type family. Similarly in case of Ramanujganj also most of the respondents (74%) had nuclear type of family and only 26% of the respondents had joint type family. This increase in nuclear type pattern is due to the separation of families after marriage between brothers or families and people preferred to live separately in their own families instead of living together as a joint family. The result of the study shows that on an average 69% of farmers have separate family which is one of the main reasons for scattering of land holding in India.

It is clear from the table-3 that in case of Daltonganj 40% of the respondents had family size of 5-7 members, respondents with family size of 11 to 13 members were around 20% whereas respondents with family size up to 4 members were only 10%. In case of Ramanujganj 52% of the respondents had family size of 5-7 members, 18% of respondent had family size of 11 to 13 members and only 6% of respondent had family size of 4 members. This might be because of increasing awareness on benefits having of small families. Farmers preferred to have 2-3 children instead of having larges families. The increasing cost of living can also be one of the reasons due to which farmers prefer to have small and medium families. Similar finding on family size have been also reported by *Bihari et al. (2012)* and *Darandale et al. (2011)*. The result of the study revealed that the family size of the farmers of Daltonganj and Ramanujganj mostly composed of 5 to 7 members and rarely composed of 14 and above.

It is clear from the table-4 that in case of Daltonganj 44% of the respondents had landing holding of 1 to 2 ha. The respondents with semi-medium land were 30% and no respondents has large land holding. In case of Ramanujganj 48% of respondents had land holding of 1 to 2 hectare. The Respondents with semi-medium land holding were 24% and large farmers were only 2% of respondents. The Small and medium land holding might be due to increasing population and partition of land between families which resulted in division of land leading to decrease in land holding of farmers. Similar finding on land holding has been also reported by *Darandale et al. (2011).* The result of the study revealed that the problem of small land holding was also persistent in Daltonganj and Ramanujganj.

It is clear from the table-5 that in case of Daltonganj were involved in rearing of cow. 70% of the respondents

Table-1 : Distribution of Respondents of Daltonganj and Ramanujganj according to Education level {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}

S. No.	Education level	Daltonganj	Percentage	Ramanujganj	Percentage	Result A+B (Avg. %)
1.	Illiterate	13	26	15	30	28
2.	Primary	7	14	2	4	09
3.	Middle	12	24	9	18	21
4.	Intermediate	3	6	8	16	11
5.	High School	9	18	10	20	19
6.	Graduate	6	12	5	10	11
7.	Post Graduate	0	0	1	02	01
	Total	50	100	50	100	100

Table-2 : Distribution of Respondents of Daltonganj and Ramanujganj according to Family type {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}

S. No.	Family Type	Daltonganj	Percentage	Ramanujganj	Percentage	Result A+B (Avg. %)
1.	Nuclear	32	64	37	74	69
2.	Joint	18	36	13	26	31
	Total	50	100	50	100	100

Table-3 : Distribution of Respondents of Daltonganj and Ramanujganj according to Family Size {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}.

S. No	Size of family	Daltonganj	Percentage	Ramanujganj	Percentage	Result (Avg. %)
1.	UP TO4	6	12	7	14	15
2.	5 TO 7	20	40	26	52	46
3.	8 TO 10	9	18	5	10	27
4.	11 TO 13	10	20	9	18	19
5.	14 AND ABOVE	5	10	3	6	08
	Total	50	100	50	100	100

Table-4 : Distribution of Respondents of Daltonganj and Ramanujganj according to Land Holding {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}

S. No.	Type of Farmer	Daltonganj	Percentage	Ramanujganj	Percentage	Result A+B (Avg.%)
1.	Marginal (0-1 ha)	9	18	7	14	16
2.	Small (1-2 ha)	22	44	24	48	46
3.	Semi-Medium (2-4 ha)	15	30	12	24	27
4.	Medium (4-10 ha)	4	8	6	14	10
5.	Large (> 10 ha)	0	0	1	2	01
	Total	50	100	50	100	100

accepted presence of cow in their animal asset, 54% respondents used ox in agriculture practices and only 3 respondents were involved in poultry rearing. Similarly in case of Ramanujganj, most of the respondents (78%) were involved in rearing of cow, 46% respondents used ox in agriculture practises and only 5% respondents were involved in poultry rearing. The respondents with cow were more because they used cow for self-consumption of milk, selling of milk for some extra income and traditional culture of village. The maintenance of cow was cheaper as compared to ox and buffalo. The result of the study revealed that cow was the most loved animal asset and Poultry was the least loved assets by farmers in Daltonganj and Ramanujganj.

It is clear from the table-6 that in case of Daltonganj had mostly Pakka houses as 44% of respondent owned Pakka house. Only 38% of the respondent had Kaccha house. This might be due to more interest in having Pakka house and standard of living of farmers. The Kaccha houses were generally old and traditional one. The semi-pakka houses were also possessed by 18% of respondents who were not able to build Pakka house in one time. In case of Ramanujganj, 70% of the respondents had Kaccha house, 24% of respondents had Pakka house and 6% of respondents had semi-pakka houses. The Kaccha houses were more in Ramanujganj because farmer's houses were generally old and traditional one. The Pakka house were less because as they were not able to build Pakka house. Similar finding on housing pattern has also been reported by *Ananthna et al. (2014).* The result of study revealed that the housing infrastructure of the farmers in Daltonganj was better than the farmers of Ramanujganj.

Table-5 : Distribution of Respondents of Daltonganj and Ramanujganj according to Animal husbandry Assets {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}

S. No.	Animal Assets	Daltonganj	Percentage	Ramanujganj	Percentage	Result A+B (Avg.%)
1.	Cow	35	70	39	78	16
2.	Ox	27	54	23	46	46
3.	Buffalo	17	34	8	16	27
4.	Goat	13	26	5	10	10
5.	Poultry	3	6	7	14	01
	Total	50	100	50	100	100

Table-6 : Distribution of Respondents of Daltonganj and Ramanujganj according to Housing Pattern {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}

S. No.	House Pattern	Daltonganj	Percentage	Ramanujganj	Percentage
1.	Kaccha	19	38	35	70
2.	Pakka	22	44	12	24
3.	Semi-Pakka	9	18	3	6
	Total	50	50	100	50

Table-7 : Distribution of Respondents of Daltonganj and Ramanujganj according to Income level {A= 50 (Daltonganj), B=50 (Ramanujganj), N = A+B=100}

S.No.	Income Level	Daltonganj	Percentage	Ramanujganj	Percentage	Result A+B (Avg. %)
1.	Up to 1.0 lakh	22	44	25	50	47
2.	Up to 1.5 lakh	13	26	4	8	17
3.	Up to 2.0 lakh	4	8	6	12	10
4.	Up to 2.5 lakh	9	18	6	12	15
5.	03 lakh and Above	2	4	9	18	11
	Total	50	100	50	100	100

Table-8 : Chi-square analysis.

S. No.	Parameter of Study	Chi-square value	Level of Significance
1.	Education Level	12.59	Non-Significant
2.	Family Type	3.84	Non-Significant
3.	Size of Family	9.49	Non-Significant
4.	Land Holding	9.49	Non-Significant
5.	Animal asset	9.49	Non-Significant
6.	Housing Pattern	5.99	Significant at 5% and 1%
7.	Income Level	9.49	Significant at 5%

It is clear from the table-7 that in case of Daltonganj most of the respondents (44%) were of small income group compromising of average annual income up to 1 lakh. The respondents with 1.5 lakh income were 26% and only 4% of respondents were of large income. In Ramanujganj 50% of respondents were of small income group compromising of average annual income up to 1 lakh. The respondents with 1.5 lakh income were 8% and only 4% of respondent were of large income group. This might be due to changing environmental condition and decreasing rainfall and increasing cost of chemical input. The small land holding by farmers is also one of the reasons of low income of farmers. Similar finding on annual income has been reported by *Roy et al. (2011-12)* The result of the study revealed that agriculture was not providing commercial benefit to majority of the farmers and probably low marketable surplus was the main reason for 47% of farmers to have income less than 1 lakh.

The data was analysed by using Chi square test and the findings signifies that there is no significant difference in Education level, Family type, Size of family, Land holding for Daltonganj & Ramananujganj. In case of Housing pattern and Income level the Chi-square signifies significant difference of 5% level of significance in Income level and Chi-square signifies significant difference of 5% and 1% level of significance in housing Pattern for Daltonganj and Ramanujganj.

Marketing Trends of Rice and Maize Seeds of Pan Seeds in Daltonganj and Ramanujganj : The results of survey work on marketing trends of rice and maize seeds of Pan Seeds include sales trend of rice and maize seeds of Pan Seeds, Purchase trends of Pan Seeds and distributor's trend in Daltonganj and Ramanujganj.

Table-9 : Distribution of sale for Rice & Maize seeds of Pan Seeds for last four year in Daltonganj (n=50) and Ramanujganj (n= 50)

Years	Daltonganj (MT)		Ramanujganj (MT)	
	Rice	Maize	Rice	Maize
2014	14	0	0	0
2015	17	2.9	4.9	1.5
2016	20.7	6.2	8.7	3.82
2017	21.11	9.8	22.98	8.98

Table-10 : Purchase Trend: Distribution of respondents according to Purchase of Rice & Maize seeds of Pan Seeds in Daltonganj (n= 50) and Ramanujganj (n=50)

Years	Daltonganj	Percentage	Ramanujganj	Percentage
2014	5	10	5	10
2015	5	10	7	14
2016	11	22	19	38
2017	19	38	25	50

Table-11 : Distribution of respondents (retailer) according to distributors of Seed company in Daltonganj and Ramanujganj (Multiple response) (n=10)

S. No.	Company	Dalton-ganj	Raman ujganj	Total	Percentage (%)
1.	Bayer Seeds	3	2	5	50
2.	Syngenta Seeds	1	1	2	20
3.	Mahyco Seeds	2	1	3	30
4.	Dhanya Seeds	3	1	4	40
5.	Pan Seeds	2	2	4	40
6.	U.s Agriseeds	2	1	3	30
7.	Monsanto	1	2	3	30

It is clear from the table-9 that sale of rice seeds in Daltonganj increased from 14MT in 2014 to 20.7MT in 2016 and sales were 21.11 MT in 2017. This increase in rice and maize seeds might due to good productivity and germination quality of seeds. The increase was sharp till 2016 because of increase in farm meeting by Pan Seeds Company sales team and introduction of new varieties like 2423 and 2112 Gold which attracted the farmers to buy Pan Seeds. The sales were not so sharp from 2016 to 2017 due to increasing competition from others companies. In Ramannujganj, sale of rice increased from 4.9 MT in 2015 to22.98 MT in 2017. This increase might be due to good productivity and germination quality of Pan Seeds. The increase in field meeting and advertisement techniques was also one the reasons of sale. The sale trend of maize seed was slow and steady in Daltonganj and only increased from 2.9MT in 2015 to 2017 9.8MT in 2017. The increase in maize seeds was also not so sharp in Ramanujganj and it only increased from 1.5 MT in 2015 to 8.98 MT in 2017.This slow growth was due to availability of only one maize seed variety of Pan Seeds and other companies had more range of varieties as compared Pan Maize in Daltonganj and Ramanujganj.

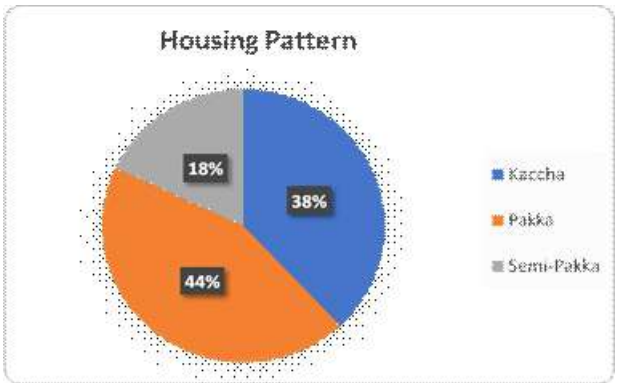


Figure-1 : Housing Pattern of Daltonganj.

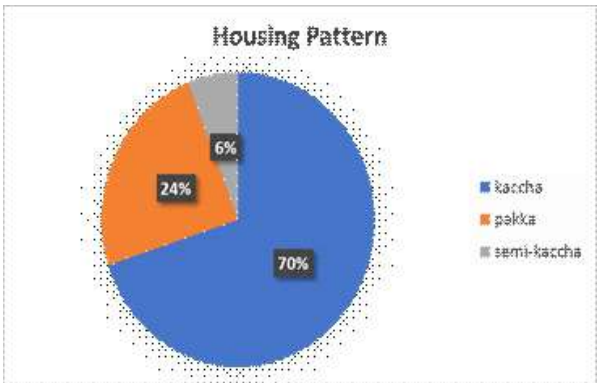


Figure-2 : Housing Pattern of Ramanujganj.

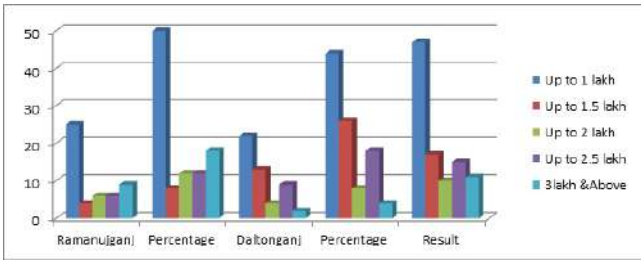


Figure-3 : Income pattern of farmers in Daltonganj and Ramanujganj

It is clear from the table-10 that purchasing preference of rice and maize seeds of Pan Seeds by respondents increased from 10% in 2014 to 38% in 2017 in Daltonganj. This can be due to mouth publicity done by farmers who used Pan Seeds in past years and also due to increase in field meeting done by the seed companies with the farmers to promote and motivate farmers to by the seeds of Pan Company. In case of Ramanujganj the purchase of the Pan Seeds (Rice and maize) increased from 10% in 2014 to 50% in 2017. This might be due to mouth publicity done by farmers who used Pan Seeds in past years and also due to increase in field meeting done by the sales team of Pan Seeds with the farmers to promote and motivate farmers.

It is clear from the table-11 that out of all the respondents (Retailers) Bayer Company had 50% of

Figure-4: Sales pattern of Rice and Maize in Daltonganj.

Figure-5: Sales pattern of Rice and Maize Ramanujganj.

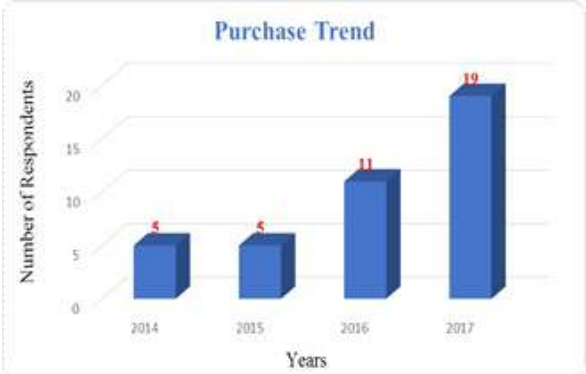


Figure-6 : Purchase trends of Farmers of Daltonganj.

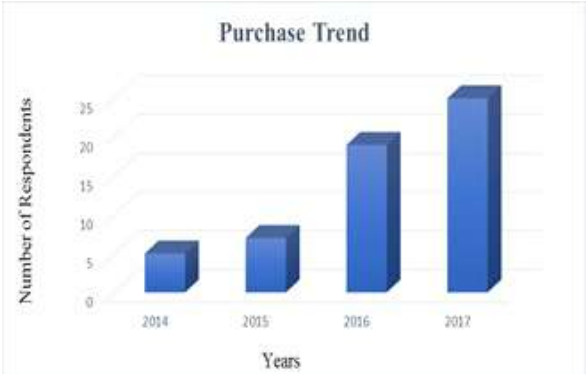


Figure-7 : Purchase trends of Farmers of Ramanujganj.

distributors followed by 40% Dhanya Seed Company and Pan Seeds have 40% of dealerships. This might be due to the reason that Bayer and Dhanya are very older companies and their seed demand is much higher than any company. Pan Seed is also growing very fast and increase in demand of seeds in 2016 – 2017 was the reason retailers are taking dealership of Pan Seeds.

Conclusions

A total of 100 farmers were selected from Daltonganj and Ramanujganj for carrying out survey work. It was found that annual income was up to 1 lakh for 44% of respondents in Daltonganj and 50% for respondents in Ramanujganj. It was found that literacy rate of respondents was 74% in Daltonganj and 70% in Ramanujganj which is similar to national literacy rate of 74.04%.It was found that small farmers with land holding was 1-2 ha were 44% of total respondents in Daltonganj and were 48% of total respondents in Ramanujganj. It was found that there was more nuclear type of families as 64% of respondents had nuclear family in Daltonganj and 74% of respondents had nuclear family in Ramanujganj. It was found that the size of family was of 5 to 7 members for 40% respondents in Daltonganj and 52% of respondents in Ramanujganj. It was found that 70% of respondents had Kaccha house was more common in Ramanujganj as 70% of respondents had Kachha house. Pakka house was more common in Daltonganj with 44% of respondents having Pakka houses. It was found cow was the most common assets in Daltonganj and Ramanujganj as more than 70% of respondent were rearing cow. It was found sale of Pan Seeds rice was increased sharply in year 2016 and 2017 due good yield of new varieties of rice seeds in past years. It was found sale of maize for Pan Seeds was not sharply increasing because only a single variety was available in market for sale. It was found that distributors for Bayer company was highest as 50% of respondents/ (Retailers) were distributor of Bayer followed by other seed companies.

References

1. Ananthnag, K, mahatabali, K. M. and kumarvinaya. (2010-11). A study on socio - economic status of farmers practicing organic farming in eastern dry zone of Karnataka, Research.
2. Ahmed, S.R. (2014). A study on marketing of paddy in Apmc Bangarpet of Karnataka state, *University of Agricultural Sciences,* Bangalore, July, 2014.
3. Bihari, B., Kumar, R.Prasad, K. and Sundarambal, P. (2012). Role Performance and Knowledge Level of Tribal Women Farmers in Meghalaya. *Indian Research Journal of External Education,* 12(1): 60-63.
4. Crompton, tom and Shiva Vandana (1998). Monopoly and Monoculture-Trends in Indian Seed Industry. *Economic and Political weekly.* Vol-33, issue no.-39.

5. Darandale, A.D. and Soni, N.V. (2011). Relationship between Attitude of Tribal Maize Growers towards Organic Farming and Their Selected Characteristics. *Gujarat Journal of Extension Education,* 22: 8-9.
6. Jadhao, P.V. (2012). A study on market potential seed business of vegetable (hybrid tomato and okra) in Pune districts of Maharashtra state. *Thesis submitted to Acharya N.G Ranga Agricultural University,* Page No. – 13-14.
7. Ray, S.K., Sabur, S.A., and Kamruzzaman, M. (2001). Vegetable Seed Marketing System in Some Selected Areas of Bangladesh, *Asian Network for Scientific Information,* 6: 534-528.
8. Reddy G. Sreenivasa, Gangisetty N. and Reddy T. Narayana. (2015). A Study on Socio Economic Conditions of Farmers in Kurnool District. MERC Global's *International Journal of Social Science & Management.* 2: 281-288.
9. Ramaswamy, B., Pray, C.E. and Kelly, T. (2002). Dissemination of private hybrid and crop yield in the semi-arid tropics of India. *Indian Journal of Agricultural Economics.* 57 (1): 39-51.
10 Krishikosh.egranth.ac.in/AgriculturalExtension/BHU/ PradeepKumar (2016)/ thesis/introduction.
11. www.youarticlelibrary.com/cultivation/maize-cultivations-production-anddistribution/20918.
12 www.censusindia,co.on/subdistrict/ramanujganj-tehsil-surguja-chhattishgarh-3236
13. https://en.wikipedia.org/wiki/Medininagar.
14. https://en.wikipedia.org/wiki/Ramanujganj
15. http://seednet.gov.in/Material/IndianSeedSector.htm
16. www.en.climate-data.org/location/174201

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1017-1022 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Cracking in Fruit Crops – A Review

N.R. Rangare[1], D.P. Sharma[2], Anay Rawat[2], Narayanlal[3], Suchi Paroha[2] and H.K. Rahangdale[2]

[1]*National Institute of Agricultural Extension Management (MANAGE)*

[2]*Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, M.P.*

[3]*ICAR-IISS, Bhopal, M.P.*

Corresponding Author Email : nrrangare@gmail.com

Abstract

Fruit cracking is a serious physiological issue that has a detrimental impact on the quality of the fruit. Fungus can infect the fruit through cracks on the surface, which also facilitate fast moisture loss and shrivelling, decreasing market quality and storage life. Fruit cracking occurs when the plants receive a large amount of water following a long period of drought, as well as when the temperature and humidity are high in the summer. Drip irrigation, mulching, fertilizer management, resistant cultivars, micronutrient spraying, and growth regulators are all utilized to decrease fruit cracking in various fruit crops. Proper fertiliser management might also help to prevent cracking (Citrus). Micronutrient foliar sprays like B (pomegranate, mango, litchi, bael), Ca (pomegranate), and K (citrus), as well as hormones like GA3, 2, 4-D (pomegranate), and NAA (citrus), reduce cracking. The presence of silixol in grapes reduces the risk of cracking. Pomegranate cracking is prevented by pactobutrazol, CPPU, cytozyme, and salicylic acid. Banana fruit breaking can also be avoided by using bagging (mango, pomegranate), various packing materials, and harvesting at the right time.

Key words : *Cracking, fruit crops, plants.*

Introduction

The physical failure of the fruit skin" manifests itself as skin or cuticle fractures that do not enter the flesh. Splitting is a type of severe breaking that reaches deep into the pulp. Fruits that have been cracked are more prone to storage illness, and their storage and shelf life are reduced. Fruit cracking occurs throughout the growth, development, and ripening of the fruit. It can also appear in some fruits after harvest, which is largely due to the storage environment. Candy cherry, plum, apricot, litchi, banana, apple, avocado, grape, pomegranate, citrus, persimmon, peach, and fig have all been known to crack.

Mechanism of fruit cracking : Fruit cracking occurs when the plants are given enough of water after a lengthy period of dryness. The reason for this is that during extended drought, both xylem and phloem become stronger, and as a result, they lose their ability to divide and enlarge. When water supply is reestablished after a dry spell, the meristematic tissues develop again, but the xylem and phloem do not (Butani *et al.* 2019). As a result, the fruit cracks due to the bursting of the tougher tissues. Furthermore, the peel of fruits becomes hard and inelastic in the summer due to high temperatures and low humidity, and strong rains during the rainy season accelerate the growth and expansion of interior tissues at a faster rate, although the peel stays inelastic. As a result, the growth of the peel does not coincide with the expansion of the internal tissues, resulting in the inelastic fruit peel shattering (Sheikh and Manjula 2012)

Cracking in mango : The two types of fruit cracking in the mango cv., 'Dashehari' fruit in India are described morphologically in Table-1. (Saran *et al.* 2014) 60 and 68 days after fruit set, the fruit fractured lengthwise or split into a star form, respectively (Saran et al. 2014). The cracking began at the fruit's beak end and progressed to the ventral sides (Saran et al. 2014). The longitudinally cracked fruits' stones were totally exposed, whereas the star-cracked fruits' stones were not. The fissures were mostly found on the fruit's west and south sides.

The stone fell out in the majority of longitudinally cracked fruits, but not in the star-cracked ones. (Kumar and Saran, 2011). Cracking could be caused by a lack of water or a calcium or boron deficiency (Saran and Kumar 2011). Temperature, humidity, and rainfall extremes may all play a role in the condition. In 'Dashehari' mango cultivars, it affects production by up to 20%. (Saran and Kumar 2011). The cultivar Dashehari had the most fruit cracking (4.12 percent) and cracked fruits (no.) (157) among the different cultivars. (Kumar and Saran, 2011) demonstrated that foliar Boron (0.10 percent) spraying at pea stage in the third week of April, followed by 2nd and 3rd sprays at 15-day intervals, resulted in minimal fruit cracking in cv. Dashehari (0.47 percent). Longitudinal cracking is the most common kind of cracking in cv. Dashehari, according to (Saran et al. 2014). Cracked fruit of cv. Dashehari has a minimum fruit fresh weight (122.40 g), pulp thickness (1.76 cm), stone breadth (6.24 cm), and maximum stone fresh weight (Butani *et al.* 2019). (25.75

g). (Rathore and Pal, 2016) found that pre-harvest bagging of mango cv. Mallika with blue paper bags resulted in the lowest number of diseased (3), insect-infested (2), and broken fruit (0).

The two varieties of fruit crack in the mango cv. 'Dashehari' fruit in India are described morphologically. The skin and flesh typically fracture, exposing the stone or seed (Ram *et al.* 1989), rendering the fruit unmarketable. The cracking can be rather round at times, yet the fruit is still unmarketable. There were two forms of cracking found: longitudinal and star types. The stone was entirely exposed in longitudinal fruit cracking, and damaged fruits had star-shaped fissures in the peel in star cracking. Cracking may start near the calyx end but is mostly seen on the side of the fruit. The fruit cracked longitudinally or split in a start from 60 and 68 days after fruit set. Cracking started from the beak end and then spread on ventral sides of the fruit

Cracking in citrus : Creasing or cracking of citrus fruit peels is a major pre-harvest physiological problem. Almost all citrus varieties are affected by this problem. The incidence of fruit cracking ranges from 10% to 35%, which has a significant impact on fruit quality and productivity (Li, 2009). Although China is one of the key places where citrus originated and one of the world's largest citrus producers, the reasons and methods of citrus fruit creasing or cracking are still unknown. Furthermore, a variety of factors, such as cultivar features, might influence citrus fruit creasing and cracking. (Agusti *et al.,* 2003), Weather (Gambetta *et al.,* 2000), rootstock (Storey *et al.,* 2002), peel thickness (Holtzhausen, 1981), peel hardness (Li, 2009), and growth regulators are all factors to consider (Li *et al.,* 2016). In order to provide theoretical advice for future researchers and citrus growers, this work explored the physiological and molecular mechanisms, as well as the influencing elements, that underpin citrus fruit creasing or fruit cracking.

Fruit cracking happens most frequently during the cell expansion or fruit maturity period in different citrus cultivars, but it can also occur during the entire fruit growth and development cycle in select cultivars. Citrus fruit cracking differs depending on the variety and stage of development of the fruit. Flavedo-splitting, inner-cracking, and albedo-splitting are three citrus fruit cracking patterns (fruit creasing or pitting). For example, flavedo breaking in 'Jincheng' oranges begins with flavedo cuticle splitting, then gradual deformation and breakdown from the outside to the inside of the flavedo cell, and finally albedo disruption. (Wang and Qin, 1987). Innercracking is the second type of citrus fruit cracking. The core axis of the 'Duwei' pomelo cracks first, then the fruit top, and lastly the fracture occurs (Wu *et al.,* 1987). Creasingfruit, also known as pitting fruit, is the third type of citrus fruit breaking. The 'Hongjiang'creasing-fruit grows pitted, and the fruit eventually cracks (Zou and Xu, 1995; Chen *et al.,* 1999; Li *et al.,* 2008). Fruit cracking is a progressive process rather than a burst. Normal fruit growth, the critical phase of fruit cracking, the first period of fruit cracking, the middle stage of fruit cracking, and the latter stage of fruit cracking are the different stages.

The fruit peel develops naturally within the normal period. The oil glands have a consistent shape and are positioned in order on the fruit peel surface. A brown stripe appears on the fruit peel surface during the important fruit cracking stage, the cuticle breaks and a crack appears, and the oil glands begin to distort. The peel cracking is worsened in the early stages of fruit cracking, and the oil glands break. Following that, the tissues of the fruit surface are severely damaged due to subsequent cell injury, and there is a greater space between cells of the shattered albedo. The tissue structures of the fruit are extensively harmed in the later stages of fruit cracking, as the fruit surface has been significantly damaged, the tissue structures of the flavedo and albedo cannot be distinguished (Wang and Qin, 1987; Li, 2006b).

Cracking in litchi : Litchi (Litchi chinensis Sonn.) is an important Sapindaceae subtropical evergreen fruit crop. The fruit is a drupe with a thin, leathery pericarp that encloses the aril, which is the edible part of the fruit, and then covers the single brown-black seed (Menzel and Simpson 1986). It is adapted to locations characterised by warm subtropics and elevated tropics with chilly dry winters and warm wet summers, as well as areas characterised by warm subtropics and elevated tropics with cool dry winters and warm wet summers (Menzel and Simpson 1988). Although commercially prominent in the Indo-Gangetic plains of Uttar Pradesh, Bihar, Uttarakhand, and West Bengal, favourable climatic conditions in the sub-tropical states of Punjab, Himachal Pradesh, and Jammu and Kashmir have led to additional expansion.

Litchi production in India is 528 260 metric tonnes per year from an area of 84 950 acres (Anon 2015), with most of it concentrated in Bihar (38 percent). Despite its distinctive and attractive qualities, litchi fruit is severely harmed by fruit cracking disorder, which results in considerable yield and economic value loss (Huang *et al.* 2005).

Litchi, as opposed to rambutan and longan, is the Sapindaceous fruit crop most prone to fruit cracking (Huang 2006). Litchi cracking is most widespread in China (Chen and Huang 2001) and India, the world's two major litchi producers.

Table-1 : Morphological description of the two types of fruit cracking in mango cv., 'Dashehari' fruit in India.

Parameters	Longitudinal cracking	Star Cracking
Site of cracking	Near neck	Near neck
Site of cracking	Ventral	Ventral
Stone	Exposed	Exposed
Mean time of set cracking	60 days	60 days
Direction of cracking	West and south	West and south
Fruit drop	Fruit not dropped but stone dropped in most of the cases	Fruit and stone not dropped

Table-2 : The incidence of different types of fruit cracking in mango fruits cv. 'Dashehari'

Fruit cracking type	Fruit cracking (%) during different years		
	2009	2010	2011
Longitudinal	3.8	3.4	1.7
Star	0.3	1.8	0.02
Total cracking	4.0	5.2	1.7
C.D. (P=0.05) N=3.R=12	0.1	0.2	0.02

In India, sensitive cultivars like Muzaffarpur and Dehra Dun may lose one-third of their harvest (Kanwar *et al.* 1972). The topic of fruit cracking in litchi was studied by Li *et al.* (2001) and Huang (2005), who found that genetics of cultivars, temperature, soil and plant water status, plant growth regulators, and nutrients all play a role. Studies of the morphology and mechanical characteristics of the cell walls in the skin or pericarp have also produced useful information about the underlying reasons of cracking as well as possible solutions to the problem.

The disorder's occurrence in litchi is as follows: Litchi fruit development is divided into two phases: pericarp (skin) and seed development, followed by aril development (Kanwar et al. 1972, Huang 2001). Cracking happens following the colour break stage, coinciding with the onset of rapid aril growth, according to field observations (Huang *et al.* 1999). When the aril develops and exerts pressure on the inactively expanding pericarp, Singh *et al.* (2013) observed cracking during the final stage of fruit growth.

These phenomena can also be seen in other fruits during their early stages of development, owing to protrusion of seeds from the seed jacket at the apical end. Short skin-deep cracks to major ruptures reaching the length of the fruit are all possible cracking injuries. When exposed to low relative humidity and hot dry air, litchi fruit cracking can start as microcracks throughout its growth and development. Microcracks are also triggered by the fast growth of the aril during the early stages of fruit development, which exacerbated as the fruit matured (Underhill and Simons 1993, Huang et al. 2004b). When stress from the 'inflating bladder' surpasses the tensile strength of the skin, Huang and Xu (1983) proposed the ball skin versus bladder effect theory, which states that cracking occurs due to a lack of growth coordination between the 'ball skin' and the 'bladder' (Kanwar et al. 1972a, Li et al. 1995).

Cracking in banana : Banana trees belong to the Musa genus and are enormous perennial herbs native to Southeast Asia. The Musa genus is separated into two segments from a botanical standpoint: edible and wild species. All consummated bananas have wild diploid and seminifar non edible parents, notably Musa acuminate (AA) and Musa balbisiana (BB). Seedless triploid clones produce the majority of bananas consumed. Peel cracking sensitivity is affected by genetic, environmental, morphologic, and physiologic factors, but post-harvest peel splitting is primarily due to storage circumstances (Wo *et. al.* 2005). Only between the third and sixth days following maturation induction does it happen. Peel cracking is usually caused by excessive relative humidity. Some cultivars, such as 'Mas (AA)', are more sensitive than others. (Paull, 1996; Paull, 1997; Paull, 1998; Paull, Green bananas picked at the ideal thermal temperature were stored in a perforated polyethylene sheet encased in a carton to test peel splitting. Exposure to ethylene causes ripening to occur. The polyethylene film is then sealed to prevent saturation humidity conditions from causing it to split (90-95 percent RH). The percentage of splitting can be estimated by dividing the number of split bananas by the total number of bananas (Dadzie and Orchrd, 1997)

It's described as damage to plant or fruit tissue that isn't caused by an illness or a mechanical factor (Dadzie and Orchrd, 1997). It evolved as a plant's reaction to changing environmental conditions (Wills *et al.* 1989). They usually only affect a small area of tissue. They can be superficial, affecting only the fruit surface (e.g. peel breaking) and leaving the pulp unaffected, or they can affect both the skin and the meat (e.g. bruising) (Putra *et al.* 2010). They have an impact on both the shelf life and the marketability of the product (Johnson *et al.* 1997). Peel browning and cracking, finger drop, and even chilling harm are examples of these. Fruit quality suffers as a result of these issues, and market value suffers as a result

(Luyckx *et al* 2016). The key variables impacting post-harvest quality and the occurrence of post-harvest physiological problems are post-harvest circumstances. The use of the most appropriate temperature and humidity, as well as the most appropriate packaging and handling methods, are all required for bananas to reach consumers in the best possible condition and quality (Hailu *et al.* 2013)

Cracking in beal : Fruit drop and cracking are two of the most critical limiting factors in bael production. Pant Sujata had the highest fruit drop and cracking, while Pant Bael 4 had the least. The largest amount of fruit breaking was seen in January, while the least amount was observed in July. Fruit necrosis (15.10 percent), fruit cracking (17 percent), and fruit drop (14.70 percent) were reduced when Boron (1 percent) + Copper sulphate (0.25 percent) + Carbendazim (0.1 percent) was applied at the pea stage and followed up one month later (Singh., et al.2013). Fruit cracking was decreased by harvesting 'African Pride' fruit one and two weeks before commercial maturity, however fruit picked three weeks before maturity did not demonstrate fruit cracking.

One of the most common postharvest issues for sugar apples and atemoya is fruit cracking or splitting on and off the tree. Preharvest treatment of 'African Pride' atemoya with gibberellic acid (GA3) reduced postharvest cracking. Fruit that had been sprayed with GA3 at 50 and 100 ppm twice, 7 and 14 days before harvest, cracked less while stored at 25 °C. Furthermore, GA3-sprayed fruit that had been treated with calcium carbide (CaC2) to speed up ripening showed no cracking (Singh et al. 2016). The physiological symptoms of fruit cracking that developed at various phases of bael fruit development clearly demonstrated that fruit cracking symptoms appeared at fruit maturity stage. Linear, epidermal fissures were discovered at the distal end of the fruit surface during the early stages of fruit cracking, and the length of the break was later expanded, widened, and deepened.

Cracking in grape : The changes that occur in the grape skin throughout fruit development are crucial to understanding the processes that cause berry breaking. The structure of the berry peel affects the grape's ability to withstand cracking (Meynhardt, 1964). The cracking of sound berries in the field is proof that the skin inhibits growth, according to (Considine and Kriedemann, 1972). He backed this up with the fact that peeled grape berries absorbed twice as much water as unpeeled grape berries without splitting. Reviewing some of what is currently known about the physiological changes the grape skin endures during fruit growth can help us better comprehend the role of the grape skin in berry breaking. The notions of elasticity and plasticity are crucial in this debate. Elasticity refers to a person's capacity to bounce back after being stretched. When the air in a balloon is released, it exhibits elasticity. The ability to retain a new shape is known as plasticity. These phrases together explain the berry skin's extensibility throughout growth. Skin extensibility remained essentially constant during Stage I of fruit growth, when cell division was taking place (Matthews *et al.* 1987). The same was true for Stage II, which had very little growth. According to (Considine and Knox 1979), the cell walls of the berry skin are thickening at this time. Matthews also noted a significant rise in extensibility at the start of Stage III, the phase of fast cell expansion. Considine noticed that the berry skin cell walls were becoming thinner at the same time, maybe due to enzyme activity. A rapid drop in berry skin extensibility was found near the conclusion of Stage III (two to three weeks before harvest) (Matthews *et. al.* 1987). Should the berry undergo an abrupt shift in water status, this "hardening-off" of the skin tissue may predispose it to cracking. Although the mechanism governing grape berry size is unknown, current data suggests that the berry skin restricts growth and undergoes complicated chemical changes during fruit development. Environmental circumstances could potentially have a substantial impact on these processes, affecting the skin's ability to resist cracking approaching harvest (Ramteke *et al.* 2017)

Cracking in pomegranate : Pomegranate fruit cracking is a severe issue. The disease is assumed to be caused by boron shortage in early fruits, although it could also be caused by changes in soil moisture content and air humidity in mature fruits. If the soils become excessively dry during fruit ripening and are later heavily irrigated or there are some showers, cracking may occur. Fruit cracking resistance has been documented in cultivars such as Gul eshan, Khog, and Kazaki. Fruit cracking has been claimed to be reduced by using regular irrigation to keep soil moisture at a desired level, as well as spraying calcium compounds or GA_3 at 120 ppm on immature fruits.

Drizzle irrigation at 12 l/h resulted in minimum fruit cracking in both years (18.5 percent) and (18.7%) and highest yield/plant in both years (30.4 kg) and (29.8 kg), according to (Prasad., *et al.* 2003). Khawaga (2007) found that spraying cv. Manfalouty with paclobutrazol 150 ppm in the first week of June (9-10 weeks before fruit harvest) resulted in the least amount of splitting fruit in both years (26.5%) and (24.1%). (Ahmed 2009) found that irrigation for 14 days plus 0.75 percent borax added to the soil at the time of fruit development resulted in the fewest cracked fruits/plants in pomegranate cv. Ganesh (2.01 percent). With CPPU 5 ppm sprayed in May in pomegranate cv. G-137, (Belsare 2011) observed minimum fruit cracking (2.38 percent) and maximum fruit

output (21.13 kg/tree). (Lal., et al. 2011) investigated the effect of different chemicals and varietal interaction on percent fruit cracking in Jyoti, Dholka, Kandhari, Bedana, and G-137 pomegranate varieties grown under Karewa conditions in Kashmir valley and discovered that foliar application of CaSO4 3000 ppm applied on 15th May (fruit set) and 15th June (fruit active development stage) among the different varieties jyoti gave the least amount of fruit cracking (23. (25.16 percent).

Better interaction was obtained in CaSO4 3000 ppm in G-137 variety which shoes lowest fruit cracking (15.28%). (Sheikh and Manjula 2012) reported that before harvest spray of boric acid 0.2% in pomegranate cv. Ganesh showed lowest percentage of cracked fruits (3.33%) and maximum yield of healthy fruits/plant (34.05 kg). (Abubakar., *et al*. 2013) observed the effect of biostimulants on fruit cracking of pomegranate cv. Kandhari kabuli and revealed that application of biostimulants, particularly cytozyme 4 ml/l applied at 45 days after bud burst and repeated 10 days after fruit set resulted in minimum fruit cracking (11.33%). (Ahmed., *et al*. 2014) reported that in the first week of March, April, May, and June, four foliar applications of salicylic acid + all nutrients in cv. Manfaulty resulted in significantly greater gross yield/tree (126.9 and 135.3 kg), marketable yield/tree (124.41 and 126.9 kg), and much less fruit splitting (4.3 and 4.2 percent). (Wafa 2014) studied that in both years, when cv. Wonderful was bagged with a prgmen bag 21 days after fruit set and continued till harvest (1st week of October), there was much less fruit breaking (1%) and sunburnt fruits (2%). (Kumar., *et al*. 2017) found that spraying cv. Jodhpur Red with 2, 4-D 10 ppm 15 days after fruit set and 30 days after fruit set resulted in the least amount of premature (5.21%) and mature (3.09%) pomegranate cracking.

References

1. Abubakar AR., "Effect of plant biostimulants on fruit cracking and quality attributes of pomegranate cv. Kandhari kabuli". *Scientific Research and Essay* 8.44 (2013): 2171-2175.
2. Agusti, M., Almela, V., Juan, M., Mesejo, C., Martinezfuentes, A., 2003. Rootstock influence on the incidence of rind breakdown in 'Navelate' sweet orange. *J Hortic Sci Biotech,* 78: 554-558.
3. Ahmed B. "Fruit cracking and yield of pomegranate as affected by borax with irrigation at different intervals". *Annals of Agricultural Research New Series* 30.3 (2009): 148-149.
4. Ahmed FF., et al. "Controlling fruit splitting and improving productivity of Manfalouty pomegranate trees by using salicylic acid and some nutrients". *World Rural Observations* 6.1 (2014): 87-93.
5. Anonymous. 2015. National Horticulture Database. National Horticulture Board, Gurgaon, Haryana.
6. Belsare CR. "Effect of plant bio-regulators and nutrients on yield, fruit cracking and quality in pomegranate (*Punica granatum* L.) cv. G-137". *M. Sc. Thesis, University of Horticulture and Forestry,* Nauni, Solan (2011).
7. Butani1 AM, Purohit HP, Solanki R, Mishra P and Dadhaniya D. A Chronic Problem of Fruit Cracking in Fruit Crops: A Review *Acta Scientific Agriculture* 3.4 (2019): 270-274.
8. Chen H B and Huang H B. 2001. China litchi industry: development, achievement and problems. *Acta Horticulturae* 558, 31–9.
9. Chen, J.Z., Wu, L., Peng, L.Z., 1999. Study on the relation between TME activity of the peel and fruit cracking in citrus. *South China Fruits,* 28: 8. (in Chinese).
10. Considine JA, Kriedemann PE 1972.) Fruit splitting in grapes: determination of the critical turgor pressure. *Australian Journal of Agricultural Research* 23: 17–24.
11. Considine, J.A. and P.E. Kriedemann 1972. Fruit splitting in grapes: determination
12. Considine, J.A. and R.R. Knox 1979. Development and histochemistry of the cell, cell walls and cuticle of the dermal system of fruit of the grape, *Vitis vinifera* L. *Protoplasma* 99: 347-365.
13. Dadzie BK, Orchrd JE. Routine post-harvest screening of banana/plantain hybrids: criteria and method. *Inibap Technical Guidelines;* 1997.75 p.
14. Gambetta, G., Arbiza, H., Ferenczi, A., Gravina, L., Orlando, V., Telias, A., 2000. Creasing in Washington Navel orange in Uruguay: study and control. *Proc Int Soc Citricult IX Congress,* 453-455.
15. Hailu M, Workneh TS, Belew D. Review on postharvest technology of banana fruit. *African Journal of Biotechnology.* 2013;12(7):635–647.
16. Holtzhausen, L.C., 1981. Creasing: formulating a hypothesis. *Proc Int Soc Citriculture Congress,* 1: 201-204.
17. Huang H and Xu J. 1983. The developmental patterns of fruit tissues and their correlative relationships in Litchi chinensis Sonn. *Scientia Horticulturae* 19: 335–42.
18. Huang H B. 2001. Towards a better insight into the development of the arillate fruit of Litchi and Longan. *Acta Horticulturae* 558: 185–92.
19. Huang X M, Wang H C, Gao F F and Huang H B. 1999. A comparative study of the pericarp of litchi cultivars susceptible and resistant to fruit-cracking. *Journal of Horticultural Science and Biotechnology* 74: 351–4.
20. Huang XM, Wang HC, Lu XJ, Yuan WQ, Lu J M, Li JG and Huang HB. 2006. Cell wall modifications in the pericarp of litchi (*Litchi chinensis* Sonn.) cultivars that differ in their resistance to cracking. *Journal of Horticultural Science and Biotechnology* 81(2): 231–7.
21. Huang X M, Yuan W Q, Wang C, Li J G, Huang H B, Shi L and Jinhua Y. 2004b. Linking cracking resistance and fruit desiccation rate to pericarp structure in litchi (*Litchi chinensis* Sonn.). *Journal of Horticultural Science and Biotechnology* 79: 897–905.
22. Huang X M. 2005. Fruit disorders.(*In*:) *Litchi and Longan - Botany, Production and Uses*, pp 41–152. Menzel C and Waite G K (Eds). CABI Pub., Wallingford, Oxford, UK.
23. Johnson GI, Sharp JL, Mine DL, et al. Postharvest

technology and quarantine treatments. In The mango: Botany, production and uses. USA: *Tropical Research and Education Center;* 1997. p. 444–506.

23. Kanwar J S, Nijjar G S and Rajpoot M S. 1972a. Fruit growth studies in litchi (Litchi chinensis Sonn.) at Gurdaspur (Punjab). *Punjab Horticultural Journal* 12: 146–51.
24. Khawaga AS. "Reduction in fruit cracking in Manfaluty pomegranate following a foliar application with paclobutrazol and zinc sulphate". *Journal of Applied Sciences Research* 3.9 (2007): 837-840.
25. Kumar K., "Effect of growth regulators and micronutrients on fruit cracking and fruit yield in pomegranate". *Indian Journal of Agricultural Research* 51.3 (2017): 272-276.
26 Lal S., et al. "Effect of different chemicals on fruit cracking in pomegranate under karewa condition of Kashmir valley". *Indian Journal of Plant Physiology* 16.3 (2011): 326-330.
27. Li J G, Huang H B, Gao F F, Huang X M and Wang H C. 2001. An overview of litchi fruit cracking. *Acta Horticulturae* 558: 205–8.
28. Li J G, Huang H B, Li J G and Huang H B. 1995. Physico-chemical properties and peel morphology in relation to fruit-cracking susceptibility in litchi fruit. *Journal of South China Agri. Univ.* 16: 84–9.
29. Li, C.Y., Zhang, G.L., Zeng, X.l., Luo, N., Hu, Q., 2006. Studies on cell wall enzymes of navel orange (*Citrus sinensis*) fruit. *Journal of Sichuan Agricultural University,* 24: 73-76. (in Chinese)
30. Li, J., 2006b. Creasing fruit and related research of the cell-wall metabolism in citrus [M.D. Dissertation]. Guangzhou: South China Agricultural University. (in Chinese).
31. Li, J., 2009. Cell wall metabolism and related gene isolation of pitting fruit peel in citrus [Ph. D. Dissertation]. Guangzhou: South China Agricultural University. (in Chinese).
32. Li, J., Chen, J.Z., Hu, Y.L., Zhou, B.Y.,Yao, Q., Hu, Z.Q., 2008. Effect of soil moisture on cell-wall metalbolism of pericarp in citrus. *Acta Ecologica Sinica,* 28: 486-492. (in Chinese).
33. Luyckx A, Lechaudel M, Hubert O, et al. Banana physiological post-harvest disorders: a review. MOJ Food Process Technol. 2016; 3(1): 226.
34. Matthews, M.A. Cheng, G. and Weinbaum, S.A. 1987. Changes in water potential and dermal extensibility during grape berry development. *J. Amer. Soc. Hort. Sci.* 112 (2): 314-319.
35. Menzel C M and Simpson D R. 1986: Lychee cultivars. *Journal of Queensland Agriculture.* 112(3): 125–36.
36. Menzel C M and Simpson D R. 1988. Effect of temperature on growth and flowering in litchi (*Litchi chinensis* Sonn.) cultivars. *Journal of Horticultural Science* 63: 349–60.
37. Meynhardt JT 1964. A histological study of berry-splitting in some grape cultivars. South African Journal of Agricultural Science of the critical turgor pressure. Austral. *J. Agr. Res.* 23: 17-24.
38. Prasad RN., et al. "Effect of drip irrigation on growth, yield and quality of pomegranate in arid region". *Indian Journal of Horticulture* 60.2 (2003): 140-142.
39. Putra E, Zakaria W, Abdullah N, et al. Weak neck of Musa sp. cv. Rastali: a review on it's genetic, crop nutrition and post harvest. *J Agro.* 2010;9(2):45–51.
40. Ram S, Bist LD, Sirohi SC (1989) Internal fruit necrosis of mango and its control. Acta Hortic 231: 805–813.
41. Ramteke SD, VIKAS Urkude V, Parhe SD and Bhagwat SR 2017, Berry Cracking; Its Causes and Remedies in Grapes - A Review *Trends in Biosciences* 10(2), 549-556.
42. Rathore AC and Pal AK. 2016 "Pre-harvest fruit bagging improves fruit quality of mango in doon valley". HortFlora Research Spectrum 5.1: 84-85.
43. Saran PL and Kumar R. 2011 "Boron deficiency disorders in mango (Mangifera indica): field screening, nutrient composition and amelioration by boron application". *Indian Journal of Agricultural Sciences* 81.6: 506–510.
44. Saran PL, Kumar R, Ercisli S and Choudhary R (2015). Fruit Cracking in Mango (Mangifera indica L.) cv. 'Dashehari' https://www.researchgate.net/ publication /276836074.
45. Saran PL., et al. 2014 "Fruit cracking in mango (Mangifera indica L) cv. 'Dashehari'". Erwerbs-Obstbau 5.2: 93-96.
46. Sheikh MK and Manjula N. 2012 "Effect of chemicals on control of fruit cracking in pomegranate (*Punica granatum* L) var. Ganesh". Options Méditerranéennes, *II International Symposium on the Pomegranate* 103 : 133-135.
47. Singh A, Mishra D S, Kumar R and Kumar P. 2013. Physico-chemical changes in litchi cultivar Rose Scented during fruit development and maturation. *Indian Journal of Horticulture* 70(3): 328–32.
48. Storey, R., Treeby, M.T., Milne, D.J., 2002. Crease: another Ca deficiency-related fruit disorder. *J Hortic Sci Biotech,* 77: 565-571.
49. Underhill S J R and Simons D H. 1993. Lychee (Litchi chinensis Sonn.) pericarp desiccation and importance of postharvest micro cracking. *Scientia Horticulturae* 54: 287–94.
50. Wafa M. 2014 "Effect of bagging type on reducing pomegranate fruit disorders and quality improvement". Egyptian Journal of Horticulture 41.2 : 263-278.
51. Wang, N., Qin, X.N., 1987. Effect of mineral nutrition levels on fruit splitting in Jin-Cheng orange. *Journal of Southweast Agricultural University,* 9: 458-461. (in Chinese).
52. Wills RHH, Mc Glasson WB, Graham D, et al. Postharvest: a introduction to the physiology and handling of fruit and vegetables. 3rd ed. Oxford, UK: *Blackwell Scientific Publications;* 1989. 280 p.
53. Wo S M, Osman A, Ahmad SH, et al. 2005, Peel and pulp splitting in Mas banana (Musa cv Mas (AA)). *Journal of Food Agriculture & Environment.*; 3(2): 213–215.
54. Wu, Z.R., Chen, J.C., Chen, W.S., 1987. 'Duwei' pomelo fruit cracking and its control. China Citrus, 2: 23. (in Chinese).
55. Zou, H.Q., Xu, J.K., 1995. Studies on the relation between peel anatomical structure and fruit-cracking in 'Hongjiang' sweet orange. *Journal of South China Agricultural University*, 16: 90-96. (in Chinese).

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1023-1025 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Genetic Variability, Heritability and Genetic Advance Analysis in Aerobic Rice (*Oryza sativa* L.)

Parul Devi[1]*, D.K. Dwivedi[1], N.A. Khan[1], Rakesh Patel[1] and Sabia Ahad[1]
[1]*Department of Plant Molecular Biology and Genetic Engineering, ANDUAT, Kumarganj Ayodhya-224229*
**Corresponding Author Email : paruldevi845@gmail.com*

Abstract

The analysis of variance was carried out for 11 characters using 34 rice genotypes under aerobic condition. The analysis of variance designated substantial differences between the treatments. This shows that the rice genotypes used in this study has lot of variation. The magnitudes of phenotypic coefficient of variability (PCV) were higher than genotypic coefficient of variability (GCV) for all the characters. The high estimates of GCV and PCV were observed for grain number per panicle followed by spikelet number per panicle, grain yield per plant , biological yield per plant, test weight and spikelet fertility. High heritability coupled with high expected genetic advance as percent of mean was observed for the traits days to 50% flowering, plant height (cm), biological yield per plant (g), grain yield per plant (g) and spikelet number per panicle.

Key words : *Aerobic rice, gcv, pcv, heritability, genetic advance.*

Introduction

Rice (*Oryza sativa* L.) is an important cereal crop in the world both in terms of production and consumption. The rice genome composed of 12 chromosomes (2n=24). Rice is the most widely consumed staple food for over half of the world human population. Rice is a biggest user of fresh water. It is mostly grown under lowland and submerged soil condition and requires much more water compared with other crops. It needed 5000 liters of water for producing 1 kg of rice.

The increasing water scarcity threatens the sustainability of the irrigated rice production system and hence the food security and livelihood of rice producers and consumers. The concept of aerobic rice was first developed in China (Bouman and Tuong 2001). The term “Aerobic Rice” was coined recently by IRRI (Bouman et al. 2002). Aerobic rice is a new method of growing rice without standing water by direct seeding in non-puddled condition and soils are kept aerobic throughout the growing season.

Genetic variability is pre-requite and important tool of any breeding programme. It provides not only the basis of selection but also some valuable information regarding selection of diverse parent for use in hybridization programme. Variability is the most important factor for the selection of superior genotypes among any segregating population. Heritability is important parameter in quantitative genetics to determine the response to selection (Piepho and Mohring, 2007). It helps to determine the degree of transmissibility of selected characters of interest to progenies during the breeding process (Sabesan et al., 2009). There is a strong relationship between heritability and genetic advance. Genetic advance describes the degree of gain acquired in a trait under a particular selection pressure (Ogunniyan and Olakojo, 2014). High genetic advance along with high heritability offers the most effective condition for selection of a specific traits (Islam et al., 2016).The most important function of heritability in the improvement of yield by utilizing heritable components of genotypes. Possible advance through selection based on phenotypic values can be predicted only from knowledge of the degree of correspondence between phenotypic and genotypic values.

Materials and Methods

The experiment was conducted at the Crop Research Station (CRS), Masodha, Acharya Narendra Dev University of Agriculture and Technology, Kumarganj Ayodhya during kharif season 2021. The experimental material consist 34 rice genotypes. The seed was direct sown in the plots with 20cm row to row and 15cm plant to plant spacing in Randomized Block Design (RBD) with 3 replications. Observations were recorded on 5 randomly selected plants in each replication at maturity. The data were recorded on 11 characters viz. days to 50% flowering, plant height (cm), productive tillers per plant, panicle length(cm), Spikelet number per panicle, grain number per panicle, spikelet fertility(%), test weight (g), biological yield per plant (g), harvest index (%) and grain yield per plant(g).The data were compiled by taking mean value over randomly selected plants from all the replications and subjected to the statistical analysis such as analysis of variance (Panse and Sukhatme 1961), genotypic and phenotypic coefficient of variation (Burton

Table-1 : Analysis of Variance for 11 characters in aerobic rice genotypes.

S. No.	Characters	Mean sum of squares			
		Replications	Treatments	Errors	Total
	d.f.	2	33	66	101
1.	Days to 50% flowering	0.16	92.07**	1.53	31.08
2.	Plant height (cm)	0.87	125.59**	2.86	42.92
3.	Productive tillers per plant	0.121	0.743**	0.258	0.414
4.	Panicle length (cm)	0.69	6.62**	0.35	2.40
5.	Spikelet Number per panicle	24.12	785.18**	29.83	276.52
6.	Grain Number per panicle	17.65	674.81**	35.54	244.06
7.	Spikelet fertility (%)	24.71	138.76**	11.70	53.47
8.	Test weight (g)	6.65	9.41**	2.55	4.87
9.	Biological yield per plant (g)	6.28	61.93**	2.09	21.72
10.	Harvest index (%)	4.91	23.90**	2.79	10.33
11.	Grain yield per plant (g)	5.15	9.99**	0.36	3.60

*, ** significant at 5% and 1% level, respectively.

Table-2 : Estimates of grand mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation (%), heritability in broad sense (h^2b) and genetic advance at 5 and 1% for 11 characters for 34 genotypes under aerobic conditions.

Characters	Mean	Min	Max	GCV (%)	PCV (%)	Heritability (%)	var (g)	var (p)	GA as 5%	GA as 5% mean	GA 1%	GA mean 1%	% contribution
Days to 50% flowering	92.51	85.67	104.33	5.94	6.09	95.17	30.18	31.71	11.04	11.93	14.15	15.29	7.14
Plant height (cm)	89.07	78.49	101.45	7.18	7.43	93.46	40.91	43.77	12.74	14.30	16.32	18.33	6.82
Productive tillers per plant	8.72	7.73	9.47	4.61	7.43	38.52	0.16	0.42	0.51	5.89	0.66	7.55	12.32
Panicle length(cm)	23.43	20.63	27.26	6.17	6.66	85.75	2.09	2.44	2.76	11.77	3.53	15.08	8.45
Spikelet number per panicle	116.30	89.40	157.80	13.64	14.43	89.41	251.78	281.62	30.91	26.58	39.61	34.06	8.21
Grain number per panicle	87.72	67.73	136.93	16.64	17.98	85.71	213.09	248.63	27.84	31.74	35.68	40.67	10.20
Spikelet fertility (%)	75.39	47.86	86.79	8.63	9.75	78.35	42.35	54.05	11.87	15.74	15.21	20.17	11.55
Test weight (g)	22.15	18.60	26.17	6.83	9.93	47.23	2.29	4.84	2.14	9.66	2.74	12.38	10.37
Biological yield per plant (g)	38.22	30.80	48.73	11.69	12.28	90.53	19.95	22.03	8.75	22.90	11.22	29.35	7.90
Harvest index (%)	34.55	27.55	40.83	7.68	9.07	71.59	7.04	9.83	4.62	13.38	5.93	17.15	8.76
Grain yield per plant (g)	13.19	10.20	17.60	13.58	14.33	89.85	3.21	3.57	3.50	26.52	4.48	33.99	8.28

and de Vane 1952) and heritability in broad sense (Hanson 1963) and genetic advance as per cent of mean (Johnson *et al.,* 1955).

Result and Discussion

Variability is a major factor for the selection process of genotypes. It provides better chances for the selection of desired characters. The analysis of variance designated substantial differences for all the characters. The magnitudes of phenotypic coefficient of variability (PCV) were higher than genotypic coefficient of variability (GCV) for all the characters. The highest PCV and GCV were found for grain number per panicle followed by spikelet number per panicle, grain yield per plant and biological yield per plant. In this regards, Babu *et al.,* (2012) recorded high PCV and GCV for number of filled grains per panicle, number of chaffy grains per panicle and iron content; Dhurai *et al.,* (2014) for number of grains per panicle and grain yield per plant; Ruchi *et* al*.,* (2020) for biological yield per plant followed by panicles per plant; Bhargava *et al.,* (2021) for productive tiller number, grain number per panicle and plant yield.

Heritability in broad sense ranged from 38.52 (productive tiller per plant) to 95.17 (days to 50% flowering). High heritability (>60%) were recorded for plant height, biological yield per plant, grain yield per plant, spikelet number per panicle, panicle length, grain number per panicle, spikelet fertility and harvest index. Whereas, moderate heritability (30-60%)were recorded for test weight and productive tiller per plant. The similar result obtained previously by Umesh *et al.,* (2015) for plant height and 1000-seed weight; Kumar *et al.,* (2018) for spikelet fertility, days to 50% flowering, days to maturity, spikelet per panicle, harvest-index, L/B ratio, 1000-grain weight, plant height, grain yield per plant and biological yield per plant; Rathod *et al.,* (2021) for Plant height.

The highest genetic advance were recorded for grain number per panicle, spikelet number per panicle, grain

yield per plant and biological yield. High heritability coupled with high genetic advance as percent mean recorded for grain number per panicle, spikelet number per panicle, grain yield per plant(g) and biological yield per plant(g).The present study showed result of genetic advance as the similar of Ketan and Sarkar (2014), Arvind *et al.,* (2015), Kumar *et al.,*(2018), Dey *et al.,* (2021) and Rathod *et al.,*(2021). Genetic advance in percent of mean is more reliable index for understanding the effectiveness of selection in improving the traits because its estimate included heritability, phenotypic standard deviation and intensity of selection.

Conclusions

The present study shows sufficient variability present in the genotypes which can used in the selection for appropriate genotypes. The magnitudes of phenotypic coefficient of variability (PCV) were higher than genotypic coefficient of variability (GCV) for all the characters shows that the selection can be done on the basis of phenotypic appearance. High heritability and high genetic advance shows least effect of environment on the traits. High heritability coupled with high genetic advance shows the role of additive gene which shows the possibility of direct selection through these traits.The selection based on these characters can be useful for arerobic conditions.

References

1. Arvind, J., Kahani, F., and Hittalmani, S.(2015). Inter Specific Indica-japonica Drought Tolerant Rice Genotypes for Aerobic Condition. *Rice Research: Open Access,* 2375-4338.
2. Bouman, B.A.M., and Tuong, T.P. (2001). Field water management to save water and increase its productivity in irrigated lowland rice. *Agricultural water management*, *49*(1), 11-30.
3. Bouman, B.A.M., Xiaoguang, Y., Huaqi, W., Zhiming, W., Junfang, Z., Changgui, W., and Bin, C. (2002). Aerobic rice (Han Dao): a new way of growing rice in water-short areas. *In Proceedings of the 12th international soil conservation organization conference* (Vol. 26, p. 31). Beijing, China: Tsinghua University Press.
4. Burton G.W. and De Vane F.H. (1953). Estimating heritability in tall fescue (Fascutata arundinaceae) from replicated clonal material. *Agron. J.* 45: 478-481.
5. Bhargava, K., Shivani, D., Pushpavalli, S.N.C.V.L., Sundaram, R.M., Beulah, P., and Senguttuvel, P. (2021). Genetic variability, correlation and path coefficient analysis in segregating population of rice. *Electronic Journal of Plant Breeding*, *12*(2), 549-555.
6. Dey, S., Kumar, R., Battan, K.R., Chhabra, A.K., and Reddy, L. (2021). Study of Coefficient of Variation, Heritability and Genetic Advance for Different Traits of Rice Genotypes Grown under Aerobic Condition. *International Journal of Bio-resource and Stress Management,* 12(5): 426-430.
7. Johnson H.W., Robinson H.F., Comostock R.E. (1955). Genotypic and phenotypic correlation in soybeans and their implications in selections. *Agron. J;* 47: 477-483.
8. Ketan, R., and Sarkar G., (2014). Studies on variability, heritability, genetic advance and path analysis in some indigenous Aman rice (Oryza sativa L.). *Journal of Crop and Weed,* 10(2):308-315.
9. Kumar, S., Chauhan, M.P., Tomar, A., and Kasana, R.K. (2018). Coefficient of variation (GCV & PCV), heritability and genetic advance analysis for yield contributing characters in rice (Oryza Sativa L.). *Journal of Pharmacognosy and Phytochemistry*, 7(3): 2161-2164.
10. Ogunniyan, D.J., and Olakojo, S.A. (2014). Genetic variation, heritability, genetic advance and agronomic character association of yellow elite inbred lines of maize (Zea mays L.). *Nigerian Journal of Genetics*, *28*(2), 24-28.
11. Piepho, H.P., and Mo¨hring, J. (2007). Computing heritability and selection response from unbalanced plant breeding trials. *Genetics*, *177*(3), 1881-1888.
12. Rathod, R., Soundharya, B., Shahana, F., Laxmi, D.V., Naik, P.J., Swathi, Y., Swapna, N., Rao, L.V. S., and Venkataiah, M. (2021). Studies on Genetic Parameters in Breeding Lines of Aerobic Rice. *Environment and Ecology,* 39(3): 605—612.
13. Sabesan, T., Suresh, R., and Saravanan, K. (2009). Genetic variability and correlation for yield and grain quality characters of rice grown in coastal saline low land of Tamilnadu. *Electronic Journal of Plant Breeding*, *1*(1), 56-59.
14. Sukhatme, P. (1961). The world's hunger and future needs in food supplies. *Journal of the Royal Statistical Society: Series A (General)*, *124*(4), 463-508.
15. Umesh, Jaiswal, H.K., Sravan, T., Awaza, S., and Bhardwaj, R., (2015). Estimation of genetic variability, heritability and genetic advance for yield and quality traits in some indigenous Basmati rice (*Oryza sativa* L) genotypes. *International Journal of Farm Sciences* 5(4): 32-40.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1026-1029 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Water Use Efficiency in Tomato Crop under Command Area of Betwa River Basin, District Vidisha, Madhya Pradesh

S.K. Sharma, R.K. Bhatnagar and P.K. Jaga
College of Agriculture, Ganj Basoda, Vidisha, M.P.

Abstract

Field experiments were conducted for three years on sandy loam soil at the Farmers field of Vidisha district under Madhya Pradesh Water Sector Restructuring Project (MPWSRP) to study the effects of furrow irrigation and variable water supply by drip irrigation on yield and water use of tomato crop. Tomato variety Arka Rakshak F1 was planted in the entire field with 90 cm spacing from row to row and 75 cm spacing from plant to plant. In drip irrigation, crops were irrigated at 2-day intervals. The result of tomato adaptive research trials conducted on farmer's field during Kharif under command area of Betwa river basin, district Vidisha, Madhya Pradesh indicated that the improved practice could lead to average tomato yield increase 151 q/ha as compared to control i.e. farmer practices (87.5 q/ha). The highest level of yield in these demonstrations was 194 q/ha under the trial "Effect of improved drainage (ridge and furrow local made) on the productivity of tomato. Mean yield of 2 Adaptive Research Trials worked out 57.94% over farmer practices. The result of tomato Adaptive Research Trials conducted on farmer's field under command area of Betwa river basin, district Vidisha, Madhya Pradesh indicated that the improved practice could lead to average water use efficiency of tomato soybean variety 95-60 in range 226.15 to 258.33 (Kg/ha/cm) as compared to control i.e. farmer practices 67.46 to 80.35 (Kg/ha/cm).

Key words *: drip, furrow, irrigation schedule, evapotranspiration, treatment, moisture content.*

Introduction

Vidisha district is lying in the central part of Madhya Pradesh. It is in Bhopal commissioners division and is well connected by roads and railway. National Highway 67, connecting Bhopal and Dewas passes through the district. There are 7 *Tehsils* and 7 blocks in the district. The block headquarters are Vidisha, Gyarspur, Basoda, Nateran, Kurwai, Sironj, Lateri. Vidisha district with an area of 7371 km2 lying between the North Latitudes 220 20' and 240 22' and East Longitudes 770 16' and 780 18'" and falls under the Survey of India toposheet No. 54H, 54L, 55E and 55 I. The district is encircled by Guna district in the North, Sagar and Raisen in the east, Raisen in the South and Bhopal in the west. Vidisha district forms the part of Malwa plateau and Vindhyan hill range with an undulating topography. Vidisha district is primarily an agricultural district occupying the Betwa basin valley, having predominantly an agricultural economy. Agriculture is the main occupation of the people in the district. Wheat, Jawar, Maize and Soyabean are the major crops sown in the district. Ground water has an important role to play for irrigation (Annonymous, 2004).

Materials and Methods

The climate of Vidisha district characterized by a hot summer and general dryness except during the southwest monsoon season. The year may be divided into four seasons. The cold season, December to February is followed by the hot season from March to middle of June. The period from the middle of June to September is monsoon season. October and November form the post monsoon or transition period. The normal rainfall of Vidisha district is 1159.7 mm. It receives maximum rainfall during southwest monsoon period. About 91.4% of the annual rainfall received during monsoon seasons. Only 8.6 % of the annual rainfalls take place during October to May period. The surplus water for groundwater recharge is available only during the southwest monsoon period. The amount of rainfall received in Vidisha is 1285 mm, the maximum rainfall received at Basoda *Tehsil* is 2020.8 mm while minimum rainfall occurred at sironj *Tehsil* i.e. 1083.3 mm during 2013 monsoon season (Land record statistics, 2013 year of Vidisha). The normal maximum temperature received during the month of May is 41.7^{o}C and minimum during the month of December is 8.9^{o}C. The normal annual means maximum and minimum temperature of Vidisha district is 32.0^{o}C and 17.9^{o}C respectively. During the southwest monsoon season the relative humidity generally exceeds 94% (August month). In the rest of the year is remaining drier. "To improved productivity of water for enhancement of socially and environment sustainable growth and poverty reduction" In five basins, namely Chambal ,Sindh, Betwa, Ken and Tons with covering 25 districts of Madhya Pradesh. The project has an outlay of Rs 13.1 corer. Adoptive research trials were conducted in farmer's field of selected canal command area on irrigation water management and production technology for existing and potential field and vegetable crops. The uniform plot size for each trial was 4000sq.m and

Table-1 : The statistical data of land use and Irrigation pattern of Vidisha district.

Block	Canals	Irrigated area (in ha)	Tube wells		Dug wells		Tank	
			No.	Irrigated area (in ha)	No.	Irrigated area (in ha)	No.	Irrigated area (in ha)
1. Vidisha	3	29813	3035	16696	696	1460	6	96
2. Gyarspur	2	-	1861	9998	2366	7007	3	693
3. Basoda	1	2733	1440	12841	2212	7691	6	1061
4. Nateran	1	766	1726	7299	2631	14411	2	1141
5. Kurwai	-	-	1999	31662	814	1052	3	324
6. Sironj	4	5344	1302	15969	1508	2922	2	390
7. Lateri	-	-	830	5830	1595	4762	1	596
District Vidisha	11	38656	12193	100295	11822	39305	23	4256

Table-2 : Improving productivity of tomato through adoption of improved production technology (Location 1).

Sl. No.	Particulars	Items	
1.	Farmer Name	Prayag Narayan Bhargav	
2.	Village	Karonda khurd	
3.	Command area	Ghatera	
4.	Crop	Tomoto	
	Area (m^2)	2000	
	Technology	Farmer practice	Improved technology
5.	Variety	Namdhari (desi)	Arka Rakshak F_1
6.	Seed rate (g/acre)	160	160
7.	Seed treatment (g/kg seed)	Nil	Bavistin @ 2
8.	Fertilizer dose (kg/ha)	50 N : 40 P_2O_5	120 N: 80 P_2O_5 : 80 K_2O
9.	Method of sowing	Transplanting	Transplanting
10.	Inter culture operations/weed management	One hand weeding	Two hand weeding
11.	Water management		
	-Method of irrigation	Flood	Drip
	-Depth of irrigation (cm)	7	5
	-Number of irrigation	16	12
	-Time required for one irrigation (hr)	12	7
12.	Depth of water (cm)	112	60
13.	Plant protection	One spray of imamectin benzoed @ 200 ml /ha	Propanophos cyper 1.5 l/ha
14.	Date of sowing	24/2/2014	24/2/2014 transplanting (28.1.14 Nursery)
15.	Date of harvesting	15/4/2013	13/4/2013
16.	Yield per (q/ha)	90	155
17.	Rate (Rs/kg)	9	9
18.	GMR (Rs/ha)	81000	139500
19.	Water Use Efficiency (Kg/ha/cm)	80.35	258.33
20.	Economic Water Use Efficiency (Rs/ha/cm)	723.15	2324.97

2000sq.m. This year the work of MPWSRP project is started right from the month of April 2012 with the aim "*To improve the productivity of the water for the enhancement of socially and environmentally sustainable growth and poverty reduction"* The project adopted the Command areas of Ghatera, Jajon tank area of Betwa river basin of Vidisha district.

Results and Discussion

Madhya Pradesh have second highest production in tomato with contributes 12% of total production in India. Water requirement including irrigation requirement of the crop for all the treatments in all three years of the study period is given in Table-1. Irrigation requirement of furrow treatment was found to be higher than the drip treatments in all years. The irrigation requirement in the case of furrow treatments was found to superior than the farmers practices. In case of drip irrigation, the treatment with 100% *ETc* was observed to require the highest irrigation (irrigation ranging from 20.0 to 24.4 cm) whereas the treatment with 60% *ETc* was found to require the lowest irrigation (ranging from 16.3 to 17.4 cm) in all the three years. The mean irrigation requirements of drip treatments with 100, 80 and 60% levels of *ETc* were obtained as 22.0, 19.2 and 17.0 cm, respectively (Table 1). Irrigation requirement for 100% levels of *ETc* treatment was

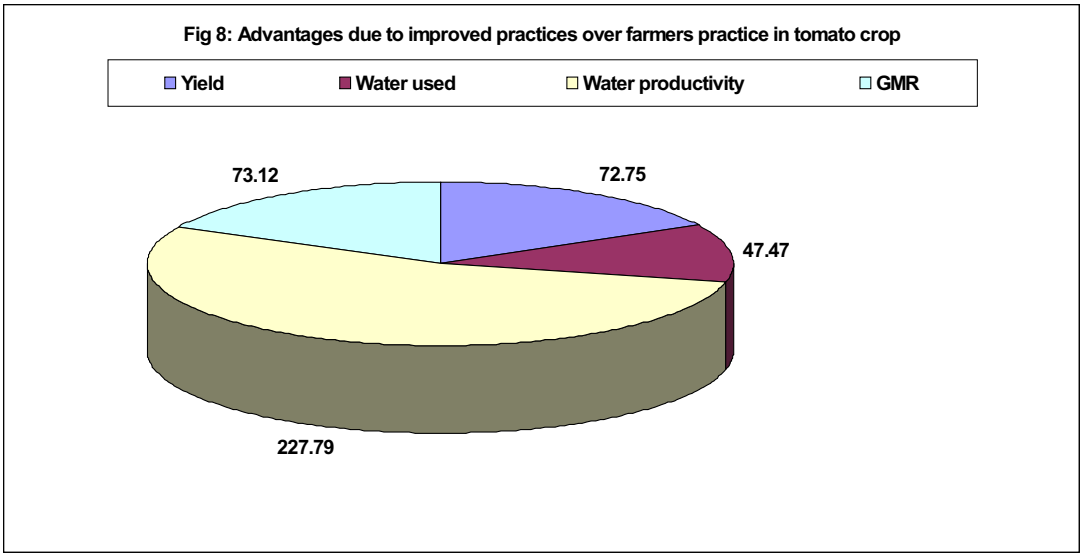
Table-3 : Improving productivity of tomato through adoption of improved production technology (Location 2).

Sl. No.	Particulars	Items	
1.	Farmer Name	Madan Kushwah	
2.	Village	Karonda khurd	
3.	Command area	Ghatera	
4.	Crop	Tomoto	
5.	Area (m^2)		2000
	Technology	Farmers practice	Improved technology
6.	Variety	Namdhari (desi)	Arka Rakshak F_1
7.	Seed rate (g/acre)	160	160
8.	Seed treatment (g/kg seed)	Nil	Bavistin @ 2
9.	Fertilizer dose (kg/ha)	50 N : 40 P_2O_5	120 N: 80 P_2O_5 : 80 K_2O
10.	Method of sowing	Transplanting	Transplanting
11.	Inter culture operations/weed management	One hand weeding	Two hand weeding
12.	Water management		
	-Method of irrigation	Flood	Drip
	-Depth of irrigation (cm)	7	5
	-Number of irrigation	18	13
	-Time required for one irrigation (hr)	12	6
13.	Depth of water (cm)	126	65
14.	Plant protection	Nil	Propanophos cyper1.5 l/ha
15.	Yield (q/ha)	85	147
16.	Date of sowing	26/2/2014	27/2/2014 transplanting (28.1.14 Nursery)
17.	Date of harvesting	15/4/2014	16/4/2014
18.	Rate (Rs/kg)	9	9
19.	GMR (Rs/ha)	76500	132300
20.	Water Use Efficiency (Kg/ha/cm)	67.46	226.15
21.	Economic Water Use Efficiency (Rs/ha/cm)	607.14	2035.35

Table-4 : Summary and Result on improving productivity of tomato through adoption of improved production technology.

S. No.	Treatment	Title	Remark		
1	T_1 (FP)	Farmer's practices (FP) or control	(I) Seed treatment. (II) Recommended dose of fertilizer. (I) Two spray of Trizophos 2.0 lit/hac and Propanophos cyper1.5 lit/hac, pendrimethalin 250ml/ ha. (II) Five irrigation at 10-15 days interval		
2	T_2 (IP)	Productivity improvement through recommended packages practices			
S. No.	Treatments	Yield (q/ha)	Water Use (cm)	Water Productivity (kg/ha/cm)	GMR (Rs/ha)
1	T_1 (FP)	87.5	119.0	73.90	78500
2	T_2 (IP)	151.0	62.5	242.24	135900

observed to be the higher than all other drip treatments because more irrigation water was required by the plant at this level. Total mean seasonal irrigation requirement of crop at 100% levels of *ETc* was 29.4% more than that at 60% level of *ETc* and 14.6% more than that at 80% level of *ETc*. However, compared to the furrow treatment, all the drip treatments needed less irrigation; mean seasonal values of savings of irrigation water in drip treatments ranged from 17.9% to 36.6% as compared to furrow treatment. Findings of Ahmad *et al*, 1987 and Panigrahi, 2006 were also reported the same results. The result of tomato adaptive research trials conducted on farmer's field during Kharif under command area of Betwa river basin, district Vidisha, Madhya Pradesh indicated that the improved practice could lead to average tomato yield increase 151 q/ha22.95 as compared to control i.e. farmer practices (87.5 q/ha). The water requirement of the crop with the furrow treatment was also found to be highest compared to any drip treatments in all three years of study. The mean water requirement of tomato by furrow irrigation schedules at 1.2 IW: CPE method for sandy loam soil in the same study area was earlier reported to be 28.4 cm (Panigrahi**,** 2006). Water requirement for the furrow treatment was observed to be maximal because of higher need of irrigation water. However, drip treatments required less water, with mean values of 24.3, 23.1 and



22.2 cm for 100%, 80% and 60% levels of *ETc* treatments, respectively (Table-2). Findings in this study also agrees with those of Kayum *et al*, (2008) and Bhandari (1995) who stated that furrows showed significant effect on growth yield components and thus on the yield of tomato. There was a significant saving of 20% water in drip irrigation with 60% level of *ETc* as compared to conventional furrow irrigation. The findings of Ramalan (2000) was the interaction of furrow irrigation method, Mulch and Soil Water Suction had significant effect on water use efficiency (WUE) of the crop. Use of ulternate furrow method was statistically at par, in terms of WUE with the conventional furrow method if it was mulched and irrigated at 5 days interval. On average, there was 16.2% reduction in water requirement in the crop when the furrow irrigation method was substituted by drip. Similar results were reported by Hanson *et al*., (1997).

Conclusions

Tomato adaptive research trials conducted on farmer's field during Kharif under command area of Betwa river basin, district Vidisha, Madhya Pradesh indicated that the improved practice could lead to average tomato yield increase 151 q/ha22.95 as compared to control i.e. farmer practices (87.5 q/ha). Imtiyaz *et. al.* (2000) agrees the findings. The highest level of yield in these demonstrations was 194 q/ha under the trial "Effect of improved drainage (ridge and furrow local made) on the productivity of tomato. Bhatnagar (2006) was also concluded seasonal water use values are largly affected by method of agricultural properties such as ridge & furrow, broad bed and furrow, etc., largely depend on weather conditions also. Mean yield of 2 Adaptive Research Trials worked out 57.94% over farmer practices. The result of tomato Adaptive Research Trials conducted on farmer's field under command area of Betwa river basin, district Vidisha, Madhya Pradesh indicated that the improved practice could lead to average water use efficiency of tomato soybean variety 95-60 in range 226.15 to 258.33 (Kg/ha/cm) as compared to control i.e. farmer practices 67.46 to 80.35 (Kg/ha/cm).

References

1. Ahmed, M., and R D. Mishra. 1987. *Mannual on Irrigation Agronomy*, 134-136. New Delhi: *Oxford and IBH Publishing*.
2. Anonymous, 2004. *Annual Report of All India Co-ordinated Research Project on Water Management*, Chiplima Centre, Orissa, India, 112.
3. Bhandari, V. 1995. Soil moisture distribution under point source in black clay soil. *Unpublished M. Tech. Thesis, Indian Institute of Technology*, Kharagpur, India, 79.
4. Bhatnagar, R.K (2006). Effect of Moissture conservation techniques on productivity and water use efficiency of soybean–gram sequence in vertisols. *Ph.D Thesis.* Pp-144 (2006).
5. Hanson, B. R., I. J. Schwanki, K. F. Schulbach, and G. S. Pettygrove. 1997. A comparison of furrow, surface drip and subsurface drip irrigation on lettuce yield and applied water. *Agricultural Water Management* 33 (2): 139-157.
6. Imtiyaz, M., N.P. Mgadia, S.K. Manase, K. Chendo and E.O. Mothobi. 2000. Yield and economic return of vegetable crops under variable irrigation. *Irrigation Science* 19(2): 87-93.
7. Kayum, M.A; Asaduzzaman, M; Haque, M.Z. (2008). Effect of Indigenous mulches on growth and yield of Tomato. *Journal of Agriculture and Rural Development*. 6(1&2):1-6.
8. Panigrahi, B. 2006. Yield and water-use efficiency of tomato under furrow irrigation. *Souvenir of Orissa Engineering Congress*, 39: 130.
9. Ramalan, A.A. (2000). Effects of furrow irrigation methods, mulching and soil water suction on the growth, yield and water use efficiency of tomato in the Nigerian Savanna. *Agricultural Water Management.* 45(3): 317-330.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1030-1033 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Potassium and Zinc on Nutrient Content and Uptake of Isabgol (*Plantago ovata* Forsk.)

Chetana Sharma[1], M.K. Kaushik[1], Jagdish Choudhary[1], Dharampal Singh[2] and N.K. Padiwal[1]
[1]*Department of Agronomy, RCA (MPUAT), Udaipur, Rajasthan*
[2]*Department of Soil Science and Agricultural Chemistry, RCA, MPUAT, Udaipur, Rajasthan*

Abstract

A field study was conducted during *rabi* 2021-22 at the Instructional Farm of the Rajasthan College of Agriculture, Udaipur to study the effect of different levels of potassium and zinc on growth, productivity and quality of isabgol using randomized block design with 3 replications. The experiment consists of 12 treatments *viz*., 40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 + 20 kg ha^{-1} K_2O, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 and control. The results revealed that application of 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn resulted in significantly higher nutrient content and uptake in seeds and straw of isabgol.

Introduction

Blond psyllium (*Plantago ovata* Forsk.) commonly known as "Isabgol" is one of the important medicinal plants. It is an important winter season crop which belongs the family Plantaginaceae having the chromosome no. 2n=28, native to the Mediterranean region and west Asia. India has the monopoly in production and export of the seed and husk in the world market (Farooqi and Sreeramu, 2001). About 80-90 per cent of the produce is exported to various countries. In India, Isabgol is commercially cultivated in the states of Madhya Pradesh, Gujarat and Rajasthan. The crop covers 336327 hectares with the production of 193702 tonnes and average productivity of 576 kg ha^{-1} (Agriculture Statistics, 2018-19) in Rajasthan.

Isabgol (*Plantago ovata* Forsk.) is an important herb that has been used in health care for many centuries in South Asia, whereas it is now widely used for its medicinal properties all over the world. Isabgol is a major contributor to the export earnings. The seeds of isabgol are composed of many different types of chemicals that are used as medicine. It contains mucilage, fatty oil, proteins, carbohydrates, mineral element, etc. Seed oils are used to make soap, paint, printing inks, and other industrial supplies. Potassium strengthens the cell walls, aids in water retention, improves disease resistance and boost nitrogen and phosphate absorption. Enhancing these functions results in improved plant quality and increased yields. Potassium application increases the plant's growth and yield because it participates in the mechanism of stomatal movement, photosynthesis and helps in osmo-regulatory adaption of plant due to water stress (Patel *et al*., 2012). Zinc is an essential element for plant that act as a metal component of various enzymes, involved in RNA metabolism and ribosomal content in plant cells, stimulation of carbohydrates, proteins synthesis, DNA formation, cell division, maintenance of membrane structure and function and sexual fertilization. It also helps in the utilization of phosphorus and nitrogen in plants. Response to applied zinc for better growth and yield of several important field crops has been reported from almost all corners of the country.

Materials and methods

The field experiment was conducted during *rabi* season of 2021-22 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) on clay loam soil having pH 7.8, EC 0.75 dS m^{-1}, 283.44 kg available nitrogen ha^{-1}, 22.2 kg available phosphorus ha^{-1} and 279.3 kg available potassium ha^{-1}. The average annual rainfall was 637 mm. The experiment was conducted using randomized block design with three replications. There were 12 treatments in the experiment *viz*., 40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn, 20 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 + 20 kg ha^{-1} K_2O, 40 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 and control. The Isabgol *cv*., UI-124 was sown in each plot. Treatments were applied in the form of urea, SSP, MOP and $ZnSO_4$. Full dose of phosphorus, potash and zinc were applied prior to sowing. Nitrogen was applied in three equal doses *viz*. 1/3rd at sowing, 1/3rd after hoeing and 1/3rd at flower initiation. Data recorded for various growth and yield parameters were statistically analyzed using the analysis of variance as described by Panse and Sukhatme (1985).

Table-1 : Effect of nutrient management on nitrogen and phosphorus content in isabgol.

Treatment	N content (%)		P content (%)	
	At harvest		At harvest	
	Seed	Straw	Seed	Straw
T_1 - Control	1.723	0.577	0.326	0.159
T_2 - N:P (40:20)	1.731	0.584	0.360	0.161
T_3 - N:P:K (40:20:20)	1.737	0.601	0.377	0.164
T_4 - N:P:K:Zn (40:20:20:20)	1.738	0.605	0.378	0.169
T_5 - N:P:K:Zn (40:20:20:25)	1.738	0.611	0.390	0.172
T_6 - N:P:K:Zn (40:20:20:30)	1.744	0.614	0.398	0.173
T_7 - N:P:K:Zn (40:20:30:20)	1.766	0.629	0.413	0.188
T_8 - N:P:K:Zn (40:20:30:25)	1.780	0.632	0.412	0.187
T_9 - N:P:K:Zn (40:20:30:30)	1.793	0.635	0.412	0.186
T_{10} - N:P:K:Zn (40:20:40:20)	1.803	0.639	0.415	0.190
T_{11} - N:P:K:Zn (40:20:40:25)	1.808	0.642	0.421	0.191
T_{12} - N:P:K:Zn (40:20:40:30)	1.811	0.646	0.432	0.193
SEm±	0.021	0.010	0.008	0.003
CD (P=0.05)	0.061	0.031	0.022	0.008

Table-2 : Effect of nutrient management on potassium and zinc content in isabgol.

Treatment	K content (%)		Zn content (ppm)	
	At harvest		At harvest	
	Seed	Straw	Seed	Straw
T_1 - Control	0.244	1.170	34.88	19.83
T_2 - N:P (40:20)	0.247	1.370	36.78	20.33
T_3 - N:P:K (40:20:20)	0.252	1.376	37.33	20.73
T_4 - N:P:K:Zn (40:20:20:20)	0.258	1.388	37.40	21.23
T_5 - N:P:K:Zn (40:20:20:25)	0.263	1.396	38.12	21.68
T_6 - N:P:K:Zn (40:20:20:30)	0.269	1.400	38.90	22.08
T_7 - N:P:K:Zn (40:20:30:20)	0.281	1.463	41.86	23.49
T_8 - N:P:K:Zn (40:20:30:25)	0.283	1.470	42.27	23.61
T_9 - N:P:K:Zn (40:20:30:30)	0.285	1.473	42.92	23.82
T_{10} - N:P:K:Zn (40:20:40:20)	0.287	1.480	44.08	23.88
T_{11} - N:P:K:Zn (40:20:40:25)	0.289	1.485	44.13	24.08
T_{12} - N:P:K:Zn (40:20:40:30)	0.291	1.504	44.23	24.17
SEm±	0.004	0.030	0.850	0.314
CD (P=0.05)	0.013	0.089	2.492	0.922

Results and Discussion

Nutrient content :

Nitrogen content in seed and straw : The data reveals that significantly higher nitrogen content of isabgol seed and straw was recorded when crop was supplied with 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (T_7) which was found at par with application of T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn). The minimum nitrogen content was found in unfertilised plot, *i.e.*, control.

Phosphorus content in seed and straw : The significantly higher phosphorus content of isabgol seed and straw was recorded when crop was supplied with 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (T_7) while minimum content was recorded under control. However, statistically at par values of phosphorus content in seed and straw of isabgol was found with application of T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn).

Potassium content in seed and straw : The data show that potassium content was found significantly higher with application of 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (T_7). This result was found at par with application of T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn). The minimum content was found under control plot.

Zinc content in seed and straw : According to data the significantly higher zinc content in isabgol seed and straw

Table-3 : Effect of nutrient management on nitrogen and phosphorus uptake by isabgol.

Treatment	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})		
	At harvest			At harvest		
	Seed	Straw	Total	Seed	Straw	Total
T_1 - Control	11.59	8.06	19.64	2.19	2.22	4.41
T_2 - N:P (40:20)	13.62	9.12	22.73	2.83	2.52	5.35
T_3 - N:P:K (40:20:20)	15.39	10.63	26.02	3.33	2.90	6.23
T_4 - N:P:K:Zn (40:20:20:20)	16.74	11.22	27.96	3.64	3.13	6.78
T_5 - N:P:K:Zn (40:20:20:25)	18.17	11.39	29.56	4.08	3.21	7.28
T_6 - N:P:K:Zn (40:20:20:30)	19.22	11.48	30.70	4.38	3.24	7.62
T_7 - N:P:K:Zn (40:20:30:20)	21.64	12.13	33.77	5.05	3.63	8.68
T_8 - N:P:K:Zn (40:20:30:25)	21.80	12.54	34.35	5.05	3.71	8.75
T_9 - N:P:K:Zn (40:20:30:30)	22.47	12.85	35.32	5.17	3.76	8.93
T_{10} - N:P:K:Zn (40:20:40:20)	22.26	12.41	34.67	5.11	3.69	8.80
T_{11} - N:P:K:Zn (40:20:40:25)	22.50	12.79	35.29	5.23	3.80	9.03
T_{12} - N:P:K:Zn (40:20:40:30)	22.77	13.16	35.93	5.43	3.93	9.36
SEm±	0.785	0.432	0.808	0.164	0.108	0.223
CD (P=0.05)	2.303	1.268	2.368	0.482	0.317	0.654

Table-4 : Effect of nutrient management on potassium and zinc uptake by isabgol.

Treatment	K uptake (kg ha^{-1})			Zn uptake (g ha^{-1})		
	At harvest			At harvest		
	Seed	Straw	Total	Seed	Straw	Total
T_1 - Control	1.64	16.33	17.97	23.495	27.677	51.172
T_2 - N:P (40:20)	1.94	21.40	23.34	28.932	31.751	60.683
T_3 - N:P:K (40:20:20)	2.23	24.32	26.55	33.088	36.612	69.700
T_4 - N:P:K:Zn (40:20:20:20)	2.49	25.71	28.20	36.032	39.329	75.361
T_5 - N:P:K:Zn (40:20:20:25)	2.75	26.01	28.75	39.868	40.409	80.277
T_6 - N:P:K:Zn (40:20:20:30)	2.97	26.18	29.15	42.885	41.285	84.170
T_7 - N:P:K:Zn (40:20:30:20)	3.45	28.25	31.70	51.284	45.339	96.623
T_8 - N:P:K:Zn (40:20:30:25)	3.47	29.12	32.59	51.907	46.793	98.699
T_9 - N:P:K:Zn (40:20:30:30)	3.57	29.81	33.38	53.842	48.210	102.052
T_{10} - N:P:K:Zn (40:20:40:20)	3.55	28.71	32.26	54.547	46.353	100.900
T_{11} - N:P:K:Zn (40:20:40:25)	3.59	29.58	33.17	54.877	47.978	102.855
T_{12} - N:P:K:Zn (40:20:40:30)	3.66	30.61	34.26	55.597	49.213	104.810
SEm±	0.136	0.942	0.986	2.206	1.343	2.831
CD (P=0.05)	0.400	2.764	2.891	6.471	3.938	8.302

was recorded when crop was supplied with 30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn (T_7) while minimum content was recorded under control. However, this result was statistically at par with application of T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn).

The marked improvement in nutritional status of grain and stover could be ascribed to their greater availability of nutrients in soil environment along with extraction and translocation towards plant system. In the same line of research Davara (2019) reported increased nutrient uptake by stover with application of potassium and zinc. The similar results with zinc application were reported by Gupta (2012) and Verma *et al.* (2012).

Nutrient uptake:

Nitrogen uptake in seed and straw : A perusal of data indicates that nitrogen uptake by seed and straw of isabgol was influenced by soil application of different doses of potash and zinc over control. The application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) resulted in significantly higher uptake of nitrogen in seed of isabgol while the lowest nitrogen uptake was recorded under control.

Phosphorus uptake in seed and straw : The data indicate that phosphorus uptake by seed and straw of isabgol was influenced by soil application of different doses of potash and zinc over control. The application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) resulted in significantly higher uptake of phosphorus in seed of isabgol. However, this was found statistically at par with T_8 (30 kg ha^{-1} K_2O +

25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn).

Potassium uptake in seed and straw : The data depict that potassium uptake by seed and straw of isabgol was influenced by soil application of different doses of potash and zinc over control. The application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) resulted in significantly high uptake of potassium in seed of isabgol which was found at par with treatments T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn).

Zinc uptake in seed and straw : A reference to data indicates that zinc uptake by seed and straw of isabgol was influenced by soil application of different doses of potash and zinc over control. The significantly high zinc uptake was recorded under application of T_7 (30 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn) which was found at par with treatments T_8 (30 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn), T_9 (30 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn), T_{10} (40 kg ha^{-1} K_2O + 20 kg ha^{-1} Zn), T_{11} (40 kg ha^{-1} K_2O + 25 kg ha^{-1} Zn) and T_{12} (40 kg ha^{-1} K_2O + 30 kg ha^{-1} Zn).

These results were similar to as reported by Singh *et al*. (2001), Meena (2003) and Narolia (2004), where application of zinc resulted in increased uptake of nutrients.

References

1. Davara Monali A., Polara K. B., Ribadiya T.R., Vadaliya B.M. and Vekariya L. C. 2019. Effect of potassium and zinc on growth, yield and quality of coriander (*Coriandrum sativum* L.). *International Journal of Chemical Studies* 7(4): 292-295.
2. Farooqui, A.A. and B.S. Sreeramu, 2001. Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd., Hyderabad. 168-174.
3. Gupta, K. 2012. Role of phosphorus and zinc in enhancing growth, yield and quality of fennel crop (*Foeniculum vulgare* Mill.) in irrigated condition of north west Rajasthan. *Ph.D.Thesis*, SKRAU, Bikaner.
4. Meena, D. R. 2003. Effect of zinc fertilization on growth, yield and quality of fenugreek (*Trigonella foenum-graecum*). *M.Sc. (Ag.) Thesis, Rajasthan Agricultural University,* Bikaner.
5. Narolia, G.P. 2004. Response of isabgol (*Plantago ovata*) to Phosphorus, PSB and Zinc. *M.Sc. (Ag.) Thesis*, *Rajasthan Agricultural University,* Bikaner.
6. Panse, V.G. and P.V. Sukhatme, 1985. Statistical Methods for Agricultural Workers. Forth Enlarged Edition. *ICAR Publication,* New Delhi.
7. Patel, C.J., J.J. Patel, R.A. Patel, K.M. Chotalia, Gedia and A.R. Patel, 2012. Response of different sources and levels of potash on quality, NPK content and uptake of Isabgol (Plantago ovata Forsk). *International Journal of Crop Improvement* 3(2): 92-94.
8. Singh, L., Pal, B. and Singh, L. 2001. Influence of saline water at fertility levels on nutrient composition and its uptake by isabgol. *Research on crops* 2(2): 174-178.
9. Verma, C. K., Prasad Kedar and Yadav D.D. 2012. Studies of sulphur, zinc and boron levels on yield, economics and nutrient uptake of mustard. *Crop Research* 44 (1 & 2): 75-78.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1034-1038 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

The Effect Silicon and Plant Growth Regulators (PGR's) on Biological Parameters of Fruit Borer *Helicoverpa armigera* (Hübner)

Mahendra Yadav[1], S. Ramesh Babu[1], S.K. Dhabhai[1], Anil Vyas[1], Devendra Jain[2], Beerendra Singh[1], Pradeep Kumar Gautam[1], Piyush Sharma[1], Mahaveer Meena[1] and J. Kavipriya[3]

[1]*Department of Entomology, RCA, MPUAT, Udaipur, Rajasthan*

[2]*Department of MBBT, RCA, MPUAT, Udaipur, Rajasthan*

[3]*Department of Nematology, RCA, MPUAT, Udaipur, Rajasthan*

**Email : mybichpuri@gmail.com*

Abstract

Investigation on "The effect Silicon and Plant Growth Regulators on biological parameters of fruit borer *Helicoverpa armigera* (Hübner)" was conducted at the Department of Entomology, Rajasthan College of Agriculture, Udaipur during 2021-22. Silicon (Si) and Plant growth regulators (PGR's) are known to induce resistance against various insect pests. The larvae fed on plant leaves treated with Si soil application @ 1-2%, Si foliar application @ 1-2%, Jasmonic acid @ 2 ml/l (2 mM), Foliar silicic acid + Gibberellic acid @ 0.3 mg per plant, Foliar silicic acid + Jasmonic acid @ 2 ml/l (2mM) and Foliar silicic acid (1-2%) + Gibberellic acid (0.3 mg/plant) + Jasmonic acid (2mM) decreased the larval, pre-pupal, pupal weight and pupal duration. Whereas Gibberellic acid @ 0.3 mg per plant had little effect on these parameters.

Key words : *H. armigera, silicon, gibberellic acid and jasmonic acid.*

Introduction

The tomato, *Solanum lycopersicum* Mill. is one of the most widely grown solanaceous vegetable crops in the world, ranking second only to potatoes in many countries. It is a culinary vegetable/botanical fruit and has its origin in the South American Andes. It contributes to a healthy, well-balanced diet. They are a rich source of minerals, vitamins, essential amino acids, sugars and dietary fibre. Tomatoes contain vitamin B and C, iron, and phosphorus (Singh *et al.* 2021). In India, tomato occupies an area of 813 thousand hectares with a production of 21195 thousand metric tonnes with productivity of 24.4 metric tonnes per ha. (Anonymous 2020). Bihar, Karnataka, Orissa, Maharashtra, and Andhra Pradesh are the major tomato-growing states in India (Singh *et al*. 2021).

The fruit borer, *H. armigera* (Hubner) is the most damaging pest of tomatoes, also known as gram pod borer, American bollworm, and tomato fruit borer and causes 40–50% crop damage (Pareek *et al*. 2003). Both production and productivity are severely affected by this pest. Physiological features like nocturnal habits, high mobility fecundity, overlapping generations, ravenous feeding habits and migration, the tendency to acquire resistance against a wide range of insecticides, direct attack on fruiting structures and multivoltine nature contribute to its severity in different situations (Sarode *et al.* 1999).

Researchers all over the world are paying more attention to host plant resistance and chemical elicitors that make plants defend themselves against insect pests (Bruinsma *et al.* 2007; Hamm *et al.* 2010). Many of these defenses are controlled by plant signaling pathways, in which plant growth regulators and other changes play important roles. Plants make a lot of different hormones. When some of the plant growth regulators (PGRs) are added outside of the plant, it makes the plant more resistant to biotic and abiotic stresses. They also change the way insects live, which slows their growth and development (Nagaratna *et al.* 2021).

Silicon is a non-essential element for the majority of plant species, but its favorable effects on plant growth, development, stress tolerance and defence mechanisms against insect pests and diseases have been thoroughly established in several plant species. Foliar application of silicon has been demonstrated to affect plant development, yield and silicon content in a variety of crops, including rice, finger millet, wheat, soybean and sugar beet, as well as reduce pests and diseases in rice, soybean, grape, coffee, cucumber and tomato (Kedarnath *et al*. 2016). It is now well-established that Si increases plant tolerance and decreases plant damage from diseases, insects, and other pests (Nagaratna *et al*. 2021)

Materials and Methods

An experiment was conducted on "The effect Silicon and Plant Growth Regulators on biological parameters of fruit borer *Helicoverpa armigera* (Hübner)" conducted at the Department of Entomology, Rajasthan College of Agriculture, Udaipur during 2021-22.

Table-1 : Treatments details

S. No.	Treatment
1.	T_1 : Si soil application @ 1-2%
2.	T_2 : Si foliar application @ 1-2%
3.	T_3 : Gibberellic acid @ 0.3 mg per plant
4.	T_4 : Jasmonic Acid @ 2 ml/l (2 mM solution)
5.	T_5 : Foliar silicic acid + Gibberellic acid @ 0.3 mg per plant
6.	T_6 : Foliar silicic acid + Jasmonic Acid @ 2 ml/l (2 mM solution)
7.	T_7 : Foliar silicic acid + Gibberellic acid + Jasmonic Acid @ 1-2%; 0.3 mg/plant; 2 mM;
8.	T_8 : Control (Water spray)

Table-2 : Effect on biological parameters of *Helicoverpa armigera* fed on tomato plant treated leaves with silicon and plant growth regulators during 2021-22.

Treatments	Larval weight (mg)		Larval duration (days)	Pre pupal weight (mg)	Pupal weight (mg)
	5th Day	10th Day			
T_1	9.40±1.14^{b}	176.00±1.58^{c}	16.20±0.84^{abc}	164.60±3.65^{cd}	155.20± 3.49^{cd}
T_2	9.20±2.95^{bC}	174.00±1.87^{cd}	16.40±1.14^{ab}	161.60±3.05^{cde}	151.60±3.05^{de}
T_3	13.80±1.30^{a}	238.60±7.70^{b}	14.40±1.14^{cd}	225.00±6.24^{b}	214.20±7.46^{b}
T_4	10.00±0.89^{b}	177.60±2.70^{c}	15.80±0.45^{abcd}	167.60±2.19^{c}	162.40±1.52^{c}
T_5	8.80±0.84^{bC}	165.80±4.09^{de}	15.40±1.14^{bcd}	157.80±1.30^{de}	146.40±2.70^{ef}
T_6	8.60±1.14^{bC}	157.20±3.03^{ef}	16.80±0.84^{ab}	154.20±2.05^{ef}	145.00±1.73^{ef}
T_7	7.20±0.84^{C}	152.00±8.12^{f}	17.60±1.14^{a}	148.00±4.53^{f}	142.40±3.58^{f}
T_8	16.40±0.55^{a}	286.80±4.66^{a}	14.00±0.71^{d}	254.40±6.02^{a}	240.60±1.82^{a}
F-value	24.33	473.70	7.92	463.27	512.42
S.Em ±	0.14	0.11	0.07	0.09	0.09
C.D. (p =0.05)	0.29	0.23	0.15	0.18	0.17

Mean values followed by different letters are significantly different by Tukey's test (P = 0.05; Note: T_1: Si soil application (1-2%); T_2: Si foliar application (1-2%); T_3: Gibberellic acid (0.3 mg/plant); T_4: Jasmonic Acid @2 ml/l (2mM); T_5: Foliar silicic acid + Gibberellic acid (0.3 mg/plant); T_6: Foliar silicic acid + Jasmonic Acid @2 ml/l (2mM); T_7: Foliar silicic acid (1-2%) + Gibberellic acid (0.3 mg/plant) + Jasmonic Acid 2 mM; and T_8- Control (Water spray).

The locally procured tomato seeds were planted in 25 cm diameter pots using standard Pro-mix potting soil. Pots were kept in a net house and watered daily to maintain moisture levels. The experiment was conducted in a completely randomized design (CRD). Each treatment consists of 20-30 tomato plants in replications.

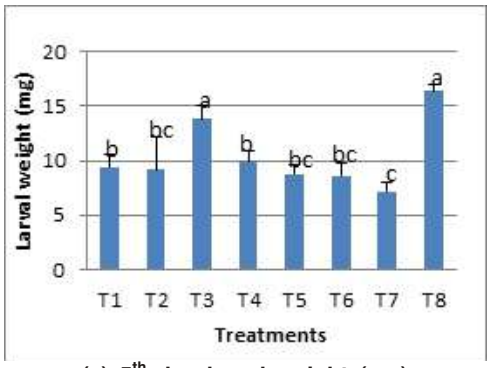
Collection and Maintenance of *H. armigera* culture : The first population of *H. armigera* larvae was obtained from the field and raised in plastic cups in the laboratory. The larvae are fed chickpea seeds until they transform into pupae. Pupae were collected, separated into males and females, and placed in separate plastic vessels until adulthood. After emergence, ten pairs of men and females were placed in an oviposition jar coated with tissue paper to collect eggs. Throughout the research period, a colony was maintained (Haq *et al.* 2021).

Experiment and Data Collection for *H. armigera* culture : *H. armigera* larvae (24 hours old) were collected from the laboratory colony and transferred to 9-cm-diameter Petri plates using a soft paintbrush and a tomato leaf slice. Individual larvae are left to feed on the leaves (two 5 cm diameter discs) of treated plants 10 days following the first spray. Until the pupation, leaf discs were changed every day with new leaf discs. The dishes were maintained at 25 ± 2°C, 70 ± 10% relative humidity and a photoperiod of 12 L:12 D hours. At the beginning of the experiment, the leaf pieces were replaced every two days until the larvae reached the third instar, after which they were replaced daily (Haq *et al.* 2021).

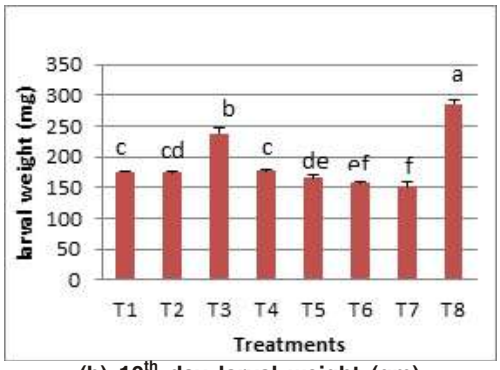
Five replications of 10 larvae were preserved for each treatment, resulting in 50 larvae per treatment. Various observations were recorded at various intervals, including larval weight (at 5th and 10th day), stage duration and pre-pupal weight (just before pupation), pupal weight (weight at 24 hr of pupation), pupal duration and pupal survival (per cent).

In calculating larval duration and biomass, only data for caterpillars that reached the pupal stage were included, and similarly, duration and biomass of the pupal stage were calculated only for pupae from which adults emerged (Haq *et al.* 2021).

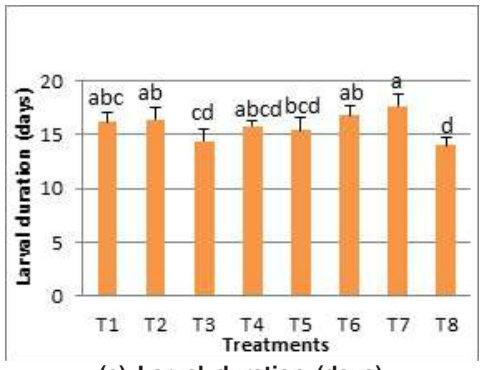
Statistical Analysis : All experimental data were transformed with sign (x + 0.5) when in percent and square root (x + 0.5) when in counts before analysis. The data were subjected to analysis of variance (ANOVA) where ANOVA was significant, and treatments were compared using Tukey's test (p = 0.05).



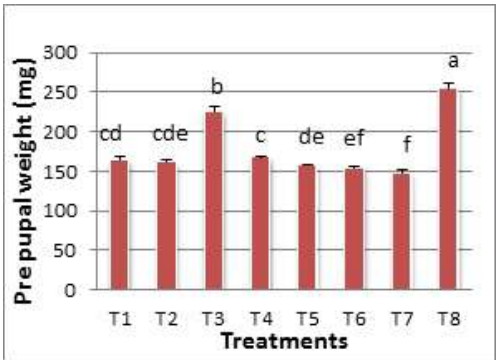
(a) 5th day larval weight (gm)



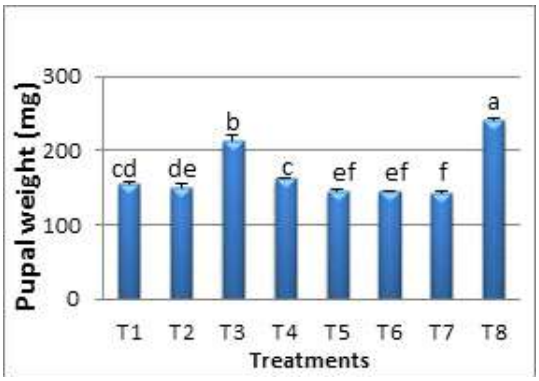
(b) 10th day larval weight (gm)



(c) Larval duration (days)



(d) Pre pupal weight (mg)



(e) Pupal weight (mg)

Fig-1; Effect on biological parameters of *H. armigera* fed on tomato plants treated with silicon and plant growth regulators (a) 5th day larval weight (mg), (b) 10th day larval weight (mg), (c) Larval duration (days) (d) Pre pupal weight (mg) (e) Pupal weight (mg) ; Different letters on bars indicate significant differences by Tukey's test (p = .05). Vertical bars indicate SD Note: T1: Si soil application; T2: Si foliar application; T3: Gibberellic acid; T4: Jasmonic Acid; T5: Foliar silicic acid + Gibberellic acid; T6: Foliar silicic acid + Jasmonic Acid; T7: Foliar silicic acid + Gibberellic acid + Jasmonic Acid and T8- Control (Water spray).

Results and Discussion

The findings show the effects of Si soil treatment, Si foliar spray, and plant growth regulators such as gibberellic acid (GA_3) and jasmonic acid (JA) on *H. armigera* larval biology and growth, when fed on treated tomato plant leaves, were detrimental.

Larval weight (mg) : The fruit borer larval weight was measured on the 5th and 10th days of the larval phase by applying various treatment applications comprising silicon and plant growth regulators to treated leaves. The results on larval weight revealed that all treatments substantially lowered larval weight owing to diminished feeding preference (Table-2 and Figure and b). On the 5th and 10th days of the larval stage, treatments of foliar silicic acid (1-2 percent) + Gibberellic acid (0.3 mg/plant) + Jasmonic acid (2 mM) resulted in minimum larval weights of 7.20 mg and 152.00 mg, respectively. Foliar silicic acid + Jasmonic acid was the next best treatment, with 8.60 and 157.20 mg larval weight at the 5th and 10th day of the larval period, respectively, followed by Foliar silicic acid + Gibberellic acid and Si foliar application, with 8.80 and 165.80 mg; 9.20 and 174.00 mg at the 5th and 10th day, respectively. The treatment that received both Si soil application and

Jasmonic acid 9.40 and 176.00; 10.00 and 177.60 mg on the 5th and 10th days, respectively, was shown to be at par with each other. On the fifth and tenth days of the larval stage, the highest larval weight was 16.40 and 286.80 mg, respectively observed in the untreated control.

Similarly, Nascimento *et al*. (2018) and Nagaratna *et al*. (2021) reported that Silicon has been shown to reduce the larval weight *of Spodoptera frugiperda* on maize which also supports the present findings.

Gibberellic acid (GA_3) had a minimal significant effect on mean larval weight when used alone, but when coupled with si foliar spray and jasmonic acid (JA), gibberellic acid (GA_3) had a considerable impact on the mean larval weight of *H. armigera*. In a previous study, Nagaratna *et al*. (2021) found that GA_3 alone had no effect on mean larval weight, but when combined with FSA, the mean larval weight of *Spodoptera frugiperda* decreased. The present study, however, found that GA_3 had a minimally significant effect on the mean larval weight of *H. armigera*, which is consistent with these findings. According to Alvarenga *et al*. (2017), GA_3 did not affect the *S. frugiperda* larval weight, which also confirms the current experiment. Jasmonic acid (JA) had a significant effect on the mean larval weight of *H. armigera* when used alone, a similar effect was shown when combined with FSA and FSA+GA3. Similarly, Nagaratna *et al*. (2021) reported that the mean larval weights of both five days old and ten days old larvae of *S. frugiperda* were significantly affected by the application of Jasmonic acid which is consistent with the present study

Larval duration (days) : The mean larval duration differed significantly between the control and larvae fed on plants treated with silicon and plant growth regulators (Table 2 and Figure 1c). The mean larval period of *H. armigera* recorded on different treatments ranged from 14.00 to 17.60 days, with the control having the shortest larval period of 14.00 days, followed by Gibberellic acid at 14.40 days, Foliar silicic acid + Gibberellic acid at 15.40 days, Jasmonic Acid at 15.80 days, and Si soil application at 16.20 days. The highest larval duration was obtained with the application of Foliar silicic acid + Gibberellic acid + Jasmonic acid at 17.60 days and Foliar silicic acid + Jasmonic Acid at 16.80 days which were to be at par with the Si foliar application with 16.40 days.

The increase in the larval period might be due to less preference for tomato leaves by larvae of *H. armigera* for 2-3 days. All treatments had shown that significant effect on the mean larval period of *H. armigera*. Similarly, Gupta *et al*. (2009) reported that GA_3 caused an increase in the larval period of *Spilarctia obliqua* (Walker) which also supports the present findings. In contrast to Nagaratna *et al*. (2021) who reported that no significant effect on the larval duration of *Spodoptera frugiperda* on maize and also Alvarenga *et al*. 2017 reported that, no significant effects of silica and GA_3 on the larval duration *of S. frugiperda* and Nascimento *et al*. (2018) who reported that silicon did not effect on the larval period of *S. frugiperda* when fed on rice.

Pre pupal weight (mg) : The findings on the pre pupal weight revealed that all treatments significantly decreased the weight (Table-2 and Figure-1d). The Foliar silicic acid + Gibberellic acid + Jasmonic Acid treatment resulted in a minimum pre-pupal weight of 148.00 mg. Whereas, Foliar silicic acid + Jasmonic Acid was recorded with 154.20 mg pre pupal weight, followed by Foliar silicic acid + Gibberellic acid, Si foliar application, and Si soil application with 157.80, 161.60, and 164.60 mg, respectively. The maximal pre pupal weight was 254.40 mg in the control and 167.60 and 225.00 mg in the Jasmonic Acid and Gibberellic acid applications, respectively.

Pupal weight (mg) : The data recorded showed that the application of all the treatments including Si and PGRs significantly reduced the pupal weight (Table-2 and Figure-1e). The pupal weight (mg) of 142.40 was recorded with the treatment of foliar silicic acid + Gibberellic acid + Jasmonic Acid followed by Foliar silicic acid + Jasmonic Acid (145.00 mg). It was on par with foliar silicic acid + Gibberellic acid (146.40 mg) followed by Si foliar application (151.60 mg). Si soil application recorded a pupal weight of 155.20. The maximum pupal weight was recorded in the control with 240.60 and with the application of Jasmonic Acid and Gibberellic acid at 162.40 mg and 214.20, respectively.

Similarly, Nagaratna *et al*. (2021) reported a significant reduction in the pre-pupal and pupal weight of *S. frugiperda* due to feeding on leaves treated with Si and JA which supports the present findings. It was previously found that *S. frugiperda* larvae fed on Si-treated rice plants showed lower pupal weight (Nascimento *et al*. 2018) Similarly, Silva *et al*. (2014) found that the pupal weight of *S. frugiperda* decreased when larvae fed on leaves from a cotton plant treated with Si. Gibberellic acid (GA_3) had minimal effect on mean pupal weight when used alone, but when combined with Si foliar spray and jasmonic acid (JA) the mean pupal weight *of H. armigera* was reduced.

Conclusions

The present investigation showed that Si and PGRs (GA_3 and JA) affect the metabolic and nutritional status of plants to produce resistance in laboratory trials. Laboratory study proved a significant negative effect of silicon and plant growth regulators on biological parameters of the *H.*

armigera. The application of silicon and plant growth regulators proved to be viable and more economical for managing the *H. armigera* in a sustainable and eco-friendly manner. The usage of silicon and PGRs are excellent pest management techniques for producing pesticide-free, high-quality agricultural products at lower production costs.

References

1. Alvarenga, R., Moraes, J.C., Auad, A.M., Coelho, M. and Nascimento, A.M. (2017). Induction of resistance of corn plants to *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) by application of silicon and gibberellic acid. *Bulletin of Entomological Research*, 107(4): 527-533.
2. Anonymous. 2020. Department of Agriculture, cooperation & Farmers Welfare.
3. Bruinsma M, Vandam NM, Vanloon J.J., Dicke M. (2007). Jasmonic acid-induced changes in *Brassica oleracea* affect oviposition preference of two specialist herbivores. *Journal of Chemical Ecology* 33: 655–668
4. Gupta, G., Yadav, S.R. and Bhattacharya, A.K. (2009). Influence of synthetic plant growth substances on the survivorship and developmental parameters of *Spilarctia obliqua* Walker (Lepidoptera: Arctiidae). *Journal of pest science*, 82(1): 41-46.
5. Hamm, J.C., Stout, M.J. and Riggio, R.M. (2010). Herbivore-and elicitor-induced resistance in rice to the rice water weevil (*Lissorhoptrus oryzophilus* Kuschel) in the laboratory and field. *Journal of chemical ecology*, 36(2): 192-199.
6. Haq, I.U., Khurshid, A., Inayat, R., Kexin, Z., Changzhong, L., Ali, S., Zuan, A.T.K., Al-Hashimi, A. and Abbasi, A.M. (2021). Silicon-based induced resistance in maize against fall armyworm [*Spodoptera frugiperda* (Lepidoptera: Noctuidae)]. *Plos one*, 16(11): 0259749.
7. Kedarnath, K.T., Rangaswamy, N.B., Prakash, N., Nagaraju, C.N., Reddy, L. and Narasegowda, N.C. (2016). In vitro evaluation of silicon sources against late blight (*Phytophthora infestans*) of tomato. *Int J Sci Nat*, 7(4): 881-884.
8. Nagaratna, W., Kalleshwaraswamy, C.M., Dhananjaya, B.C. and Prakash, N.B. (2021). Effect of silicon and plant growth regulators on the biology and fitness of fall armyworm, *Spodoptera frugiperda*, a recently invaded pest of maize in India. *Silicon*, 14(3): 783-793.
9. Nascimento, A.M., Assis, F.A., Moraes, J.C. and Souza, B.H.S. (2018). Silicon application promotes rice growth and negatively affects development of *Spodoptera frugiperda* (JE Smith). Journal of applied entomology, 142(1-2): 241-249.
10. Pareek, B.L. and Bhargava, M.C. (2003). Estimation of avoidable losses in vegetable crops caused by borers under semi-arid conditions of Rajasthan. *Insect Environment*, 9(2): 59-60.
11. Sarode SV. (1999). Sustainable management of *Helicoverpa armigera* (Hubner). *Pestology.* 13: 279-284.
12. Silva, A.A., Alvarenga, R., Moraes, J.C. and Alcantra, E. (2014). Biology of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in Colored Cotton Treated with Silicon. *EntomoBrasilis*, 7(1): 65-68.
13. Singh, A.D., Malik, Y.P., Prathyusha, P., and Dwivedi, R.K. (2021). Seasonal Incidence of Major Insect Pests of Tomato (*Lycopersicon esculentum* Mill.) in Relation to Weather Parameters. *International Journal of Current Microbiology and Applied Sciences*, 10(06): 53-63.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1039-1043 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Studies of Genetic Variability in Groundnut (*Arachis hypogaea* L.)

Mukesh Chandra Meena*, P.B. Singh, Amit Dadheech and Deepak Meena
Department of Genetics and Plant Breeding, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan
**Corresponding Author Email: meena.mukesh6379@gmail.com*

Abstract

Thirty six promising genotypes with four checks (TG37A, JL-501, GG-7 and Pratap Raj Mungphali) of groundnut were evaluated for qualitative and yield parameters. A wide range of variation was observed for important yield components. High estimates of the genotypic coefficient of variation (GCV) were observed for harvest index, dry pod yield per plant, kernel yield per plant, plant height and oil content. The estimates of heritability were observed to be high for Seed oil content, plant height, 100-kernel weight, harvest index, biological yield per plant, dry pod yield per plant, day to initiation of pegging, days to 50% flowering, kernel yield per plant indicated that these characters were less influenced by the environmental fluctuations. High heritability along with high genetic advance was observed for harvest index, dry pod yield per plant, plant height, oil content and kernel yield per plant indicating that these traits were mainly governed by additive gene action and responsive for further improvement of these traits.

Key words : *Genetic variability, heritability, genetic advance, groundnut.*

Introduction

Groundnut (*Arachis hypogaea* L.) is the 'king' of oilseeds. It is very important oil seed crop for India as well as in world and this crop is a member of *Papilionaceae* family. Groundnut was originated from Brazil and it was popularly known as peanut/Monkey-nut/African nut/Chinese nut/ Manila nut/ Kipper nut/ Hawks nut/ Jar nut/ Earth chestnut/ Goober pea/ Ground pea and Ground bean (Johnson, 1964). Groundnut is an annual legume crop which is responsible to supply edible oil for human consumption and recognized as peanut in America and several other names such as it is well known as Mungphali in India. Groundnut is an autotetraploid legume crop with basic chromosome number of 2n= 4x=40. The flowers of groundnut are characterized as cleistogamy, therefore crop is highly self-pollinated in nature. After pollination ovary becomes stalk like structure known as Gynophore. Groundnut's fruit known as Pods. Botanically, cultivated groundnut can be classified into two sub-species, which mainly differed in their branching pattern (sub-species *hypogaea* with alternate branching habit and sub-species *fastigiata* with sequential branching habit). India ranks the first in area and second largest producer next to China. Genetic variability is the basic requirement for crop improvement as it provides wider scope for selection. Thus, effectiveness of selection is dependent upon the nature, extent and magnitude of genetic variability present in the material and the extent to which it is heritable. Hence, in present investigation an attempt was made to assess the variability of important pod yield and yield contributing traits, along with the indices of variability *i.e.* genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability in broad sense (h^2_{bs}), genetic advance (GA) and genetic advance as percentage of mean (GAM). This study had facilitated an understanding behind expression of character and also role of environment therein.

Materials and Methods

The experimental materials consisted of 36 promising genotypes with four checks (TG37A, JL-501, GG-7 and Pratap Raj Mungphali) of groundnut derived from different origins, which were obtained from the All India Coordinated Research Improvement Project on Groundnut, MPUAT, Udaipur and sown in a Randomized Block Design with three replications during *kharif*, 2018 at the Instructional Farm, College of Technology and Agriculture Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur. Each genotype was accommodated in a three row plot of 5.0 m length with a spacing of 30 cm between rows and 10 cm between plants. Fertilizer was applied @ 20 kg N/ha and 60 kg P_2O_5/ha.

Estimation of variability parameters : The following parameters were calculated for the characters having significant mean of squares due to the genotypes.

Genotypic variance : It was calculated by the following formula as suggested by Burton and De-Vane (1953).

$$Vg\ (\ ^2g) = \frac{MSG - MSE}{r}$$

Where,

Vg (^{2}g) = genotypic variance

MSG = mean sum of squares due to genotypes

MSE (^{2}e) = mean sum of squares due to error

r = number of replications

Table-1 : List of genotypes used in study.

S. No.	Genotype	S. No.	Genotype
1.	UG-183	21.	UG-204
2.	UG-185	22.	UG-205
3.	UG-186	23.	UG-206
4.	UG-187	24.	UG-207
5.	UG-188	25.	UG-208
6.	UG-189	26.	UG-209
7.	UG-190	27.	UG-210
8.	UG-191	28.	UG-211
9.	UG-192	29.	UG-212
10.	UG-193	30.	UG-213
11.	UG-194	31.	UG-214
12.	UG-195	32.	UG-215
13.	UG-196	33.	UG-216
14.	UG-197	34.	UG-217
15.	UG-198	35.	UG-218
16.	UG-199	36.	UG-219
17.	UG-200	37.	TG37A(ZC)
18.	UG-201	38.	JL-501(ZC)
19.	UG-202	39.	GG-7(ZC)
20.	UG-203	40.	UG-5(LC)

Phenotypic variation : It was also calculated by the following formula as suggested by Burton and De-Vane (1953).

$$Vp(^2p) = Vg(^2g) + Ve(^2g)$$

Where,

Vp = phenotypic variance

Vg = genotypic variance

Ve= error variance i.e. MSE

Genotypic coefficient of variation (GCV) : It was calculated as per the standard formula suggested by Burton (1952).

$$GCV\ (\%) = \frac{\sqrt{Vg}}{\overline{X}} \quad 100$$

Vg = genotypic variance

$\overline{X}$=general mean of the character under investigation

Phenotypic coefficient of variation (PCV) : The magnitude of PCV was calculated by using the formula as suggested by Burton (1952).

$$PCV\ (\%) = \frac{\sqrt{Vg}}{\overline{X}} \quad 100$$

Where,

Vp = phenotypic variance

$\overline{X}$=general mean of the character under investigation

Heritability (h^2) : It was calculated in broad sense by adopting the following formula given by Burton and De-Vane (1953), Johnson *et al*. (1955) and Hanson *et al*. (1956).

$$h^2\ (\%) = \frac{Vg}{Vp} \quad 100$$

Where,

h^2 = Heritability in broad sense

Vg = genotypic variance

p = phenotypic variance

Genetic gain (GG) : It is the genetic advance expressed as per cent of mean. It was estimated by adopting the formula of Lush (1945) and Johnson *et al*. (1955).

$$GG\ (\%) = \frac{G.A.}{\overline{X}} \quad 100$$

$$G.A. = \text{Genetic advance} = \frac{K.Vg}{\sqrt{Vp}}$$

$\overline{X}$=general mean of the character under investigation

Where,

K = selection differential at 5 per cent selection intensity i.e. 2.06

Vg = genotypic variance

Vp = phenotypic variance

Results and Discussion

Success of any breeding programme is largely dependent on the extent of genetic variability present in the material, greater the variability in the material, better are the chances of evolving promising and the desired types. The magnitude of variability is measured in terms of variance, since environment has a greater impact on quantitative characters. The observed variability can be grouped under heritable and non-heritable components with the help of suitable parameters, like genotypic coefficient of variation, heritability (broad sense) and genetic gain, so as to give a basis for selection to breeders.

In this study, an attempt was made to work out the magnitude of variability both at phenotypic and genotypic level for different characters by estimating variance and corresponding coefficient of variation. The estimates of various variability parameters *viz*., GCV, PCV, heritability, genetic advance and genetic gain are presented in Table-2.

Phenotypic coefficient of variation : The highest phenotypic coefficient of variation was observed for harvest index (18.62%), followed by kernel yield per plant (16.18%), number of branches per plant (14.85%), dry

Table-2 : Variability parameters.

S. No.	Characters	GCV	PCV	ECV	h^2	GA	GG
1.	Days to 50 percent flowering	3.40	4.13	2.35	67.64	1.73	5.76
2.	Days to maturity	1.25	3.12	2.86	16.03	1.05	1.03
3.	Day to initiation of pegging	3.55	4.24	2.31	70.21	2.15	6.13
4.	Plant height	10.50	10.73	2.20	95.80	7.38	21.17
5.	No. of branches per plant	9.89	14.85	11.08	44.31	0.86	13.56
6.	Biological yield per plant	9.94	11.27	5.32	77.72	5.84	18.04
7.	Harvest index	17.07	18.62	7.43	84.07	14.68	32.24
8.	Dry pod yield per plant (g)	12.64	14.81	7.72	72.87	3.24	22.24
9.	Sound mature kernel	5.13	7.03	4.81	53.22	6.49	7.70
10.	100-Kernel weight	8.73	9.51	3.76	84.38	7.02	16.53
11.	Shelling percentage	4.37	6.57	4.91	44.15	4.12	5.98
12.	Kernel yield per plant	12.49	16.18	10.28	59.63	2.00	19.88
13.	Oil content	10.06	10.20	1.66	97.35	8.41	20.45

pod yield per plant (14.81%), Biological yield per plant (11.27%), plant height (10.73%), and oil content (10.20%), 100-kernel weight (9.51%), exhibited moderate values for phenotypic coefficient of variation where as sound mature kernel (7.03%), shelling percentage (6.57%), days to initiation of pegging (4.24%), days to 50 percent flowering (4.13%), day to maturity (3.12%), had low phenotypic coefficient of variation.

Estimates of phenotypic coefficient of variation was slightly higher than genotypic coefficient of variation for all the characters. Low difference between GCV and PCV indicated that variability was primarily of genotypic in nature.

Genotypic coefficient of variation : The existence of high magnitude of genetic variability was evident through high values of genotypic coefficient of variation for majority of the characters. The highest genotypic coefficient of variation was observed for harvest index (17.07%), followed by dry pod yield per plant (12.64%), kernel yield per plant (12.49%), plant height (10.50%), oil content (10.06%) indicating the presences of genetic variability for the traits. The characters viz., days to maturity (1.25%), days to 50 percent flowering (3.40%), day to initiation of pegging (3.55%), and shelling percentage (4.37%) exhibited lower genotypic coefficient of variation.

Higher magnitude of GCV was also observed for harvest index by Kadam *et al.* (2007), John *et al.* (2012), Patil *et al*. (2014), Gupta *et al*. (2014), and Balaraju and Kanchangoudar (2016). While for dry pod yield per plant by Hampannavar *et al*. (2017) and Singh *et al*. (2017). For kernel yield per plant high GCV as well as PCV was also observed by John *et al*. (2008), Nandini *et al*. (2011), Zaman *et al.* (2011).

Lower magnitude of GCV, for day to maturity, days to 50 percent flowering was also observed by Madhura *et al*. (2012). Reported lower GCA for shelling percentage and day to initiation pegging.

Heritability : Heritability represents the proportion of total variation transmitted to the progenies. Hence character having higher values of GCV coupled with greater heritability can be improved through selection. In the present investigation the heritability was estimated in broad sense. The results indicated that the heritability was high for most of the characters studied. Seed oil content showed maximum heritability (97.35%) followed by plant height (95.80%), and 100-kernel weight (84.38%). High heritability estimates indicated that the characters were less influenced by the environmental effects and their greater proportion of variability is transmitted to subsequent generations. Thus selection based on phenotypic expression is likely to be effective in the above traits. The characters viz. harvest index (84.07%), biological yield per plant (77.72%) dry pod yield per plant (72.87%), day to initiation of pegging (70.21%), days to 50% flowering (67.64%), kernel yield per plant (59.63%), exhibited moderate heritability. The characters like number of sound mature kernel (53.22%), number of branches per plant (44.31%), shelling percentage (44.15%), and days to maturity (16.03%) showed low estimates of heritability.

Similar results were also reported for high heritability for the characters viz., seed oil content, plant height, 100-kernel weight, days to 50% flowering and kernel yield per plant by Patil *et al.* (2015), Yadlapalli (2014), Balaraju and Kanchanagoudar (2016), Korat *et al*. (2009), and Gupta *et al.*(2014). Harvest index, biological yield per plant, dry pod yield per plant and day to initiation of pegging by John *et al.* (2009).

Genetic gain : Genetic Advance is the improvement in the mean of selected families over the base population (Lush, 1949 and Johnson *et al.* 1955). It was also expressed as

the shift in gene frequency towards superior sides on exercising selection pressure. Genetic advance when expressed as percent of mean is called genetic gain.

The highest genetic gain was observed for harvest index (32.24) followed by dry pod yield per plant (22.24), plant height (21.17), seed oil content (20.45),kernel yield per plant (19.88), biological yield per plant (18.04), and 100-kernel weight (16.53).The characters viz. number of branches per plant (13.56), sound mature kernel (7.70), day to initiation of pegging (6.13), shelling percentage (5.98), days to 50 % flowering (5.76), and days to maturity (1.03), had lower genetic gain.

Similar results for high genetic gain for the characters like harvest index, dry pod yield per plant and plant hight was also observed by Kadam *et al.* (2007), Dolma *et al*. (2010), Vishnuvardhan *et al*. (2013), Patil *et al*. (2014), Gupta *et al*.(2014), Dewangan *et al*.(2015), Balaraju and Kanchanagoudar (2016), Bhargavi *et al*. (2017). Reported high genetic gain for all the characters except day to maturity and sound mature kernel.

In the present investigation, high genetic gain alone with high heritability and high genotypic coefficient of variation was recorded for harvest index, dry pod yield per plant, plant height, oil content and kernel yield per plant. The characters like biological yield per plant, 100-kernel weight, number of branches per plant had moderate to high genetic gain along with moderate heritability and genotypic coefficient of variation. Higher heritability coupled with greater genetic gain is suggestive of relatively greater role of additive genes in the available genetic variability. Further such character have high selective value. On the other hand, the characters such as sound mature kernel, day to initiation of pegging, shelling percentage, day to 50 percent flowering and days to maturity showed low genetic gain with moderate to low heritability and low genotypic coefficient of variation, hence these traits seemed to greatly affected by environment.

References

1. Balaraju, M. and Kenchanagoudar, P.V. 2016. Genetic variability for yield and its component traits in interspecific derivatives of groundnut (*Arachis hypogaea* L.). *Journal Farm Sciences,* 29: 172-176.
2. Bhargavi, G., Rao, V.S., Babu, D.R. and Rao, K.L.N. 2017. Genetic variability, heritability and genetic advance of pod yield component traits of Virginia bunch groundnut (*Arachis hypogaea* L.). *International journal of pure and Applied Bioscience,* 5: 1452-1456.
3. Burton, G.W. 1952. Quantitative inheritance of grasses. Proceeding 6thInternational Grassland Congress, 1: 227-283.
4. Burton, G.W. and De-Vane, E.M. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal,* 45: 478-481.
5. Dewangan, H., Jaiswal, N.K., Gabrilal, M.L. and Rai, P.K. 2015. Study on genetic variability in groundnut *(Arachis hypogaea* L.*)* germplasm. *International Journal of Agricultural Science and Research,* 5: 2250-0057.
6. Dolma, T., Sekhar, M.R. and Reddy, K.R. 2010. Genetic variability, correlation and path analysis for yield, its components and late leaf spot resistance in groundnut (*Arachis hypogaea* L.). *Journal of Oilseeds Research,* 27: 154-157.
7. Gupta, R.P., Vachhani, J.H., Kachhadia, V.H., Vaddoria, M.A. and Reddy, P. 2014. Genetic variability and heritability studies in Virginia groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding,* 6: 253-256.
8. Hampannavar, M.R., Khan, H., Temburne, B.V., Janila, P. and Amaregouda, A. 2017. Genetic variability, correlation and path analysis studies for yield and yield attributes in groundnut (*Arachis hypogaea* L.). *Journal Pharmacognosy and Phytochemistry,* 7: 870-874.
9. Hanson, C.H., H.F. Robinson and R.E. Comstock. 1956. Biometrical studies on yield in segregating population of Korean lespedesa. *Agronomy Journal*, 48: 268-272.
10. John, K., Reddy, P.R., Reddy, K.H., Sudhakar, P. and Reddy, N.P.E. 2012. Studies on genetic variability for morphological, water use efficiency, yield and yield traits in early segregating generation of groundnut (*Arachis hypogaea* L). *International Journal of Biodiversity and Conservation,* 4: 446-452.
11. John, K., Vasanthi, R.P and Venkateswarlu, O. 2008. Estimates of genetic parameters and character association in F_2 segregating populations of spanish x virginia crosses of groundnut (*Arachis hypogaea* L.). *Legume Research,* 31: 235-242.
12. John, K., Vasanthi, R.P. and Venkateswarlu, O. 2009. Studies on variability and character association in spanish bunch groundnut (*Arachis hypogaeae* L.). *Legume Research,* 32: 65-69.
13. Johnson, F.R. 1964. The peanut story. Johnson publishing Co., Murfreesboro, N.C.
14. Johnson, H. W., Robinson, H. F. and Comstock, R. E. 1955. Estimation of genetic and environmental variability in soybean. *Agronomy Journal*, 47: 314-318.
15. Kadam, D.E., Patil, F.B., Bhor, T.J. and Harer, P.N. 2007. Stability for dry pod yield and days to maturity in groundnut genotypes. *Journal of Maharashtra Agricultural Universities,* 25: 322-323.
16. Korat, V.P., Pithia, M.S., Savaliya, J.J., Pansuriya, A.G. and Sodavadiya, P.R. 2009. Studies on genetic variability in different genotypes of groundnut. *Legume Research,* 32: 224-226.
17. Lush, J.L. 1949. Heritability of quantitative characters in farm animals. *Herbicides*, 35: 356-357.
18. Lush, J.L. 1945. Intra-sire correlation or regression offspring on dam as a method of estimating heritability of characteristics. Record of Proceedings, American Society of Animal Production, 33: 293-301.

19. Madhura Chandrashekar Kenchanagoudar, P.V. 2012. Assessment of genetic variability and inter-relationship among minicore collection of groundnut (*Arachis hypogaea* L.). *International Journal of Plant Sciences,* 7:307-312.

20. Nandini, C., Savithramma, D.L. and Babu, N.N. 2011. Genetic variability analysis for water use efficiency in F8 recombinant inbred lines of groundnut (*Arachis hypogaea* L.). *Current Biotica*, 5: 282-288.

21. Patil, A.S., Punewar, A.A., Nandanwar, H.R. and Shah, K.P. 2014. Estimation of variability parameters for yield and its component traits in groundnut (*Arachis hypogaea* L.). *The Bioscan*, 9: 749-754.

22. Patil, S.K., Shivanna, S., Irappa, B. M. and Shweta 2015. Genetic variability and character yield attributing components in groundnut. *International Journal of Recent Scientific Research,* 6: 4568-4570.

23. Singh, P.B., Bharti, B., Kumar, A., Singh, R., Kumar, N. and Rathnakumar, A.L. 2017. Genetic characterization, character association for yield and yield component traits in groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding*, 8: 1229-1235.

24. Vishnuvardhan, K.M., Vasanthi, R.P. and Reddy, K.H. 2013. Genetic variability studies for yield, yield attributes and resistance to foliar diseases in groundnut (*Arachis hypogaea* L.). *Legume Research,* 36: 111-115.

25. Yadlapalli, S. 2014. Genetic variability and character association studies in groundnut (*Arachis hypogaea* L.). *International Journal of Plant, Animal and Environmental Sciences,*4: 298-300.

26. Zaman, M.A., Tuhina-Khatun, M., Ullah, M.Z., Moniruzzamn, M. and Alam, K.H. 2011. Genetic variability and path analysis of groundnut (*Arachis hypogaea* L.). *The Agriculturists,* 9: 29-36.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1044-1046 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Creating Entrepreneurship through Business Education

Pradeep Dwivedi
Department of Agricultural Extension, BRD (PG) College, Deoria-274001, U.P.

Abstract

Entrepreneurs play an important role in developing and contributing to the economy of a nation. It is all in developing world where the ample of opportunities for innovations to exploit the available resources and initiate entrepreneurial ventures. India's latent entrepreneurship potential lies untapped because of life skills that are not taught and social expectations that are not set right. The research paper is conceptual paper highlights the importance of the business education, frame work for the development of business education, the competencies that are require building strong entrepreneurs, the role business schools and their initiatives taken by them in imparting management education to build entrepreneurial competencies in an efficient effective excellent manner to encounter the challenges of business.

Key words : *Entrepreneurs, entrepreneurship, business education, competencies, economy, untapped*

Introduction

Entrepreneurship is a dynamic process of vision, change, and creation. It requires an application of energy and passion towards the creation and implementations of new ideas and creative solutions. Essential ingredients include the willingness to take calculated risk, in terms of time, equity, or career the ability to formulate an effective ventures team: the creative skill to economic needed resources and fundamental skill of building solid plan: business and finally the vision to recognize opportunity

Entrepreneur : An entrepreneur is one who does not go with the rest of the crowd and instead goes along a path which others have not taken. Entrepreneur is defined as a person who owns or manages a business and makes money through initiative and risk.

Entrepreneurs are leaders, managers, innovators and use their skills to drive a business successfully. Following the 1990s economic reforms in India, there have been many successful entrepreneurs who have made a name for themselves. These entrepreneurs have made a big contribution to the Indian economy through their ventures. Entrepreneurship involves the process of transforming creative ideas into commercially viable business. Successful entrepreneurship does not merely involve money and luck. It is the holistic synergy of creativity, risk taking and planning. It is the view that successful business man is born and cannot be made. But it has been proved time and again that entrepreneurship, or at least many aspects o f it, can be taught. And the best forum to teach entrepreneurship is business school.

Research Methodology

This is the conceptual paper and the researcher has adopted the method of reviewing different research articles, research journals, and case studies to collec t about the building the entrepreneurs through Business Education.

Objectives

To know the need for the entrepreneurial development.

To know the factors influencing the entrepreneurial development.

To know the role of business education to building the entrpreneurs.

To find the education about enterprise and for enterprise.

How the B-schools be a launch pad for young entrepreneurs.

Secondary Data : Secondary data was collected from journals, magazines, reports, books, periodical articles, research papers and websites.

Limitations of the study

1. The study is limited to secondary data only.
2. The findings cannot be generalized

Need for Entrepreneurship Development : Entrepreneurship has an important role to play in the development of a country. It is the one of the most important inputs in economic development. The economic history of the presently advanced countries like USA, Russia and Japan supports the fact that economic development is the outcome for which entrepreneurship is an inevitable cause. The crucial and significant role played by the entrepreneurs in the economic development of advanced countries has made the people of developing underdeveloped countries conscious of the importance of entrepreneurship for economic development. It is now a

widely accepted fact that active and enthusiastic entrepreneurs can only explore the potentials of the countries availability of resources such as labor, capital and technology. The role of entrepreneurs is not identical in the various economics. Depending on the material resources, industry contribution of entrepreneurs may be more in favorable opportunity conditions than in economics with relatively less favorable opportunity conditions. The World Bank estimates that by 2015 there will be three billion people in the world under age of 25. The quality and the level of their education and employment will play a crucial role in the world's ability to meet the challenges of the 21st century. In UN 2013 report on " Global employment Trends for Youth ' estimates that youth make up as much as 40 percent of the world's total unemployed, and are almost three times as likely to be unemployed as adults. This situation represents a huge, and in many regions growing, challenge. However it can be an opportunity to create a fundamental shift in society if policies and resources are intelligently targeted towards these demographic groups. Supporting youth enterprise in one solution to the youth employment and it is also a challenge that requires great attention from policy makers and practitioners.

Factors Influencing Entrepreneurship Development : "Entrepreneurship at its core is not only an activity. It is an attitude. That can and should infuse every sector of our society". A literature review of the entrepreneurial personality has found that that certain traits seem to be dominant in case of entrepreneurs. They action oriented and highly motivated individuals who take risk to achieve goals. Such a capability is the outcome of certain personality traits in an individual which are acquired by training and practicing. An entrepreneur should possess distinct qualities like risk dealing, goal setting, decision making, information seeking, problem solving, time management and maintaining good interpersonal relations. In addition to other set of confidence, perception, team building, trust worthiness, hard work, consistency and analytical strengths. These soft skills are smart skills a person should acquire in order to be successful.

Business Education Schools : A business education schools is place where a student gets educated on various aspects of business theories, principles and practices. Business education schools not only provide theoretical inputs but can also provide practical knowledge to students to help them succeed in the work place. A Business education schools can promote the entrepreneurship characteristics among its students by developing the required skills that are necessary to stimulate them to become future leaders and successful entrepreneurs.

Business education as launch pad for entrepreneurs : Entrepreneurship requires capital- money to start the business. It also requires the ability to take risks. The first step is there therefore important. It is just like a rocket requires a launch pad to launch it into space. Similarly, an entrepreneur requires a launch pad to help him to plan for an entrepreneurship career. Most business school students aim to work for a multinational corporation for good salary. There are not many students who would be ready and willing to give up the comfort and safety of a job to take up the risk of starting a venture. So, when a student is interested in becoming an entrepreneur, the Business education has a greater responsibility to help him find the launch pad for his venture take – off. Presently, there are many limitations when it comes to business education students taking up.

Role of Educational Institutions in building Entrepreneurs : Forty seven percentage of India's population is under 20 years. In the factor driven economics like India, the higher the quality of after school training, the higher the levels of necessity based entrepreneurship. From GEM 2013 report, the post level entrepreneurship education and training for adult population has been poor with less than 5%. This calls for rigorous and continuous entrepreneurship development program on campuses of higher learning to accelerate the supply of entrepreneurs.

Growth of institutions and universities providing business education in India is increasing day by day. It is the social responsibility of universities to provide alternate career opportunities for their graduates. The need of the hour is to continuously inventory student attitude, skills and competencies for an entrepreneurial career and build up a data base of prospective entrepreneurs The present education system in India has not been promoting independent thinking, creativity, a sprit of innovation and motivation for setting a challenging and achievable goal. The environment and policy offers diverse opportunities for sustainable self –employment to ensure contribution of workforce to industrial economy. There is thus a need to inculcate and enterprise creation provides a solution to the crisis of both unemployment and economic growth.

Education about enterprise : The paradox exists in terms of increasing number of unemployed population, seeking wage earners career and unaware of the wide opportunities for entrepreneurial career. This is mainly because of lack of education about entrepreneurship. Thus the education plays an important role in raising awareness of enterprise and entrepreneurship as a key change agent in economic process.

Education through Enterprise : In which the education process itself can be enhanced by using pedagogic styles

which work in and makes use of enterprising situations including the student concerned and real world project driven approach. Internship Industry and institutional interface Entrepreneurs interface Case studies.

Education for enterprise : This is aimed at entrepreneurship development and includes training exiting entrepreneurs as well as for new business start- up preparation of business plan marketing assistance financial assistance.

Conclusions

Successful entrepreneurship depends on many factors, including the characteristics of the entrepreneur and the entrepreneur's economic development. The business education plays an important role in identifying the students who can become entrepreneurs and designing the programs that would help to become potential entrepreneurs.

One of the objectives of business schools building entrepreneurship, but is not primary objective. The focus is more on developing people as managers. So, few graduates from business education background became entrepreneurs. Some of the business schools imparting the entrepreneurial competencies to certain extent through curricular, co–curricular and other initiatives. But the relevance and adequacy of these initiatives have to be improved.

References

1. Asia pacific development journal , Vol12, No 2, Dec 2008.
2. EDI reports 86 by Entrepreneurship Development Institute of India, Ahmadabad, Issue 2, 2011-12.
3. Entrepreneurship development program-Vasant Desai, Appannaiah.
4. GEM Report 2013, executive Report.
5. International journal of business and social science , Vol. 2, No. 2, Feb 2011.
6. Motilal Dash and Umesh Dhyani, Entrepreneurship Culture, Allied publishers Pvt., Ltd.
7. Motivational patterns for Entrepreneurship among Business Students: An empirical Study 'Rev iew of business and technology Research volume I.
8. The importance of competencies for Entrepreneurship: A view from entrepreneurs and scholars perspective a report by ESPA.
9. The IUP journal of Entrepreneurship Development (2011), Volume VIII (2011).
10. The IUP Journal of Entrepreneurship Development (2011), Volume VIII (2010).
11. United Nations university report on innovation and entrepreneurship in developing countries. www.unu.edu.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1047-1054 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Character Association and Path Analysis in Groundnut (*Arachis hypogaea* L.)

Raju Lal*, P.B. Singh and Manmohan Singh
Department of Genetics and Plant breeding, Rajasthan College of Agriculture, MPUAT, Udaipur-313001, Rajasthan, India
**Corresponding Author Email : rajujunjariya@gmail.com*

Abstract

The present investigation was carried out at Instructional farm College of Technology and Engineering, MPUAT, Udaipur (Rajasthan) on the 27 Spanish Bunch genotypes along with 5 checks of groundnut (*Arachis hypogaea* L.) in randomized block design with three replications during *kharif* 2019 to estimate genetic variability, heritability, genetic advance as percentage of mean, correlation and path coefficient analysis for days to 50% flowering, duration between flowering to pegging, plant height, days to maturity, number of branches per plant, dry pod yield per plant, shelling percentage, sound mature kernel, 100-kernel weight, biological yield per plant, harvest index and oil content. The analysis of variance revealed highly significant differences among the genotypes for all the traits studied indicating presence of wide genetic variation for different characters among the genotypes of groundnut.

Key words : *Groundnut, correlation, selection and variability.*

Introduction

Groundnut (*Arachis hypogaea* L.) is an important crop among oilseeds, self-pollinated and chromosome number (2n= 4x = 40) grown in tropical and subtropical regions of the world. Groundnut (*A. hypogaea* L.) is believed to be the native crop of Brazil. It was introduced in India during the first half of the sixteenth century from one of the Pacific Islands of China, where it was introduced earlier from either Central America or South America. Groundnut has other synonyms such as peanut, earthnut, monkey nut, goober, panda and manila nut. Research efforts of Dr. George Washington Carver during early 1900 made it an important commercial crop in the southern USA. Now, groundnut is one of the principal economic crops of the world; ranking 6th in edible oil production among oilseed crops, 3rd most important source of vegetable protein and 13th among food crops. It also occupies first rank among oilseed crops of India (Nigam, 2015).

Groundnut is widely grown under wet conditions in semi-arid regions including Africa, Americas and Asia (Singh and Singh 1992) and it grows best in light, sandy loam soils. To develop well, groundnut need warm weather throughout the growing season. It can be grown with as little as 350 mm of water but for best yields need at least 500 mm rainfall. Groundnut is the also known as “The king of oil seeds”. Groundnut contains on the average 12-15% carbohydrates, 25-30% protein and 45-50% oil. The nuts may be chewed uncooked, but are usually eaten boiled or roasted. The nuts can also be boiled, fried, ground into groundnut butter, or crushed for oil. Groundnut is also a rich and dietary source of minerals such as K, Na, Ca, Mn, Fe and Zn and biologically active compounds like riboflavin, thiamine, arginine, resveratrol, phytosterols and flavonoids (Stigter *et al*., 2006; Wessells and Brown, 2012) that are ingested right away as fresh, baked or cooked kernels otherwise, oil isolated from the kernel is consumed as cooking oil. The haulms (vegetative portions of plant) of groundnut deliver superior quality hay as animal feed since these are enrich with protein and ensure enhanced deliciousness as well as assimilation rate in comparison to other forage (Singh *et al*., 2010).

Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and also among various components. When change in one variable causes the change on other variable, the variables are said to correlate. Correlation coefficient measures the degree of association, genetic or non-genetic between two or more characters which form the basis for selection. In this context, correlation study is of vital importance for selecting superior genotypes.

Materials and Methods

The experimental material used in the present investigation was consisted of the 27 Spanish Bunch genotypes along with 5 checks groundnut genotypes representing diversity in adaptability and variability in characters and geographical origin. The experimental material was evaluated for genetic variability, association analysis and path analysis for 12 economically important traits during *kharif,* 2019. The experimental material was collected from All India Coordinated Research Project (AICRP) on Groundnut, Department of Genetics and Plant Breeding, Rajasthan College of Agriculture, Udaipur. The experimental material was evaluated in randomized block

design with 3 replications during *kharif,* 2019. Each genotype was sown in a plot of 4.80m x 0.90m accommodating two rows spaced at 30 cm apart. The plant-to-plant distance of 10 cm was maintained. Non-experimental rows were planted all around the experimental field to eliminate the border effects, if any. All the recommended package of practices was followed to raise a good and healthy crop. The analysis of variance and covariance was worked out for all the traits using standard statistical procedure given by Panse and Sukhatme (1985). Genotypic and phenotypic Correlation coefficients were computed from variance and covariance as per method suggested by Al-Jibouri *et al.* (1958). Path coefficients were estimated by principles and techniques given by Wright (1921) and Dewey and Lu (1959).

Results and Discussion

Results of the present investigation entitled "Character Association and Path Analysis in Groundnut (*Arachis hypogaea* L.)" carried out during *Kharif,* 2019 at Instructional Farm, College of Technology and Engineering, MPUAT, Udaipur (Rajasthan) are presented under

Character association

The concept of correlation was first given by Galton (1889) and later, it was elaborated by Fisher (1918). The yield is a complex character dependent on many attributes of plants. The correlation studies help in understanding the association between the traits. The phenotypic and genotypic correlation coefficients between all possible combinations among the characters were worked out and are depicted in table 4.4 and table 4.5. In general, the genotypic coefficients were higher in magnitude than their respective phenotypic correlation coefficients for most of the character pairs. The results of phenotypic correlation coefficient and genotypic correlation coefficients between different characters are presented as under:

Days to 50% flowering : Days to flowering showed significant and negative correlation at genotypic level with number of branches per plant (rg= -0.410**), sound mature kernel % (rg= -296**), 100-kernel weight (g) (rg= -0.346**) and Harvest index (%) (rg= -0.242*). The non-significant association with all other traits was observed for this character.

Duration between flowering to pegging : Duration between flowering to pegging showed significant and negative correlation at genotypic level with shelling % (rg= 0.616**), number of branches per plant (rg= -0.601**), dry pod yield per plant (rg= 525**), harvest index (-0.448**) days to maturity (rg= -0.396**), 100-kernel weight (rg= -0.317**) whereas, at phenotypic level it was positively significant with harvest index (rp= -0.348**), shelling % (rg= -0.347**), dry pod yield per plant (rp= -0.323**) and number of branches per plant (rp= -0.215*),

Plant height : Plant height showed significant and positive correlation at genotypic level with number of branches per plant (rg= 0.710**), sound mature kernel (rg= 0.654**), biological yield per plant (0.438**), dry pod yield per plant (rg= 0.391**), days to maturity (0.267**) and significant and negative correlation with days to maturity whereas, at phenotypic level with number of branches per plant (rp= 0.335**), dry pod yield per plant (rp= 0.295**) and sound mature kernel (rp= 0.276**)

Number of branches per plant : Number of branches per plant showed a positive and significant correlation with dry pod yield (0.993**), shelling % (rg = 0.747**), harvest index (0.666**) sound mature kernel (rg= 0.638**), 100-kernel weight (g) (rg= 0.230*) at genotypic levels. Whereas, it exhibited a positive and non-significant correlation with sound mature kernels (0.276**) and harvest index (rp= 0.207*) at phenotypic levels.

Days to maturity : Days to maturity showed a positive and significant correlation with biological yield (0.519**) followed by 100-kernel weight (g) (rg= 0.499**), harvest index (0.395**) and sound mature kernel (rg= 0.319**) at genotypic levels. Whereas, it exhibited a non-significant correlation with all the traits at phenotypic levels.

Sound mature kernel (%) : Sound mature kernel showed a positive and significant correlation with dry pod yield per plant (0.689**) and Shelling % (rg = 0.350**) while negative and significant correlation with oil content (-0.507**) at genotypic level only. It showed a positive and significant correlation with dry pod yield per plant(0.324**) and100-kernel weight (0.297**) at phenotypic level only.

100-kernel weight (g) : 100-kernel weight showed a positive and significant association with dry pod yield per plant (0.490**), followed by harvest index (0.468**), biological yield per plant (0.389**) and shelling % (0.250*) at genotypic level while at phenotypic level with harvest index (0.344**) and dry pod yield per plant (0.260*).

Shelling percentage : Shelling percentage showed a positive and significant association with dry pod yield per plant (0.872**), harvest index (0.634**), and biological yield (0.319**), at genotypic level. While at phenotypic level with harvest index (0.333**) and dry pod yield per plant (0.298**).

Biological yield per plant (g) : Biological yield per plant showed a positive and significant association with dry pod yield per plant (0.513**) and harvest index (0.348**) at genotypic level while at phenotypic level with dry pod yield per plant(0.204*).

Harvest index (%) : Harvest index exhibited a positive

Table-1 : Genotypic correlation coefficients between different characters in groundnut.

Characters	Days to 50 per cent flowering	Duration between flowering to pegging	Plant height	Number of branches per plant	Days to maturity	Sound mature kernels	100-kernel weight	Shelling percentage	Biological yield per plant	Harvest index	Oil content	Dry pods yield per plant
Days to 50 per cent flowering	1.000	0.051	0.082	-0.410**	0.191	-0.296**	-0.346**	-0.139	-0.025	-0.242*	0.013	-0.010
Duration between flowering to pegging		1.000	-0.038	-0.601**	-0.396**	-0.103	-0.317**	-0.616**	-0.197	-0.448**	0.127	-0.525**
Plant height			1.000	0.710**	-0.267**	0.654**	0.170	-0.038	0.438**	0.158	0.035	0.391**
Number of branches per plant				1.000	-0.036	0.638**	0.230*	0.747**	-0.127	0.666**	0.115	0.993**
Days to maturity					1.000	-0.319**	0.499**	0.061	0.519**	0.395**	-0.107	-0.151
Sound mature kernels						1 .000	0.050	0.350**	-0.134	0.031	-0.507**	0.689**
100-kernel weight							1.000	0.250*	0.389**	0.468**	0.107	0.490**
Shelling percentage								1.000	0.319**	0.634**	0.197	0.872**
Biological yield per plant									1.000	0.348**	0.173	0.513**
Harvest index										1.000	0.223*	0.804**
Oil content											1.000	0.071
Dry pods yield per plant (g)												1.000

*significant at P = 0.05 and ** significant at P = 0.01

Table-2 : Phenotypic correlation coefficients between different characters in groundnut.

Characters	Days to 50 per cent flowering	Duration between flowering to pegging	Plant height	Number of branches per plant	Days to maturity	Sound mature kernels	100-kernel weight	Shelling percentage	Biological yield per plant	Harvest index	Oil content	Dry pods yield per plant
Days to 50 per cent flowering	1.000	0.070	0.103	-0.080	-0.094	0.095	-0.078	0.091	0.009	-0.136	-0.000	-0.136
Duration between flowering to pegging		1.000	-0.078	-0.215*	-0.148	-0.039	-0.051	-0.347**	0.003	-0.348**	0.106	-0.323**
Plant height			1.000	0.335**	-0.029	0.276**	-0.026	0.157	0.109	0.173	0.125	0.295**
Number of branches per plant				1.000	0.026	0.276**	-0.114	0.050	-0.029	0.207*	0.080	0.194
Days to maturity					1.000	-0.197	0.101	0.027	-0.035	0.188	-0.044	0.097
Sound mature kernels						1.000	0.297**	0.105	0.013	0.103	-0.136	0.324**
100-kernel weight							1.000	0.193	0.143	0.344**	0.061	0.260*
Shelling percentage								1.000	0.001	0.333**	0.121	0.298**
Biological yield per plant									1.000	-0.000	0.146	0.204*
Harvest index										1.000	0.246*	0.619**
Oil content											1.000	0.101
Dry pods yield per plant												1.000

*Significant at P = 0.05 and ** significant at P = 0.01

Table-3 : Genotypic path coefficient analysis showing direct (diagonal) and indirect (non-diagonal) effect of different characters on dry pod yield per plant in groundnut.

Characters	Days to 50 per cent flowering	Duration between flowering to pegging	Plant height	Number of branches per plant	Days to maturity	Sound mature kernels	100-kernel weight	Shelling percentage	Biological yield per plant	Harvest index	Oil content	Dry pods yield per plant
Days to 50 per cent flowering	0.26015	0.00658	0.05316	0.14338	-0.11298	0.09873	-0.17116	-0.1565	0.0042	-0.12873	-0.0068	-0.010
Duration between flowering to pegging	0.01328	0.12881	-0.02454	0.21055	0.23352	0.03442	-0.15649	-0.69219	0.03287	-0.23817	-0.06685	-0.525**
Plant height	0.02129	-0.00487	0.64959	-0.24862	0.15771	-0.21816	0.0842	-0.04217	-0.07322	0.08389	-0.01868	0.391**
Number of branches per plant	-0.10653	-0.07746	0.46125	-0.35013	0.02146	-0.21289	0.11358	0.83944	0.02121	0.35386	-0.06055	0.993**
Days to maturity	0.04978	-0.05095	-0.17352	0.01272	-0.59041	0.10645	0.24637	0.06889	-0.08665	0.20969	0.05643	-0.151
Sound mature kernels	-0.07697	-0.01329	0.42467	-0.22338	0.18834	-0.3337	0.02473	0.39287	0.02243	0.01621	0.26719	0.689**
100-kernel weight	-0.0901	-0.04079	0.11067	-0.08046	-0.29433	-0.0167	0.49422	0.28033	-0.06493	0.24861	-0.05659	0.490**
Shelling percentage	-0.03625	-0.07938	-0.02439	-0.26169	-0.03622	-0.11673	0.12335	1.12316	-0.05336	0.33673	-0.10369	0.872**
Biological yield per plant	-0.00654	-0.02534	0.28469	0.04444	-0.30623	0.0448	0.19208	0.35875	-0.16707	0.18519	-0.09147	0.513**
Harvest index	-0.06302	-0.05773	0.10255	-0.23315	-0.23297	-0.01018	0.23122	0.71169	-0.05822	0.53141	-0.11783	0.804**
Oil content	0.00335	0.01633	0.02302	-0.04021	0.06319	0.1691	0.05304	0.22087	-0.02898	0.11875	-0.52728	0.071

Residual effect is -0.21666

and significant association with dry pod yield per plant (0.804**) and oil content (0.223*) at genotypic level while at phenotypic level dry pod yield per plant (0.619**) and oil content (0.246*) also exhibited positive and significant association.

Oil content : Oil content showed non-significant association with dry pods yield per plant at both phenotypic and genotypic level.

Dry pods yield per plant : Dry pods yield per plant showed a positive and significant association with duration between flowering to pegging, plant height (cm), number of branches per plant, days to maturity, sound mature kernels, 100-kernel weight, shelling percentage, biological yield per plant, harvest index and oil content at genotypic as well as phenotypic levels.

Path coefficient analysis

The concept of partitioning of correlation into direct and indirect effects through path analysis was originally developed by Wright (1921), but the technique was first used for plant selection by Dewey and Lu (1959). It measures the interrelationships of major yield contributing characters with yield and amongst them with their direct and indirect effects on yield for making the selection more effective.

The genotypic and phenotypic correlation coefficients of dry pod yield with its contributing characters were partitioned into direct and indirect effect through path coefficient analysis are presented in table 4.6 and table 4.7. The correlation coefficient indicates the absolute total association with different characters while path coefficient revealed the relative importance of different component characters on dry pod yield.

At genotypic level, highest positive direct effect on dry pod yield per plant was observed for shelling percentage (1.12316) followed by plant height **(**0.64959**)**, harvest index (0.53141), 100-kernel weight (0.49422), and days to 50% flowering (0.26015); duration between flowering to pegging (0.12881) whereas, the highest negative direct effect was observed for days to maturity (-0.59041), oil content (-0.52728), number of branches per plant (-0.35013), sound mature kernel (-0.3337) and biological yield per plant (-0.16707).

At phenotypic level, highest positive direct effect on dry pod yield per plant was observed for harvest index (0.53465) followed by sound mature kernel (0.27612), biological yield per plant (0.20079), plant height (0.12398), shelling percentage (0.06624) and days to maturity (0.04259) and; whereas, the highest negative direct effect was observed for days to 50% flowering (-0.11057), duration between flowering to pegging

(-0.09592), 100-kernel weight (-0.0691) and oil content (-0.02384).

Days to 50% flowering : At genotypic level, days to 50 % flowering had a non-significant correlate on with dry pod yield per plant (rg = -0.010) due to its positive direct effect (0.26015), while positive indirect effect through plant height (0.05316), duration between flowering to pegging (0.00658), sound mature kernel (0.09873); biological yield per plant (0.0042), whereas, negative indirect effect through days to maturity (-0.11298), harvest index (-0.12873), 100-kernel weight (-0.17116) and oil content (-0.0068).

At phenotypic level, days to 50 % flowering had a negative correlation with dry pod yield per plant (rp= -0.136) due to its negative direct effect (-0.11057), while positive indirect effect through sound mature kernel (0.02637), shelling percentage (0.00605), biological yield per plant (0.00172), plant height (0.01277), 100-kernel weight (0.00538); whereas, negative indirect effect through duration between flowering to pegging (-0.00674), days to maturity (-0.00402) and harvest index (-0.07250).

Duration between flowering to pegging : At genotypic level, duration between flowering to pegging days to maturity had a negative correlation with dry pod yield per plant (rg= -0.525**) due to its positive direct effect (0.12881), while positive indirect effect through sound mature kernel (0.03442), biological yield per plant (0.03287) and days to 50% flowering (0.01328); whereas, negative indirect effect through shelling percentage (-0.69219), 100-kernel weight (-0.15649), oil content (-0.06685) and harvest index (-0.23817).

At the phenotypic level, duration between flowering to pegging had a negative correlation with dry pod yield per plant (rp = -0.323**) due to its negative direct effect (-0.09592), while positive indirect effect through), biological yield per plant (0.00051), 100-kernel weight (0.00355) and no. of branches per plant (0.01480); whereas, negative indirect effect through oil content (-0.00254), sound mature kernel (-0.01088) and shelling percentage (-0.02295), days to 50% flowering (-0.00777) plant height (-0.00962) and harvest index (-0.18620).

Plant height : At genotypic level, plant height had a negative correlation with dry pod yield per plant (rg= 0.391**) due to its positive direct effect (0.64959), while positive indirect effect through harvest index (0.08389), days to 50% flowering (0.02129) and 100-kernel weight (0.0842); whereas, negative indirect effect through oil content (-0.01868), shelling percentage (-0.04217), biological yield per plant (-0.07322) and sound mature kernel (-0.21816).

At the phenotypic level, plant height had a negative correlation with dry pod yield per plant (rp = 0.295**) due to its positive direct effect (0.12398), while positive indirect effect through sound mature kernel (0.07611), biological yield per plant (0.02183), harvest index (0.09226), 100-kernel weight (0.00178) and shelling percentage (0.01039); whereas, negative indirect effect through days to 50% flowering (-0.01139),

Number of branches per plant : At genotypic level, number of branches per plant had a positive correlation with dry pod yield per plant (rg= 0.993) due to its negative direct effect (-0.35013), while positive indirect effect through shelling percentage (0.83944), biological yield per plant (0.02121), harvest index (0.35386) and 100-kernel weight (0.11358); whereas, negative indirect effect through sound mature kernel (-0.21289) and days to 50% flowering (-0.10653).

At the phenotypic level, number of branches per plant had a positive correlation with dry pod yield per plant (rp = 0.194) due to its negative direct effect (-0.06894), while positive indirect effect through sound mature kernel (0.07631), days to 50% flowering (0.00888), harvest index (0.11088) and 100-kernel weight (0.00784) and shelling percentage (0.00332); whereas, negative indirect effect through biological yield per plant (-0.00581).

Days to maturity : At genotypic level, days to maturity had a negative correlation with dry pod yield per plant (rg= -0.151) due to its negative direct effect (-0.59041), while positive indirect effect through shelling percentage (0.06889), days to 50% flowering (0.04978), oil content (0.05643), number of branches per plant (0.01272), harvest index (0.20969) and sound mature kernel (0.10645) and 100-kernel weight (0.24637); whereas, negative indirect effect through biological yield per plant (-0.08665).

At the phenotypic level, days to maturity had a positive correlation with dry pod yield per plant (rp = 0.097) due to its positive direct effect (0.04259), while positive indirect effect through and shelling percentage (0.00177), oil content (0.00104), days to 50% flowering (0.01043) and harvest index (0.10040); whereas, negative indirect effect through biological yield per plant (-0.00705), number of branches per plant (-0.00177), sound mature kernel (-0.05444) and 100-kernel weight (-0.00695).

Sound mature kernel (%) : At genotypic level, the sound mature kernel had positive correlation with dry pod yield per plant (rg= 0.689) due to its negative direct effect (-0.3337), while positive indirect effect through harvest index (0.01621), days to maturity (0.18834), biological yield per plant (0.02243), shelling percentage (0.39287),

oil content (0.26719) and 100-kernel weight (0.02473); whereas, negative indirect effect through days to 50% flowering (-0.07697).

At the phenotypic level, sound mature kernel had negative correlation with dry pod yield per plant (rp= 0.324) due to its negative direct effect (0.27612), biological yield per plant (0.00258), oil content (0.00324), shelling percentage (0.00699) and positive indirect effect through harvest index (0.05518); whereas, negative indirect effect through 100-kernel weight (-0.02054), days to 50% flowering (-0.01056) and days to maturity (-0.00840) and number of branches per plant (-0.01905).

100-kernel weight (g) : At genotypic level, 100-kernel weight had a positive correlation with dry pod yield per plant (rg= 0.490) due to its positive direct effect (0.49422), while positive indirect effect through harvest index (0.24861), shelling percentage (0.28033); whereas, negative indirect effect through biological yield per plant (-0.06493), days to maturity (-0.29433), sound mature kernel (-0.0167), oil content (-0.05659), days to 50% flowering (-0.0901) and number of branches per plant (-0.08046).

At the phenotypic level, 100-kernel weight had a positive correlation with dry pod yield per plant (rp= 0.260) due to its negative direct effect (-0.06910), while positive indirect effect through harvest index (0.18411), days to 50% flowering (0.00861), number of branches per plant (0.00782), days to maturity (0.00428), biological yield per plant (0.02868) sound mature kernel (0.08208) and shelling percentage (0.01282); whereas, negative indirect effect through oil content (-0.00146).

Shelling percentage : At genotypic level, shelling percentage had positive and significant correlation with dry pod yield per plant (rg= 0.872) due to its positive direct effect (1.12316), while positive indirect effect through harvest index (0.33673) and 100-kernel weight (0.12335); whereas, negative indirect effect through and days to 50% flowering (-0.03625) oil content (-0.10369), number of branches per plant (-0.26169), days to maturity (-0.03622), biological yield per plant (-0.05336) and sound mature kernel (-0.11673).

At phenotypic level, shelling percentage had positive correlation with dry pod yield per plant (rp= 0.298) due to its positive direct effect (0.06624), while positive indirect effect through biological yield per plant (0.00023), sound mature kernel (0.02912), harvest index (0.17807) and days to maturity (0.00114); whereas, negative indirect effect through oil content (-0.00289), number of branches per plant (-0.00346), 100-kernel weight (-0.01337) and days to 50% flowering (-0.01010).

Biological yield per plant (g) : At genotypic level, biological yield per plant had a positive and significant correlation with dry pod yield per plant (rg = 0.513) due to its negative direct effect (-0.16707), harvest index (0.18519), sound mature kernel (0.0448), shelling percentage (0.35875), number of branches per plant (0.04444), 100-kernel weight (0.19208) while negative indirect effect through days to 50% flowering (-0.00654), days to maturity (-0.30623) and oil content (-0.09147).

At the phenotypic level, biological yield per plant had a positive and significant correlation with dry pod yield per plant (rp = 0.204*) due to its positive direct effect (0.20079), while positive indirect effect through plant height (0.01348),number of branches per plant (0.00199), sound mature kernel (0.00355), and shelling percentage (0.00008); whereas, negative indirect effect through harvest index (-0.00003), 100-kernel weight (-0.00987), duration between flowering to pegging (-0.00025), oil content (-0.00347), days to 50% flowering (-0.00095) and days to maturity (-0.00150).

Harvest index (%) : At genotypic level, harvest index had a positive correlation with dry pod yield per plant (rg= 0.804) due to its positive direct effect (0.53141), while positive indirect effect through shelling percentage (0.71169) plant height (0.10255) and 100-kernel weight (0.23122); whereas, negative indirect effect through biological yield per plant (-0.05822), oil content (-0.11783), number of branches per plant (-0.23315), sound mature kernel (-0.01018), days to maturity (-0.23297) duration between flowering to pegging (-0.05773) and days to 50% flowering (-0.06302).

At the phenotypic level, harvest index had a positive correlation with dry pod yield per plant (rp= 0.619) due to its positive direct effect (0.53465), while positive indirect effect through sound mature kernel (0.02850), duration between flowering to pegging (0.03341) and shelling percentage (0.02206), days to maturity (0.00800), plant height (0.02140) and days to 50% flowering (0.01499); whereas, negative indirect effect through biological yield per plant (-0.00001), 100-kernel weight (-0.02379), oil content (-0.00587) and number of branches per plant (-0.01430).

Oil content : At genotypic level, oil content had positive and significant correlation with dry pod yield per plant (rg= 0.071) due to its negative direct effect (-0.52728), while positive indirect effect through plant height (0.02302), duration between flowering to pegging (0.01633), harvest index (0.11875), days to maturity (0.06319), shelling percentage (0.22087), sound mature kernel (0.1691), days to 50% flowering (0.00335) and 100-kernel weight (0.05304); whereas, negative indirect effect through number of branches per plant (-0.04021).

At phenotypic level, oil content had positive and significant correlation with dry pod yield per plant (rp = 0.101) due to its negative direct effect (-0.02384). while positive indirect effect through biological yield per plant (0.02925), days to 50% flowering (0.00002) plant height (0.01546), shelling % (0.00804) and harvest index (0.13175); whereas, negative indirect effect through 100-kernel weight (-0.00422), duration between flowering to pegging (-0.01021), sound mature kernel (-0.03755) no. of branches per plant (-0.00550) and days to maturity (-0.0018).

Residual effect : The residual effect at genotypic and phenotypic level was found (-0.21666) and (0.46603), respectively.

Conclusions

High estimates of phenotypic coefficient of variation, genotypic coefficient of variation, heritability and genetic advance as percentage of mean were observed for harvest index, duration between flowering to pegging and plant height.

The association analysis revealed that dry pod yield per plant was positively and significantly correlated with duration between flowering to pegging, plant height, sound mature kernels, 100-kernel weight, shelling percentage, biological yield per plant and harvest index at genotypic as well as phenotypic levels while number of branches per plant at genotypic level only. These associations indicated that improvement in dry pod yield can be achieved by improving above characters.

Path coefficient analysis revealed that traits such as shelling percentage followed by plant height, harvest index, 100-kernel weight and days to 50% flowering were the important characters for the selection of high yielding genotype as they exerted positive direct effect along with significantly positive correlation with dry pod yield per plant.

References

1. Al-Jibouri, H.A. Miller, P. A. and Robinson, H.F. 1958. Genotypic and environmental variance in upland cotton of interspecific origin. *Agronomy Journal,* 50: 633-63.
2. Babariya, C.A. and Dobariya, K.L. 2012. Correlation coefficient and path coefficient analysis for yield components in Groundnut (*Arachis hypogaea* L.). *Electronic Journal of Plant Breeding,* 3: 932-938.
3. Bhargavi, G., Rao, V.S., Babu, D.R. and Rao, K.N., 2015. Character association and path coefficient analysis of pod yield and yield components in spanish bunch groundnut. *Electronic Journal of Plant Breeding*, 6(3): 764-770.
4. Burton, G. W. 1952. Quantitative inheritance of grasses. *Proceeding 6th International Grassland Congress*, 1: 227-283.
5. Dewey, D. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of wheat grass seed production. *Agronomy Journal,* 51: 515-518.
6. Dhakar, T. R. Sharma, H., Kumar, R. and Kunwarram 2017. Correlation and path analysis for yield its contributing traits in groundnut (*Arachis hypogaea* L.). *International Journal of Agriculture Sciences,* 9:3997-3999.
7. Fisher, R.A. 1918. The correlation between relatives on the supposition of Mendelian inheritance. *Transactions of the Royal Society of Edinburgh* 52: 399-433.
8. Fisher, R.A. 1954. Statistical methods for research workers. 12th Edition, *Biological Monograph and Manual,* 5:130-131.
9. Fisher, R.A. and Yates, F. 1938. Statistical tables for biological, Agricultural and Medicinal Research. Published by Oliver and Boyd, Edinburgh.
10. Galton, F., 1889. I. Co-relations and their measurement, chiefly from anthropometric data. *Proceedings of the Royal Society of London*, 45(273-279): 135-145.
11. Ganvit, R.S. and Jagtap, P.K. 2018. Character association and path co-efficient analysis studies for yield and its contributing traits in groundnut (*Arachis hypogaea* L.). *International Journal of Current Microbiology and Applied Sciences,* 7(11): 3566-3572.
12. Gonya, N.P., Venkataiah, M., Revathi, P. and Srinivas, B. 2018. Correlation and genetic variability studies in groundnut (*Arachis hypogaea*) genotypes. *International Journal of Genetics,* 10(2): 354-356.
13. Kadam, V.K., Chavan, B.H., Deshmukh, M.P. And Mali, A.R. 2018. Study on character association and path analysis in summer groundnut (*Arachis hypogaea* L.). *Journal of Pharmacognosy and Phytochemistry,* 7(3): 3654-3657.
14. Li, C.C. 1955. The concept of path coefficient and its impact on population genetics. *Biometrika*, 12: 190-192.
15. Lindmer, R.C. 1944. Rapid analytical method for some of more common organic substance of plant and oil. *Physiology*, 19: 76-84.
16. Mandal, G.S., Das, A., Dutta, D., Mondal, B. and Senapati, B.K. 2017. Genetic variability and character association studies in groundnut (*Arachis hypogaea* L.). *Scholars Journal of Agriculture and Veterinary Sciences*, 4(10):424-433.
17. Mitra, M., Gantait, S. and Kundu, R. 2019. Genetic variability, character association and genetic divergence in groundnut (A*rachis hypogaea* L.) accessions. *Legume Research*, ISSN: 0976-0571.
18. Nigam, S. N. 2015. Groundnut at a Glance, pp. 1-2.
19. Pandey, S. and Gritton, E.T., 1975. Genotypic and Phenotypic Variances and Correlations in Peas 1. *Crop Science*, 15(3): 353-356.
20. Panse VG and Sukhatme PV 1985. Statistical methods for Agricultural workers. 4th Ed. ICAR, New Delhi.
21. Panse, V.G. and Sukhatme, P.V. 1967. Statistical methods for agricultural workers, ICAR Publication, New Delhi.
22. Saini, H. and Sharma, M.M. 2018. Genetic variability and

character association study in a RIL population for yield and quality traits in groundnut (*Arachis hypogea* L.). *International Journal of Chemical Studies*, 6(6): 2179-2185.

23. Singh, R. K., & Chaudhary, B. D. 1985. Biometrical methods in quantitative genetic analysis Kalyani Publishers. Ludhiana, India.
24. Singh, S., Singh, A.L., Kalpana, S. and Misra, S. 2010. Genetic diversity for growth, yield and quality traits in groundnut (*Arachis hypogaea* L.). *Indian J. Plant Physiol.,* 15: 267-271.
25. Stigter, K., Orivaldo, B., Kumar, P.V. and Prasad, P.V.V. 2006. Agrometeorology and groundnut production. *Retrieved from http://www.Agrometeorology .org/files.*
26. Wessells, K.R. and Brown, K.H. 2012. Estimating the global prevalence of zinc deficiency: results based on zinc availability in national food supplies and the prevalence of stunting. *PloS One*, 7(11): e 50568.
27. Wright, S. 1921. Correlation and causation. *Journal of agriculture Research,* 20: 557-587.
28. Zaman, M.A., Khatun, M.T., Ullah, M.Z., Moniruzzamn, M. and Alam, K.H. 2011. Genetic variability and path analysis of groundnut (*Arachis hypogaea* L.). *A Scientific Journal of Krishi Foundation,* 9(1&2): 29-36.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1055-1058 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Nano Urea on Nutrient Content and Economics of Wheat (*Triticum aestivum* L.) under Restricted Irrigation Condition

Ritesh Patidar[1], J, Choudhary[2*], Roshan Choudhary[3], Manish Tomar[4], Kannoj[5] and Ruchika Choudhary[6]
Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan
**Corresponding Author Email : jaggiudr@gmail.com*

Abstract

An experiment was conducted at Instructional Agronomy Farm, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) from November 2021 to March 2022 to assess the effect of nano urea on nutrient content, uptake and economics of wheat (*Triticum aestivum* L.) under restricted irrigation condition. The investigation was carried out in RBD design with three replications with nine different treatments. These treatments consist of different sources of nitrogen *i.e.,* nano urea and convectional urea. Nano urea has been proposed as a way to increase the overall NUE values of fertilizers through a more controlled and slower nutrient release. The experimentation results revealed that the maximum nitrogen content in grain (1.907%) and straw (0.490%) and the highest economic returns were fetched under the application of RDN + two sprays of nano urea at tillering and jointing (N5). This may be because nano fertilizers have a large surface area and particle size less (1–30 mm) than the pore size of leaves (5–50 mm) of the plant which can increase penetration into the plant tissues from the applied surface and improve content and uptake of the nutrients.

Key words : *Nano urea, economics, restricted irrigation, nutrient content, wheat, rabi, RDN.*

Introduction

Wheat (*Triticum aestivum* L.) is the most important and widely grown cereal crop of the globe which is grown since prehistoric times. It is referred to as the “king of cereals” and is the oldest cereal food crop belonging to the family *Poaceae*. Globally wheat (*Triticum spp.*) occupies an area of about 216.14 million hectares with an estimated annual production of 763.58 million tonnes with a productivity of 3.53 metric tonnes (USDA, 2020). In the world, the main wheat-producing countries are China, India, Russia, the USA, France, Canada, Ukraine, Pakistan, Germany, Argentina and Turkey (Anonymous, 2019). In India, wheat is farmed on around 31.76 million hectares, yielding 108.75 million tonnes with a productivity of 34.24 quintal hectare^{-1} (Anonymous, 2021). In the state of Rajasthan, the wheat crop covers an area of 34.97 lakh hectares with an annual production of 10.92 million tonnes and average productivity of 3.5 tonnes ha^{-1}. Rajasthan state is in the fifth position in terms of wheat production after Uttar Pradesh, Punjab, Haryana and Madhya Pradesh (Anonymous, 2021).

According to a report submitted by Food and Agricultural Organization, the United Nations, global demand for fertilizers is expected to rise in the upcoming years. Therefore, it is imperative to involve intelligent strategies for sustainable agriculture such as nanotechnology-based nano fertilizers which are environment-friendly or smart fertilizers with the potential to increase the application rates of fertilizers and reduce the loss of nutrients from it mainly phosphorous and nitrogen (Dimkpa and Bindraban, 2018). It offers the gradual and controlled release of nutrients to the targeted site which helps to prevent the contamination of water bodies and the environment (Dwivedi *et al.*, 2016). Recent estimates suggest that fertilizers usage may contribute around 30 % of the total crop yield, while the rest 70% depending on the effective application of other factors and agricultural inputs. However, 50–70% of nitrogenous fertilizers applied through conventional fertilization are either fixed in the soil or are lost to the environment due to volatilization, leaching and water runoff or they are incorporated as minerals in the soil through the action of microorganisms. Ironically, the unbalanced and haphazard use of inorganic fertilizers has a negative effect on the availability of nutrients to plants as well as on soil fertility and soil health resulting in lowering the productivity of crops and causing chronic diseases in human beings. Among the primary nutrients, nitrogen is the most crucial nutrient for crop productivity and it also plays a major role in agriculture.

To overcome all these drawbacks, nanotechnology comes into play and nano fertilizers can go a long way in ensuring sustainable soil health and crop production (Lal, 2008). In recent years, researchers have tended to study several modern techniques in the agricultural field, particularly the possibility of using nanotechnology to improve fertilizer use efficiency towards the design and development of so-called nano fertilizers (NF) (Rastogi, 2017). Nano liquid urea is an eco-friendly, smart fertilizer

with high nutrient use efficiency and a long-term solution for reducing pollution and global warming as it lowers nitrous oxide emissions, doesn't contaminate soil, air and water bodies and offers great potential for the secure and effective delivery of nutrients (Liu *et al*., 2016). Nano fertilizers are important in modern agriculture having appropriate formulations and delivery mechanisms to ensure optimal uptake/usage in plants (Adisa, 2019). The usage of nano-enabled fertilizers may improve nutrient delivery efficiency in plants (Chhipa, 2017). These nanoscale fertilizers reduce nutrient losses due to leaching, and chemical alterations can be avoided to enhance nutrient use efficiency and environmental quality (Raliya, 2017). They are further characterized by their small size and large specific surface area, making them ideal materials in the manufacture of fertilizers called smart fertilizers after encapsulation with polymers or chelated to be slow release to suit the stages of a plant (Shang, 2019).

Material and Methods

Site description and experimental design : The field experiment was conducted during the *rabi* season of 2021–2021 at the Instructional Agronomy Farm, Rajasthan College of Agriculture (MPUAT), Udaipur (Rajasthan). Geographically, the experimental site was located in the southern-eastern region of Rajasthan at 24° 35' N latitude, 73° 42' E longitude and an altitude of 581.13 meters above mean sea level. The area is part of Rajasthan's agro-climatic zone IV a (Sub-Humid Southern Plain and Aravalli Hills). The climate of the experimental site was mainly sub-tropical in nature endowed with hot and dry early summers followed by hot and humid monsoon seasons and cold and dry winters. The mean annual rainfall of the location varies from 373–1140 mm (600.7 mm) with which the majority of this occurring from the South-West monsoon from July to October. However, the total rainfall and its distribution are subjected to large variations. The soil texture of the experimental unit was clay loam, slightly alkaline in reaction (7.75). The nutrient status of the soil showed organic carbon (0.66 %), available nitrogen (286.50 kg ha^{-1}), phosphorus (21.60 kg ha^{-1}) and available potassium content (369.30 kg ha^{-1}) depicting the overall medium nutrient status of the soil.

The experiment consisted of 9 treatments *viz*., N_1 (One spray nano urea at tillering), N_2 (Two sprays nano urea at tillering and jointing), N_3 (RDN 1/3rd basal, 2/3rd CRI), N_4 (RDN + one spray of nano urea at tillering), N_5 (RDN + two spray of nano urea at tillering and jointing), N_6 (RDN + one spray of urea (5%) at tillering), N_7 (RDN + two spray of urea (5%) at tillering and jointing), N_8 (RDN + one spray of urea (5%) + Nano urea at tillering) and N_9 (absolute control) which was arranged in Randomized Block Design with three replications. The crop variety RAJ4079 was sown on 11th November 2021. The full dose of N, P and K (80:40:20 kg ha^{-1}) was applied as a basal dose at the time of sowing through inorganic sources of nutrients *viz*. Urea, SSP and MOP, respectively. Foliar forms nitrogen *i.e.*, nano urea (IFFCO) and Urea (5%) solution were applied as per the treatments.

Nutrient content : For estimation of N, P and K contents the plant samples were collected at the time of harvest and oven dried at 70°C for 72 hours to obtain constant weight. Fully dried samples were grinded to fine powder and nutrient content in grain and straw was estimated as per the following method.

Nutrients	Method of analysis	Reference
Nitrogen	Nesseler's reagent colorimetric method	Linder (1944)
Phosphorus	Ammonium vanadomolybdo phosphoric acid method	Richards (1968)
Potassium	Flame photometer method	Jackson (1973)

Net return and B-C ratio : Gross return was calculated by multiplying the total grain and straw yield with prevalent market prices of the items and then presented on per hectare basis as per treatments. Net returns were computed by deducting the total cost of cultivation from the gross return as per treatments.

Net return (₹ ha^{-1}) = Gross return (₹ ha^{-1})– Cost of cultivation (₹ ha^{-1}) ....(1)

B-C ratio was calculated by dividing the present value of benefits by that of costs and investments by using the formula :

$$\text{B-C ratio} = \frac{\text{Net return (₹ ha}^{-1}\text{)}}{\text{Total cost (₹ ha}^{-1}\text{)}} \quad \text{....(2)}$$

Results and Discussion

Nutrient content : The higher value of nitrogen content in grain(1.907 %) and straw (0.490 %) was found under the application of treatment N_5 (RDN + two sprays of nano urea at tillering and jointing) that was statistically at par with treatment N_2 (Two spray nano urea at tillering and jointing), N_3 (RDN 1/3rd basal, 2/3rd CRI), N_4 (RDN + one spray of nano urea at tillering), N_6 (RDN + one spray of urea (5%) at tillering), N_7 (RDN + two spray of urea (5%) at tillering and jointing) and N_8 (RDN + one spray of urea (5%) + nano urea at tillering) but statistically superior over rest of the treatments. The magnitude of increase in nitrogen content in grain and straw with the application of N_5 (RDN + two sprays of nano urea at tillering and jointing) was 5.88 and 6.06 per cent over control. While there was no significant variation was observed in phosphorus and potassium content of grain and straw under various

Table-1 : Effect of nitrogen sources on nutrient content in grain and straw of wheat.

Treatments	Nutrient content %					
	Grain			Straw		
	N	P	K	N	P	K
N_1	1.860	0.429	0.352	0.471	0.153	1.636
N_2	1.863	0.433	0.357	0.475	0.155	1.646
N_3	1.865	0.427	0.351	0.476	0.154	1.627
N_4	1.879	0.438	0.364	0.482	0.156	1.657
N_5	1.907	0.451	0.371	0.490	0.163	1.677
N_6	1.876	0.435	0.362	0.479	0.156	1.653
N_7	1.884	0.441	0.366	0.485	0.158	1.661
N_8	1.891	0.445	0.369	0.488	0.160	1.668
N_9	1.801	0.423	0.348	0.462	0.153	1.618
SEm±	0.014	0.006	0.005	0.005	0.002	0.026
CD (P = 0.05)	0.044	NS	NS	0.015	NS	NS

Table-2 : Effect of nitrogen sources on the economics of wheat.

Treatments	Economics	
	Net return (₹ ha^{-1})	B–C ratio
N_1	86423	2.10
N_2	91825	2.20
N_3	103931	2.50
N_4	111226	2.64
N_5	119937	2.81
N_6	104814	2.52
N_7	107222	2.58
N_8	103217	2.45
N_9	68255	1.68
SEm±	6938.75	0.16
CD (P = 0.05)	20802.38	0.50

sources of nitrogen applied. This may be because nano fertilizers have large surface area and particle size less (1–30 mm) than the pore size of leaves (5–50 mm) of the plant which can increase penetration into the plant tissues from the applied surface and improve the content of the nutrients. The results are agreed with the consequences of Junrungrean *et al*., 2002 and Aljabri M., 2010 (Table-1).

Economics : The maximal net return (₹119937) and B-C ratio (2.81) were fetched under the crop treated with RDN + two sprays of nano urea at tillering and jointing (N_5) which was statistically comparable to N_3 (RDN 1/3rd basal, 2/3rd CRI), N_4 (RDN + one spray of nano urea at tillering), N_6 (RDN + one spray of urea (5 %) at tillering), N_7 (RDN + two spray of urea (5%) at tillering and jointing) and N_8 (RDN + one spray of urea (5%) + nano urea at tillering) and higher over rest of the treatments (Table-3). The increase of net return and B–C ratio with the application of N_5 (RDN + two sprays of nano urea at tillering and jointing) was 75.71 and 67.26 per cent over control. Nano fertilizers may boost crop development and yield characteristics as well as make active photosynthetic activities and source-sink relationships which directly affect yield. Reduced urea treatment and efficient foliar nano fertilizer application led to lower cultivation costs, which in turn increased grain and straw yield and ultimately net return. These results were consistent with the results of Manikandan *et al*., 2016 and Kumar *et al*., 2020.

Conclusions

Application of nano urea fertilizer in combination with RDN *i.e*., 80 kg ha^{-1} shows a significant increase in content and uptake of nutrients. It was also found beneficial and highly cost-effective for the farmers because of increased economic returns. This may be because it controls the release of nitrogen steadily for a longer time as per the requirement of the crop.

References

1. Adisa, I.O., Pullagurala, V.L.R., Peralta-Videa, J.R., Dimkpa, C.O., Elmer, W.H., Gardea-Torresdey, J.L. and White, J.C. 2019. Recent advances in nano-enabled fertilizers and pesticides: A critical review of mechanisms of action. *Environmental Science: Nano* 6(7), 2002–2030.
2. Aljabri, M., 2010. Nano technology of zeolite mineral for slow-release nitrogen of urea fertilizer on vertisols paddy soil. *Proceeding of the International Conference on Materials Science and Technology* (Indonesia) pp. 205–210.
3. Anonymous. 2021. Statement showing area sown during *rabi* season, crop wise sowing area 2020–2021 Available from rajasthan.gov.in Accessed on dated 09-09-2021.
4. Anonymous. 2019. Available from http://www. fao.org/worldfoodsituation/csdb/en/Accessed on dated 14-10-2021).
5. Anonymous. 2021. Indian Institute of Wheat and Barley Research, Karnal. Available from https://iiwbr.icar.gov.in Accessed on dated 09-09-2021).

6. Chhipa, H. 2017. Nano fertilizers and nano pesticides for agriculture. Environmental Chemistry Letters 15,15–22.
7. Dimkpa, C.O. and Bindraban, P.S. 2018. Nano fertilizers: new products for the industry. Journal of Agriculture and Food Chemistry 66(26), 6462–6473.
8. Dwivedi, S., Saquib, Q., Al-Khedhairy, A.A. and Musarrat, J. 2016. "Understanding the role of nanomaterials in agriculture," in microbial inoculants in sustainable agricultural productivity (New Delhi: Springer), pp-271–288.
9. Guru, T., Veronica, N., Thatikunta, N., Reddy, S. 2015. Crop nutrition management with nano fertilizers. *International Journal of Environmental Science and Technology* 1(1), 4–6.
10. Jackson, M.L., 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi.
11. Junrungrean, S.P., K. Limtong, K. Wattanaprapat, and T. Patsarayeangyong. 2002. Effect of zeolite and chemical fertilizer on the change of physical and chemical properties latya soil series for sugarcane. 17th WCSS,14–21 August, Thailand, 1–7.
12. Kumar, Y., Tiwari, K.N., Nayak, R.K., Rai, A., Singh, S.P., Singh, A.N. Kumar, Y., Tomar, H., Singh, T., Raliya, R., 2020. Nano fertilizers for increasing nutrient use efficiency, yield and economic returns in important winter season crops of Uttar Pradesh. *Indian Journal of Fertilizers* 16(8), 772–786.
13. Lal, R. 2008. Promise and limitations of soils to minimize climate change. *Journal of Soil Water Conservation* 63(4): 113-118.
14. Linder, R.C., 1944. Rapid analytical method for some of the more common substances of plant and soil. *Plant Physiology* 19(1), 76–84.
15. Liu, R., and R. Lal. 2016. Nano fertilizers. In: R. Lal (ed.) Encyclopedia of Soil Science, 3rd Edition, CRC Press.
16. Manikandan, A., Subramanian, K.S., 2016. Evaluation of zeolite-based nitrogen nano fertilizers on maize growth, yield and quality on inceptisols and alfisols. *International Journal of Plant and Soil Science* 9(4), 1–9.
17. Raliya, R., Saharan, V., Dimkpa, C. and Biswas, P. 2017. Nano fertilizer for precision and sustainable agriculture: current state and future perspectives. *Journal of Agriculture and Food Chemistry* 66(26), 6487–6503.
18. Rastogi, A., M. Zivcak, O. Sytar, H.M., Kalaji, X. He, S. Mbarki and M.Brestic. 2017."Impact of Metal and Metal Oxide Nanoparticles on Plant: A Critical Review". Frontiers in Chemistry 5, 78 DOI:10.3389/ fchem. 2017.00078
19. Richards, L.A., 1968. Diagnosis and improvement of saline and alkaline soils. United States, Department of Agriculture, Handbook No. 60, pp. 432.
20. Shang, Y., Md. K., Hasan, G.J. Ahammed, M. Li, H. Yin and J. Zhou. 2019. Applications of Nanotechnology in Plant Growth and Crop Protection: A Review. Molecules 24(14), 2558.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1059-1062 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

The Effect of the Push-Pull Strategies on Egg Parasitoids of Fall Armyworm, *Spodoptera frugiperda* in Kharif Maize

S.K. Dhabhai*, S. Ramesh Babu, Mahendra Yadav, M.K. Mahla, Arvind Verma, M.L. Ojha, Beerendra Singh, Pawan Gahlot, Ankita Yadav, Mohd. Monish and Piyush Sharma

[1]*Department of Entomology, RCA, MPUAT, Udaipur, Rajasthan*
[2]*Department of Agronomy, RCA, MPUAT, Udaipur, Rajasthan*
[3]*Department of Plant pathology, RCA, MPUAT, Udaipur, Rajasthan*
[4]*College of Fisheries, MPUAT, Udaipur, Rajasthan*
**Email : sunilkumardhabhai@gmail.com*

Abstract

The present investigations on "The effect of the push-pull strategies on egg parasitoids of fall armyworm, *Spodoptera frugiperda*in *Kharif* Maize" was carried out at Agronomy farm, Rajasthan College of Agriculture, MPUAT, Udaipur during *kharif*2021. Seven treatments *viz*., maize + *Desmodium* species with Napier grass as border crop (Conventional Push Pull Technology), maize + groundnut, maize + Cluster bean, maize + Cowpea, maize + Sunhemp, maize + soybean and maize sole crop.A significantly higher rate of parasitization of egg mass of fall armyworm by *Trichogrammachilonis* was recorded in the maize + *Desmodium* species(Conventional Push Pull Technology) and *Telenomusremus*was recorded in the maize + groundnut compared to the sole crop of maize.The results of the study indicated the defined role of Push-Pull strategies in reducing fall armyworm damage and increasing egg parasitoids in maize.

Introduction

Maize (*Zea mays* L.) is the major cereal crop that contributes significantly to the global agricultural economy. It is often referred to as the "Queen of Cereals" around the world due to its great genetic yield potential and adaptability (Ashok *et al*., 2021). Apart from being a staple food for humans and a high-quality feed for animals, maize is also used as a raw material in a variety of industrial goods. Maize is planted on 192.14 million hectares worldwide, yielding 1,113.02 million tonnes with a productivity of 5,790 kg ha-1 (Anonymous, 2020). In India, maize is a very important cereal crop that is grown on a large scale. It ranks fourth in the world in terms of land area and seventh in terms of production. India grows 4 percent of the world's maize and makes 2 percent of the world's maize (Srujana*et al*., 2021). Maize is primarily used for animal feed (60%), human food (24%), industrial (starch) goods (14%), beverages (1%), and seeds (1%). Thus, maize has established a significant position as an industrial crop, with 75% of its production going to the starch and feed sectors. Maize is India's third-most significant food crop, after rice and wheat. The maize crop covers around 9.2 million ha in 2018-19 with an output of 280.80 million MT and average productivity of 3070 kg/ha (Ashok *et al*., 2021; DACNET, 2021). Maize crops span around 0.89 lakh hectares in Rajasthan, with average productivity of 1355 kg per hectare (Anonymous, 2019-20).

The fall armyworm (FAW)*Spodoptera frugiperda* (Lepidoptera: Noctuidae), is a devastating polyphagous insect pest that has been observed to cause economic damage to maize crops worldwide (Clark *et al*., 2007; Nabity*et al*., 2011). This extremely polyphagous insect is insatiably hungry for maize and can thrive on over 274 different crop plants (Montezano*et al.,* 2018). This invasive insect has also altered the native stem borer population in Africa's usage of maize resources during the larval stage (Ntiri*et al*., 2019; Sokame*et al.,* 2020). It is a very damaging economic pest that is extremely migratory and has a high reproductive potential. In India, fall armyworm was first detected on maize in May 2018 in the state of Karnataka (Sharanabasappa*et al.,* 2018) andit has expanded to various states in the country, including Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Telangana, Kerala and West Bengal (Ramesh Babu *et al.,*2019), Arunachal Pradesh, Meghalaya, Manipur, Sikkim, Mizoram, Nagaland, and Tripura (Firake*et al.,* 2019). FAW was found for the first time in Rajasthan in early 2019 in the state's southern area on kharif and rabi maize, causing severe losses in the crop (Ramesh Babu *et al.,* 2019; Deepika *et al.,* 2020; Ahir*et al.,* 2021).

In India, the egg parasitoids, including *Telenomus sp.* (Hymenoptera: Platygastridae) and *Trichogramma sp.* (Hymenoptera: Trichogrammatidae), gregarious larval parasitoids, *Glyptapantelescreatonoti* (Viereck) (Hymenoptera: Braconidae), solitary larval parasitoids, *Campoletis chloride* were reported during the survey in Karnataka state (Shylesha*et al*., 2018).Navik*et al.,* (2021)

observed that *T.chilonis* and *Telenomusremus* egg parasitism rates were 15.81–23.87% and 5.44–8.78%, respectively. Whereas, the larval parasitoids caused 9.18% of parasitism. Various locations were surveyed across Meghalaya state and found that about 26 species of natural enemies were found attacking *S. frugiperda* (Firake and Behere, 2020).

Materials and Methods

The egg mass of *S. frugiperda*was collected and taken to the laboratory for the emergence of the parasitoids; The per cent parasitisation of eggs was worked out by taking the ratio of the number of eggs parasitized by the total number of eggs. The number and species of common parasitoids present were also recorded.

FAW were collected from maize fields; FAW life stages (egg masses) were collected from different push-pull treatments and maize sole crop; Egg masses present on plant parts were detached carefully, placed inside polythene bags, and bring to the laboratory where they were held separately in rearing containers until the emergence of parasitoids.

All specimens were held in the biocontrol laboratory (at 25 ± 1 °C, 75 ± 5% RH, and 12:12 (L:D) photoperiod until completion of development or mortality due to biocontrol agents/biopesticides.

Data Analysis : Per cent parasitism (%P) by the larval parasitoids was determined by the number of parasitized larvae/total number of larvae observed × 100 (Pair *et al*. 1986); Means were separated by Tukey's HSD test (ά=0.05).

Parasitoid identifications : The parasitoids that emerged from egg masswere recorded every 24 h. Parasitoidswere identified and counted.

Relative abundance and parasitism rate : The number of egg mass collected was corrected by subtracting the number that died due to pathogens, parasitic nematodes and/or unknown causes during the first few days after collection before calculating relative abundance and parasitism rate.

Results and Discussion

During the present study, out of the 43 egg masses collected from different treatments (conventional PPT and intercropped systems with sudangrass as border crop) and two egg parasitoids and entomopathogenic fungus, *Metarhizumrileyi*. The egg parasitoids included *Telenomusremus* Nixon (Hymenoptera: Scelionidae) and *Trichogrammachilonis* Ishii (Hymenoptera: Trichogrammatidae).

There was a significant difference in the per cent parasitization of fall armyworm by both the egg parasitoids in the conventional PPT and intercropped systems with sudangrass as border crop (*F* value= 78.55; *P* value < 0.0001) and (*F* value = 190.55; *P* value < 0.0001) (Table-1). The per cent parasitization of FAW egg mass by *Trichogrammachilonis*ranged from 8.59 to 27.65. The highest parasitization of *T.chilonis*on FAW eggs (27.65%) was in maize intercropped with *Desmodium* spp(Conventional Push Pull Technology), which was statistically significant from other treatments. The next highest parasitization in FAW eggs by *T.chilonis*was observed in maize intercropped with sunhemp (20.54%), cowpea (19.51%), groundnut (19.04%) and soybean (18.08%) which was at par with each other. Whereas, in the intercropping systems maize + cluster bean recorded the lowest percentage parasitization of 13.51% when compared to sole maize crop (8.59%).

The per cent parasitization of egg mass of fall armyworm by *Telenomusremus* was statistically significant in maize intercropped with groundnut (30.31%) then followed by maize + sunhemp (25.64%), maize + *Desmodium* spp (Conventional Push Pull Technology) (24.91%), maize + cowpea (23.40%), maize + soybean (23.22%) and maize + cluster bean (21.50%). The per cent parasitization of egg mass of fall armyworm in sole maize crop was6.20 by *Telenomusremus*.

Relative abundance and parasitism rate : There were reports of relative abundance of egg parasitoids *Trichogrammachilonis* (44.19%) and *Telenimusremus* (55.81%),but no parasitism rate of larvae in our present investigation.

In the present study maize intercropped with *Desmodium*spp. (Conventional Push Pull Technology) and groundnut recorded statistically significant higher rates of egg parasitization through *Trichogrammachilonis* and *Telenomusremus* from other treatments. Similarly, Udayakumar *et al.* (2020) reported that when maize inter-cropped with broad bean, *Desmodium* species and groundnut recorded significantly higher rates of eggparasitization and predators, which is also consistence with the present results. Navik *et al*. (2021) reported that *Trichogrammachilonis* Ishii and *Telenomusremus* Nixon egg parasitoids parasitized the eggs of *S. frugiperda* in the maize growing region and they reported that *T. chilonis* parasitized a higher percentage of *S. frugiperda* eggs than the *T. remus,*which are also agreed with the present investigation. Prasanna *et al.*(2018) observed that the percentage of *Spodoptera frugiperda* egg parasitized by *T. remus* varies from 36-100%. Da Silva *et al*. (2015) reported the spontaneous occurrence of *T. remus*, *T. pretiosum* and *T. atopovirilia*, three egg parasitoids of *S. frugiperda*, in maize, implying

Table-1 : Per cent parasitization of eggs of fall armyworm by *Trichogrammachilonis* and *Telenomusremuson* Maize in Conventional Push-Pull Technology (PPT) and Maize Intercropped Systems over Sole Maize during Kharif, 2021.

Treatment	*Trichogrammachilonis*	*Telenomusremus*
T_1	27.65 (31.72)[a]	24.91 (29.94)[b]
T_2	19.04 (25.87)[b]	30.31 (33.40)[a]
T_3	13.51 (21.56)[c]	21.50 (27.61)[c]
T_4	19.51 (26.21)[b]	23.40 (28.93)[bc]
T_5	20.54 (26.95)[b]	25.64 (30.42)[b]
T_6	18.08 (25.14)[b]	23.22 (28.81)[bc]
T_7	8.59 (17.02)[d]	6.20 (14.39)[d]
F value	78.55	190.55
P value	P< 0.0001	P< 0.0001

Mean values followed by different letters are significantly different by Tukey's test (P = 0.05); Figures in parenthesis are arc-sine transformed values. Note: T1: Maize + Desmodium (1:1) +Napier grass as border crop (Conventional Push-Pull Technology), T2: Maize + Groundnut (1:1) + Sudan grass as border crop, T3: Maize + Cluster bean (1:1) + Sudan grass as border crop, T4: Maize + Cowpea (1:1) + Sudan grass as border crop, T5: Maize + Sunhemp (1:1) + Sudan grass as border crop, T6: Maize + Soybean (1:1) + Sudan grass as border crop, T7: Maize sole crop (1:1) + Sudan grass as border crop.

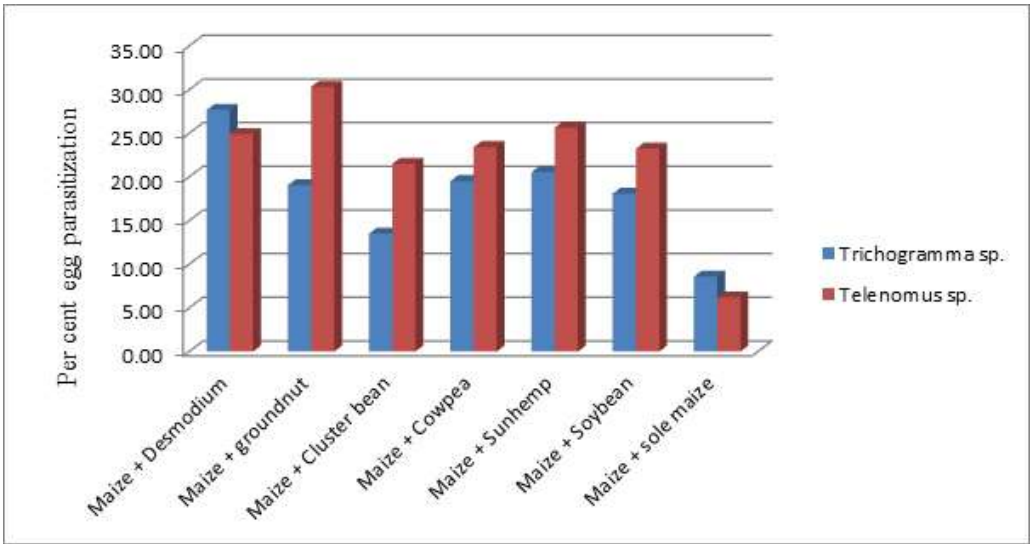


Figure-1 : Per cent parasitization of eggs of fall armyworm by *Trichogrammachilonis* and *Telenomusremuson* Maize in Conventional Push-Pull Technology (PPT) and Maize Intercropped Systems over Sole Maize during Kharif, 2021.

that these wasp species were engaged in exploitative competition and likely involved in interference competition towards eggs of S. *frugiperda* in the field these results of this study are in line with the present findings.

Similarly, many studies have also reported that the egg parasitoid *T. remus* is a potential biological control agent for three Spodopteran, *S. frugiperda*, *S. cosmioides* and *S. eridania* (Bortolotto *et al.,* 2014; Goulart *et al*., 2011; Pomari *et al*., 2013) which are strongly agreed with the present results.

Conclusions

The results showed the first evidence of the maize-the effect of the push-pull strategies on egg parasitoids of fall armyworm, *Spodoptera frugiperda*in the southern region of Rajasthan.Push-Pull strategies reduce fall armyworm damage and increase egg parasitoids in field conditions of maize. Natural parasitization of eggs of *Spodoptera frugiperda*by *Telenomusremus* better performance than *Trichogrammachilonis* in field conditions.

References

1. Ahir, K.C., Mahla, M.K., Swaminathan, R. and Dangi, N.L., 2020. Biology of fall armyworm, *Spodoptera frugiperda* (JE Smith) on maize (Zea mays L.). *Journal of Entomological Research*, *44*(3) : 429-432.
2. Anonymous, 2019-20. Government of Rajasthan, Department of Agriculture, Rajasthan.(Commissionerate of Agriculture, Rajasthan-Jaipur) 1.
3. Anonymous. 2020. Circular Series, WAP 4-20. United States Department of Agriculture (Foreign Agricultural Service).
4. Ashok, K., Balasubramani, V., Kennedy, J.S., Geethalakshmi, V., Jeyakumar, P. and Sathiah, N., 2021. Effect of elevated temperature on the population dynamics of fall armyworm, *Spodoptera frugiperda*. *Journal of Environmental Biology*, 42: 1098-1105.

5. Babu, S.R., Kalyan, R., Joshi, S., Balai, C., Mahla, M. and Rokadia, P. 2019. Report of an exotic invasive pest the fall armyworm, *Spodoptera frugiperda* (JE Smith) on maize in Southern Rajasthan. *Journal of Entomology and Zoology Studies*, 7(3): 1296-1300.
6. Bortolotto, O.C.; Silva, G.V.; De Freitas Bueno, A.; Pomari, A.F.; Martinelli, S.; Head, G.P.; Carvalho, R.A.; Barbosa, G.C. Development and reproduction of *Spodoptera eridania* (Lepidoptera: Noctuidae) and its egg parasitoid *Telenomusremus* (Hymenoptera: Platygastridae) on the genetically modified soybean (Bt) MON 87701 _ MON 89788. *Bull. Entomol. Res.* 2014, 104, 724–730.
7. Clark, P.L., Molina-Ochoa, J., Martinelli, S., Skoda, S.R., Isenhour, D.J., Lee, D.J., Krumm, J.T. and Foster, J.E., 2007. Population variation of the fall armyworm, *Spodoptera frugiperda*, in the Western Hemisphere. *Journal of Insect Science*, 7(1).
8. DACNET- (2021) Directorate of economics and statistics, Ministry of Agriculture and farmers welfare, Government of India,https:// eands. dacnet. nic. In.
9. Da Silva, C.S.B.; Vieira, J.M.; Loiácono, M.; Margaría, C.; Parra, J.R.P. Evidence of exploitative competitionamong egg parasitoids of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in maize. *Rev. Colomb. Entomol.* 2015, 41, 184–186.
10. Deepika Kalyan 2020. Bio-ecology of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on maize and its molecular characterization.
11. Firake, D.M. and Behere, G.T. 2020. Natural mortality of invasive fall armyworm, *Spodoptera frugiperda* (JE Smith)(Lepidoptera: Noctuidae) in maize agroecosystems of northeast India. *Biological Control*, 148: 104303.
12. Firake, D.M., Behere, G.T., Babu, S. and Prakash, N. 2019. Fall armyworm: Diagnosis and management (An extension pocket book) ICAR Research Complex for NEH Region, Umiam-793 109, Meghalaya, India. *Plant Protection*, 48.
13. Folmer, R.H.A., Nilges, M., Folkers, P.J.M., Konings, R.N.H. and Hilbers, C.W., 1994. A model of the complex between single-stranded DNA and the single-stranded DNA binding protein encoded by gene V of filamentous bacteriophage M13. *Journal of molecular biology*, 240(4): 341-357.
14. Goulart, M.M.P.; de Freitas Bueno, A.; de Freitas Bueno, R.C.O.; Vieira, S.S. Interaction between *Telenomusremus* and *Trichogrammapretiosum* in the management of *Spodoptera* spp. *Rev. Bras. Entomol.* 2011, 55, 121–124.
15. Montezano, D.G., Specht, A., Sosa-Gómez, D.R., Roque-Specht, V.F., Sousa-Silva, J.C., Paula-Moraes, S.V., Peterson, J.A. and Hunt, T.E.2018. Host plants of *Spodopterafrugiperda* (Lepidoptera:Noctuidae) in the Americas. *African Entomology*, 26: 286-300.
16. Nabity, P.D.; Zangerl, A.R.; Berenbaum, M.R.; Delucia, E.H. (2011): Bioenergy crops Miscanthus giganteus and Panicum virgatum reduce growth and survivorship of *Spodoptera frugiperda* (Lepidoptera: Noctuidae). *Journal of Economic Entomology*, 104: 459–464.
17. Navik, O., Shylesha, A.N., Patil, J., Venkatesan, T., Lalitha, Y. and Ashika, T.R.2021. Damage, distribution and natural enemies of invasive fall armyworm *Spodoptera frugiperda* (JE smith) under rainfed maize in Karnataka, India. *Crop Protection*, 143: 105536.
18. Ntiri, E.S., Calatayud, P.A., Van den Berg, J., Le Ru, B.P., 2019. Spatio-temporal interactions between maize lepidopteran stemborer communities and possible implications from the recent invasion of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in Sub-Saharan Africa. *Environ. Entomol.* 48, 573–582.
19. Pomari, A.F.; Bueno, A.F.; Bueno, R.C.O.F.; Menezes, A.O. *Telenomusremus* Nixon egg parasitization of three species of spodoptera under different temperatures. *Neotrop. Entomol.* 2013, 42, 399–406.
20. Prasanna, B. M., Huesing, H. E., Regina, E. and Virginia, M. P. (eds) (2018). Fall Armyworm in Africa. *AGuide for Integrated Pest Management, 1st edn.*CDMX : CIMMYT, Mexico
21. Sharanabasappa, Kalleshwaraswamy, C.M., Poorani, J., Maruthi, M.S., Pavithra, H.B. and Diraviam, J.2019. Natural enemies of *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), a recent invasive pest on maize in South India. *Florida Entomologist*, 102: 619-623.
22. Shylesha, A.N., Jalali, S.K., Gupta, A., Varshney, R., Venkatesan, T., Shetty, P., Ojha, R., Ganiger, P.C., Navik, O., Subaharan, K. and Bakthavatsalam, N.2018. Studies on new invasive pest *Spodoptera frugiperda*(JE Smith) (Lepidoptera: Noctuidae) and its natural enemies. *Journal of Biological Control*, 32(3): 145-151.
23. Sokame, B.M., Rebaudo, F., Malusi, P., Subramanian, S., Kilalo, D.C., Juma, G., Calatayud, P.A., 2020. Influence of temperature on the interaction for resource utilization between fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), and a community of lepidopteran maize stemborers larvae. *Insects* 11, 73.
24. Srujana, Y., Kamakshi, N. and Krishna, T.M. (2021). Insecticidal activity of diversechemicals for managing the destructivealien pest fall armyworm *Spodoptera frugiperda* (J.E. Smith) on Maizecrop in India. *International Journal of Tropical Insect Science*, 42(2): 1095-1104. https://doi.org/10.1007/s42690-021-00624-2.
25. Udayakumar, A., Shivalingaswamy, T.M. and Bakthavatsalam, N., 2021. Legume-based intercropping for the management of fall armyworm, *Spodoptera frugiperda* L. in maize. *Journal of Plant Diseases and Protection*, *128*(3): 775-779.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1063-1066 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

An Example of Precis(e) Varietal Recommender System in Wheat

Durgesh Kumar Kharwar, Shri Niwas Singh*, Pratap Narayan Singh and S.C. Gaur
Department of Genetics & Plant Breeding, B.R.D. (P.G.) College, Deoria–274001 (U.P.) India
**Corresponding author Email : singhshriniwas769@gmail.com*

Abstract

A field experiment in a randomized block design was conducted during Rabi season 2019-2020 on ten wheat varieties with the objectives of selecting and precisely recommending the suitable plant types to farmers of Deoria district in eastern Uttar Pradesh. The ten varieties viz., SR-19, CR-100, BL-1496, FLW-15, WH-1320, NW-1076, WH-1322, KRL-19, NW-1076 and HD-2967were evaluated on 12 characters likeplant height, effective tillers, spike length, days to 50% flowering, biological yield, grain yield, flag leaf area and peduncle length. Normalized cumulative ranks were used to objectively select suitable plant ideotypes. The top five varieties viz., WH1320,CR-100, NW-1076, BL-1496 and SR-19 were precisely recommended to farmers of this region for cultivation.

Key words : *Plantideotypes, normalized cumulative ranks, recommender system, selection.*

Introduction

Wheat is a staple food crop, However, its production is limited due to non-availability of suitable varieties and local field conditions. Variety plays an important role and selection of suitable wheat variety is crucial as per local conditions of farmers' fields. That is why an experiment was designed and conducted to evaluate ten wheat varieties under the conditions of farmland of B. R. D. P. G. College, Deoria, in eastern Uttar Pradesh, India. The main objectives of this experiment were to provide a very objective way of variety selection procedure and based on this selection, andto develop a very precise varietal recommender system so that farmers of this region get the best varieties suitable to their field conditions.

Materials and Methods

The field experiment under present investigation was conducted during Rabi 2019-2020 at Agricultural Research Farm of Baba Raghav Das Post Graduate College,Deoria in eastern Uttar Pradesh, India. This College is located in the eastern part of Uttar Pradesh, India. The site of experimentis located at 26.5°N latitude, 83.79°E longitude and 68 meter (223 feet)above mean sea level. The climate of district is semi-arid with hot summer and cold winter. Nearly 80% of total rainfall is received during monsoon (only up to September) with a few winter showers.

The experimental materials comprised of 10 wheat genotypes that were procured from various sources. The varieties included areSR-19, CR-100, BL-1496, FLW-15, WH-1320, NW-1076, WH-1322, KRL-19, NW-1076 and HD-2967. The experiment was conducted in a randomized block design consisting of ten treatments and three replications. The data were recorded on eight characters includingplant height (cm), flag leaf area (cm2), spike length (cm), effective tillers, grains per spike (grain number), grain yield per plant (g), biological yield per plant (g) andpeduncle length (cm).

Data Analysis : The experimental data were collected on eight parameters of ten wheat genotypes. These data were compiled by taking the mean values (Table-1) of five selected plants in each plot and subjected to following non-parametric analysis :

Ranking, normalizing and calculating normalized cumulative ranks : An example of a nonparametric statistical analysis procedure is given here to comprehend a small data-set of wheat-diversity for wheat breeding. Ten wheat genotypes in three replications were evaluated on eight parameters. The proposed normalized cumulative ranks considered all the eight parameters and gave an ordered list of genotypes. Each parameter was given due consideration and a normalized cumulative rank for each genotype was calculated. The cumulative ranks could be normalized in any desired way either by minimum, maximum (directional selection) or mid values (stabilizing selection). In this case the cumulative ranks were normalized by minimum. The parameters needing further attention for the improvement in desired genotypes were identified.

The procedure was carried out in two steps : 1. Calculation of ranks of each genotype and summing the ranks to find cumulative rank, and 2. Normalizing the cumulative ranks by minimum value and finding out a preferred list of genotypes by sorting the normalized cumulative ranks. The two steps could be easily understood by the following two formulae : 1. $CR = \sum_{i=1}^{n} R_i$ and 2. $NCR = CR/CR_{min}$,

Table-1 : Average values based on three replications.

S.N.	Variety Sort order	Plant Height	Effective Tillers	Spike length (cm)	Days of 50% Flowering	Biological Yield / Plant(g)	Grain yield/ Plant	FLA	Peduncle Length
		0	0	0	1	0	0	1	0
1.	SR-19	97.98	6.23	12.72	77.13	34.51	13.75	53.22	47.37
2.	CR-100	99.13	7.04	11.22	88.82	38.73	15.33	48.98	48.93
3.	BL-1496	96.47	7.31	9.12	72.67	31.37	13.43	42.45	51.5
4.	FLW-15	90.37	8.74	10.27	77.44	34.53	10.92	49.54	48.72
5.	WH-1320	104.12	6.42	12.76	76.71	34.12	14.11	48.19	51.38
6.	NW-1076	105.93	6.32	10.11	84.19	28.37	12.23	46.91	54.19
7.	WH-1322	98.22	7.33	10.35	75.12	26.98	10.28	45.18	48.72
8.	KRL-19	84.82	6.13	11.27	12.43	31.12	12.45	50.19	39.11
9.	NW-1076	102.17	5.88	11.42	70.19	32.44	14.53	40.22	42.43
10.	HD-2967	96.55	6.53	10.43	84.33	31.62	13.28	50.55	44.42

(0 = Descending, 1 = Ascending)

Table-2 : Ranks, CR and NCR values that give Table-3 on sorting on CR or NCR.

S.N.	Variety Sort order	Plant Height	Effective Tillers	Spike length (cm)	Days of 50% Flowering	Biological Yield / Plant (g)	Grain yield/ Plant	FLA	Peduncle Length	CR	NCR
		0	0	0	1	0	0	1	0		
1.	SR-19	6	8	2	6	3	4	10	7	46	1.59
2.	CR-100	4	4	5	10	1	1	6	4	35	1.21
3.	BL-1496	8	3	10	3	7	5	2	2	40	1.38
4.	FLW-15	9	1	8	7	2	9	7	5	48	1.66
5.	WH-1320	2	6	1	5	4	3	5	3	29	1
6.	NW-1076	1	7	9	8	9	8	4	1	47	1.62
7.	WH-1322	5	2	7	4	10	10	3	5	46	1.59
8.	KRL-19	10	9	4	1	8	7	8	10	57	1.97
9.	NW-1076	3	10	3	2	5	2	1	9	35	1.21
10.	HD-2967	7	5	6	9	6	6	9	8	56	1.93

where, CR = cumulative rank; NCR = normalized cumulative rank; R = Rank; n = number of parameters (or characters) evaluated. The values of NCR would range from one to CR/CRmin. NCR value one (1) would show the best genotype and the maximum value would show the worst genotype. The range would be an indicator of diversity. The range of CR (and NCR) values depends on number of varieties evaluated and the diversity within each parameter. A single line formula for normalized cumulative ranks (NCR) analysis could be given as NCR = ($_{i\ 1}^{n} R_i$) / ($_{i\ 1}^{n} R_i$).

From sort order as given in table-1, it is clear that desirable plant types being selected are for tall plants, more effective tillers, long spike, early flowering, more biological yield per plant,more grain yield per plant, small flag leaf andlong peduncle.

Results and Discussion

The results of the analysis are given in table-2.

Based on the sorted NCR values, as shown in Table-3, the top five varieties viz., WH1320,CR-100, NW-1076, BL-1496 and SR-19were recommended to farmers of this region for cultivation. The most popular variety (HD-2967) can be replaced by top performers namely WH-1320, CR-100 and NW-1076.

Precis(e) varietal recommender system : Quite often, due to shortage of time and resources, we have no option but to be very precis(e) in our presentation. This happens during paper presentations, poster presentations and paper writings. This problem comes while presenting the varietal screening data especially when a large number of varieties/ genotypes/ accessions are tried in multi-location

Table-3 : Varietal preference order based on eight parameters analyzed.

S.N.	Variety Sort order	Plant Height	Effective Tillers	Spike length (cm)	Days of 50% Flowering	Biological Yield / Plant(g)	Grain yield/ Plant	FLA	Peduncle Length	CR	NCR
		0	0	0	1	0	0	1	0		
1.	WH-1320	2	6	1	5	4	3	5	3	29	1
2.	CR-100	4	4	5	10	1	1	6	4	35	1.21
3.	NW-1076	3	10	3	2	5	2	1	9	35	1.21
4.	BL-1496	8	3	10	3	7	5	2	2	40	1.38
5.	SR-19	6	8	2	6	3	4	10	7	46	1.59
6.	WH-1322	5	2	7	4	10	10	3	5	46	1.59
7.	NW-1076	1	7	9	8	9	8	4	1	47	1.62
8.	FLW-15	9	1	8	7	2	9	7	5	48	1.66
9.	HD-2967	7	5	6	9	6	6	9	8	56	1.93
10.	KRL-19	10	9	4	1	8	7	8	10	57	1.97

Table-4 : Precis(e) varietal recommendation : Combining initial two tables.

S.N.	Variety Sort order	Plant Height	Effective Tillers	Spike length (cm)	Days of 50% Flowering	Biological Yield /Plant(g)	Grain yield/ Plant	FLA	Peduncle Length	CR	NCR
		0	0	0	1	0	0	1	0		
1.	SR-19	97.98 (6)	6.23 (8)	12.72 (2)	77.13 (6)	34.51 (3)	13.75 (4)	53.22 (10)	47.37 (7)	46	1.59
2.	CR-100	99.13 (4)	7.04 (4)	11.22 (5)	88.82 (10)	38.73 (1)	15.33 (1)	48.98 (6)	48.93 (4)	35	1.21
3.	BL-1496	96.47 (8)	7.31 (3)	9.12 (10)	72.67 (3)	31.37 (7)	13.43 (5)	42.45 (2)	51.5 (2)	40	1.38
4.	FLW-15	90.37 (9)	8.74 (1)	10.27 (8)	77.44 (7)	34.53 (2)	10.92 (9)	49.54 (7)	48.72 (5)	48	1.66
5.	WH-1320	104.12 (2)	6.42 (6)	12.76 (1)	76.71 (5)	34.12 (4)	14.11 (3)	48.19 (5)	51.38 (3)	29	1
6.	NW-1076	105.93 (1)	6.32 (7)	10.11 (9)	84.19 (8)	28.37 (9)	12.23 (8)	46.91 (4)	54.19 (1)	47	1.62
7.	WH-1322	98.22 (5)	7.33 (2)	10.35 (7)	75.12 (4)	26.98 (10)	10.28 (10)	45.18 (3)	48.72 (5)	46	1.59
8.	KRL-19	84.82 (10)	6.13 (9)	11.27 (4)	12.43 (1)	31.12 (8)	12.45 (7)	50.19 (8)	39.11 (10)	57	1.97
9.	NW-1076	102.17 (3)	5.88 (10)	11.42 (3)	70.19 (2)	32.44 (5)	14.53 (2)	40.22 (1)	42.43 (9)	35	1.21
10.	HD-2967	96.55 (7)	6.53 (5)	10.43 (6)	84.33 (9)	31.62 (6)	13.28 (6)	50.55 (9)	44.42 (8)	56	1.93

trials. Under such a scenario, the average data (e.g., Table-1) and the ranking data (Table-2) could be combined into a single table as given in Table-4. After sorting the table 4 on CR or NCR, we get Table-5. To be even more precis(e) than the above suggestions, we can give only one table (Table-5) to sum up whole findings. When the numbers of entries in the trials are large enough to present in a single page table, then only a single page could be presented showing only the top performers. This precis(e)ness saves paper, time and money. This experiment and the paper got inspiration from crop ideotype concept of Donald, C.M. (1968). Similar types of non-parametric analyses were carried out by Singh 2017, Singh et al. 2018 and Yadavet al. 2020.

Tables-3 and 5 show that WH-1320 is the best performer and CR-100 and NW-1076 are equally good after WH-1320. The standard check variety HD-2967 is lagging far behind on ninth position. It means, varieties above the standard check might eventually replace HD-2967. These tables also indicate that the best performer (WH-1320) could be improved further by paying attention to its effective tillers, days to 50% flowering and flag leaf area.

The correlation data are given in Table-6. A perusal of correlation data reveals high positive correlation between plant height and days to 50% flowering (0.705),days to 50% flowering and peduncle length (0.685), biological yield and grain yield (0.667) and plant height and peduncle length (0.616). This means tall plants would tend to flower late and will have long peduncle. Similarly, tall plants would tend to have high biological yield and grain yield. It means, we need to look for stout (non-lodging) tall plant types that might give significant jump in yield. Perhaps this is the kind of plant type that has been imagined by Yuan Long Ping (2017) while describing “Progress in super-hybrid rice breeding” looking for “Tall (new type)” and “Super tall” with estimated yield levels 18-20 t ha-1 and >20 t ha-1 respectively.

Table-5 : Precis(e) varietal recommendation: sorting on CR or NCR values.

S.N.	Variety Sort order	Plant Height	Effective Tillers	Spike length (cm)	Days of 50% Flowering	Biological Yield /Plant(g)	Grain yield/ Plant	FLA	Peduncle Length	CR	NCR
		0	0	0	1	0	0	1	0		
1.	WH-1320	104.12 (2)	6.42 (6)	12.76 (1)	76.71 (5)	34.12 (4)	14.11 (3)	48.19 (5)	51.38 (3)	29	1
2.	CR-100	99.13 (4)	7.04 (4)	11.22 (5)	88.82 (10)	38.73 (1)	15.33 (1)	48.98 (6)	48.93 (4)	35	1.21
3.	NW-1076	102.17 (3)	5.88 (10)	11.42 (3)	70.19 (2)	32.44 (5)	14.53 (2)	40.22 (1)	42.43 (9)	35	1.21
4.	BL-1496	96.47 (8)	7.31 (3)	9.12 (10)	72.67 (3)	31.37 (7)	13.43 (5)	42.45 (2)	51.5 (2)	40	1.38
5.	SR-19	97.98 (6)	6.23 (8)	12.72 (2)	77.13 (6)	34.51 (3)	13.75 (4)	53.22 (10)	47.37 (7)	46	1.59
6.	WH-1322	98.22 (5)	7.33 (2)	10.35 (7)	75.12 (4)	26.98 (10)	10.28 (10)	45.18 (3)	48.72 (5)	46	1.59
7.	NW-1076	105.93 (1)	6.32 (7)	10.11 (9)	84.19 (8)	28.37 (9)	12.23 (8)	46.91 (4)	54.19 (1)	47	1.62
8.	FLW-15	90.37 (9)	8.74 (1)	10.27 (8)	77.44 (7)	34.53 (2)	10.92 (9)	49.54 (7)	48.72 (5)	48	1.66
9.	HD-2967	96.55 (7)	6.53 (5)	10.43 (6)	84.33 (9)	31.62 (6)	13.28 (6)	50.55 (9)	44.42 (8)	56	1.93
10.	KRL-19	84.82 (10)	6.13 (9)	11.27 (4)	12.43 (1)	31.12 (8)	12.45 (7)	50.19 (8)	39.11 (10)	57	1.97

Table-6 : Correlation data.

	Plant Height	Effective Tillers	Spike length	Days to 50% Flowering	Biological Yield	Grain yield	FLA	Peduncle Length
Plant Height	1							
Effective Tillers	-0.335	1						
Spike length	0.171	-0.491	1					
Days to 50% Flowering	0.705	0.269	-0.094	1				
Biological Yield	-0.064	0.132	0.451	0.21	1			
Grain yield	0.351	-0.524	0.444	0.172	0.667	1		
FLA	-0.347	0.045	0.424	-0.076	0.345	-0.052	1	
Peduncle Length	0.616	0.344	-0.229	0.685	-0.049	-0.09	-0.096	1

References

1. Donald, C.M. 1968. The breeding of crop ideotype. *Euphytica,*17: 385-403.
2. Singh, S.N. 2017. Normalized Cumulative Ranks for Plant Breeding: An Example. *Frontiers in Crop Improvement Journal,* 5 (Spl.): 304-306.
3. Singh, S.N., Sahu, R.K. and Tarkeshwar 2018. Selection from quinoa (Chenopodium quinoa Willd.) accessions through normalized cumulative ranks. Progressive Research–*An International Journal,* 13 (Special): 537-538.
4. Yadav, M., Singh, S.N., Tarkeshwar, Sahu, R.K., Kumar, K. and Yadav, P.K. 2020.Selecting suitable wheat (Triticum aestivum L.) variety for Gorakhpur and Deoria region through normalized cumulative ranks. Int. J. Curr. Microbiol. App. Sci, Special Issue-11: 556-560.
5. Yuan, L.P. 2017. Progress in super-hybrid rice breeding. The Crop Journal, 5: 100-102.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1067-1069 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Bio-Efficacy of Organic Treatments Against Major Lepidopteran Predators of Lac Insect

Mahaveer Meena[1], Hemant Swami[1], Lekha[1], Gaurang Chhangani[1], Pradeep Kumar Gautam[1], Piyush Sharma[1], Mahendra Yadav[1] and Neeraj Kumar Meena[2]

[1]*Department of Entomology, RCA (MPUAT), Udaipur, Rajasthan*

[2]*Department of Plant Pathology, RCA (MPUAT), Udaipur, Rajasthan*

Email : mahaveermeena575@gmail.com

Abstract

Investigation on Bio-efficacy of organic treatments against major lepidopteran predators of lac insect was carried out in the Department of Entomology, Rajasthan college of Agriculture, MPUAT, Udaipur, during 2021 to evaluate the bio-effecacy of organic treatments against major lepidopteran predators of lac insect. Among the treatments, the most effective treatment with the highest mean survival percentage of lac insect was Emamectin benzoate 5 SG @ 0.4 gm/lit (68.89 percent). Among the organic treatments, two applications of Tekha sat @ 10% was the most effective in reducing the predatory population on lac, followed by NSKE @ 5% and Bramhastra @ 5%. Whereas, Neem oil @ 2% and cow urine @ 10% two treatments that were found least effective against *E. amabilis* and *P. pulverea*.

Key words : *Bio-efficacy, lac insect, E. amabilis, P. pulverea, and organic treatments.*

Introduction

The Lac insect, *Kerria lacca* (Kerr) is a member of family Tachardiidae (Kerriidae), super family Coccoidea of the order Hemiptera, a is unique insect of economic use one beneficial importance producing the natural resin of wide use. It secretes resin in the form of lac to protect its body and is found throughout the world in different agro-climatic conditions on wide range of host plant. The life cycle of lac insect starts with first instar larval stage known as crawlers, which after settlement undergoes three successive moulting to become the adult. The first instar is mobile and crawls over the shoot of host trees, settles and feeds on phloem sap by piercing its proboscis into phloem region of shoot. During its feeding phase it secrets a resin to protect its body which on drying is recovered in the form of lac.

Several attempts have been made by researchers for the effective management of these predators infesting lac insect, which broadly includes the chemical insecticide. These chemical insecticides besides having effective against the natural enemies of lac insect also exerts a determinant effect on the lac insect itself. I overcome this the non-chemical approach including plant product and organic formulations for the management of natural enemies infecting lac insect could serve as an effective alternative with minimum determinatal effect on lac insect. Importance of organic control recently, the use of animal by products such as cow urine and butter milk for insect pest control is gaining importance. Indian farmers are using cow urine and cow dung as manures in their fields since for a long period as traditional method. During past few years' attempts have been made to evaluate and demonstrate the impact of cow urine on crop growth and in suppressing the insect pest population. Cow urine tested at different levels (concentrations) either alone or in combination with recommended insecticides provided effective control of many insect pests. Neem Seed Kernel Extract used with cow urine at 3% concentration found to be promising to manage various insect pests infesting chilli, soybean, pigeon pea, sesame, linseed, mustard, cabbage, beans and black gram. This practice ultimately reduces the insecticidal load in nature. (Korat 2011).

Materials and Methods

The field experiment to evaluate the bio efficacy of different organic treatments against major predators was conducted at Lac Insect Gene Bank of Rajasthan College of Agriculture, Udaipur during *Baishakhi* season 2021. The available *Ber* plants were utilized for the study during *Baisakhi* (2021) and were pruned in the month of March 2021. To have the new and good flush of tender shoots for the inoculation of broodlac was very good and was ready for broodlac inoculation.

The *Ber* plants were inoculated with locally collected broodlac after appearance of new shoots of *Ber*. The brood lac having fully mature female cells on the appearance of yellow spot were tied on the *Ber* plants in the month of October for the emergence and settlement of crawlers of lac insects. Seven different organic treatments along with the insecticidal check were evaluated for the efficacy against the major predator *Eublamma amabilis* and *Pseudohypatopa pulverea.* The different treatments

were applied at 45 days (this period coincides with the most critical stage of the predatory caterpillars *i.e.* peak period of its egg hatching) or 11-13 weeks after the inoculation of broodlac on the completion of male emergence of lac insect. The first treatment application was applied at 7 days after the completion of male emergence followed by second application of treatment at 30 days' interval. The treatments were applied on lac bearing twigs of the *Ber* plant to cover the encrustation of lac insect.

Treatment Detail :

S. No.	Treatment	Dose or Concentration
1.	Neem Oil (2%)	20 ml/lit
2.	Neem Seed Kernel Extract (5%)	50 ml/lit
3.	Dashparni	10%
4.	Teekha sat	10%
5.	Bramhastra	5%
6.	Cow urine	10%
7.	Emamectin benzoate 5 SG	0.4 gm/lit
8.	Control	-

Observations : The efficacy of different treatments was recorded in terms of living/dead cells at harvest. The mature lac stick samples for each treatment in each replication were harvested and observed to count numbers of mature live and dead cells per 4 sq. cm. The samples were collected from upper, middle and lower portion of the treated plants for each treatment replication and were kept in predator emergence cage for emergence of predators.

The numbers of living and dead larvae as well as adult moths of lac predators emerging from the caged samples were counted. The data were retransformed to original values from Square root v (X + 0.5) transformation values. Subsequently, percentage reduction in the incidence of predators over control was calculated. Broodlac to broodlac yield ratio was worked out by dividing the broodlac yield obtained at harvesting from brood lac inoculated at the beginning of the crop cycle.

Statistical analysis : The data recorded for efficacy of different treatments were statistically analyzed using standard procedure for analysis of variance (ANOVA) of CRD in order to test the significance of experimental. The CD for treatments was also worked out. Survival percentage of lac insect was worked out using the formula.

$$\text{Survival percentage} = \frac{\text{No. of live cells / cm}^2}{\text{Total no. of cells / cm}^2} \quad 100$$

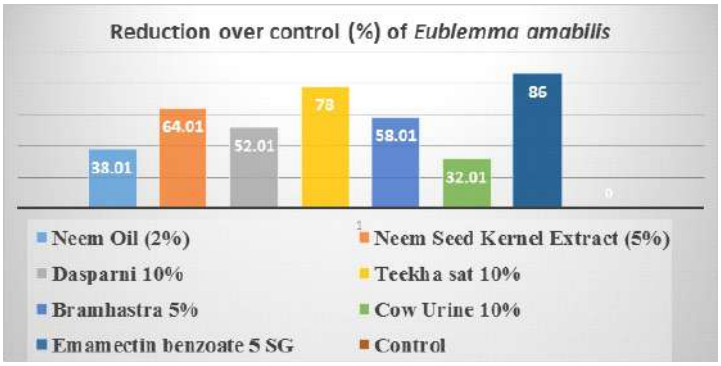
Results and Discussion

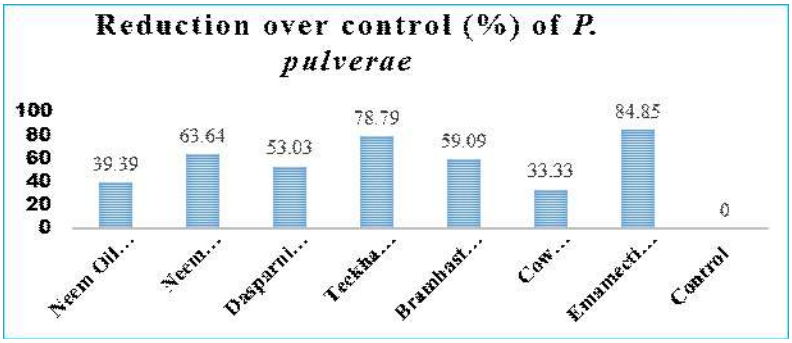
The investigation to evaluate the efficacy of different organic treatments namely, viz Neem Oil (2%), Neem Seed Kernel Extract (5%), Dashparni @ 10%, Teekha sat @ 10%, Bramhastra @ 5%, Cow urine @ 10%, Emamectin benzoate 5 SG against major lepidopteron predators of lac insect i.e. *Eublemma amabilis and Pseudohypatopa pulverea* was carried out during bhaisakhi season 2021-22. The results revealed that the application of Emamectin benzoate 5 SG and @ 0.4 gm/lit proved to be most effective with maximum per cent reduction of the mean population of both the predators *i.e. E. amabilis* (84.85%) and *P. pulverea* (78.95) over control with the minimum mean population of 3.33 and 1.33 per meter lac stick; Respectively Among the organic treatment application of Tekha sat @ 10% proved to be most effective in reducing predatory population on lac with 78% and 78.79% reduction of *E. amabilis* and *P. pulverea*; Respectively. followed by NSKE @ 5%, Bramhastra @ 5%, Neem oil @ 2% and Cow urine @ 10%. Highest mean population of *E. amabilis* and *P. pulverea i.e.* 16.67 and

Table-1 : Bio-efficacy of organic treatments on the population of major lepidopteran predators of lac of insect during *Baisakhi* season 2021-22.

Treatments	Doses/ Conc.	*E. amabillis*		*P. pulverea*		Survival of lac insect (%)
		Mean population at time of harvest	Reduction over control (%)	Mean population at time of harvest	Reduction over control (%)	
Neem Oil (2%)	20 ml/lit	10.33 (3.29)*	38.01	13.33 (3.72)	39.39	29.17
Neem Seed Kernel Extract (5%)	50 ml/lit	6.00 (2.54)	64.01	8.00 (2.91)	63.64	50.00
Dashparni	10%	8.00 (2.91)	52.01	10.33 (3.29)	53.03	37.78
Teekha sat	10%	3.67 (2.04)	78.00	4.67 (2.27)	78.79	63.89
Bramhastra	5%	7. 00 (2.73)	58.01	9.00 (3.08)	59.09	46.67
Cow urine	10%	11.33 (3.44)	32.01	14.67 (3.89)	33.33	26.11
Emamectin benzoate 5 SG	0.4 gm/lit	2.33 (1.68)	86.00	3.33 (1.95)	84.85	68.89
Control	-	16.67 (4.14)	-	22.00 (4.74)	-	-
S. Em. ±		0.598	-	0.630	-	-
CD at 5%		1.268	-	1.336	-	-

*Square root $\sqrt{}$ (X + 0.5) transformed values.





22.00 were recorded in control. The findings of present investigation are in line with the results of Singh *et al*., (2013) and Singh *et al*. (2014) who reported the higher efficacy of spinosad 2.5 SC against *E.amabilbis* and *P. pulverea* of lac insect. Similarly Singh and Jaiswal (2015) also reported spinosad (0.005, 0.007 and 0.01%) as most promosing with significant reduction cent per cent in the population of *E.amabilbis* infecting of lac during rainy and summer crops. The present findings are in close agreement with the study of Meshram *et al*. (2018) who reported overall higher impact of emamectin benzoate @ 0.002 per cent for the management of population of lac predator, *E. amabilis.* The results of Vikram *et al* (2020) also confirmed the present findings who reported that botanicals and insecticidal treatments proved superior in reducing the predator population. The treatment application of spinosad 2.5 EC @ 20ml/lit effectively reduced the population of *E. amabilbis* and *P. pulverea* followed by emamectin benzoate 5 SG @ 0.4gm/lit and cartap hydrochloride 50 SP @ 2gm/lit., and both treatments were found at par with spinosad 2.5 EC.

Conclusion

Among the treatments, Emamectin benzoate 5 SG @ 0.4g/lit was found most effective in reducing the predators population on lac. Among the organic treatments, two applications of Tekha sat 10% was found most effective in reducing the predators population on lac followed by NSKE at 5%, Bramhastra at 5%. Whereas, Neem oil at 2% and Cow urine 10% were found least effective against *Eublemma amabilis* and *Pseudohypatopa pulverea.*

References

1. Korat, D.M. and Dengale, K.R. 2011. Cow urine – A natural animal by product for insect pest suppression. *Green Farming,* 2: 502-504.
2. Meshram, Y.K., Bhagat, P.K. and Devi, P. 2018. Management of Prevalence of Natural Enemy, *E. amabilis* (Moore) by Novel Insecticides at Korba District of Chhattisgarh, India. *International Journal of Current Microbiology and Applied Sciences*, 7: 732-7371.
3. Singh, J.P., Jaiswal, A.K. and Monobrullah, M.D. 2014. Impact of some selected insecticides and bio-pesticides on incidence of predators, parasitoid and productivity of lac insect, *Kerria lacca. Indian Journal of Agricultural Science,* 84: 64–72.
4. Singh Jai Prakash, Jaiswal Anil Kumar, Monobrullah Mohammad and Patamajhi P. 2013. Effect of Broodlac Treatment with Insecticides on Population Reduction of Predators and Parasitoids of Lac Insect, *Kerria lacca* (Kerr). *National Academy Science Letters,* 36: 379-383.
5. Singh, J.P., Jaiswal, A.K. and Monobrullah, M.D. 2014. Impact of some selected insecticides and bio-pesticides on incidence of predators, parasitoid and productivity of lac insect, *Kerria lacca. Indian Journal of Agricultural Sciences,* 84: 64–72.
6. Singh. J.P. and Jaiswal, A.K. 2015. Response of broodlac treatment with insecticides on predators and parasitoids of lac insect, *Kerria lacca* (Kerr) harbouring broodlac. *Indian Journal of Entomology,* 77: 21-26.
7. Vikram, Lekha, Swami, H., Chhangani, G. and Sharma, K. 2020. Bio-efficacy of eco-friendly pesticides against major predators of lac insect, *Kerria lacca* Hemiptera: Kerriidae. *Journal of Entomology and Zoology Studies*, 8: 732-735.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1070-1073 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Influence of Abiotic Factors on the Seasonal Occurence and Parasitization Pperformance of *Campoletis chlorideae* (Uchida), a Larval Parasitoid of *Helicoverpa armigera* (Hübner) in Chickpea

Piyush Sharma, M.K. Mahla, S. Ramesh Babu, Hemant Swami, Sheenam Bhateja, Pradeep Kumar Gautam, Mahendra Yadav, Mahaveer Meena, Mohd. Monish and S.K. Dhabhai

Department of Entomology, RCA, MPUAT, Udaipur, Rajasthan

**Email : piyushsharma.123438@gmail.com*

Abstract

Investiagtion on Influence of abiotic factors on the seasonal occurence and parasitization of *Campoletis chlorideae* (Uchida), a larval parasitoid of *Helicoverpa armigera* (Hübner) in Chickpea was conducted at the Department of Entomology, Rajasthan College of Agriculture, Udaipur during *rabi*, 2021-22. Population of *C. chlorideae* initiated in the 50th SWM (0.80 adults/plant) and continued up to 12th SMW during *rabi,* 2021-22. The population of *C. chlorideae* touched its peak (1.90 adult/plant) during the 8th standard meteorological week. The maximum and minimum temperature recorded during the peak period was 30.0^{o}C and 7.59^{o}C, respectively and the maximum and minimum humidity recorded was 86.14 per cent and 57.86 per cent with no rainfall. The least population of *C. chlorideae* was recorded during the 52nd meteorological week. The maximum and minimum temperature recorded during the least incidence was 23.58^{o}C and 7.86^{o}C and maximum and minimum relative humidity of 94.38 and 59.38 per cent, respectively with 18.00 mm rainfall. Per cent parasitization by parasitiod; *Campoletis chlorideae during* rabi, 2021-22 ranges from 8.00 to 43.60 per cent. Correlation studies between the various weather parameters and the adult population of *C. chlorideae* shows that there was a significant positive correlation with the maximum temperature (r = 0.512*) and a positive correlation with minimum temperature (r = 0.365), respectively whereas a negatively non-significant correlation with maximum (r =-0.171), minimum relative humidity (r = -0.066) and rainfall (r = -0.346).

Key words : *Helicoverpa armigera, Campoletis chlorideae, Per cent parasitization*

Introduction

Chickpea (*Cicer arietinum* L.), member of the Fabaceae family, subfamily Fabiodea and self-pollinated in nature with a chromosomal number 2n=14. It's a native crop of India (Southwest Asia). Chickpea (*Cicer arietinum* L.) is the 3rd most important pulse crop and an economically beneficial protein-rich food legume. India is the largest chickpea-producing country, with a 75 per cent share of global production (Maurya and Kumar, 2018; Gaur *et al.* 2019). Nutritionally, it contains 24 per cent protein, 59 per cent carbohydrates and 3.2 per cent minerals. Henceforth, Indian Council of Medical Research (ICMR) has recommended pulse intake of 80 g/capita/day. Beside all this it is suitable for various crop rotations and bear nodules on their roots, which use to fix the atmospheric nitrogen in to the soil and make more fertile (Cumming and Jenkins, 2011).

The major insect pests of chickpea crop are mainly *Helicoverpa armigera* (Hübner), *Spodoptera litura* Fabricius, *Agrotis ipsilon*, *Plusia orichalsia* (Fabricius) and *Bemisia tabaci* (Gennadius). Among the insect pest, the chickpea pod borer (*Helicoverpa armigera*) is the most destructive pest of chickpea. The young larvae feed upon the tender portion of foliage before attacking the fruiting bodies, causing heavy losses to chickpea. Even sometimes the crop faces failure due to an attack of pod borer. *Helicoverpa armigera* (Hübner) belongs to the family Noctuidae of the order Lepidoptera. This pest is commonly known as pod borer and it is a polyphagous pest that feeds on tomato, cotton, pigeon pea, chickpea, sorghum and cowpea, also feed on various wild host and grasses (Gajbe, 2020). The pod borer attacks the crop from seedling to maturity, damaging all parts of the plant (leaves, flowers, and pods). Some natural enemies are also found associated with chickpea and among them, *Campoletis chlorideae* Uchida is the major one. *Campoletis chlorideae* belongs to family Ichneumonidae, order Hymenoptera. Natural enemies are major biotic constraints to the population build-up of *H. armigera* in crops (Singh *et al.,* 2015). It has been discovered that Campoletis chlorideae (Uchida) parasitizes the pest's early larvae (Uchida) (Kaur *et al.,*2020). It's been noted that this parasitoid parasitizes 80.5% *H. armigera* larvae in chickpea ecosystem of (Pandey *et al*., 2004). The parasitic activity was noticed higher at minimum temperature 9.7^{0}C and was ceased at maximum temperature more than 40^{0}C in chickpea. (Gupta and Desh Raj, 2003). Monitoring of the *C. chlorideae*, its relation to abiotic factor and pre cent parasitization will be helpful in enhancing its activity and suppression of pod borer population. Therefore, in order to design a superior

pest management model for gram pod borer, the present research study was undertaken to know the seasonal incidence of *C. chlorideae* in relation to abiotic (Maximum and minimum temperature, relative humidity during morning & evening hours, rainfall) factors and biotic factor (natural parasitization by *Campoletis chlorideae* Uchida) under chickpea field conditions.

Materials and Methods

An experiment was conducted on "Influence of abiotic factors on the seasonal occurence and parasitization performance of *Campoletis chlorideae* (Uchida), a larval parasitoid of *Helicoverpa armigera* (Hübner) in Chickpea was conducted at the Department of Entomology, Rajasthan College of Agriculture, Udaipur during *rabi*, 2021-22.

The seasonal incidence of *Campoletis chlorideae* was recorded from plots of 9 sq. m (3 m x 3 m) that were replicated thrice. The seedling of Chickpea variety 'GNG-2144' was transplanted with 30 cm row to row and 10 cm plant to plant distance in uniformly sized plots measuring 3 m x 3 m (9 m^2). The plots were maintained pesticide-free to allow natural infestation and seasonal incidence of major insect pests and their associated natural enemies was recorded on 10 randomly selected and tagged plants from each plot by adopting the sampling method and observations according to the insect pest.

Observations

Observations for the *C. chlorideae* in chickpea was collected from ten plants selected at random. The field-collected larvae were brought to the laboratory and maintained in jars. The larvae were reared on fresh leaves and pods of gram until pupation or emergence of the parasitoid.

Parasitization of *Helicoverpa armigera* (Hübner) by *Campoletis chlorideae* Uchida: The larval parasitization of *H. armigera* was studied by collecting 50 larvae at weekly intervals and brought to the laboratory from the chickpea field and kept in jars. Collected larvae were kept in separate jars to avoid cannibalism. The larvae were reared on fresh leaves and pods of a gram to check the emergence of the adult parasitoid. The jars were covered with a muslin cloth secured with rubber bands and placed at ambient conditions of temperature and humidity. The effective parasitization (%) was computed using the methodology adopted by Hugar *et al*. (2014) and Tian *et al.* (2008).

$$\text{Parasitization (\%)} = \frac{\text{No. of parasitoids emerged}}{\text{No. of larvae collected}} \quad 100$$

Following statistical analysis will be done :

Formula for simple correlation (Pearson, 1895) :

$$r_{xy} \quad \frac{XY \quad \frac{(X)(Y)}{n}}{\sqrt{X^2 \quad \frac{(X)^2}{n} \quad Y^2 \quad \frac{(Y)^2}{n}}}$$

The correlation coefficient (r) values were subjected to the test of significance by Using t-test :

$$t \quad \frac{r}{\sqrt{1 \quad r^2}} \quad \sqrt{n \quad 2} \sim t_{n \ 2} \ d.f$$

The calculated t-value obtained was compared with tabulated t-value at 5 per cent level of significance.

Results and Discussion

Campoletis chlorideae is the major parasitoid of gram pod borer. According to data depicted in Table Its population was initiated in the third week of December (50th SWM) with a mean of 0.80 adults/plant and continued up to the last week of March (12th SMW) during *rabi,* 2021-22. The population of *C. chlorideae* touched its peak (1.90 adult/plant) during the 8th standard meteorological week (4th week of February) when the *H. armigera* population was near to its peak (3.12 larvae/plant) and then declined gradually with a slight increase in 10th standard meteorological week. The activity of the pest is observed from its initiation till the harvest of the crop. The maximum and minimum temperature recorded during the peak period was 30.0^{o}C and 7.59^{o}C respectively and maximum and minimum humidity was 86.14 per cent and 57.86 per cent with no rainfall. The least population of *C. chlorideae* was recorded during the 52nd meteorological week (last week of December). The maximum and minimum temperature recorded during the least incidence was 23.58^{o}C and 7.86^{o}C and maximum and minimum relative humidity of 94.38 and 59.38 per cent respectively with 18.00 mm rainfall. The present findings are in partial conformity with the findings of Pillai *et al.* (2016) who also observed that the larval parasitoid *C. chlorideae* attained its peak population in the 7th and 8th standard meteorological week while it makes its first appearance in the 3rd standard meteorological week. Kankale *et al.* (2018) recorded the incidence of *C. chlorideae* from 1st standard meteorological week to the 11th standard meteorological week and the results are almost similar to the findings of the present investigation.

Jaba *et al.* (2018) reported that *Campoletis cholrideae* Uchida was the single most prominent parasitoid in chickpea for major pest *Heliocverpa armigera* (Hübner) under the natural ecosystem with its

Table-1 : Seasonal incidence of *Campoletis chlorideae* (Uchida) during rabi, 2021-22.

SMW	Mean abiotic factors				Rainfall (mm)	Mean population/ plant	Percent parasitization (%)
	Temperature (°C)		Relative Humidity (%)				
	Max.	Min.	Max.	Min.			
50	25.04	6.46	95.86	55.29	0.00	0.80	8.00
51	23.64	3.34	92.29	51.14	0.00	0.60	10.00
52	23.58	7.86	94.38	59.38	18.00	0.20	9.00
1	23.31	8.91	94.43	69.00	4.80	0.30	14.50
2	20.89	3.86	95.71	53.14	0.00	0.22	19.20
3	23.56	3.87	96.00	61.86	0.00	0.60	27.0
4	21.59	3.26	92.57	64.00	0.00	0.50	25.00
5	27.00	4.21	89.29	59.71	0.00	1.00	29.00
6	25.87	5.07	92.00	69.14	0.00	1.10	34.90
7	26.69	5.11	95.29	66.71	0.00	1.32	37.60
8	30.00	7.59	86.14	57.86	0.00	1.90	43.60
9	30.07	8.93	90.43	70.57	0.00	1.50	35.00
10	31.40	12.36	82.71	48.00	3.50	1.80	39.00
11	36.26	12.31	59.29	17.14	0.00	1.50	23.00
12	37.71	13.14	48.83	19.86	0.00	0.90	13.00
13	38.01	11.96	45.57	14.86	0.00	0.60	11.00
Seasonal Mean	27.79	7.39	84.42	52.35	1.64		
Correlation coefficient between population of *C. chlorideae* and abiotic factors							
Max. Temperature (°C)						0.512*	
Min. Temperature (°C)						0.365	
Max. Relative Humidity (%)						-0.171	
Min. Relative Humidity (%)						-0.066	
Rainfall (mm)						-0.346	
Correlation coefficient between population of *H. armigera* and *Campoletis chlorideae*						0.938	

SMW = Stanadard meteorological week *significant at 5% level

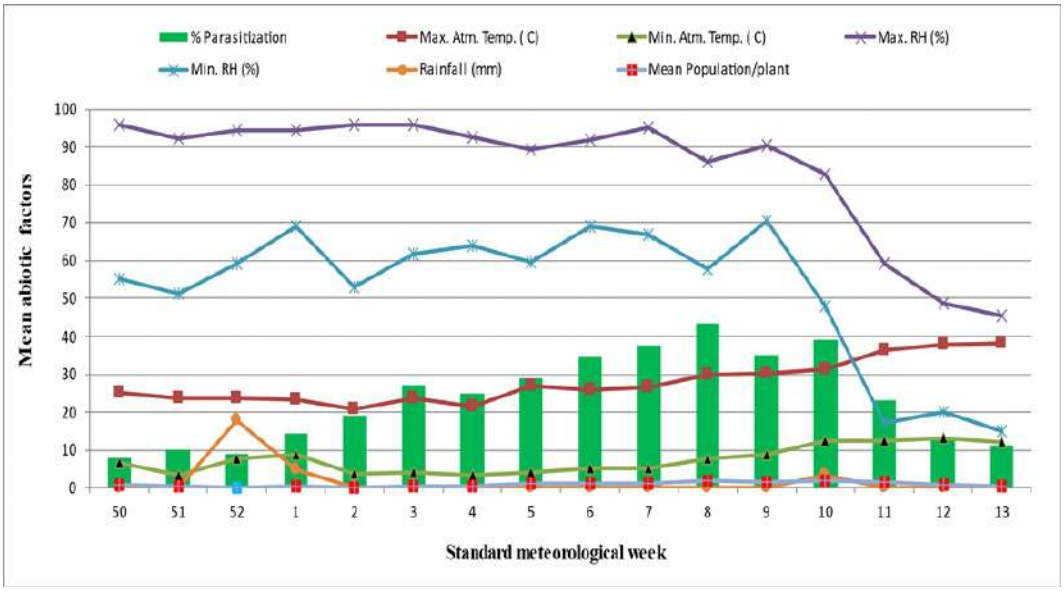


Fig.-1 : Seasonal incidence of *Campoletis chlorideae* (Uchida) during rabi, 2021-22.

highest occurrence in the 11th standard meteorological week.

Correlation studies between the various weather parameters and the adult population of *C. chlorideae* show a significant positive correlation with the maximum temperature (r = 0.512*) and a positive correlation with minimum temperature (r = 0.365), respectively. Whereas it shows a negative non-significant correlation with maximum and minimum relative humidity (r =-0.171, r = -0.066) and rainfall (r=-0.346), respectively. In

confirmation of the above findings, Jaba *et al.* (2018) also observed that the parasitoid population was positively related to maximum temperature and negatively correlated to minimum temperature. Whereas, contrary to the above finding evening relative humidity and rainfall were found to be positively correlated with the parasitoid population. Pillai *et al*. (2016) reported a significant negative correlation between maximum and minimum temperature and a significant positive correlation between maximum relative humidity and minimum relative humidity, these findings are in contrast to the findings of the present investigation.

Parasitization of *Campoletis chlorideae* Uchida on *Helicoverpa armigera* (Hübner) in chickpea : In the present investigation to understand the parasitization of *Helicoverva armigera* (Hübner) by *Campoletis chlorideae* Uchida per cent parasitization was worked out. A perusal of the data depicted in Table, shows that the per cent parasitization of *H. armigera* larvae by its parasitoid; *Campoletis chlorideae during* rabi, 2021-22 reveals that the parasitization ranges from 8.00 to 43.60 per cent. The highest per cent parasitization of 43.60 per cent was observed in the 8th standard meteorological week (4th week of February) whereas the lowest per cent parasitization of 8 per cent was observed in the 50th standard meteorological week (third week of December). The findings of the present investigation are in close confirmation with the findings of Devi *et al*. (2002), Gupta and Raj (2003), Jagdish *et al.* (2018), Kankale *et al*. (2018) and Meena *et al*. (2011).

According to Devi *et al*. (2002) the parasitism of *H. armigera* larvae in chickpea by *C. chlorideae* ranged from 0.18 to 23.81 per cent. Gupta and Raj (2003) reported parasitism from 8.33 to 28.00 per cent. Jagdish *et al*. (2018) reported a higher per cent parasitization of 60.67 per cent on the 1st collection of 11th S.W of march. Meena *et al.* (2011) reported the peak period of the parasitoid activity during the 6th standard meteorological week. Ojha *et al*. (2017) reported a higher parasitization of 56.67 per cent during December month.

References

1. Cumming, G. and Jenkins, L., 2011. Chickpea: Effective crop establishment, sowing window, row spacing, seeding depth and rate. *Australian Pulse Bulletin* PA, 7.
2. Devi, N.S., Singh, O.H., Devjani, P. and Singh, T.K. 2002. Natural enemies of *Helicoverpa armigera* (Hubner) on chickpea. *Annals of Plant Protection Sciences*, 10(2): 179-183.
3. Gajbe, P.U., 2020. Integrated Pest Management Strategies for the Management of Global Pest, *Helicoverpa armigera*. *Recent Trends in*, 1: 45.
4. Gaur, P. M., Samineni, S., Thudi, M., Tripathi, S., Sajja, S.B. and Jayalakshmi, V. 2019. Integrated breeding approaches for improving drought and heat adaptation in chickpea (*Cicer arietinum* L.). *Plant Breeding*, 138: 389–400.
5. Gupta, R.K. and Raj, D., 2003. Extent of parasitism and seasonal activity of *Campoletis chlorideae* Uchida in chickpea ecosystem of lower hills of Himachal Pradesh. *Indian Journal of Plant Protection*, 31(2): 5-8.
6. Hugar, S.V., Sharma, H.C. and Basavan Goud, K., 2014. Pigeonpea genotypes influence parasitization preference and survival and development of the *Helicoverpa armigera* larval parasitoid, *Campoletis chlorideae*. *Springer Plus*, 3(1): 1-8.
7. Jaba, J. and Agnihotri, M., 2018. Relationship of abiotic factors and the copiousness of larval parasitoid, *Campoletis chlorideae* on pod borer, *Helicoverpa armigera* under sole and chickpea-coriander ecosystem at Pantnagar, Uttarakhand. *Journal of Entomology and Zoology Studies*, 6(6): 316-319.
8. Kankale, M., Kelwatkar, N. and Das, S., 2018. Influence of weather factors on the extent of parasitization of *Campoletis chlorideae*, larval parasitoid of *Helicoverpa armigera*. *Journal of Entomology and Zoology Studies*, 6: 2497-2499.
9. Kaur, S., Brar, K.S., Sekhon, B.S., Joshi, N., Shenhmar, M. and Singh, J., 2000. Role played by *Campoletis chlorideae* Uchida in natural mortality of *Helicoverpa armigera* (Hübner) on chickpea in Punjab. *Journal of biological control*, 14(1): 51-54.
10. Maurya, O., Kumar, H. 2018. Growth of chickpea production in India. *Journal of Pharmacognosy and Phytochemistry*, 7(5): 1175-1177.
11. Meena, A., Gairola, S.C. and Anju, B., 2011. Seasonal incidence of *Campoletis chlorideae Uchida*, a larval parasitoid of *Helicoverpa armigera* (Hübner) in chickpea. *Journal of Insect Science*, 24(4): 362-366.
12. Pandey RK, Singh GR, Tripathi A. Effect of biopesticides (*Ha*NPV) on larval population of *Helicoverpa armigera* on chickpea in eastern part of U.P. under rainfed low-land ecosystem. National conference on role of Bio-agents and Bio-fertilizers for sustainable Agriculture and Horticulture. *IISR-Lucknow*. 2004; 1316-86.
13. Pearson, K., 1895. Correlation coefficient. In *Royal Society Proceedings*, 58: 214.
14. Pillai, A.K., Selvaraj, S. and Agnihotri, M. 2016. Seasonal abundance of *Campoletis chlorideae* (Uchida) (Hymenoptera: Ichneumonidae), A larval parasitoid of *Helicoverpa armigera* (Hubner) hardwick in chickpea. *Legume Research-An International Journal*, 39(4): 643-647.
15. Singh, D., Singh, S.K. and Vennila, S., 2015. Weather parameters influence population and larval parasitization of Helicoverpa armigera (Hübner) in chickpea ecosystem. *Legume Research*, 38(3): 402-406.
16. Tian, S.P., Zhang, J.H., Yan, Y.H. and Wang, C.Z., 2008. Interspecific competition between the ichneumonid *Campoletis chlorideae* and the braconid *Microplitis mediator* in their host *Helicoverpa armigera*. *Entomologia Experimentalis et Applicata*, 127(1): 0-19.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1074-1076 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Variability and Path Analysis in Isabgol (*Plantago ovata* L. Forsk.)

Rahul Khatik[1], Amit dadheech[1], N.K. Padiwal[2], Ajay Sharma[3] and Rohini Nain[1]

[1]*Department of Genetics and Plant Breeding, RCA (MPUAT), Udaipur, Rajasthan*

[2]*Department of Agronomy, RCA (MPUAT), Udaipur, Rajasthan*

[3]*Department of MBBT, RCA (MPUAT), Udaipur, Rajasthan*

Email : khatikrahul234@gmail.com

Abstract

Thirty five Isabgol (*Plantago ovata* L. Forsk) elite germplasm were evaluated during Rabi- 2020 at Udaipur, Rajasthan. The genotypes were planted in Augmented design. Observations for thirteen characters viz., days to 75% flowering, days to 75 per cent maturity, plant height, number of effective tillers per plant, number of spikes per plant, spike length, number of florets per plant, leaf length, leaf width, 1000 seed weight, swelling factor, seed yield per plant and total soluble solids were recorded and analysed to estimate variability parameters, correlation and path coefficient. The results revealed that differences between the estimates of GCV and PCV were found least for most of the characters however, High GCV was found for Seed yield per plant (42.90%), number of effective tillers per plant (40.76%), number of spikes per plant (21.48%). High PCV was found for seed yield per plant (56.69%), number of effective tillers per plant (41.25%), spike length (30.10%), number of spikes per plant (28.89%). The high estimates of heritability values noticed in characters like number of effective tillers per plant (97.64%), leaf width (95.42) plant height (94.94%), total soluble sugar (89.66%), number of florets per plant (86.09%). The genetic advance was found high (>20%) in the character spike length (24.76%).

Key words : *Isabgol, variability, heritability, correlation, path coefficient, seed yield per plant.*

Introduction

Isabgol *(Plantago ovata* Forsk) belong to plantaginaceae family *Plantago* which comprises about 200 species. Out of these 10 are found in India including 3 important species these are *ovata*, *psyllium* and i*ndica.* Isabgol has (2n=2x=8) chromosome number. The flowers of Isabgol are bisexual, tetramerous, animophilous and protogynous in nature and such as favour cross pollination (Husain et al., 1984). Isabgol *(Plantago ovata forsk)* is a short stemmed medicinal annual herb that growns up to a height of 25 to 40 cm. Isabgol is mainly grown for its seeds and husks. India is top producer of isabgol seeds and husk. Isabgol is Rabi season medicinal crop it is also being used in food industries especially in candies, biscuit and ice creams.

The source of any breeding programme success is determined on the amount of genetic varibility in the population. The combination of genetic variability and heritability provides a reliable picture of the genetic advance that can be expected from selection (Burton 1952), while the combination of heritability and genetic advance aids in predicting the valuable conclusion for effective selection based on phenotypic performance. Correlation studies allow researchers to investigate the degree and direction of a yields, correlation with its constituents, as well as with other components. It is necessary to consider the implications of the interrelationships of multiple characteristics, as well as path coefficients, in order to utilize the best combination of yield contributing characters in a single genotype.

Materials and Methods

The experimental material comprised of 35 diverse genotypes of Isabgol at the Instructional Farm, Department of Genetics and Plant Breeding, Rajasthan College of Agriculture, MPUAT, Udaipur, during Rabi 2019-20. Recommended cultural practices were adopted to raise a healthy crop.

The observations were recorded on ten randomly selected competitive plant for characters viz., Days to 75 per cent flowering and Days to 75 per cent maturity were recorded on plot basis. Also the representative bulk sample from each entry in each replication was used for 1000-seed weight and for analysis of swelling factor and total soluble sugar were observed on plot basis.

Analysis of variance was carried out as per method suggested by Fisher (1918). Genotypic coefficient of variation and Phenotypic coefficient of variation as per the method suggested by Burton (1952), heritability (broad sense) was calculated according to formula suggested by Lush (1941) and genetic gain as per Johnson et al (1955). The phenotypic and genotypic correlation coefficients were computed as per Al-Jibouri et al. (1958). Path coefficient analysis was done using genotypic correlation coefficients as suggested by Dewey and Lu (1959).

Table-1 : Mean squares for various characters in isabgol.

S. No.	Character	Block [2]	Treatment [34]	Check [3]	Germplasm [30]	C v/s G [1]	Error [6]
1.	Days to 75% flowering	0.58	47.22	36.75	31.89	538.52**	22.92
2.	Days to 75% maturity	26.33	15.48	4.89	16.20	25.93	6.56
3.	Plant Height (cm)	43.57	23.12	19.24	12.09	365.83**	23.56
4.	Number of effective tillers per plant	0.59	5.87**	0.03	6.43**	6.67**	0.15
5.	Number of spikes per plant	423.19*	169.37*	55.73	90.10	2888.28**	40.31
6.	Spike length	0.16	1.51	1.05	1.30	9.26*	1.16
7.	Number of florets per spike	1066.33**	264.33**	54.78	194.95*	2974.64**	27.11
8.	Leaf length	33.58**	10.35*	5.83	8.84*	69.22**	2.07
9.	Leaf width	0.00	1.40**	0.02	1.58**	0.03	0.07
10.	100o seed weight (g)	0.03	0.03	0.01	0.03	0.15*	0.01
11.	Swelling factor	0.47	0.45	0.09	0.46	1.22	0.41
12.	Seed yield per plant (g)	5.43*	2.61	0.44	1.94	29.15**	0.83
13.	Total soluble solids	2.29	70.02**	15.08	50.01**	834.91**	5.17

*, **Significant at 5% and 1% level of significance, respectively.

Table-2 : Estimates of PCV, GCV, heritability (broad sense), genetic advance and genetic gain for different characters in Isabgol.

Character	GCV	PCV	h^2	GA	GG
Days to 75 per cent flowering	4.39	8.28	28.15	3.27	4.80
Days to 75 per cent maturity	2.90	3.76	59.52	4.93	4.61
Plant height	6.90	14.10	94.94	6.80	27.58
Number of effective tillers per plant	40.76	41.25	97.64	5.10	82.97
Number of spikes per plant	21.48	28.89	55.26	10.80	32.89
Spike length	9.74	30.10	10.48	0.25	6.50
Number of florets per plant	12.19	13.14	86.09	24.76	23.30
Leaf length	16.93	19.35	76.54	4.69	30.50
Leaf width	21.30	24.18	95.42	2.47	44.08
1000-seed weight	9.73	12.21	63.58	0.24	15.99
Seed yield per plant	42.90	56.69	57.27	1.64	66.88
Swelling factor	2.15	6.33	11.57	0.16	11.51
Total soluble sugar	9.02	9.52	89.66	13.06	17.59

Results and Discussion

Analysis of variance indicated that mean sum of squares were significant for all the characters studied. All of the fourteen characters exhibiting significant variation among the genotypes were used for analysis (Table-1).

However, High GCV was found for Seed yield per plant (42.90%), number of effective tillers per plant (40.76%), number of spikes per plant (21.48%). High PCV was found for seed yield per plant (56.69%), number of effective tillers per plant (41.25%), spike length (30.10%), The high estimates of heritability values noticed in characters like number of effective tillers per plant (97.64%), leaf width (95.42) plant height (94.94%), total soluble sugar (89.66%), number of florets per plant (86.09%). The genetic advance was found high (>20%) in the character spike length (24.76%).

Based on mean values, three best genotypes UI-11, UI-17, UG-10 were identified for seed yield per plant.

The seed yield per plant exhibited significant and positive correlation with number of effective tillers per plant, number of spikes per plant, number of florets per plant and 1000 seed weight at both genotypic and phenotypic level. Swelling factor exhibited significant and positive correlation with number of effective tillers per plants at both genotypic and phenotypic level.

Estimation of path analysis is not possible for present experimental material because dependent character i.e.seed yield per plant (g) is not significant at both 1% and 5% level of significance.

Kumar et al. (2013), Sarkar et al. (2015), Tyagi et al. (2018) also reported the similar results in Isabgol.

Table-3 : Estimation genotypic (rg) and phenotypic (rp) correlation coefficients for different characters in isabgol.

Characters (rp / rg)	Days to 75 % flowering	Days to 75 % maturity	Plant height	No. of effective tillers per plant	No. of spikes per plant	Spike length	No. of florets per plant	Leaf length	Leaf width	1000 seed weight	Seed yield per plant	Swelling factor	Total soluble sugar
Days to 75 % flowering				0.44*			-0.05	-0.40*	0.01	-0.46**		-0.98**	0.30
Days to 75 % maturity	0.25			-0.10	0.27	-0.85**	0.09	-0.28	-0.37*	0.42*		0.20	-0.22
Plant height	-0.30	0.07											
No. of effective tillers per plant	0.27	-0.07	0.59**		0.95**		0.59**	0.54**	0.03	0.56**	0.92**	0.81**	0.64**
No. of spikes per plant	-0.14	-0.00	0.71**	0.75**			0.83**		0.22	0.48**	0.62**	0.96**	0.72**
Spike length	-0.19	-0.00	0.70**	0.51**	0.78**				-0.00	0.56**			0.95**
No. of florets per plant	0.05	0.22	0.60**	0.55**	0.61**	0.54**		0.63**	0.17	0.61**		0.68**	0.54**
Leaf length	-0.32	0.08	0.79**	0.48**	0.79**	0.82**	0.65**		-0.01	0.78**			0.46**
Leaf width	-0.08	-0.25	0.03	0.04	0.09	0.06	0.16	0.01		0.17	0.94**	0.01	0.27
1000-seed weight	0.18	0.09	0.38*	0.49**	0.58**	0.38*	0.45*	0.44*	0.15			0.60**	0.59**
Seed yield per plant	-0.01	-0.04	0.42*	0.28	0.53**	0.57**	0.40*	0.49**	0.21	0.64**		0.30	0.84**
Swelling factor	-0.04	0.15	0.67**	0.58**	0.72**	0.81**	0.59**	0.76**	-0.02	0.57**	0.47**		0.23
Total soluble sugar	0.29	-0.08	0.37*	0.59**	0.56**	0.40*	0.54**	0.43*	0.24	0.51**	0.39*	0.35	

*, **Represent significant at 5% and 1% level of significance respectively.

Conclusions

An overall view of the present investigation revealed that the genotypes UI-12, UI-17, UI-1O, UG-129, UI-4, UI-6-1, UI-25, UI-96, UI-89 and GI-2 were found to have considerably high mean values for traits like seed yield per plant, plant height, number of effective tillers per plant, number of spikes per plants, spikes length, 1000-seed weight, leaf length, leaf width, total soluble solids, swelling factors, while genotypes UI-4 and UI- 125 A have considerably low mean values for traits like days to 75 per cent flowering and days to 75 per cent maturity, respectively. So above genotypes can be further used in breeding programme**.**

References

1. Al-Jibouri, H.A., Millar, P.A. and Robinson, H.F. 1958. Genotype and environmental origin. *Agronomy Journal*. 50: 633-637.
2. Burton G.W. (1952). Quantitative inheritance in grasses. *Proc. Int.* Grassland Congr., 6: 277-28
3. Dewey D.R. and Lu K.H. (1959). A correlation and path coefficient analysis of components of wheat grass seed production. *Agron. J.*, 51: 515-518.
4. Fisher, R.A. 1918. The correlations among relatives on the supposition of Mendelian inheritance. *Tran. Royal Society, Edin.,* 52: 399-433.
5. Husain, A., Sharma, J.R., Puri, H.S. and Tyagi, B.R. 1984. Genetic resources of medicinal and aromatic plants in South Asia. CIMAP, Lucknow, U.P. (INDIA). pp.
6. Johnson H. W., Robinson H.F. and Comstock R.E. (1955). Estimates of genetic and environmental variability in soybean. *Agron. J.,* 47: 314-318.
7. Kumar, R., Dodiya N.S and Khatik, C.L. 2013a. Assessment of genetic variability and magnitude of correlation co-efficient among different traits in isabgol (*Plantago ovata L. Forsk*). *International Journal of Plant Sciences*, 8(1): 193-196.
8. Sarkar, S., Lal, R.K., Gupta, P. and Yadav, R. 2015. Inter and intra-specific genetic differentiation for agro-economical traits in Plantago germplasm. *Industrial Crops and Products* 74(15) 183-191.
9. Tyagi, S., Sahay, S., Kumar A., D.D. Singh., RajKumar, Imran, M. and Kumari, R. 2017. Correlation analysis for seed yield and its contributing traits in Isabgol genotypes. *Journal of Pure and Applied Microbiology,* 11(1): 475-478.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1077-1079 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Organic Management of Nutrients and Bio-Stimulants on Profitability of Wheat (*Triticum aestivum* L.)

Rajesh Choudhary[1], Roshan Choudhary[1], S.K. Sharma[1], D.P.S. Dudi[2], S.K. Yadav[1], R.K. Jain[1] and Gajanand Jat[2], Shivani Meena[1] and Ashok Kumar Samota[1]

[1]*Department of Agronomy, RCA (MPUAT), Udaipur, Rajasthan*

[2]*Department of Soil Science and Agricultural Chemistry, RCA (MPUAT), Udaipur, Rajasthan*

Abstract

Field experiment was conducted during *Rabi* 2021-2022 at Instructional Agronomy Farm of Rajasthan College of Agriculture, MPUAT, Udaipur. The experiment was laid out in factorial randomized block design with three replications and assigning sixteen treatment combinations consisting of control and three levels of organic nutrients (100% RDN, 75% RDN and 50% RDN through 1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake) as nutrient supplier and control and three levels of bio-stimulants (panchagavya 5% at 60 & 75 DAS as foliar, jeevamrut 500 L ha^{-1} at sowing & 10% at 30 DAS as foliar and panchagavya 5% at 60 & 75 DAS as foliar + jeevamrut 500 L ha^{-1} at sowing & 10% at 30 DAS as foliar. The result revealed that application of 100% RDN was recorded significantly higher grain (4415 kg ha^{-1}), straw (5536 kg ha^{-1}) and biological yield (9951 kg ha^{-1}) as compared to 75% RDN, 50% RDN and control. Bio-stimulants application registered significant improvement in most of the yield, consequently grain (4420 kg ha^{-1}), straw (5464 kg ha^{-1}) and biological yields (9884 kg ha^{-1}) over control.

Key words : *RDN, FYM, vermicompost, neemcake, panchagavya, jeevamrut.*

Introduction

Organic agriculture has been recognized to aid in increasing crop production and ensuring quality harvest. It involves the use of farm wastes, urban wastes and industrial wastes as a source of nutrients for crops being raised. Organic farming is being practiced in 187 countries of the world. Wheat (*Triticum aestivum* L.) is the most important cereal crop and like by the majority of world's populations. Wheat provides nearly 55 percent of the carbohydrates and 22 percent of the food calories consumed globally (Breiman and Graur, 1995). In India, total area under wheat cultivation is 30.55 million ha with 107.18 million tons production and average yield of 35.08 q ha-1 in 2019-20. Preference of consumers for organic wheat is increasing now days. It has been reported that yield of organic wheat decreases by 5 to 8 percent after 6 years of organic cycle. However, organic wheat fetches 20-25 percent high premium price in the market. Manure from cattle and other livestock is an important source of nutrients in the livestock-intensive regions. Farmyard manures are the major source of nutrient supply under small farm holdings (Tarafdar *et al*., 2012). Vermicompost is a mixture of worm castings, undigested organic wastes, microbes, vitamins, enzymes, hormones and antibiotics. It has less soluble salts, neutral pH, greater ion exchange capacity, humic acid content, nitrates, calcium and magnesium. It improves water holding capacity of the soil. Bio-stimulants used in organic agriculture like panchagavya and jeevamrut are the fermented products which used as plant growth enhancing substances prepared with material available with farmers. They are the rich sources of beneficial micro- flora which stimulate the plant growth and help in getting better vegetative growth and also good quality yield. Formulations prepared from agricultural by- products, *viz.,* bran of grains, oil cakes, farmyard manure *etc.*, are excellent growth carriers and storage media (Devakumar *et al*. 2011). During the last few years, there has been an increasing interest in the use of panchagavya and jeevamrut and other liquid organic manures in organic agriculture and acceptability among organic farming practitioners.

Materials and Methods

The experiment was conducted in block C_5 at the Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur which is situated in South-Eastern part of Rajasthan at an altitude of 581.13 metre above mean sea level with 24°35' N latitude and 74 °42' E longitude. The mean annual rainfall of Udaipur is 637 mm with a range between 373-1140 mm and the most of which (80-85%) is received from south-west monsoon during July to early September. The mean minimum and maximum temperatures at Udaipur fluctuate in between 3.3°C to 13.1°C and 20.9°C to 37.7°C, respectively. The soil of the experimental site was clay loam in texture with 283.42, 22.23 and 279.31 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively with pH 7.9. The experiment was laid out in factorial randomized block design with three replications and assigning sixteen treatment combinations consisting of control and three levels of organic nutrients (100% RDN, 75% RDN and

Table-1 : Effect of organic management of nutrients and bio-stimulants on yield and harvest index of wheat.

Treatments	Yield (kg ha^{-1})			Harvest index (%)
	Grain	Straw	Biological	
Levels of organic nutrients				
N_1	3653	4373	8026	45.51
N_2	4415	5536	9951	44.36
N_3	4119	5155	9274	44.41
N_4	3887	4726	8613	45.12
S.Em±	74	127	163	0.62
C.D. (P= 0.05)	213	367	471	NS
Bio-stimulants				
B_1	3592	4369	7961	45.15
B_2	4017	4949	8966	44.80
B_3	4046	5008	9053	44.69
B_4	4420	5464	9884	44.71
S.Em±	74	127	163	0.62
C.D. (P= 0.05)	213	367	471	NS

50% RDN through 1/3 FYM+ 1/3 Vermicompost + 1/3 Neem cake) as nutrient supplier and control and three levels of bio-stimulants (panchagavya 5% at 60 & 75 DAS as foliar, jeevamrut 500 L ha^{-1} at sowing & 10% at 30 DAS as foliar and panchagavya 5% at 60 & 75 DAS as foliar + jeevamrut 500 L ha^{-1} at sowing & 10% at 30 DAS as foliar). Doses of FYM, vermicompost and neem cake were applied as per treatments and thoroughly incorporated with the help of spade in 15 cm top soil layer. Spray of panchagavya 5% at 60 & 75 DAS as foliar, jeevamrut 500 L ha^{-1} at sowing & 10% at 30 DAS as foliar and panchagavya 5% at 60 & 75 DAS as foliar + jeevamrut 500 L ha^{-1} at sowing & 10% at 30 DAS as foliar in different treatments.

Results and Discussion

Levels of organic nutrients : In the present investigation, application of 100% RDN through 1/3 FYM + 1/3 vermicompost + 1/3 neem cake recorded significantly higher grain yield (4415 kg ha^{-1}) with an increase of 20.85% over control (3653 kg ha^{-1}). Similarly, significantly higher straw yield (5536 kg ha^{-1}) was also recorded with 100% RDN with an increase of 26.59% over control (4373 kg ha^{-1}) and maximum biological yield (9951 kg ha^{-1}) was obtained when applied 100% RDN, while minimum biological yield (8026 kg ha^{-1}) was found in control (Table 1). The combined use of different organic manures like FYM, vermicompost and neem cake are important to maintain and sustain higher level of soil fertility and nutrient availability to crop. The increase in grain yield and straw yield of wheat due to application of 100% RDN could be due to better availability of nutrients and plant growth hormones during the critical period of crop growth during the year of experiment. It may be attributed to the beneficial effects of higher yield parameters in this treatment. The aim is to meet the nutrient requirement of crops as per demand at different stages which can give higher productivity of crops. Studies showed that the combination of different sources of organics given better results and higher productivity than their individual application. The efficiency will be higher when these organics were applied in combination Reddy *et al*. (2020). Continuous mineralization and availability of nutrients as per the requirements during later stage of the plant growth might be the reason for higher values of yield attributes. The results are in close agreement with the findings of Sharma and Abraham (2010), Yadav *et al*. (2017) and Subrata *et al*. (2020).

Bio-stimulants : Bio-stimulants application registered significant improvement in most of the yield, consequently grain (4420 kg ha^{-1}), straw (5464 kg ha^{-1}) and biological yields (9884 kg ha^{-1}) over control (Table 1). The increase in grain yield and straw yield of wheat due to application of jeevamrut could be due to better availability of nutrients and plant growth hormones during the critical period of crop growth. Similar results were also observed by Shwetha (2008) and she reported that 25 to 35% increase in seed yield of soybean with the application of beejamrut, jeevamrut and panchagavya along with different organic manures. In the present study, all the yield attributing parameters were significantly higher with application of panchagavya 5% at 60 and 75 DAS as foliar + jeevamrut 500 L ha^{-1} at sowing and 10% at 30 DAS as foliar which might be due to favorable effects of IAA, GA_3, macro and micro nutrients and also due to presence of beneficial microorganisms in the liquid organic manures (Somasundaram, 2003). Whenever liquid manures are applied at regular intervals (2 to 3 times), they act as a stimulus in the plant system and in turn increase the production of growth regulators in the cell system. These

findings are in conformity with the results of Pagar *et al.* (2016).

References

1. Breiman, A., and Graur, D. 1995. Wheat evolution. *Israel Journal of Plant Sciences* 43(2): 85-98.
2. Tarafdar, J.C., Raliya, R., and Rathore, I. 2012. Microbial synthesis of phosphorous nano particle from tri-calcium phosphate using *Aspergillus tubingensis* TFR-5. *Journal of Bio nanoscience* 6(2): 84-89.
3. Devakumar, N., Rao, G.G.E. and Shuba, S. 2011. Evaluation of locally available media for the growth and development of nitrogen fixing micro-organisms. *In* Proceedings of the 3rd scientific conference of ISOFAR "Organic are life knowledge for tomorrow", held on 28 September-01 October, 2011, 504-509.
4. Reddy, K. R., Jing, H., Villapando, O., Rupesh, K. Bhomia, Vardanyan, L. and Osborne, T. 2020. Long-term accumulation of macro- and secondary elements in subtropical treatment wetlands. *Ecosphere* 12(11): e03787. 10.1002/ecs2.3787.
5. Sharma, V. and Abraham, T. 2010. Response of black gram to nitrogen, zinc and farmyard manure. *Legume Research* 33(4): 295-298.
6. Yadav, J.K., Sharma, N., Yadav, R.N., Yadav, S.K. and Yadav, S. 2017. Effect of different organic manures on growth and yield of chickpea (*Cicer arietinum* L.). *Journal of Pharmacognosy Phytochemistry* 6(5): 1857-1860.
7. Subrata, T., Md., Rahman,A., Hossain, A. and Hossain, A. 2020. Yield of greengram (*Vigna radiata* L.) and post-harvest soil fertility in response to integrated nutrient management. *Agricultural and Biological Sciences Journal* 6(1): 32- 43.
8. Shwetha, B.N. 2008. Effect of nutrient management through the organics in soybean wheat cropping system. *M.Sc. (Agri.) Thesis, University of Agriculture Science* Dharwad, Karnataka (India).
9. Somasundaram, E., Sankaran, N., Meena, S., Thiyagarajan, T.M., Chandaragi, K.K. and Panneerselvam, S. 2003. Response of greengram to varied concentrations of panchagavya (organic nutrition) foliar application. *Madras Agriculture Journal* 90(1-3): 169-172.
10. Pagar, R. D., Jangliwad, B. D. and Chaudhary, K. M. 2016. Effect of panchagavya on growth and yield of wheat (*Triticum aestivum* L.). *Advances in Life Sciences* 5(3): 756-760.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1080-1089 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Detection, Identification and Management of Common Storage Grain Insect-Pests during Quarantine Processing

Subham Kumar[1] and Kavita Gupta[2]
[1]*Department of Plant Protection, C.C.S. University Campus, Meerut-250004*
[2]*Division of Plant Quarantine, NBPGR, PUSA Campus, New Delhi-110012*

Abstract

The present work on "Detection, identification and management of common storage insect pests during quarantine processing" was undertaken to study five different storage insect pests (*Sitophilus oryzae, S. granarius, S. zeamais, Tribolium castaneum* and *Rhyzopertha dominica*) causing both internal and external damage. Their morphology and life cycles were studied in detail and the management using fumigation technique was verified. The detection of the pests was done through visual examination, observing the samples under higher magnification, sieving, etc. and upon detection the insects were separated and killed using standard insect killing agents. The insects were then card mounted and identified based on standard identification keys and their morphological characters studied. A separate sample of insects was reared in the BOD under optimal conditions of temperature and humidity for studying their life cycle. The differentiating characters including those of antenna, pronotum, elytra, pygidium and genitalia were studied for all the five species. Management option available of fumigation using EDCT (Ethylene Dichloride- Carbon Tetrachloride) mixture at normal atmospheric pressure (NAP) and ambient temperature and vacuum fumigation. The use of ethylene dichloride and carbon tetrachloride mixture (3:1) kills the stored insect pests such as *Sitophilus oryzae*, *Sitophilus granarius*, *Sitophilus zeamais*, *Tribolium castaneum* and *Rhyzopertha dominica*. It has no harmful effect on grain even if it is intended to use for seed purpose. That is why it is being used in quarantine of seed material. Atmospheric fumigation as conducted using ethylene dichloride carbon tetrachloride (EDCT) (@ 250 ml ethylene dichloride and 750 ml of carbon tetrachloride mixture) was found to be effective against all stages of pest infestation. All insect stages were found dead after 24 hrs @ 620 mg/l dose as well as after 48 hrs @ 320 mg/l dose. When vacuum was created in the fumigation chamber of atmospheric, the insects were found dead after 5 h of fumigation @ 320 mg/ l dose. This is primarily due to better penetration of the fumigant due to the vacuum created. The present study gives an insight into the detection, identification and management aspects of five serious common storage pests and these findings would be a useful reference for students and researchers interested in the important field of storage Entomology.

Key words : *Magnifying glass/illuminating magnifier, infested materials (Wheat, Rice, Maize, Bajra and Suji), Stereoscopic binocular microscope, Fumigants (EDCT) and fumigation chamber (Atmospheric and Vacuum Fumigation).*

Introduction

Insect pests are the most important biotic factors that interfere with health of seeds and plant materials, especially quality of seeds and vigor of seedlings. Several hundred species of insect and mite pests are associated with stored grain and products but only 14 species are well adapted for living in stored grain and responsible for most of damages. Minor pests constitute approximately 175 species of insects and mites that may rise to populations that are injurious to grain and grain products. The group of insects that damage stored grain can broadly be placed in two groups. The first group, internal feeders spent the most of their life feeding within the kernels of seeds and the second group, External feeders spent their life feeding on the surface of grain or on the finished products of grain (Gahukar, 1994).

The biotic potential of rice weevil is enormous i.e. at the end of 6 months the progeny of a single pair would attain 675 million adults. The young insects' stages consume large quantity of seeds. The seed damage caused by insects-pests in general may be divided in to two main categories.

1. Direct Damage : This is the group of feeding of insects' larvae and adults which resulted from either the biting and chewing (Mandibulated) type or piercing (Haustellate) type mode of feeding on developing seeds within the pods seeds. Much of the damage from seed infesting insects is done directly to the kernels, the rice weevil, granary weevil and lesser grain borer consume varying amount of endosperm.

2. Indirect Damage : Dry grain heating or wet grain heating, activates moulds, fungi, and could lead to germ activation as well. Germination is impaired or destroyed by heating or high moisture or by damage to either germ or endosperm.

The present work was undertaken to study five different storage insect pests (*Sitophilus oryzae*, *S. granarius*, *S. zeamais*, *Rhyzopertha dominica,* and *Tribolium castaneum*) causing both internal and external damage. Their morphology and life cycle was studied in

detail and the management using fumigation technique was verified.

Materials and Methods

The experiment was conducted in the Entomology Laboratory of Division of Plant Quarantine, at NBPGR, New Delhi during 2012-2013. The materials and methods used in the present project work and given below:

Infested seed materials : A total of five infested seed samples namely, Wheat, Rice, Maize, Bajra and Suji, were collected from the Division of Germplasm Conservation, NBPGR, New Delhi. The seed samples were brought to the Entomology Laboratory of Division of Plant Quarantine, at NBPGR, New Delhi for further study.

Technique for detection and identification for common storage grain insect pests :

Spread the seeds in a white tray so that every seed is clearly visible.

Sieve the material through a sieve of suitable mesh size, if required, to remove dusty material which may otherwise hamper the examination.

Examine all the seed material visually or under higher magnification (with magnifying glass illuminating magnifier or stereo binocular microscope) to detect any tale-tell signs of the pests, excreta, exuviae, damaged seeds, soil clods, plant debris, weeds, deformed and shriveled seeds, discolored.

Separate out the infested seeds, abnormal seeds, dead or living insects etc.

Keep the infested seeds in a petriplate and label it.

Keep the seeds infested with different stages of the pest in the BOD incubator at particular temperature of 25±1^{0}C and 70%±5% RH for adult emergence.

Keep the dead insects in alcohol and label it.

Research Methodology

Five species of seed feeding insects were identified and used in these experiment and the major pests of stored product collected were the rice weevils (*Sitophillus oryzae*), Wheat weevils (*Sitophilus granarius*), Maize weevils (*Sitophilus zeamais*), Red flour beetle (*Tribolium castaneum*), and Lesser grain borer (*Rhyzopertha dominica*), (Fig.-1). The collected samples from the infested seeds materials, five of each sample of Wheat, Rice, Maize, Bajra and Suji were examination under magnifying Stereoscopic binocular microscope in the laboratory. The examined revealed the following pests infesting each type of material :

1. Wheat : *Sitophilus granarius*, *Rhyzopertha dominica*

2. Rice : *Sitophilus oryzae*, *Tribolium castaneum*

3. Maize *: Sitophilus zeamais*

4. Bajra : *Tribolium castaneum*

Suji : *Tribolium castaneum*

General symptoms of seed damage:

Whole seed is consumed or reduced to dust

Internal contents of grain are eaten leaving only outer shell

Germinal portion is scraped and devoured

Scarving of grain surface or burrowing holes in them

Tunneling of the seeds

Webbing together of the grains

Some common methods are used for detection and identification of common storage insect-pest:

1. Visual examination : This is the simplest way to detect infestation in a given seed sample as it provides information on the kind of infestation that might be present. Free forms, like adults of internal feeders and all life stages of their species may be seen when the sample is examined with naked eye or under magnifying glass or stereoscopic binocular microscope depending upon the size of seed as well as that of insect stage present. Symptoms of damage caused by various pests i.e. holes, broken grains, frass, webbing etc.

2. Sieving : In a larger sample, where visual inspection is cumbersome and time consuming, different mesh sized sieves, e.g. 2 mm for wheat and 3 mm for pulses can be used to separate insects and insect forms from seeds. This method can only be successfully used for free forms and is poorly adopted for older larvae, which may get stuck in the mesh.

3. Floatation : It is based on the principle of using the density differential between healthy and infested seeds by immersing them in a liquid having density slightly lower than the seeds, so that the healthy seeds sink down at the bottom and the infested ones float on the liquid. Density required varies with different seeds and can be attained by mixing varying quantities of glycerol in water, adjusting it with hygrometer. The method needs confirmation as shriveled or under developed seeds may also float.

Mounting of Insects : The figure above illustrates the card-point method used to mount very small insects. Cut all triangular points to a uniform size, 3/8 to ½ inch long and approximately 1/8 inch wide at the base. Index card paper is a durable and sturdy material to use. A specialized point punch can assist in creating a supply of points very quickly. If a punch is available, cut a large supply at one time and keep them in a box for future use.

(a). *Sitophilus oryzae* (b). *Sitophilus granaries* (c). *Sitophilus zeamais*. (d). *Tribolium castaneum* (e). *Rhyzopertha dominica*

Fig.-1 : Five species of common storage grain insect pests detected in infested seed materials.

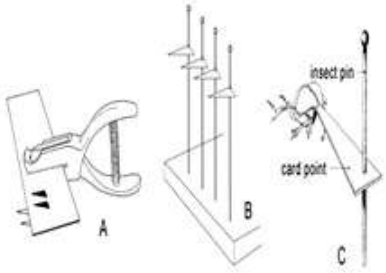
This saves time and assures that the card points are uniform. When a point punch is unavailable, a pair of fine pointed scissors will suffice. A series of card points may be cut from the pre-measured template found here. Mounting insects on card points is not difficult if you follow the correct procedure. Note from that the pin is pushed through the widest part or base of the triangle and the specimen is glued to the point. First, the card point is put on the pin, and a small amount of white glue or clear fingernail polish is placed on the tip. As little adhesive as possible is used so that body parts do not become unnecessarily covered by glue. Next, the specimen to be pointed is laid on its back on the edge of a block or thick book in such a manner that the pin can be turned upside down and the card point pressed lightly against the insect. It is important to attach the card point to the right side of the specimen. The specimens are labeled and kept in the insect collection box as given below (Fig.-2).

Results and Discussion

Detection and Identification of Pests in Seed : The following section describes in detail the various insect pests detected during visual examination. Their taxonomic details are also elaborated and the morphological characters, life cycle as study has been described.

1. Family : Curculionidae :

Curculionidae or true weevils form the largest single family in the Animal Kingdom. Many species are pests of growing crops of many kinds throughout the world, and approximately 30 species have been recorded in stored food products, three species of *Sitophilus* are of extreme importance.



(a). Mounting of Insects

(b). Insect Collection Box.

(c). Mounting and labeling

(d). Reference Collection

Fig.-2 : Collection, Mounting and labeling of Insects.

Systematic Position :

Kingdom–Animal

Class–Insecta

Order–Coleoptera

Family–Curculionidae

Genus–*Sitophilus*

Species–*oryzae, granarius & zeamais*

Common name-Weevils

1. *Sitophilus oryzae :* The rice weevil *Sitophilus oryzae* (L.) is somewhat similar to the granary weevil *S. granarius* in both appearance and habits, but is better adapted to warmer grain then *S. granarius*. The name is misleading, because it may infest other grains besides rice. It is restricted in its habitats, only in frequently breeding in commodities other than cereal grains. The larvae develop inside kernels of whole grain in storage**.** A part from the indirect effects, arising from the production of heat by the insects, the major effect of infestation by *Sitophilus* spp. is the damage to grain by feeding activities of the adults and the development of immature stages within the grain. (Longstaff, 1981 and Anonymous, 2008).

2. *Sitophilus granaries* : Granary weevil *Sitophilus granarius* (L.) along with the closely related rice weevil, is among the most destructive of all stored grain insects. The larvae develop inside kernels of whole grain in storage, thus making an infestation difficult to remove in the milling process. The granary weevil is mainly a pest of stored grains, especially in bulk storages, grain mills and elevators, and does not develop in loose flour or products unless it is compacted. (Longstaff, 1981 and Anonymous, 2008).

3. *Sitophilus zeamais :* Maize weevil, *Sitophilus zeamais*, is a pest of stored maize and of cob maize prior to harvest. Infestation initiated in the standing crop may further develop in storage as the grain dries whether stored as cobs or bulk grain. It may also infest other cereals if the moisture content is moderate or high. Apart from the indirect effects, arising from the production of heat by the insects, the major effect of infestation by the maize weevil *Sitophilus* spp. is the damage to grain by feeding activities of the adults and the development of immature stages within the grain. (Longstaff, 1981 and Anonymous, 2008).

Nature of damage : *Sitophilus* spp. is the most destructive insect pests of stored cereal in the world. Both adult and grubs damage the grain on which they feed voraciously so much so the grain is rendered unfit for human consumption as well as for the seed purposes. The grub is more injurious than adult, it makes a tiny hole in to the grain, enters inside and feeds on the content of the grain leaving only shell behind. It remains active throughout the year but serious damage is caused from July to November, moisture is important factor for its development. Under favorable condition, it is found in a large number and due to respiration "hot spot" are developed in the grain. In case of heavy infestation the grain becomes a mass of broken matter. Some time black fungus also grows (Fig.-3).

(a) Infested Wheat by *Sitophilus granarius*.

(b) Infested Maize by *Sitophilus zeamais.*

(c) Infested Rice by *Sitophilus oryza.*

Fig.-3 : Nature of damage of *Sitophilus* Spp.

Development of life stages : Complete development time for the life cycle of *Sitophilus oryzae* averaged 37 days (range 33-49) at 27 ± 1°C, and 69 ± 3% RH. (Sharifi and Mills, 1971). This is about 6 days faster than *S. granarius* under similar conditions. All three species (*Sitophilus oryzae, S. granarius* and *S. zeamais*) have similar life cycles (Fig. 4, 5 & 6). The female drills a hole into the kernel, deposits the egg, and then secretes a mucilaginous plug to enclose the egg as the ovipositor is withdrawn. The plug rapidly hardens, leaving a small raised area above the seed surface, which provides the

only external evidence that the kernel is infested. Eggs may be laid anywhere in the kernel, but few are laid in the embryo. In wheat, most eggs are deposited at the end farthest from the embryo. Sometimes, more than one egg may be laid in a single grain but it is rare for more than one larva to develop to maturity, because of cannibalism (Longstaff, 1981). Female *Sitophilus* spp. does not oviposit into all excavated holes, some are abandoned and others are expanded into feeding holes (Campbell, 2002).

Egg : Egg is deposited by the female after 5 days. The gravid female weevil makes a small cavity in the grain by means of its powerful jaws and then lays an egg in the cavity and covers it with a gelatinous fluid. Usually one egg is laid in a grain but sometimes 2 or 3 eggs may be deposited. The egg is white in colour, oval in outline and measure about 0.7 mm long and 0.3 mm broad. A single female can lay 250-300 eggs in her life span. The egg hatch in about two days during summer and 6-9 days during winter**.**

Larva : The tiny grub immediately after hatching bore into the grain kernel. The grub is white in colour with yellowish brown head, legless and provided with biting type of mouth parts. It remains inside the grain, feed on starchy content and emerges on reaching the adult weevil stage. It mouths 3 times inside the grain and become full grown in 25-35 days. The full grub is yellowish-white in colour and about 0.3 cm in length.

Pupa : The grub makes a pupal shell inside the grain and pupates there an after passing a day or two as pre-pupal period. The pupa is at first dirty white in colour but later on it changes to dark brown and measure 2.5 mm in length. The pupal stage lasts for 4-6 days during summer and 14-20 days during winter.

Adult : Newly emerged adult is reddish brown in colour which turns into black brown; about 3.5 mm in length and its head has a slender pointed forward projection (snout) with a pair of snout mandibular jaws at its extremity. The snout is about 1 mm long with clavate antennae at its base. The adult of *Sitophilus oryzae* are light brown in colour having two pairs of spots on each elytra while those are absent in *S. granarius*. The latter cannot fly as its wings are fused while *S. oryzae* and *S. zeamais* are strong fliers. The life-cycle is completed in 36-69 days and 6-8 generation are found in a year. The adult weevil may live 21-28 days in summer and 3 month in winter. The weevil hibernates during severe winter in cracks and crevices. Its life history is mainly dependent on humidity and temperature. At 70% R.H. and 70^0C temperature it is completed in 220 days, as the humidity increases it takes much less time to complete the life-cycle. During rainy season, when conditions are favourable a pair of weevil may produce 10, 00,000 insects in a season.

Sitophilus zeamais (Maize weevil) adult are larger in appearance than *S. oryzae*. Females fly readily and infect standing crop of maize, particularly when husk cover are damaged by bird and other insects. *S. zeamais* can tolerate high moisture content as cobs are infested when in milky stages. Though the species is capable of breeding in wheat, it is rarely found in cereals other than maize.

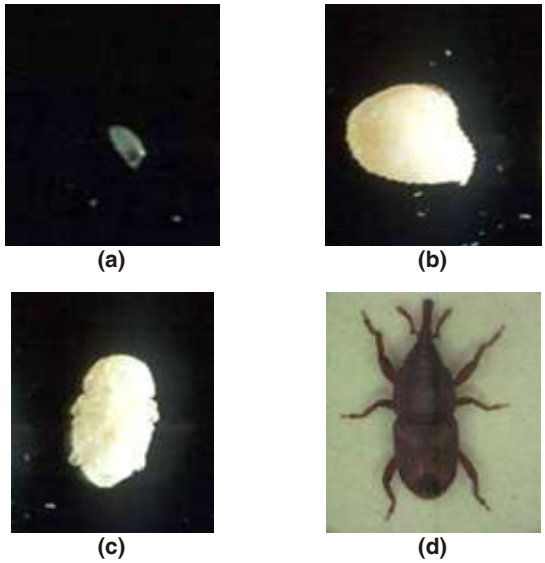


Fig.-4 : Life stages of *Sitophilus oryzae,* (a). Egg, (b). Larva, (c). Pupa & (d). Adult.

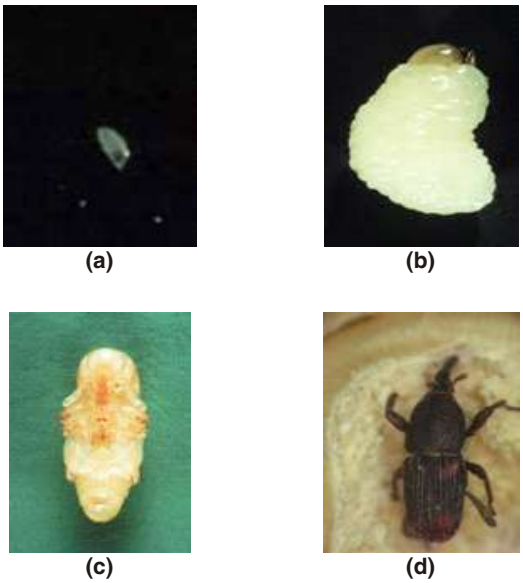
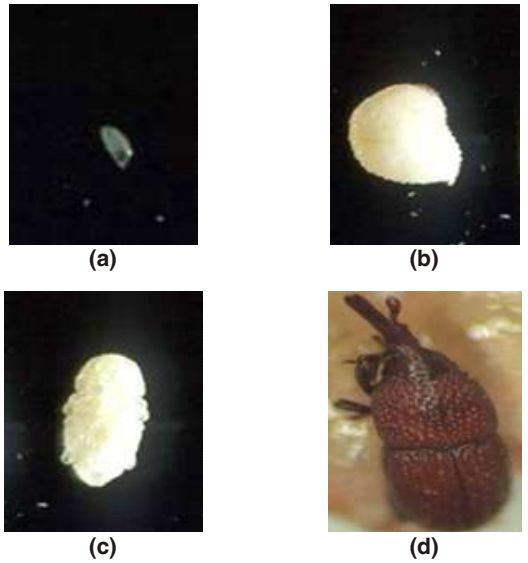


Fig.-5 : Life stages of *Sitophilus zeamais* (a). Egg, (b). Larva, (c). Pupa & (d). Adult.



(a) (b) (c) (d)

Fig.-6 : Life stages of *Sitophilus granaries*, (a). Egg, (b). Larva, (c). Pupa & (d). Adult.

A comparative description of the three species and their morphological characters in given table-1.

2. Family : Bostrychidae :

A cosmopolitan family of mainly wood-boring beetles which, particularly in the tropics and subtropics, attack felled timber or dry wood and, occasionally, unhealthy trees. Prothorax coarsely tuberculate, concealing the deflexed head. Antennae terminate in a loose three segmented club.

Systematic position :

Kingdom–Animal
Class–Insecta
Order–Coleoptera
Family–Bostrichidae
Genus–*Rhyzopertha*
Species–*dominica*
Common name–Lesser grain borer

Table-1 : Morphological Comparison for Identification of Adult *Sitophilus* species.

Characters	*Sitophilus granaries*	*Sitophilus oryzae*	*Sitophilus zeamais*
Images			
Colour	o Uniformly polished chestnut-brown or reddish-brown to shiny black in colour. The body is sparsely covered with short, stout yellow hairs.	o Usually red-brown, dull with coarse microsculpture	o Usually blacker than *S. oryzae*, with fine micro sculpture and is more shiny
Head	o The head is prolonged into a slender snout. The antennae have eight segments and are often carried in an extended position when the insect is walking.		
Prothorax	o The prothorax has distinctly oval punctures. The dorsal surface of rostrum more closely and strongly punctured in males than in females.	o Circular punctures on the prothorax	o Circular punctures on the prothorax
Scutellum		o Scutellum usually with lateral elevations closer together than their length and evidently more than half as long as scutellum.	o Scutellum with lateral elevations further apart than their longitudinal length which is about half as long as the scutellum.
Genitalia			
Male		o Males with median lobe of aedeagus evenly convex dorsally in cross section.	o Males with median lobe of aedeagus with two longitudinal grooves dorsally, except in the apical quarter, and is thus sinuous in cross section.
Female		o Females with lateral lobes of internal, Y-shaped sclerite broader and rounded apically, more narrowly separated.	o Females with lateral lobes of the Y-shaped sclerite pointed and their separation is greater than for *S. oryzae.*
Common/ Distinguishig Characters	o Sitophilus granarius are uniformly polished chestnut-brown or reddish-brown to shiny black in colour o Adults do not have wings, and therefore cannot fly.	o *S. oryzae* and *S. zeamais* are almost indistinguishable from each other externally; identification is by examination of the genitalia. o Both species usually have four pale reddish-brown or orange-brown oval markings on the elytra, but these are often indistinct. o Both species can be separated from *S. granarius* by the presence of wings beneath the elytra (absent in *S. granarius*) and by having circular, rather than oval, punctures on the prothorax.	

***Rhyzopertha dominica* :** The lesser grain borer, *Rhyzopertha dominica* (F.), though one of the smallest species of the beetles injurious to grain, is capable of doing severe damage and is rapidly becoming one of the most serious major grain pests. The species was first described by Fabricius in 1792 from a shipment of seed and roots carried from India to South America. *Rhyzopertha dominica* (F.) is one of the most economically important beetles infesting kernels. In mills and pasta factories, due to poor cleaning of machines and of processing departments, dusts, kernels and pasta debris can accumulate and become breeding ground of pests. The habitat of *Rhyzopertha dominica* is not known for certain, but originated either in India or the Indian subregion. Both larvae and adults are particularly voracious feeders, which makes this a formidable pest (Cotton, 1960 and Appert, 1987).

Nature of damage : The damage is caused by both beetle and grub but beetle is more harmful than the grub. In some places it is considered to be next to rice-weevil but other places it is reported to be causing more damage than even rice-weevil. The grubs eat out the starchy contents of the grains which are reduced to frass and waste flour. The first stage larva is straight hence it can bore easily into sound grain but in the later stages of growth it is curved, therefore, it becomes difficult for them to penetrate the grain. The grubs which are unable to penetrate the grain feed on the waste flour left by the adults. Some time adult beetles attack the grain in the field itself. The serious damage is caused during May to August (Fig.-7).

Fig.-7. Infested Wheat by *Rhyzopertha dominica.*

Development of life stages : The four developmental stages *viz*., egg, larva, pupa and adult are found its life cycle which is described as below:

Egg : The beetle starts egg laying often 4-5 days of becoming adults. The eggs are laid from April to November. The female generally laid egg on the grain near the embryo-end, which is comparatively soft and from where the newly hatched grub easily enter the grain. The eggs are pear shaped and are laid either singly or some time in clusters. They are initially white in colour which later turns into pinkish. A female can lay 300-500 egg in her life time. The hatching period varies 5-6 days during summer and 15-21 days during winter (Fig.-8a).

Larva : The newly hatched grub is quite active and white in colour, soon enters into grain generally near the comparatively soft embryo end passes the rest of the its life therein. Some of them remain feeding on the powdered starchy material without entering the grain. The larva undergoes 4-5 moults. The full grown larva is dirty white in colour with a light brown head and covered abdomen, somewhat 'C' shaped. It measures 2-3 mm in length and covered with tiny hairs. The grub period lasts for 45-50 days (Fig.-8b).

Pupa : Pupation takes place either inside the grain or outside the grain upon where grub lives. The pupa is dirty white in colour and irregular in shape. The pupal period is 7-8 days (Fig.-8c).

Adult : It is a small polished, dark brown or black beetle measuring 3-4 mm in length and a slender cylindrical body with its head turned down under the thorax. The antennae are 10 segmented and terminate in a prominent club. The life cycle is completed in 56-84 days and 5-7 generations are found in a year. The insect hibernates both as a grub and adults during December to February. They resume activity in March and adults start to lay eggs in April after 4-5 days of copulation (Fig.-8d).

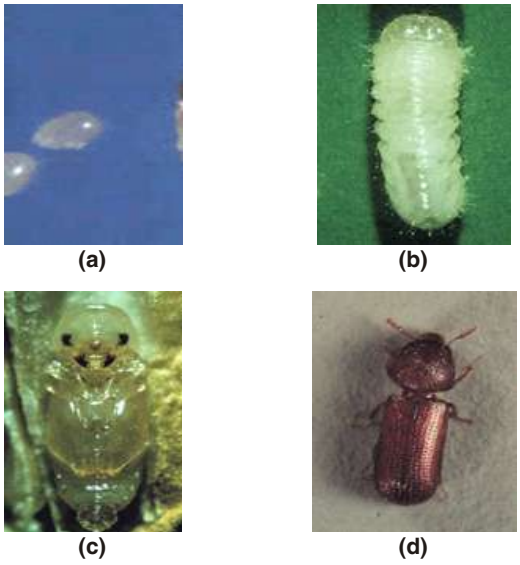


Fig.-8 : Life stages of *Rhyzopertha dominica*, (a). Egg, (b). Larva, (c). Pupa & (d). Adult.

3. Family : Tenebrionidae :

This family is represented by a number of species in the granary and ware house fauna. Except for those of the genus *Tenebrio* itself, which are the largest of stored product beetle (14-18 mm.) they are small beetles from 2.5-5 mm. long. All are reddish brown to pitchy black in

colour. The chief characters of the Tenebrionidae are the tarsi which in the front and middle legs are five-segmented and in the hind-legs are four-segmented. The family is a very large one and Hinton estimates that more than 100 species are associated with stored products.

Systematic position :

Kingdom – Animal
Class – Insecta
Order – Coleoptera
Family – Tenebrionidae
Genus – *Ttribolium*
species – *Castaneum*
Common name – Rust red flour beetle

***Tribolium castaneum* (Herbst) :** The rust red flour beetle is a worldwide pest of milled products, animal feed and processed foods. The pest attacks the already damaged seeds. Both the adult and larva cause damage. Adults are flat brown, 5-6 mm in length and reddish brown in color. Head, thorax and abdomen are distinct and antennae are club shaped. The rust red flour beetle is secondary seed feeders. Adult and larva feed on seed already damaged during harvesting, threshing, processing or by primary seed feeders. The larvae are negatively phototactic and are always found hidden in the feed. The embryo portion of seed is preferred for feeding. In severe infestation the flour turns grayish and moldy, and has a pungent disagreeable odour making it unfit for human consumption. The greatest damage is done during hot and humid monsoon season.

Nature of damage : The insect does not cause damage to whole grain but mainly feeds on broken or attacked grain by other insects. It is generally found in association with Khapra beetle, rice weevil and lesser grain borer beetle. The insects especially harmful to flour, maida and suji. In case of severe infestation flour and flour product turn grayish yellow and become mouldy which produces pungent small and become unfit for human consumption. Both grub and adult are responsible for causing damage (Fig.-9). The maximum damage is caused during rainy season.

Fig.-9 : Infested Rice by *Tribolium castaneum.*

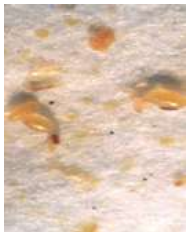
Development of life stages : The four developmental stages *viz.*, egg, larva (grub), pupa and adult are found in its life cycle which is described as below :

Egg : The female start egg lying after 2-3 days of copulation. The egg are generally laid singly in flour of among grains and being sticky, get covered with flour or dust and are difficult to detect. A single female can lay 400-500 egg in her life times, which are cylindrical and white in colour. The egg hatch in 4-12 days depending upon environmental conditions (Fig.-10a).

Larva : The young grub is small, slender and cylindrical in appearance with its body segments having a number of fine hairs and the terminal segment being in addition provided with a pair of spine like appendages. At the time of hatching the grub is 1mm long which grows up to 5 mm when fully developed. It moults 6-7 time and becomes full grown in 27 to 90 days depending upon the food available and prevailing temperature. It become full grown in 22 to 25 days (Fig. 10b).

Pupa : Usually pupation takes place on the surface of the food. Initially the pupa is white in color which gradually turns into yellowish and covered with hairs on the dorsal surface. Pupal stage lasts for 5-9 days (Fig. 10c).

Adult : It small reddish-brown beetle measuring 3.5 mm in length and 1.2 mm in breadth. The head, thorax and abdomen are distinct. The antennae are well developed and the last three segments are enlarged at terminal end. The life-cycle is completed in 38-114 days and many generations are found in a year. The beetle hibernates during winter and resumes activity in spring when they copulate after 1-2 days of their emergence. The insect does not stand colder climate and another allied species. The infestation of these beetle are successful in out witting development of other primary pest (Fig.-10d).



(a)

(b)

(c)

(d)

Fig.-8 : Life stages of *Rhyzopertha dominica*, (a). Egg, (b). Larva, (c). Pupa & (d). Adult.

Management of common storage grain insect pests during quarantine processing : The dose as per the schedule is calculated on the basis of the volume of the space containing the commodity and not the volume of the commodity. The volume of the fumigant (when dose is represented in grams) is calculated as below.

$$\text{Volume of fumigant} = \frac{\text{Required dose (grams)}}{\text{Volume of container (litres)}} \Big/ \text{Specific gravity of fumigant}$$

Research Methodology

1. Atmospheric fumigation : Atmospheric fumigation of seeds with ethylene dichloride-carbon tetrachloride against stored grain insect-pests :

Preparation of the fumigant e.g. ethylene dichloride-carbon tetrachloride (EDCT) which is mixture of two in the ratio of 3:1 (by volume). For the preparation of one litre of the mixture, 250 ml. of ethylene dichloride is put in the bottle. To this, 750 ml. of carbon tetrachloride is added. It is mixed thoroughly and stored in a brown bottle.

Packets are opened, loaded and properly arranged under normal air pressure (NAP) airtight chamber so as to facilitate the circulation of the gas in the container as well through the material.

Measured volume of dose is dispensed from a measuring cylinder onto the cotton into small evaporating pan. The cotton easily absorbs the required amount of the fumigant, EDCT (a fumigant in the liquid form), to be released slowly. As EDCT is heavier than air, it is kept on the top of the material as its vapours move downward.

Atmospheric fumigation is generally done for 48 hrs to facilitate proper penetration of the fumigant and it also saves the fumigant as the dose depends upon the concentration x time product, i.e. 320mg/ liter for 48 h and 640mg/ lit. For 24 hours.

Aeration or ventilation of fumigant after treatment is essential so as to remove the fumigant from the space and the material for the safety of the commodity as well as the environment.

2. Vacuum fumigation : The number of fumigant which may be safely used in vacuum fumigation is limited due to various technical considerations. E.g. methyl bromide - a general purpose fumigant in this fields can be used for vacuum fumigation. But under no condition phosphine can be used in vacuum fumigation as it is unstable at reduced pressure.

Air pressure in the loaded chamber is reduced by vacuum pump. Which evacuate the chamber by removing the air in the specially designed fumigation chamber, which helps in hastening the penetration of the fumigant through tightly packed material or internal infestation.

Fumigant is then introduced causing usually only a small rise in pressure. Treatment may last 1.5 to 4 hours.

Atmospheric pressure is restored by allowing air to enter.

Fumigant air mixture is then pumped out

The cycle of air introduction and evacuation is repeated several times, a process termed as `air washing' until it is considered safe to open the door for unloading.

Air washing' until it is considered safe to open the door for unloading.

Safety Precautions : As all fumigants are highly toxic to all living forms, it is imperative to take all the necessary safety precautions while undertaking any fumigation :

A fumigator must know the threshold limits of the exposure above which it is hazardous; protective clothing including gas masks must always be used.

Gas leak detectors viz., Riken gas indicators or thermal conductivity meter, concentration monitoring units, first aid, a self-contained breathing apparatus (SCBA) and anti-dotes should always be kept readily available.

he use of SCBA is mandatory when within 10 m of fumigation site, which should be cordoned off and labeled.

Conclusions

The present work on "Detection, identification and management of common storage insect pests during quarantine processing" was undertaken to study five different storage insect pests (*Sitophilus oryzae, S. granaries, S. zeamais, Rhyzopertha dominica,* and *Tribolium castaneum* causing both internal and external damage. Their morphology and life cycle was studied in detail and the management using fumigation technique was verified. The objectives of the study were to detect the pests associated with the seed material, to study their life cycle after identification on the basis of their morphological characters and to study fumigation as a method for their management.

The detection of the pests was done through visual examination, observing the samples under higher magnification, sieving etc and upon detection the insects were separated and killed using standard insect killing agents. The insects were then card mounted and identified based on standard identification keys and their morphological characters studied. A separate sample of

insects was reared in the BOD under optimal conditions of temperature and humidity for studying their life cycle. The differentiating characters including those of antenna, pronotum, elytra, pygidium and genitalia were studied for all the five species. Management option available of fumigation using EDCT (Ethylene Dichloride-Carbon Tetrachloride) mixture at normal atmospheric pressure (NAP) and ambient temperature and vacuum fumigation have also been discussed. The present study gives an insight into the detection, identification and management aspects of five serious common storage pests and these findings would be a useful reference for students and researchers interested in the important field of storage Entomology.

References

1. Birch, L.C. (1945). A contribution to the ecology of *Calandra oryzae* L. and *Rhyzopertha dominica* Fab. (Coleoptera) in stored wheat. *Trans. R. Soc., South Australia,* 69(1): 140-149.
2. Brown, W.B. and Heuser, S.G. (1953). Behaviour of fumigants during vacuum fumigation. Penetration of methyl bromide into bagged wheat feed. *J. Sci. Food Aqric.*, 4: 378-386.
3. Dawson, P.S. (1977). Life history strategy and evolutionary history of *Tribolium* flour beetles. Cited by P. Dobie, C. P. Haines, R. J. Hodges and P.F. Prevett. 1984. Insect and Arachnids of Tropical Stored Products: Their Biology and Identification. Tropical Development and Research Institute, 237 pp.
4. Golebiowska, Z. (1969). The feeding and fecundity of *Sitophilus granarius* (L.), *Sitophilus oryzae* (L.) and *Rhyzopertha dominica* (F.) in wheat grain. *Journal of Stored Products Research*, 5: 143-155.
5. Gupta, K., Bhalla, S., Kapur, M.L. and Lal, B. (2005). Insect-pests of quarantine significance in cereals. *National Bureau of Plant Genetic Resources,* New Delhi, India, pp 1-34.
6. Hassan, M. and khan, A.R. (1988). Growth and development of the red flour beetle, *Tribolium castaneum* (Herbest.) (Coleoptera: Tenebrionidae) on red lentil flour, Lens esculent. Bangladesh *J. Zool.*, 16(2): 177-180.
7. Lin, T. (1958). Bionomics studies of rice weevil, *Sitophilus oryzae* Linnaeus. Agricultural Research, 8: 44-54.
8. Longstaff, B.C. (1981). Biology of the grain pest species of the genus *Sitophilus* (Coleoptera: Curculionidae): A critical review. *Protection Ecology*, 2: 83-130.
9. Osuji, F.N.C. (1982). Development of the lesser grain borer, *Rhyzopertha dominica*, in maize kernels as affected by site of larval entry. - *Ent. Exp. et appl.*, 31: 391-394.
10. Sattigi, H.N., Kulkarni, K.A. and Lingappa, S. (1997). Biology of red flour beetle, *Tribolium castaneum* Herbst. On different cereal flour under laboratory condition. Karnataka *J. Agric.Sci.* 8 (1): 86-89.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1090-1094 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Influence of Electric, Magnetic and Biofiliming on Growth and Yield Attributing Traits on Mustard (*Brassica juncea* L.)

Venkata Chalapathi Maganti*, Bineeta Michael Bara and Prashanth Kumar Rai
Dept. of Genetics and Plant Breeding, Sam Higginbottom University of Agricultre Technology and Sciences, Prayagraj U.P.
**Corresponding Author Email : chalapathimaganti1432@gmail.com*

Abstract

The field experiment entitled "Influence of Electric, Magnetic field and Bio filming on growth, yield and yield attributing traits of mustard *(Brassica juncea* L.)" was conducted during *Rabi* 2021 at field experimental center, Department of Genetics and Plant Breeding, SHUATS, Prayagraj, (U.P). The experiment was laid out in Randomized Block Design with thirteen treatments including control which were replicated thrice. The treatments are as follows, T_0- Control, T1, T2, T3, T4, - Magnetic - 200, 400, 600, 800 gauss, T5, T6, T7, T8 – Electric – 100, 200, 300, 400 m Amp, T9, T10, T11, T12 – Bio filming @ 1% (methyl cellulose, alginate, polyvinyl glycol, no sticker) respectively. The experiment results revealed that seeds treated with Magnetic – 200 gauss gave better than other treatments *viz*, , Field emergence (96.67 %), Plant height (173.87 cm), Days to 50% flowering (59.51), no. of primary branches (7.20) and secondary branches (13.67), Days to maturity (117.66), number of siliqua per plant (295.60), number of seeds per siliqua (17.07), siliqua length (7.27), seed yield/plant (26.55 gm), seed yield per plot (2.12 gm), straw yield (4.28 gm), test weight (5.32), harvest index (35.11)were recorded significantly higher compared to other treatments.

Key words *: Mustard, electric, magnetic, bio filming, polyvinyl glycol, methyl cellulose, alginate, seed priming.*

Introduction

Rapeseed mustard crops are cultivated around the world in a variety of agricultural climatic zones, from rainwater to irrigation conditions. In India, these crops are cultivated in normal salt soils in the northeastern to western hills and in various cultivation systems. Among the various oil seeds, Indian mustard (*B. juncea* L. Czern & Coss) is one of the most important edible oil seeds, contributing to the production of 9.3 tons with a productivity of 1.5 t / ha between 2018 and 2019 (Bodh et al., 2020). Year). However, due to yield caps and biological and abiotic losses, there is a large gap between domestic edible oil supply and demand. Mustard germ plasm is a rich source of valuable genes that plant breeders can use to develop improved varieties with resistance / tolerance to a variety of biological and abiotic stresses and to increase yields. The success of breeding programs depends on the genetic diversity of the germ plasm, its intensive use and its use in improving crops (Singh *et al.* 2016a; Mishra *et al.* 2019). Parents with genetic differences, primarily associated with the number of genes and / or different allelic genotypes, resulted in good heterosis. Therefore, assessing genetic diversity between genotypes, which has a significant impact on the success of breeding programs, is important. Knowledge of the population structure, similarities, and differences of the *B. juncea* genotype helps breeders predict the best parents for the Brassica improvement program. Indian mustard is a winter crop and requires relatively cool temperatures, adequate soil moisture during the growing season, and a dry harvest season. She requires well-drained sandy loam soil and a rainwater cultivation system. It has a low water requirement (240-400 mm) suitable for. Mustard seed oils range from 35-48% and 37-42% protein in cakes. Mustard accounts for about 10% of the world's oilseed production, 5-7% of the world's vegetable oil production, almost 7% of protein meal products, and has a 27.8% share of India's oilseed economy for flour milling. It is ranked second. Yellow mustard has a yellow seed coat and is cultivated primarily for the North American seasoning industry and is used in the production of traditional yellow mustard seasonings, mayonnaise, and certain salads in his dressings. Yellow mustard seeds also contain hydrophilic mucilage and have been used as a binder and protein bulking agent in processed meats. These plants are also used as raw materials for various industrial products. The protein-rich oilseed meal obtained after the oil is extracted is used as animal feed. India is an oilseed paradise.

Static, alternating current (AC), direct current (DC), alternating current and steady-state fields are used in a wide variety of experiments around the world. Experiments were conducted on different aspects such as germination rate, germination rate, seed weight, plant height, protein content, productivity, fruit size, fruit weight, number of fruits, etc., and different Various power levels, frequencies, and durations were used. Results were determined by selection of different seeds, plants, frequencies, power levels, and lengths of time. Exposure

to electric, magnetic and electromagnetic fields can have both positive and negative effects in various combinations. Finding the right combination of different seeds, plants is important and depends on your requirements.

Materials and Methods

A research on "Influence of Electric, Magnetic field and Bio filming on growth, yield and yield attributing traits of mustard (*Brassica juncea* L)" was made to identify the effect of seed priming of different kinds on seed quality parameters of mustard and to find out suitable seed priming method for mustard. The trail was conducted in Randomized Block Design (RBD) with Twelve treatments and control which were replicated thrice. Treatments are as follows, T0- Control, (T1, T2, T3, T4, - Magnetic - 200, 400, 600, 800 gauss), (T5, T6, T7, T8 – Electric – 100, 200, 300, 400 m Amp), (T9, T10, T11, T12 – Bio filming @ 1% (methyl cellulose, alginate, polyvinyl glycol, no sticker) respectively. The mustard seeds were primed with above different priming agents in above different concentrations and intensities for a given duration. After priming seeds were dried to initial moisture content at room temperature. After that the primed seeds were used to grow under field conditions.

Results and Discussion

Pre-Harvest Observations

Plant height : The minimum plant height was exhibited by treatment T0 [control] (161.74 cm), while maximum plant height was recorded in treatment T1 – Magnetic – 200 gauss - (173.87 cm), followed by T2 - Magnetic – 400 gauss - (173.66 cm), T3 - Magnetic – 600 gauss - (168.29 cm), And T4 – Electric – 100 mA mp (168.24) was significantly higher than other significant treatments. Compared to untreated seeds, magnetic field treatment considerably increases seed output in terms of germination rate, seedling length, and seedling dry weight (control). The capability for plant seeds to germinate is increased by an appropriate magnetic field strength. Shazia Bukhari Anwer (2021) [16].

Days to 50% flowering : The minimum days to 50% flowering was exhibited by treatment T1 – Magnetic – 200 gauss (59.51), while maximum days to 50% flowering was recorded in treatment T0 – Control (65.48) followed by T9 – Bio filming(methyl cellulose) (63.93), T10 – Bio filming (Alginate) (64.39), T11 – Bio filming (polyvinyl glycol) (64.87), T12 – Bio filming (no sticker) (65.13) were significantly higher than other significant treatments.

The white mustard seedlings' metabolism changed as a result of bio magnetic priming, moving from primary to secondary metabolism. In order to revitalise aged seeds and increase germination, a suitable combination of biological priming and static magnetic field treatment can be applied.

Number of primary and secondary branches : The minimum number of branches was exhibited by treatment T0 – Control (5.47), while maximum number of branches was recorded in treatment T1 – Magnetic – 200 gauss (7.20) followed by T6 – Electric 200 mA mp (6.73) was significantly higher than other significant treatments. The minimum Number of secondary branches was exhibited by treatment T0 [control] (8.67), while maximum Number of secondary branches was recorded in treatment T1 – Magnetic – 200 gauss - (13.67) was significantly higher than other significant treatments. Afrasiyab (2020) [2] proposed that the electric field affected plant growth, that seed germination rate was improved, study proved that cellular metabolism can be positively increased by the application of appropriate electric field intensities, and registered the positive effect of 3, 6, 9 and 12 V intensities of the electric field in some parameters, including plant height, root length, and leaf number in chickpea plants.

Days to maturity : The minimum Days to maturity was exhibited by treatment T1 – Magnetic (117.66), while maximum Days to maturity was recorded in treatment T0 – Control - (127.88), followed by T11 – bio filming (polyvinyl glycol) (123.20), T12 – bio filming (no sticker) (123.49) were significantly higher than other significant treatments. Magnetic field treatment in order to improve germination and seedling growth of *Festuca arundinacea* Schreb and *Lolium perenne* L., it was found that magnetic field significantly decreased the time of germination (e.g. 10% compared to the control); however, root characters of treated seedlings increased significantly compared to the control (Carbonnel *et al.,* 2008) [6].

Yield Attributes

Number of siliquas per plant : The minimum number of siliqua/plants was exhibited by treatment T0 [control] (255.00), while maximum number of siliqua/plants was recorded in treatment T1 – Magnetic – 200 gauss - (295.60) was significantly higher than other significant treatments. De Souza *et al*. (2005) [1] It was suggested that seed manipulation with a magnetic field increased tomato average fruit weight, fruit yield and biological yield. Increased maize germination rate, shoot weight and seedling length were recorded when the seeds were exposed to a magnetic field.

Number of seeds per siliqua **:** The minimum number of seeds/siliquas was exhibited by treatment T0 [control] (12.80), while maximum number of seeds/siliquas was recorded in treatment T1 – Magnetic – 200 gauss - (17.07) was significantly higher than other significant

Table-1 : Analysis of variance for effect of "Influence of Electric, Magnetic field and Bio filming on growth, yield and yield attributing traits of mustard (*Brassica juncea* L.)"

S. No.	Characters	Mean sum of squares		
		Replications (d. f = 2)	Treatments (d. f = 12)	Error (d. f = 24)
1.	Plant height	37.50	46.79*	18.49
2.	Days to 50% flowering	2.04	9.71*	3.52
3.	Number of Primary branches	1.43	2.80*	0.82
4.	Number of Secondary branches	1.25	15.35*	0.61
5.	Number of siliquas per plant	38.41	333.90*	20.62
6.	Number of seeds per siliqua	3.02	4.02*	0.61
7.	Days to maturity	5.88	27.14	7.91
8.	Length of siliqua	0.07	0.90*	0.04
9.	Seed yield per plant	6.09	34.21*	1.30
10.	Seed yield per plot	0.001	0.02*	0.01
11.	Straw yield	0.03	0.19	0.03
12.	Test weight	0.08	0.30	0.04
13.	Harvest index	4.81	5.29	1.41

*Indicates significant at 5% level of significance.

Table-2 : Influence of Electric, Magnetic and Bio – filming on plant height, days to 50% flowering, number of branches, number of secondary branches.

Treatment	Plant height	Days to 50% flowering	Number of primary branches	Number of secondary branches	Days to maturity
T0 – Control	161.74	65.48	5.47	8.67	127.88
T1	173.87	59.51	7.20	13.67	117.66
T2	173.66	60.98	5.40	8.73	117.91
T3	168.29	61.33	5.53	8.60	118.23
T4	168.24	61.87	5.53	7.60	118.79
T5	167.61	62.41	5.07	7.47	118.79
T6	166.25	62.93	6.73	11.00	119.13
T7	166.13	63.76	5.13	6.53	119.29
T8	164.26	63.90	4.33	6.13	121.88
T9	164.00	63.93	4.27	6.47	122.39
T10	163.27	64.39	4.27	6.13	122.77
T11	163.27	64.87	6.33	10.00	123.20
T12	162.10	65.13	4.20	6.07	123.49
F test	S	S	S	S	S
S. Em (±)	2.48	1.08	0.52	0.45	1.62
CD (p=0.05)	7.25	3.17	1.53	1.32	4.73

treatments. .A Matwijczuk *et al* (2012) [3] Magnetically treated water increases the permeability of seed cell membranes, affects calcium ions, and inhibits the growth of microorganisms that are harmful to seed germination and plant growth processes.

Length of siliqua : maximum length of siliqua was recorded in treatment T1 – Magnetic – 200 gauss - (7.27) was significantly higher than other significant treatments. Corn seeds exposed to a magnetic field of 125 mT or 250 mT for different periods germinated faster and the treated seedlings became taller and heavier. In wheat, Pittman and Ormrod [10] found that seedlings grown from magnetically treated seeds (180 mT) absorbed more water, breathed more slowly, and received less heat energy than untreated controls. Reported that it released and grew faster. In soybeans

Seed yield per plant : The minimum number of seeds yield per plant was exhibited by treatment T0 [control] (14.09 gm), while maximum number of seed yield per plant was recorded in treatment T1 – Magnetic – 200 gauss - (26.55 gm) was significantly higher than other significant treatments. Use of a magnetic field *Festuca arundinacea* Schreb and *Lolium perenne* L. were found to benefit from improved germination and seedling growth. It

Table-3 : Influence of Electric, Magnetic and Bio – filming on Number of siliquas per plant, Number of seeds per siliqua, Length of siliqua seed yield per plot, seed yield per plant.

Treatment	Number of siliquas per plant	Number of seeds per siliqua	Length of siliqua	Seed yield per plant	Seed yield per plot
T0 – Control	255.00	12.80	5.27	14.09	1.83
T1	295.60	17.07	7.27	26.55	2.12
T2	262.33	13.87	6.83	16.98	1.96
T3	267.67	13.60	6.87	17.22	1.92
T4	267.87	13.67	6.77	16.71	1.89
T5	265.67	13.67	6.70	16.04	1.91
T6	268.93	14.93	7.00	19.40	1.94
T7	260.53	13.40	6.63	14.94	1.83
T8	258.47	13.40	6.80	15.81	1.88
T9	256.27	13.13	6.10	14.20	1.81
T10	257.73	13.00	6.13	14.37	1.84
T11	263.33	14.27	6.77	18.09	1.89
T12	256.47	12.60	5.84	13.94	1.85
F test	S	S	S	S	S
S Em (±)	2.62	0.45	0.11	0.66	0.03
CD (p=0.05)	7.65	1.32	0.33	1.92	0.08

Table-4 : Influence of Electric, Magnetic and Bio – filming on Test weight, straw yield, harvest index.

Treatment	Test weight	Straw yield	Harvest Index
T0–Control	4.26	3.97	29.95
T1	5.32	4.28	35.11
T2	4.72	3.77	34.22
T3	4.73	3.68	34.28
T4	4.57	3.69	33.87
T5	4.51	3.95	32.75
T6	4.82	3.93	34.89
T7	4.38	3.51	34.59
T8	4.46	3.50	32.88
T9	4.22	3.46	33.75
T10	4.29	3.49	33.91
T11	4.80	3.79	34.50
T12	4.24	3.48	33.73
F test	S	S	S
S Em (±)	0.11	0.09	0.68
CD (p=0.05)	0.33	0.29	2.00

was discovered that the magnetic field significantly sped up the time of germination (by 10% compared to the control), but that the root characteristics of treated seedlings increased significantly compared to the control (Carbonnel *et al.,* 2008) [6].

Seed yield per plot : seed yield per plot was recorded was recorded higher in treatment T1 – Magnetic – 200 gauss - (2.12) was significantly higher than other significant treatments. According to Radha Krishna R. *et al.* (2018) [11], seed yield is a measure of how well a plant has grown and how well it has adapted to biotic and abiotic variables, both of which are often started by a plant as it moves through the life cycle. Wheat seeds that have undergone electro priming retain healthy hormonal balances, produce more enzymes, produce a wider variety of metabolites, and produce more grain overall.

Straw yield : The minimum straw yield was exhibited by treatment T0 [control] (3.97), while maximum straw yield was recorded in treatment T1 – Magnetic – 200 gauss - (4.28) was significantly higher than other significant treatments. Florez *et al.* (2004) [5] observed an increase for the initial growth stages and an early sprouting of rice seeds exposed to 125 and 250 mT stationary magnetic field.

Test weight : The minimum test weight was exhibited by treatment T0 [control] (4.26), while maximum test weight was recorded in treatment T1 – Magnetic – 200 gauss - (5.32) was significantly higher than other significant treatments. Rochalska *et al.* (2008) [12] investigated the effects of low frequency magnetic fields on sugar beet output and quality. treatment of seeds with a low frequency magnetic field prior to sowing (16 Hz, 5mT). The emergence of seeds was accelerated by magnetic treatments, particularly for weak seeds. The plant's yield increased as a result.

Harvest index : The minimum harvest index was exhibited by treatment T0 [control] (29.95), while maximum harvest index was recorded in treatment T1 – Magnetic – 200 gauss - (35.11), followed by T2 - Magnetic – 400 gauss (34.22), T3 - Magnetic – 600 gauss (34.28), T4 - Magnetic – 800 gauss (33.87), T6 – Electric – 200 mA mp (34.89), T7 - Electric – 300 mA mp (34.59), T9 – bio

filming (methyl cellulose) (33.75), T10 – bio filming (alginate) (33.91), T11 – bio filming (polyvinyl glycol) (34.50), T12 – bio filming (no sticker) (33.73) was significantly higher than other significant treatments. Zheng and XU Jian (2009) [17] investigated the impact of varied magnetic field strengths and treatment times on wheat seed germination and photosynthetic properties. In this study, the wheat seed germination rate, germination energy, vigour index, seedling chlorophyll content, and net photosynthetic rate, as well as the intercellular CO_2 concentration, stomatal conductance, and inspiration rate, were determined. The outcomes demonstrated that the majority of the aforementioned indices were greater in treated seeds and seedlings than in the control.

Conclusions

It is concluded from the present study that the seeds of mustard (*Brassica juncea* L)" were treated with Magnetic – 200 gauss (T1) showed significant increase in seed yield per plant (26.55 g), seed yield per plot (2.12 g). Findings are based on research done in one season in Prayagraj (Allahabad) U.P. further trails may be required for considering it for the recommendation.

References

1. De Souza, D. Garcia, L. Sueiro, L. Licea, and E. Porras, "Presowing magnetic treatment of tomato seeds: effects on the growth and yield of plants cultivated late in the season," *Spanish Journal of Agricultural Research,* vol. 3, no. 1, pp. 113–122, 2005
2. Afrasiyab, J. Zafar, H. Muhmmad (2020). Effect of electric field on seed germination and growth parameters of chickpea *Cicer arietinum* L. 10(4), 12-16.
3. Matwijczuk, K. Kornarzyñski*, and S. Pietruszewski (2012). Effect of magnetic field on seed germination and seedling growth of sunflower 26, 271-278.
4. Bodh PC, Yadav RK, Sharma A, Yadav M, Arora N, Dawar S, Prasad G (2020). Pocket Book of Agricultural Statistics. In: Dir. Econ. Stat. Dep. Agric. Coop. Farmers Welfare. Minist. Agric. Farmers Welfare, Gov. India. https://eands.dacnet.nic.in/PDF/Pocket Book 2019.pdf. Accessed 14 Jul 2021.
5. Florez, M., 2005. "Exposure of maize seeds to stationary magnetic fields: Effects on germination and early growth," Environmental and Experimental Botany, 2005.
6. Carbonell, M.V., Martínez, M., Flórez, M., Maqueda, R., López-Pintor, A. and Amaya, J.M. (2008). Magnetic field treatments improve germination and seedling growth in *Festuca arundinacea* Schreb. and *Loliumperenne* L. *Seed Science and Technology* 36, 31-37.
7. Elham Bagheri Abyaneh, Ahmad Majd, Sayeh Jafari, Golnaz Tajaddod, Fahimeh Salimpour (2014). Influence of the Electromagnetic Fields on Some Biological Characteristics of *Lepidium sativum* L., 8(4): 980-984.
8. Kavi, P. S. (1977). The effect of magnetic treatment of soybean seed on its moisture absorbing capacity [India]. *Science and Culture,* 43(9): 405-406.
9. Naz, A., Jamil, Y., ul Haq, Z., Iqbal, M., Ahmad, M. R., Ashraf, M. I., et al. (2012). Enhancement in the germination, growth and yield of Okra (*Abelmoschus esculentus*) using pre-sowing magnetic treatment of seeds. *Indian J. Biochem. Biophys.* 49, 211–214
10. Pittman, U.J., and Ormrod, D.P. (1970). Physiological and chemical features of magnetically treated winter wheat seeds and resultant seedlings. *Canadian journal of plant science,* 50(3), 211-217.
11. Radhakrishnan, R. (2018). 'Seed pre-treatment with magnetic field alters the storage proteins and lipid profiles in harvested soybean seeds'. *Physiology and Molecular Biology of Plants* 24(2): 343-347.
12. Rochalska, M. (2005). Influence of frequent magnetic field on chlorophyll content in leaves of sugar beet plants. Nukleonika 50, S25–S28. Rochalska, M. (2008). The influence of low frequency magnetic field upon cultivable plant physiology. *Nukleonika* 53, S17–S20.
13. Rochalska, M., and Orzeszko-Rywka, A. (2005). Magnetic field treatment improves seed performance. Seed Sci. Technol. 33, 669–674. doi: 10.15258/sst.2005.33.3.14.
14. Racuciu M, Creanga D, Horga I (2008). Plant growth under static Magnetic field influence. *Rom. J. Phys.* 53: 353-359.
15. Singh BK, Mishra DC, Yadav S (2016a) Identification, characterization, validation and crossspecies amplification of genic-SSRs in Indian Mustard (*Brassica juncea*). *J Plant Biochem Biotechnol* 25: 410–420. https://doi.org/10.1007/s13562-016-0353-y
16. Shazia Anwer Bukhari, Muhammad Tanveer, Ghulam Mustafa and Nighat Zia-Ud-Den (2021) Magnetic Field Stimulation Effect on Germination and Antioxidant Activities of Pre sown Hybrid Seeds of Sunflower and Its Seedlings.
17. XU Jian-Ping, LI Lan, LV Li-Ya, ZHANG Xiao-Song, CHEN Xi-Ming, WANG Jian-Feng, ZHANG Feng-Ming, ZHONG Wei, DU You-Wei (2009) Structural and Magnetic Properties of Fe-Doped Anatase TiO_2 Films Annealed in Vacuum, vol 26 (9).
18. Xianzong XIA (2020) Effect of low frequency magnetic field (LFMF) on seed quality of radish (*Raphanus sativus* L.) *seeds:* vol.48 (3).

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1095-1098 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Biochar on Soil Nutrients Availability after Harvest of Wheat (*Triticum aestivum* L.) under Water Stress Condition

Naresh Kumar[1], S.K. Intodia[1], M.K. Kaushik[1], R.H. Meena[2] and Devendra Jain[3]

[1]*Department of Agronomy, RCA (MPUAT), Udaipur, Rajasthan*

[2]*Department of Soil Science and Agricultural Chemistry, RCA (MPUAT), Udaipur, Rajasthan*

[3]*Department of MBBT, RCA (MPUAT), Udaipur, Rajasthan*

Abstract

A field experiment was conducted at Rajasthan College of Agriculture (MPUAT), Udaipur (Rajasthan) during *rabi* season of 2021-22 to evaluate the effect of water stress and biochar application on soil parameter and available nutrient content in soil after harvest of wheat. The experiment was consists of four levels of water stress as main-plot and four levels of biochar as sub-plot conducted in split plot design (SPD) replicated thrice. Results revealed that water stress at various growth stages and biochar had no effect on soil pH, electrical conductivity and bulk density. Water stress at flowering and grain filling stages resulted in higher organic carbon and available nitrogen content in soil as compared to no water stress. Further, water stress at tillering flowering and grain filling stages increased available phosphorus and potassium in soil over no water stress. Application of biochar @ 2 t/ha, 3 t/ha and 4 t/ha improved organic carbon, available nitrogen, available phosphorus and available potassium contents in soil as compared to control, except biochar @ 2 t/ha in respect of organic carbon.

Key words *: Biochar, water stress.*

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops and grown in wide range of climatic environment and geographic regions of the world (Dixon et al., 2009). In India wheat is grown in 31.45 M ha area with production of 107.59 MT and productivity 3421 kg/ha^{-1}, while in Rajasthan it is cultivated in 3.12 M ha area with production and productivity of 10.92 M T and 3501 kg ha^{-1}, respectively (DAC and FW, 2020). Currently water scarcity has become the leading menace to curtail crop productivity around the globe (Hussain et al., 2008). Water stress is major harmful factor in arid and semi-arid regions worldwide that limits the area under cultivation and yield of crops. Drought is observed in irrigated areas due to insufficient supply of water and canal closure. Recently, biochar is getting importance worldwide to improve the water holding capacity and physiochemical properties of soil.

Biochar is a carbon-rich co-product resulting from pyrolyzing biomass. When applied to the soil it resists decomposition, effectively sequestering the applied carbon and mitigating anthropogenic CO2 emissions. Zhang et al. (2012) reported that application of biochar to calcareous and infertile dry croplands poor in soil organic carbon will enhance crop productivity and reduce GHGs emissions. Other benefits of biochar application to soil include increased plant productivity and reduced nutrient leaching. Biochar soil amendment can affect leaf N status and photosynthesis, but the effect varied with soil type (Xu et al., 2015). Biochar is preferred due to its unique properties of low density (providing additional void age and aeration in the soil), significant adsorption and cation exchange capacity, and the ability to promote living microbiology in the soil. Due to these properties, biochar has the capacity to increase the soil carbon reserves by holding the soil nutrients and thus helps in building and maintain soil fertility.

The main purposes of this investigation were the studying of the effect of water stress on soil fertility status and the effect of biochar application to soils at different rates under plant water stress on soil nutrients availability after harvest of wheat.

Materials and Methods

The field experiment was conducted at Rajasthan College of Agriculture, MPUAT, Udaipur during rabi season of 2021-22. The soil of experimental site was clay-loam in texture, slightly alkaline in reaction (pH 8.5), electrical conductivity (1.01 dS/m at 250 C), bulk density (1.44 mg/m3), organic carbon (0.70 %), medium in available nitrogen (278.42 kg/ ha) and phosphorus (18.07 kg/ha), while high in available potassium status (312.45 kg/ha). Treatments comprised of sixteen treatment combinations consisting of four water stress [No water stress (W1), water stress at tillering (W2), water stress at flowering (W3) and water stress at grain filling stage (W4)] as main plot and four biochar levels (0, 2, 3 and 4 t/ha) as sub plot were tested in SPD with three replications. In water stress treatments, water stress was imposed at tillering,

flowering and grain filling stage of the crop as per treatments, whereas in no water stress six irrigations were provided at critical growth stages of wheat. Biochar was prepared at the Department of Renewable Energy Engineering, College of Technology and Engineering, Udaipur from the twigs of trees, weeds and agricultural waste. The chemical composition of biochar is being mentioned in Table-1. Biochar was applied as per treatments and mixed well in soil prior to sowing of the crop. Recommended dose of fertilizers i.e., 90 N, 60 P_2O_5 and 40 K_2O kg/ ha were applied through commercial fertilizers viz., urea, DAP and MOP. After harvest of the crop, soil samples were collected from the random spots from each plot and then it was pooled to make a composite sample for soil testing, which was of about 500 g. Samples were oven dried at 650 C till the constant weight was achieved. Soil organic carbon, pH, EC, bulk density, available nitrogen, phosphorus and potassium were analyzed from the soil samples. Following methodologies and procedures were adopted for determination of soil–

Soil Parameters	Method of analysis	Reference
Bulk density (mg m^{-3})	Core sampler method	Piper (1950)
Electrical conductivity (dSm^{-1} at 25°C)	Conductivity bridge	Richards (1968)
pH (1:2.5 soil water suspension)	pH meter	Piper (1950)
Organic carbon (%)	Rapid titration method	Walkley and Black (1934)
Available nitrogen (N kg/ha)	Alkaline $KMnO_4$ method	Subbiah and Asija (1956)
Available phosphorus (P_2O_5 kg/ ha)	Olsen's method	Olsen *et al.* (1954)
Available potassium (K_2O kg/ha)	Flame photometer	Jackson (1973)

Data were analyzed statistically for analysis of variance (ANOVA). Treatments were compared by computing the 'F-test'. The significant differences between treatments were compared by critical difference at 5% level of probability (Panse and Sukhatme, 1989).

Results and Discussion

The pH value, electrical conductivity and bulk density of the experimental field were 8.5, 1.01 dS/m at 25°C and 1.44 mg/m3, respectively and data indicated that water stress at various stages of crop growth and biochar had no significant effect on soil pH, electrical conductivity and bulk density (Table-2). The water stress and biochar had significant effect in increasing organic carbon content in soil organic carbon content and their interaction also affected organic carbon. Water stress at flowering and grain filling stage estimated higher organic carbon in soil as compared to no water stress. Biochar application @ 2t/ha and @ 3t/ha had significant effect in increasing organic carbon. Interestingly in treatment water stress at grain filling stage, application of biochar @ 3 t/ha and 4t/ha had significant effect in increasing organic carbon over control and biochar @ 3 t/ha (Table-3).

Table-1 : Chemical and mineral composition of biochar.

S. No.	Parameters	Quantity (%)
1.	Carbon	82.90
2.	Hydrogen	2.80
3.	Nitrogen	0.80
4.	Oxygen	9.35
5.	H / C	0.03
6.	O / C	0.11
7.	Moisture	3.82
8.	Calcium	0.03
9.	Iron	0.0045
10.	Zinc	0.028
11.	Sodium	0.09
12.	Potassium	0.12
13.	Sulphate	0.022
14.	Nitrate	0.0014

The soil nutrients availability was affected by different treatments (Table-3). Water stress at tillering, flowering and grain filling stages had significant effect in increasing available nitrogen, available phosphorus and available potassium in soil after harvest of crop over no water stress. In fact, is present study water stress imposed at various growth stages of crop significantly reduced the nutrient uptake by the crop. This might be reason, why higher nutrient contents (N, P and K) in soil were estimated in water stress treatments. Biochar application caused significant improvement in available nutrient contents (Nitrogen, Phosphorus and Potassium) in soil after harvest of crop over control. Biochar @ 2t/ha, 3 t/ha and 4 t/ha increased available nitrogen content in soil by 7.63, 10.8 and 11.36 kg/ha, respectively over control. Corresponding increases in available phosphorus and potassium content were 1.17, 1.31 and 1.55 kg/ha and 8.26, 12.28 and 13.72 kg/ha, respectively. Biochar improved soil chemical properties because of its ability to absorb soluble organic matter and inorganic nutrients (Thies and Rillig, 2009). Lehmann and Rondon (2006) reported that biochar can adsorb both NH_4^+ and NH_3^- from the soil solution. Biochar is very efficient at adsorbing dissolved solute nutrients such as ammonium (Lehman *et al*., 2002), nitrate (Mizuta *et al*., 2004), phosphate (Beaton *et al*., 1960), and other ionic solutes (Radovic *et al*., 2001). Biochar as reported by Jia *et al*. (2015) can absorb leachate which can help to absorb organic matter, total soluble N, plant available P, and K, thereby increasing the nutrient retention capacity of the soil.

Table-2 : Effect of water stress and biochar on soil pH, EC, Bulk density and organic carbon in soil after crop harvest.

Treatments	Soil properties at harvest			
	Soil pH	EC (dS/m)	Bulk density (mg/m^3)	Organic carbon (%)
Water stress				
Control (no water stress)	8.20	0.6209	1.451	0.617
Water stress at tillering	8.19	0.6004	1.417	0.624
Water stress at flowering	8.15	0.5888	1.403	0.644
Water stress at grain filling	8.07	0.5810	1.388	0.655
CD (P=0.05)	NS	NS	NS	0.022
Biochar application				
Control	8.18	0.5953	1.418	0.618
2 t/ha	8.17	0.5969	1.416	0.626
3 t/ha	8.15	0.5969	1.413	0.645
4 t/ha	8.10	0.6020	1.412	0.650
CD (P=0.05)	NS	NS	NS	0.014

Table-3 : Interaction effect of water stress and biochar on organic carbon (%) in soil after harvest of the crop.

Water stress	Biochar			
	Control	2 t/ha	3 t/ha	4 t/ha
Control (no stress)	0.601	0.619	0.624	0.623
Water stress at tillering	0.622	0.623	0.625	0.628
Water stress at flowering	0.641	0.644	0.644	0.646
Water stress at grain filling	0.609	0.619	0.686	0.705
CD (P=0.05)	0.028			

Table-4 : Effect of water stress and biochar on nutrient status of soil after crop harvest.

Treatments	Available nutrient content in soil (kg/ ha)		
	Nitrogen	Phosphorus	Potassium
Water stress			
Control (no water stress)	241.72	20.84	351.69
Water stress at tillering	249.69	22.17	366.62
Water stress at flowering	252.59	22.94	371.02
Water stress at grain filling	254.46	22.85	370.93
CD (P=0.05)	8.47	0.61	10.16
Biochar application			
Control	242.17	21.19	356.50
2 t/ha	249.80	22.36	364.76
3 t/ha	252.97	22.50	368.78
4 t/ha	253.53	22.74	370.22
CD (P=0.05)	4.83	0.51	6.09

References

1. Beaton, J.D., Peterson, H.B. and Bauer, N. 1960. Some aspects of phosphate adsorption by charcoal. *Soil Science Society of America Journal* 24(5): 340-346.
2. DAC and FW. 2020. Agricultural statistics at a glance. Website: http://eands.dacnet.nic.in retrieved on dated 02-10-2021.
3. Dixon, J., Braun, H. J. and Crouch, J. 2009. Overview: transitioning wheat research to serve the future needs of the developing world. *Wheat Facts and Futures* 23: 1.
4. Hussain, M., Malik, M.A., Farooq, M., Ashraf, M.Y. and Cheema, M.A. 2008. Improving drought tolerance by exogenous application of glycine betaine and salicylic acid in sunflower. *Journal of Agronomy and Crop Science* 194: 193-199.
5. Jackson, M.L. 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi.
6. Jia, X., Yuan, W. and Ju, X., 2015. Effects of biochar addition on manure composting and associated N_2O emissions. *Journal of Sustainable Bioenergy Systems* 5(02): 56.
7. Lehmann, J., da Silva Jr, J.P., Rondon, M., Cravo, M.D.S., Greenwood, J., Nehls, T., Steiner, C. and Glaser, B. 2002, August. Slash-and-char-a feasible alternative for soil fertility management in the central Amazon. *In*

Proceedings of the 17th World Congress of Soil Science 1-12 Thailand.

8. Mizuta, K., Matsumoto, T., Hatate, Y., Nishihara, K. and Nakanishi, T. 2004. Removal of nitrate-nitrogen from drinking water using bamboo powder charcoal. *Bioresource Technology* 95(3): 255-257.
9. Olsen, S.R., Cole, C.V., Wantnable, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soil by extraction with HNO_3. United States Department of Agriculture Handbook No 60.
10. Panse, V.G. and Sukhatme, P.V. 1989. Statistical methods for agricultural workers Indian Council of Agricultural Research, New Delhi.
11. Piper, C.S. 1950. Soil and plant analysis. Interscience Publisher, New York, USA.
12. Radovic, L.R., Moreno-Castilla, C. and Rivera- Utrilla, J. 2001. Carbon materials as adsorbents in aqueous solutions. *Chemistry and Physics of Carbon* 227-406.
13. Richards, L.A. 1968. Diagnosis and improvement of saline and alkaline soils. United States, Department of Agriculture, Handbook No. 60. pp-432.
14. Thies, J.E. and Rillig, M.C. 2009. Characteristics of biochar: biological properties. In Biochar for environmental management, 117-138.
15. Walkley, A. and Black, I.A. 1934. An examination of digestion method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science* 37(1): 29-37.
16. Xu, C., Hosseini-Bai, S. and Hao, Y. 2015. Effect of biochar amendment on yield and photosynthesis of peanut on two types of soils. *Environmental Science and Pollution Research* 22: 6112–6125.
17. Zhang, A., Liu, Y., Pan, G., Hussain, Q., Li, L., Zheng, J. and Zhang, X. 2012. Effect of biochar amendment on maize yield and greenhouse gas emissions from a soil organic carbon poor calcareous loamy soil from central china plain. *Plant and Soil* 351(1): 263-275.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1099-1102 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Individual and Combined Effect of Seed Priming with Biofertilizers on Seedling Parameters of Wheat (*Triticum aestivum* L.)

Akumalla Melle Sugandha, Bineeta. M. Bara, Prashanth Kumar Rai and D. Filomina
Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, U.P.

Abstract

The present study entitled, "Individual and Combined Effect of Seed Priming with Biofertilizers on Seedling Parameters of Wheat (*Triticum aestivum* L.)" was carried out to assess the effect of seed priming with biofertilizers during 2021-2022 to find the suitable seed treatment for wheat. Fifteen treatments along with control consists of Distilled water, Azotobacter, PSB, and Azospirillum in different concentrations individual and combination as well. A completely Randomized Design was used for Statistical Analysis. The results indicated that all treatments recorded significant variation for seedling parameters that were studied. The treatment T4 (Individual) – Phosphate Solubilizing Bacteria @5ml/kg for 12 hours significantly recorded the higher values for seedling characters, *viz.,* seed germination percentage (96.67), speed of germination (17.30), shoot length (7.66), root length (12.62), seedling length (20.04), seedling fresh weight (2.29), seedling dry weight (0.43), seed density (1.42), seed vigour index-I (1924.24), seed vigour index-II (41.12) and treatment T13 (combined) - Azotobacter + Phosphate Solubilizing Bacteria recorded significantly higher values for seedling characters, *viz.,* seed germination percentage (97.33), speed of germination (17.60), shoot length (8.52), root length (13.60), seedling length (21.84), seedling fresh weight (2.33), seedling dry weight (0.48), seed density (1.43), seed vigour index-I (2158.76), seed vigour index-II (46.07), in compared with other treatments, and lowest recorded in control. This study helps to find the best suitable seed treatment.

Key words : *Seed priming, biofertilizers, seed treatments, germination, seed vigour.*

Introduction

Seed is the basic input of agriculture and agriculture is the foundation of India's national economy. Seed is the carrier of the genetic potential for higher crop production. A good quality seed may contribute to national agriculture development. Good quality seed is presumed to possess a high seed vigour, high germination percentage, free from seed-borne disease, and high yielding ability. Seed quality is one of the major factors that determine the success or failure of a crop.

The self-pollinated, *Triticum aestivum* L. is among the most recognized staple food crop in the world known as the "King of cereals". Wheat also provides minerals, vitamins, essential amino acids, and dietary fibre to the human diet, and particularly these are enriched whole-grain contents (Shewry and Hey 2015). For the bulk of the world's population, wheat (*Triticum aestivum* L.) is the most essential and strategic cereal crop. It is the most important staple food of about two billion people (36% of the world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. It outnumbers all other grain crops in terms of acreage and production (including rice, maize, and others).

Currently, agriculture has become heavily reliant on cost-intensive crop inputs such as inorganic fertilizers and pesticides (Das and Mandal, 2015). Seed is the most fundamental input required to sustain agriculture.

Seed treatment is the application of beneficial microorganisms on seeds for supplying essential nutrients and restricting pests and diseases. Heydecker (1973) successfully used seed priming to improve germination and emergence under stressful conditions. Several investigations confirmed that seed priming has many benefits including higher water use efficiency, increase in root growth, uniform germination in a wide range of temperatures, break of seed dormancy, better competition with weed, early flowering and maturity, resistance to environmental stresses accompanying with higher grain yield in wheat (Ghana and William, 2003). In cold areas where the farming period is short, primed seeds can lead to the early emergence of plants and provide proper opportunity to achieve tolerance against cold weather conditions. In case of delay in farming, seed treatment is needed to compensate the postponement. In limited water resource access conditions, seed treatment will provide a cost-effective irrigation. Seed priming causes an increase in performance and a decrease in waste of water because of the early establishment of crops during the winter period and enhances the plant's tolerance ability to many unfavourable conditions.

Biofertilizers are rated as the one of most promising alternatives to chemical fertilizer application. Azospirillum, Azotobacter, Azola, blue-green algae, Phosphate

solubilizing microorganisms, *sinorhizobium*, and *mycorrhizae* are among the most prominent microorganisms that act as effective biofertilizers (Me Carty *et al*., 2017). Seed treatment is an inexpensive and effective technique of applying beneficial microorganisms as a biofertilizer for eco-friendly management of plant nutrients and diseases, respectively that enhance the uniform plant stand establishment. *Azotobacte*r is the most common free-living heterotrophic bacterium having a valuable role in case of crop production. Bio-fertilizer normally contains microorganisms which are having a particular function such as N2 fixation by *Azospirillum* and phosphorus solubilisation by phosphorus solubilizing bacteria from the soil and fertilizer which are to be available for plants (Saraswati and Sumarno 2008).

Chemically based products have been widely used in agricultural fields that promote plant production and plant growth. These agents are toxic that accumulate in the plant and in the soil that is harmful to humans and the environment. It considers the negative impacts of products in agriculture. In search of more sustainable and eco-friendly ways to improve agriculture products. So researchers have focussed their attention on organically based products with biofertilizers a valuable resource for crop production and protection. The use of biofertilizer increases crop yield, and active soil biologically; restores natural soil fertility, provides protection against drought and some soil-borne diseases and stimulates- plant growth.

Materials and Methods

The present study entitled "Individual and Combined Effect of Seed Priming with Biofertilizers on Seedling Parameters of Wheat (*Triticum aestivum* L.)" under post - graduate laboratory of Seed Science and Technology was conducted in the Department of genetics and plant breeding, Sam Higginbottom University of Agriculture and Technology Sciences, Prayagraj. Prayagraj is located in the South-East part of Uttar Pradesh, India. The lab experiment was analysed by using C.R.D. (Completely Randomized Design) seeds of wheat DBW-187 (Karan Vandana) with four replications and 15 treatments under laboratory condition with control (dry seeds), seed priming with distilled water (12hours), Azotobacter(liquid) @5ml/kg, Azotobacter (powder) @25g/kg, Phosphate Solubilizing Bacteria(PSB) (liquid) @5ml/kg, Phosphate Solubilizing Bacteria(PSB) (powder) @25g/kg, Azospirillum @15g/kg, Seed Priming + Azotobacter (liquid), Seed Priming + Azotobacter (powder), Seed Priming + PSB(liquid), Seed Priming + PSB (powder), Seed Priming + Azospirillum, Azotobacter + PSB, Azotobacter + Azospirillum of seed as per recommended dosage. Afterwards, primed seeds were allowed to dry back to their moisture content under shade to access the parameters.

The germination test was conducted using four replicates of 100 seeds each in between paper and incubated in the germination room. The germination room was maintained at 25 ± 2? temperature and 90 ±5% RH. The germination percent, Seedling length, Root and Shoot length, Seedling fresh and dry weight, and Seedling vigour index- I and II was calculated on the 8th day. The seedling vigour index was determined by multiplying the percent germination and total seedling length.

The observation on the characters *viz.,* Germination percent (ISTA 2004), Speed of Germination, Root length (cm), Shoot length (cm), Seedling length (cm), Seedling fresh weight (g), Seedling dry weight (g), Seed Density (g/cm3) Seedling vigour index – I and Seedling vigour index–II (Baki and Anderson 1973) were recorded. The experimental data recorded were subjected to statistical analysis for calculating analysis of variance, range, mean, and critical difference (Fisher 1936).

Results and Discussion

The results on the effect of seed priming with biofertilizers on seedling parameter of wheat were present in Table-1.

The present investigation was carried out to assess seedling parameters in 15 treatments of wheat under laboratory conditions. The Germination percentage ranged from 82.67 to 97.33% with a Grand Mean of 92.18%. The maximum Germination percentage was exhibited by treatment (T13) Azotobacter + Phosphate Solubilizing Bacteria (97.33%) Followed by Phosphate Solubilizing Bacteria (T4) (97%). Whereas minimum Germination percentage was depicted by treatment (T0) control (82.67%).

Speed of germination significant differences across the treatments ranges from 13.03 to 17.60. The maximum speed of germination was exhibited by treatment (T13) Azotobacter + Phosphate Solubilizing Bacteria (17.60) Followed by Phosphate Solubilizing Bacteria (T4) (17.37). Whereas the minimum speed of germination was depicted by treatment (T0) control (13.03).

Shoot length ranged from 5.81 cm to 8.52 cm with grand mean value of 7.05cm. The maximum shoot length was observed in the treatment (T13) Azotobacter + Phosphate Solubilizing Bacteria (8.52cm) followed by the treatment Phosphate Solubilizing Bacteria (T4) (7.66cm). Whereas the minimum shoot length was observed in the T0 control (5.81cm).

Root length ranged from 9.16 cm to 13.60 cm with grand mean value of 11.18cm. The maximum root length was observed in the treatment (T13) Azotobacter +

Table-1 : Effect of seed priming with biofertilizers on seedling parameters of wheat.

Treatments	Germination %	Speed of Germination	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Seedling fresh weight (g)	Seedling dry Weight (g)	Seed Density (g/cm^3)	Vigour index length (cm)	Vigour index mass (g)
T0	82.67	13.03	5.81	9.16	15.58	1.81	0.29	1.18	1289.77	24.23
T1	88.67	14.80	7.44	11.35	18.57	2.14	0.33	1.22	1645.66	29.57
T2	84.67	14.40	6.70	11.25	16.84	2.01	0.41	1.26	1423.34	34.65
T3	92.00	16.33	5.90	9.85	15.64	1.93	0.38	1.21	1435.13	34.97
T4	97.00	17.37	7.66	12.62	20.04	2.29	0.43	1.42	1924.24	41.12
T5	96.00	16.63	7.18	11.03	17.96	2.08	0.40	1.29	1724.16	38.72
T6	90.67	15.93	7.29	11.22	18.29	1.92	0.34	1.40	1657.61	30.8
T7	95.00	17.03	7.48	11.30	18.53	2.08	0.33	1.35	1761.24	31.33
T8	93.67	16.63	6.90	10.87	17.54	1.92	0.35	1.4	1641.57	32.43
T9	95.00	17.10	6.71	10.40	16.88	1.85	0.42	1.20	1602.43	40.88
T10	90.33	17.30	7.55	12.41	19.67	2.16	0.35	1.36	1776.24	31.61
T11	89.33	16.30	6.20	10.34	16.33	1.92	0.33	1.36	1459.85	29.8
T12	96.00	16.03	7.53	10.91	18.14	2.15	0.4	1.26	1741.3	38.16
T13	97.33	17.60	8.52	13.60	21.84	2.33	0.48	1.43	2158.76	46.07
T14	95.33	16.50	6.86	11.33	18.01	1.90	0.43	1.21	1717.64	41.02
MEAN	92.18	16.17	7.05	11.18	17.99	2.03	0.38	1.30	1663.93	35.02
MAX.	97.33	17.60	8.52	12.62	21.84	2.33	0.48	1.43	2158.76	46.07
MIN.	82.67	13.03	5.81	9.16	15.58	1.81	0.29	1.18	1289.77	24.23
SEM	1.47	0.46	0.29	0.72	0.9	0.07	0.02	0.06	82.41	1.53
CD @ 5%	4.31	1.29	0.78	2.08	2.18	0.18	0.05	0.27	225.98	5.18

T0-Control, T1-Seed Priming with Distilled Water, T2-Azotobacter (liquid), T3-Azotobacter (powder), T4-PSB (liquid), T5-PSB (powder), T6-Azospirillum, T7-Seed Priming+Azotobacter (liquid), T8-Seed Priming+Azotobacter (powder), T9-Seed Priming+PSB (liquid), T10-Seed Priming+PSB (powder), T11-Seed Priming+Azospirillum (12g/kg), T12-Seed Priming+Azospirillum (15g/kg), T13-Azotobacter+PSB, T14-Azotobacter+Azospirillum.

Phosphate Solubilizing Bacteria (13.60cm) followed by the treatment Phosphate Solubilizing Bacteria (T4) (12.62cm). Whereas the minimum Root length was observed in the T0 control (9.16cm).

The Seedling length is associated with the earliness of the treatment in respect of emergence, plant growth, and potential. In this investigation, the treatment exhibited a wide range of seedling length (15.58cm to 21.84cm) with significant differences. The maximum and significantly higher seedling length was observed for (T13) Azotobacter + Phosphate Solubilizing Bacteria (21.84cm) followed by Phosphate Solubilizing Bacteria (T4) (20.04cm). The minimum value of seedling length was noted in control (T0) 15.58cm. The general mean for this trait was 17.99cm.

Seedling Fresh Weight significant differences across the treatments range of 1.81g to 2.33g. The maximum seedling fresh weight was exhibited by treatment (T13) Azotobacter + Phosphate Solubilizing Bacteria (2.33g) Followed by Phosphate Solubilizing Bacteria (T4) (2.29g). Whereas minimum seedling fresh weight was depicted by treatment (T0) control (1.81g).

Seedling Dry Weight significant differences across the treatments range of 0.29g to 0.48g. The maximum seedling dry weight was exhibited by treatment (T13) Azotobacter + Phosphate Solubilizing Bacteria (0.48g) Followed by Phosphate Solubilizing Bacteria (T4) (0.43g). Whereas minimum seedling dry weight was depicted by treatment (T0) control (0.29g).

The Seed Density ranged from 1.18g/cm3 to 1.43g/cm3. The maximum Seed density was exhibited by treatment (T13) Azotobacter + Phosphate Solubilizing Bacteria (1.43 g/cm3) Followed by Phosphate Solubilizing Bacteria (T4) (1.42 g/cm3). Whereas minimum Seed density was depicted by treatment (T0) control (1.18 g/cm3).

The mean performance of the treatment for seedling vigour index length varied significantly and ranged from 1289.77cm to 2158.76cm. The highest value of vigour index length was observed in (T13) Azotobacter + Phosphate Solubilizing Bacteria (2158.76cm) followed by Phosphate Solubilizing Bacteria (T4) (1924.24cm). The minimum value of vigour index length was recorded in T0 control (1289.77cm. Germination percentage and seedling length were the major factors for deciding the vigour index length. All fifteen treatments of wheat showed a significant and wide range of variability seedling vigour index mass from 24.23g to 46.07g. The highest value of seedling vigour index mass was recorded in (T13) Azotobacter + Phosphate Solubilizing Bacteria (46.07g) followed by Phosphate Solubilizing Bacteria (T4) (41.12g). The overall mean of treatments for this character is 35.02g.

Seed treatments perform a significant role in the

management of seed borne pathogens whose responsible for causing diseases that affect the radicle emergence, seed germination, seedling emergence, and growth of crops (Kay, 2012; Taha *et al*., 2013). In seeds of wheat, seeds treated with, Phosphate solubilizing bacteria (individual), Azotobacter+PSB (combined), showed the maximum seed quality improvement in standard germination, speed of germination, root length (cm), shoot length (cm), seedling length (cm), seedling fresh weight (g), seedling dry weight (g), seed density, vigor index-I, vigor index-II. The outcomes and results were in favour of biofertilizers treatments to enhance the performance of seed quality by El-Sirafy *et al*. (2006) in wheat, Narula *et al.,* 2005 in cotton, Zaki *et al.,* 2009 in rice, Mahato *et al*., 2017 in maize treated with Azotobacter, Harinathan *et al*., 2016 in pearl millet treated with PSB. The maximum germination and vigour was observed in seed treated with T4- Phosphate Solubilizing Bacteria and T13 – Azotobacter + Phosphate Solubilizing Bacteria. It might be due to the biofertilizers helped the seed in mobilizing the essential nutritional elements from non-usable to usable form via biological processes and nitrogen fixing properties of bioinoculants along with the encouragement to seed for nutrient uptake by Me Carty *et al*. (2017) in wheat by using Azotobacter and PSB, Singh *et al*. (2008) in black gram. Dalvi *et al.* (2015) in wheat and mungbean. Treatment with control showed the minimum germination percentage and vigor in treatments as compared to other treatments.

Conclusion

It is concluded from the present study, on the basis of mean performance, the treatment with Azotobacter + Phosphate Solubilizing Bacteria has been identified as the best seed treatment for the seedling parameters *viz*., Germination percent, Speed of Germination, Shoot length, Root length, Seedling length, Seed Density, Seedling Vigour Index – I and Seedling Vigour Index – II.

References

1. Abnavi, M. S., Shafiei, M., & Ghobadi, M. (2012). The effects of source of priming and post-priming storage duration on seed germination and seedling growth characteristics in wheat (*Triticum aestivem* L.). *Journal of Agricultural Science*, 4 (9), 256-68.
2. Bhattacharya, S., and Bose, B. (2017). Influence of Seed Priming on Germination and Seedling Growth of Cicer arietinum L. *International Journal of Advances in Agricultural & Environmental* (IJAAEE) Vol. 4, Issue 1 (2017) ISSN 2349-1523 EISSN 2349-1531.
3. Buyela S.N., Muthomi J.W., Mwanombe A.W., Njau P. and Olubayo F., (2018). Effect of seed treatment on wheat seed viability and vigor. *American Journal of Agricultural Science*, 5(1): 1-9.
4. Elien, L., Lomme, J. D., Niels, D. B., Wannes, L., Maurice, P., Prinsen, E., and Delcour, J. A. (2019). The impact of hydro-priming and osmo-priming on seedling characteristics, plant hormone concentrations, activity of selected hydrolytic enzymes, and cell wall and phytate hydrolysis in sprouted wheat (*Triticum aestivum* L.). *American Chemical Society Omega*, 4, 22089-100.
5. Freiberg, J. A., Ludwig, M. P., Avelar, S. A. G. and Girotto, E., (2017). Seed treatment and its impact on wheat crop yield potential. *Journal of Seed Science,* 39(3): 280-287.
6. Ghana, S. G., and William, F. S. (2003). Seed priming of winter wheat for germination, emergence and yield. *Crop Science*, 43, 2135-41.
7. Harinathan, B., Sankaralingam, S., Palpperumal, S., Kathiresan, D., Shankar, T. and Prabhu, D., (2016). Effect of phosphate solubilizing bacteria on growth and development of pearl millet and ragi. *Journal of Advances in Biology & Biotechnology*, 1-7.
8. ISTA, (2011). International rules for seed testing. Chapter 5: The Germination Test. ISBN 978-3-906549-53-8. *International Seed Testing Association*, Baserdorf, Switzerland.
9. ISTA, (1999). International rules for seed testing. *Seed Science & Technology*. 23: 1-334.
10. Kader, M.A., Milan, M.H. and Hoque, M.S. (2002) Effects of Azotobacter innoculant on the yield and nitrogen uptake by wheat. Online *J. Bio. Sci*. 2 (4): 259-261.
11. Krishna, A., Patil, C.R., Raghavendra, S.M., and Jakati, M.D. (2008). Effect of biofertilizer on seed germination and seedling quality of medicinal plants. *Karnataka Journal of Agricultural Sciences*, 21(4), 588-590.
12. Lemrasky, M.G., and Hosseini, S.Z. (2012). Effect of seed priming on the germination behaviour of wheat. *International Journal of Agriculture and Crop Sciences*, 4 (9): 564-67.
13. Maguire, J.D. (1962). Speed of germination-aid selection and evaluation for seedling emergence and vigor. *Crop Science*. 2: 176-177.
14. Pathak, A., Chakrabarti, S.K., Das, R. and Mandal, M.K., (2016). Response of different wheat varieties towards Azospirillum and phosphate solubilizing bacteria (PSB) seed inoculation. *Journal of Applied and Natural Science*, 8(1): 213-217.
15. Rao, M.B., Tanksale, A. M., Ghatge, M.S. and Deshpande, V. V. (1998). Molecular and biotechnological aspects of microbial proteases. *Microbiology and Molecular Biology Reviews*. 62: 597-635.
16. Sharma, K.K., Singh, U.S., Sharma, P., Kumar, A. and Sharma, L., (2015). Seed treatments for sustainable agriculture a review. *Journal of Applied and Natural Science*, 7(1): 521539.
17. Shewry, P.R. and Hey, S.J., (2015). The contribution of wheat to human diet and health. *Food and energy security*, 4(3): 178-202.
18. Singh, R.R. and Prasad, K., (2011). Effect of bio-fertilizers on growth and productivity of wheat (*Triticum aestivum*). *International Journal of Farm Sciences*, 1(1): 1-8.
19. Yasaria, E., and Chepib, O.G. (2014). Response of wheat seed to priming combinations. *Agricultural Advances*, 3(2), 48-55.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1103-1106 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Assessment of different priming methods on growth and seed yield attributes of French bean (*Phaseolus vulgaris* L.) Var. Arka suvidha

Mereddy Sai Krishna Reddy[1]*, Bineeta Michael Bara[1] and Prashant Kumar Rai[2]
[1]*M.Sc. Scholar, Department of Genetics and Plant Breeding, SHUATS, Prayagraj.*
[2]*Assistant Professor, Department of Genetics and Plant Breeding, SHUATS, Prayagraj*

ABSTRACT

An experiment entitled "Assessment of different priming methods on growth and seed yield attributes of French bean (*Phaseolus vulgaris* L.)" was conducted during *Rabi 2021-22* at the field experimentation centre. of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) The trial was conducted in Randomized Block Design(RBD) with three replications and thirteen treatments. The treatments were T_0 (Control), T_1 (Priming with moringa leaf extract @2%), T_2 (Priming with moringa leaf extract @6%), T_3 (Priming with moringa leaf extract @8%), T_4 (Priming with Gibberellic acid @80ppm), T_5 (Priming with Gibberellic acid @100ppm), T_6 (Priming with Gibberellic acid @150ppm) T_7 (Priming with *Pseudomonas fluorescens* @ 0.4%) T_8 (Priming with *Pseudomonas fluorescens* @ 0.6%) T_9 (Priming with *Pseudomonas fluorescens* @ 0.8%)T_{10} (Priming with *Trichoderma harzianum* @0.4%)T_{11} (Priming with *Trichoderma harzianum* @0.6%) T_{12} (Priming with *Trichoderma harzianum* @0.8%) seeds of French bean variety Arka suvidha was taken and different priming treatments were done for 12 hours followed by growing the crop in the field as per recommended package of practices. Observations on 12 characters were taken during the experiment. Among 13 treatments treatment T6 found to be superior for maximum growth and yield of French bean followed by T9. The present study concludes that priming with Gibberellic acid and *Pseudomonas fluorescens* @150 ppm and 0.8% respectively for 12 hours performs best with respect to growth and yield parameters and reduces disease incidence in French bean crop.

Key words : *Gibberellic acid, Pseudomonas fluorescens, Trichoderma harzianum*

Introduction

French bean or common bean (*Phaseolus vulgaris* L.) is one of the most important leguminous crop it has chromosome number 2n = 22 it is an annual short duration crop grown under different cropping patterns. It is native to South America domesticated in Mexico, Peru and Colombia about 8000 years ago and now it is widely cultivated in tropics, subtropics and temperate regions of the world (Singh, 2001). The world production of green beans was 23.6 million tonnes, led by China with 79% of the total world dried bean production was 26.8 million tonnes with Myanmar, India and Brazil as leading producers. In India it is largely grown in hilly areas of Himachal Pradesh, Uttarakhand, Jammu and Kashmir and North Eastern states during summer and as winter and autumn crop in parts of Uttar Pradesh, Maharashtra, Karnataka, Andhra Pradesh Punjab, Haryana, Bihar, Gujarat, Madhya Pradesh and Tamil Nadu, having an area of 230078 ha with Annual production of 647965 tonnes with a productivity of 28163 kg/ha French bean is consumed as immature tender fruits and green grains as vegetables and mature seeds as pulses (rajmash).It has some Medicinal properties in control of Diabetes, Cardiac problems, and natural cure for bladder burn, depurative, diuretic, dropsy, dysentery, eczema, hiccups, kidney resolcarminative and reparative properties against Constipation and diarrhea as reported by (Duke, 1981). Availability of quality seeds is considered crucial for realizing productivity and adoption of crop to different agro climatic zones. Quality of seeds alone increase 10-15% more productivity. Lack of quality seeds continues to be one of the greatest impediment to bridge the vast yield gap Seed priming is a modern technique of quality enhancement of seed which is often used as seed invigoration treatment for rapid, uniform as well as to improve germination of seeds as well as optimum plant stand in field. The beneficial as well as important role of seed priming is that it enhances the moisture content of seed and increases 35-40% of its weight and ultimately activates the biochemical events, advancing seed germination process with radical emergence. Various priming methods like hydro-priming, osmo-priming, halo-priming, biopriming, hormonal priming, botanical priming are used in horticultural crops to increase speed and uniformity of germination and improve field stand. Seed priming with hormone solutions referred to as hormonal priming, it plays an important role in seed metabolism, which enhances seedling growth and yield by increasing nutrient uptake through enhanced physiological activities and root production among the plant growth regulators IAA, cytokinin, Gibberellic acid,

Salicylic acid are commonly used for seed priming. Biopriming is an innovative technique to treat the seeds which integrates inoculating beneficial bio agents to protect the seeds it is considered to be the best method for managing many seeds and soil borne pathogens. (Waren & Bennet, 2000). In this context the present experiment was appraised the effect of diverse priming methods for seed quality enhancement of French bean.

Materials and Methods

The present investigation was carried out to study the effect of different priming methods on growth and seed yield attributes of French bean (*Phaseolus vulgaris* L.) at the central research field of Seed Science and Technology in the department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini Agriculture Institute, Prayagraj (U.P). Field experiment was laid out in Randomized Block Design (RBD) with treatment material consists 12 treatments and untreated (control) seeds of French bean and three replications respectively respectively during Rabi 2021-22. viz., T_0 Control,T_1 Moringa leaf extract 2% (12Hrs),T_2 Moringa leaf extract 6% (12Hrs),T_3 Moringa leaf extract 8% (12Hrs),T_4 Gibberellic acid 80 ppm (12Hrs),T_5 Gibberellic acid 100 ppm (12Hrs), T_6 Gibberellic acid 150 ppm (12 Hrs),T_7 *Pseudomonas fluorescens* 0.4% (12 Hrs),T_8 *Pseudomonas fluorescens* 0.6% (12Hrs), T_9 *Pseudomonas fluorescens* 0.8% (12Hrs), T_{10} *Trichoderma harzianum* 0.4% (12Hrs),T_{11} *Trichoderma harzianum* 0.6% (12Hrs),T_{12} *Trichoderma harzianum* 0.8% (12Hrs),The untreated seeds served as control. The soaked seeds were surface dried for one day and were evaluated for the growth and seed yield attributing parameters viz., Field emergence percentage, Plant height (30,60DAS), Number of primary branches, Days to 50% flowering, Number of Pods per plant, Number of seeds per pod, yield of pod per plant Seed yield per plot, Seed index, Biological Yield, Harvest index to find the best treatment result in French bean variety Arka suvidha

Results and Discussions

Effect of different priming methods on growth parameters

The mean performance of field emergence percentage ranged from 71.90 to 89.52 with mean value of 80.94. Maximum field emergence percentage (89.52) was recorded by T_6 with priming of Gibberellic acid (@150ppm). Minimum field emergence percentage was recorded by T_0 (71.90) with control as shown in(table 1).It was might be due to hydration with GA3 aided in initiation of early sprouting and resulted in accelerated the germination on account of which field emergence was enhanced. The similar results were obtained by (Ahmed *et al*., 2014) in Chickpea, (Narayanaswamy *et al*., 2012) in ground nut The mean performance of plant height at 30 DAS ranged from19.50 to 24.50 with mean value of 21.95. Maximum plant height (24.50) was recorded by T_6 with priming of Gibberellic acid (@150ppm) and minimum plant height was recorded by T_0(19.50) with control. The mean performance of plant height at 60 DAS ranged from 38.80 to 45.90 with mean value of 42.26. Maximum plant height (45.90) was recorded by T_6 with priming of Gibberellic acid (@150ppm) and minimum plant height was recorded by T_0 (38.80) with control as shown in (table 1).The increase in plant height and spread is due to GA3 which might be due to enhanced vegetative growth by active cell division, enlargement and cell elongation and thus concluded in better vegetative and reproductive growth Similar findings were reported by (R.V Sathavahana and L. Edwin 2022) in lentil The mean performance of number of Primary branches ranged from 2.87 to 4.52 with mean value of 3.59. Maximum number of Primary branches (4.52) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) minimum number of Primary branches was recorded by T_0 (2.87) with control as shown in(table 1).It might be due to increased rate of cell division, cell enlargement, and protein synthesis associated with high dry matter accumulation in the plant. Similar findings were reported by (Chavan *et al*., 2013) in soyabean. The mean performance of number of days to 50% flowering ranged from 45.00 to 48.00 with mean value of 48.00. Minimum number of days to 50% flowering (45.00) was recorded by T_6 with priming of Gibberellic acid (@150ppm) and maximum number of days to 50% flowering was recorded by T_0 (48.00) with control as shown in (Table-1). The earliness of Flowering might be due to the effect of GA3 that helps in regulating the activities of sub-apical meristem as well as flower initiation in many species. These results are in agreement with (Pushpalatha, 2008)

Effect of different priming methods on Yield Parameters

The mean performance of number of pods per plant ranged from 20.20 to 32.39 with mean value of 25.97. Maximum number of Pods per plant (32.39) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) and minimum number of pods per plant was recorded by T_0 (20.20) with control as shown in (Table-2) this might be due to increase in number of flowers, primary and and secondary branches per plant results increase in photosynthesis, biomass act as source for maximum pod setting. Similar findings were reported by **(Moosavi *et al.,* 2014)** in Soyabean. The mean performance of number of seeds per pod ranged 3.73 to 5.23 with mean value of 4.61. Maximum number of seeds per pod (5.23) was

Table-1 : Mean performance of different treatments for pre-harvest characters in French bean.

Treatments	Field emergence %	Plant height at 30 DAS	Plant height at 60 DAS	Number of Primary Branches	Days to 50 % Flowering
T_0	71.90	19.50	38.80	2.87	48.00
T_1	74.94	20.10	40.20	2.95	47.00
T_2	73.13	21.70	40.90	3.27	47.66
T_3	76.91	21.90	41.70	3.29	46.00
T_4	83.09	21.60	41.80	3.98	46.00
T_5	88.29	23.90	44.50	4.32	45.00
T_6	89.52	24.50	45.90	4.52	45.00
T_7	79.60	21.50	41.90	3.31	46.66
T_8	80.21	22.30	42.50	3.35	46.00
T_9	86.80	22.80	43.90	4.14	46.00
T_{10}	79.46	20.90	40.50	3.30	48.00
T_{11}	84.26	22.50	43.30	4.01	46.00
T_{12}	84.10	22.20	43.50	3.39	47.00
G mean	80.94	21.95	42.26	3.59	48.00
SEd +	3.0	0.4	0.7	0.18	0.45
CD @ 5%	8.7	1.2	2.0	0.52	1.32
F test	S	S	S	S	S

Table 2 : Mean performance of different treatments for post harvest characters in French bean.

Treatments	Number of Pods Per Plant	Number of Seeds Per Pod	Yield of Pod Per Plant (gm)	Seed yield per plot (gm)	Seed Index (gm)	Biological yield (gm)	Harvest index
T_0	20.20	3.73	114.13	324.33	34.91	1016.33	31.91
T_1	21.82	4.10	123.83	373.53	35.19	1065.53	35.05
T_2	22.51	4.23	127.92	377.00	36.14	1069.00	35.26
T_3	23.21	4.30	128.60	381.93	36.99	1073.93	35.54
T_4	26.50	4.70	147.30	404.26	35.16	1096.26	36.87
T_5	28.50	5.10	173.40	420.80	36.09	1112.80	37.80
T_6	32.39	5.2	202.60	509.86	39.21	1201.86	42.41
T_7	26.20	4.53	136.20	397.00	35.95	1089.00	36.45
T_8	27.50	4.96	168.40	445.06	36.20	1137.06	39.13
T_9	30.40	5.13	175.30	485.00	38.52	1177.00	41.19
T_{10}	24.60	4.46	134.20	400.86	35.72	1092.86	36.67
T_{11}	28.30	4.90	164.30	457.13	36.31	1149.13	39.77
T_{12}	25.50	4.60	132.00	431.20	36.91	1123.20	38.38
G mean	25.97	4.61	148.33	416.00	36.41	1108.00	37.42
SEd +	1.13	0.16	6.24	7.43	0.25	7.44	0.42
CD @ 5%	3.28	0.48	18.20	21.69	0.74	21.73	1.22
F test	S	S	S	S	S	S	S

recorded by T_6 with priming of Gibberellic acid (@150ppm) and minimum number of seeds per pod was recorded by T_0 (3.73) with control as shown in (table 2). The mean performance of yield of pod per plant ranged from 114.13 to 202.60 with mean value of 148.33 maximum pod yield per plant (202.60) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) minimum pod yield per plant was recorded by T_0 (114.13) with control as shown in (Table-2). The mean performance of Seed yield per plot ranged from 324.33 to 509.86 with mean value of 416.00 maximum seed yield per plot (509.86) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) and minimum seed yield per plot was recorded by T_0 (324.33) with control as shown in (table 2). This might be

due to higher field emergence percentage, number of Primary branches and secondary branches per plant, number of Pods per plant and seed yield per plant, similar findings were reported by (Setareh Rastin *et al.,* 2013). The mean performance of seed index ranged from 34.91 to 39.21 with mean value of 36.41 maximum seed index (39.21) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) and minimum seed index was recorded by T_0 (34.91) with control as shown in (Table-2). This might be due to increase in moisture content with initial increase in membrane permeability and osmotic potential of seed, high water absorption rate. The mean performance of biological yield ranged from 1016.33 to 1201.86 with mean value of 1108.00 maximum biological yield (1201.86) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) and minimum biological yield (1016.33) was recorded by T_0 with control as shown in (Table-2). The mean performance of harvest index ranged from 31.91 to 42.41 with mean value of 37.42.maximum harvest index (42.41) was recorded by T_6 with priming of Gibberellic acid (@150 ppm) and minimum harvest index (31.91) was recorded by T0 with control as shown in (Table-2).

Conclusion

It can be concluded that priming with gibberellic acid @150 ppm concentration gives better results in growth and yield characters. Priming with *Pseudomonas fluorescens* @ 0.8% also performed best respect seed yield attributing characters, hence hormonal and biopriming with gibberellic acid and *Pseudomonas fluorescens* respectively are the best priming methods in enhancing French bean production when practiced by farming community.

References

1. Ananthi, M.; Selvaraju, P. and Sundaralingam, K. (2017). Evaluation of seed biopriming with biocontrol agents and biopesticides spraying on pests and its effect on seed yield and quality in chilli. *Journal of Environmental Zoology Sciences* 5(4) : 667-672
2. Ahmed, J.; Lodhi, M. S.; Saeed, M.; Asghar, M. and Shahwani, N. (2014). Influence of different Hydropriming times on seed germination and yield of chickpea under ecological conditions of quetta. *Life Science: An International Journal* 8 (1, 2, 3, & 4): 3048-3052.
3. Brocklehurst, P. A. and Dearman, J. (1983) Interactions between seed priming treatments and nine Seed lots of carrot, celery and onion. II. Seedling emergence and plant growth. *Annals of Applied Biology* 102 (3): 585–593
4. Begum, M. M.; Sariah, M.; Puteh, A. B.; Abidin, Z. M. A.; Rahman, M. A. and Siddiqui, Y. (2010). Field Performance of bio-primed seeds to suppress Colletotrichum truncatum causing damping-off and Seedling stand of soybean. *Biological Control* 53: 18-23
5. Bowers, J. H.; Locke, J. C.; (2000). Effect of botanical Extracts on the population density of *Fusarium Oxysporum* in soil and control Of Fusarium wilt in the greenhouse. *Plant Disease.* 84(3): 300-305
6. Chavan, N. G.; Bhujbal, G. B. and Manjare, M. R. (2013). Effect of seed priming on field Performance and seed yield of soybean [*Glycine max* (L.) Merill] varieties. *The Bioscan,* 9(1): 111-114.9.
7. Deshmukh, M. A.; Gade, R. M.; Belkar, Y. K. and Koche, M. D. (2016). Efficacy of bioagents,Biofertilizers And soil amendaments to manage root rot in green gram. *Legume Research* 39(1): 140-144.
8. Dawson, M. J. (1965). Effect of seed soaking on the growth and development of Finger millet. *Indian Journal of Plant Physiology*, 8: 52-56.
9. Duke, J. A. (1981). Handbook of legumes of world economic importance. New York, USA/ London, UK : Plenum Press,195-200.
10. Moosavi, S. S.; Alaei, Y. and Khanghah, A. M. (2014**)**. The Effects of water seed pre-treatment on soybean Vegetative and reproductive traits. *International journal of Agriculture and Forestry,* 4(3A): 12-17
11. Narayanaswamy, S.; Siddaraju, R. and Rajendraprasad, S. (2012). Effect of vigour levels and pre-sowing seed Treatments on initial seed quality and crop performance In groundnut cv. TMV-2. *Mysore Journal of Agriculture Sciences* 46(1): 15-19.
12. Pushpalatha, B. T. (2008**).** Effect of seed priming on storability And field performance in okra (*Abelmoschus esculentus* (L.) Moench). Department of seed science and Technology, university of agriculture sciences, Dharwad. Th9799 (Accession Number), university Library, UAS, Dharwad.
13. Reddy, V. S.; Luikham, E. (2021). Effect of seed priming with plant growth regulators on lentil (*Lens culinaris* L. Medik.),*SKUAST Journal of Research* 23 (2): 172-177.
14. Singh, P. S. (2001**).** Broadening the genetic base of common bean cultivars. *Crop Science* 41: 1659-1675
15. Setareh, R.; Hamid, M. and Shahram, S. (2013). Effect of seed Priming on red bean (*Phaseolus calcaratus*) growth and Yield. *Annals of Biological Research* 4(2): 292-296.
16. Warren JE, and Bennet MA. (2000). Biopriming tomato (Lycopersicon eschlentum Mill.) seeds for improvement of stand establishment. Advances and Applications in seed Biology. CAB Intl., Wallingtoford, U. K. 48-69.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1107-1110 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Impact of Salinity on Germination Percentage and Seedling Growth in Wheat (*Triticum aestivum* L.) Var. DBW–303

Mangali Siva Prasad*, Bineeta Michael Bara and Prashant Kumar Rai
Department of Genetics and Plant Breeding, SHUATS, Prayagraj, U.P.
**Corresponding Authour Email : sivaprasad1480@gmail.com*

Abstract

The Present investigation were carried out for 'Impact of Salinity on Germination Percentage and Seedling on Wheat (*Triticum aestivum.* L)". For this purpose, 13 priming treatments including control on wheat 303- variety were used to study under lab conditions during Rabi, 2021-2022. Lab experiment was laid out in completely randomized design (CRD) with four replications respectively. Analysis for the data in field experiment revealed significance mean sum of squares due to seed priming to specific wheat crop and they were evaluated by screening a range of duration and concentration : T0- control, T_1- KCl (50mM), T_2- KCl (100mM), T_3- KCl (150mM), T_4- Na_2Co_3 (50mM), T_5- Na_2Co_3 (100mM), T_6- Na_2Co_3 (150mM), T_7- $MgCl_2$ (50mM), T_8- $MgCl_2$ (100mM), T_9- $MgCl_2$ (150mM), T_{10}- $CaCl_2$ (50mM), T_{11}- $CaCl_2$ (100mM), T_{12}- $CaCl_2$ (150mM). The objective to find out of salinity on germination percentage and seedling growth of wheat. To study the parameters of germination (%), Speed of Germination (%), Root length (cm), Shoot Length (cm), Seedling length (cm), Fresh weight of root (g), Dry weight of root (g), Fresh weight of shoot (g), dry weight of shoot (g), Seedling vigour index-i, Seedling vigour index-ii, Test weight, Tetrazolium test, Electrical Conductivity(EC). The study helps to improve the quality to improve of seed with help of seed different chemicals in wheat crop. In wheat was correlated with higher accumulation of ionic and osmotic solutes in salt tolerances in that of salt sensitive plants. Pre- soaking treatment with is concluded from the present study that the seeds of wheat (variety – DBW-303) were treated with T_6- Na_2Co_3 (150mM/12hrs) enhanced the seed quality parameters followed by T_8- $MgCl_2$ (100mM) and T_4- Na_2Co_3 (50mM) as compared to control (untreated) seeds.

Key words : *Wheat seed priming, KCl, Na_2Co_3, $MgCl_2$ and $CaCl_2$*

Introduction

Wheat is one of the most important cereal crops around the world. Many species of wheat together make up the genus Triticum the most widely grown is commonly wheat (*Triticum aestivum* L.). Wheat is considered to be one of the first domesticated crops and has been a staple food. In North Africa, wheat (*Triticum aestivum* L.) *em.* Thell is the most important and strategic cereal crop for the majority of world's population. Worldwide, wheat productivity nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995). It exceeds in average and production every other grain crops like Rice, Maize etc.., which is cultivated over a wide range of climatic conditions and the understanding of genetics and genome organizations using molecular markers is of great value for Genetic and Plant Breeding purpose. Among these major cereals, wheat is ranked at the first position due to its domestication and contribution as the primary staple food crop globally (Iqbal *et al.,* 2021). In climate change and global warning have directly affected the crops yield and quality by intensifying the frequency and extent of numerous stresses. Wheat, Rice and Maize are the most important staple crops globally and contribute a significant part of daily calories and protein intake (Kizilgeci *et al.,* 2021). Most of the agricultural lands, which are affected by different degrees of salinity, are located in semi-arid or arid regions (Lin *et al.,* 2020). Salinity stress causes osmotic stress and ion toxicity, through increasing the assimilation of Na+/Ka+ ratio due to lower osmotic potential within the plant roots. Further, these ionic imbalance affects the uptake, and transport of other important essential ions in target cells and hamper the crucial plant processes and functions (Arif *et al.,* 2020). Salt stress affects 20% of global cultivable land and is increasing continuously owing to the change in climate and anthropogenic activities (Arora, 2019). The grass family poaceae (Gramineae) includes major crop plants such as wheat (*Triticum aestivum* L), barley (*Hordeum vulgare* L.), oat (*Avena sativa* L.), rye (*Secale cereale* L.), Maize (*Zea mays* L.) and rice (*Oryza sativa* L.). Triticaceae is one of the tribes containing more than 15 genera and 300 species including wheat and barley. The area and production of wheat is grown in an area of about 31.36 million ha. With a production of 107.86 million tons per ha. The total world area is 221.82 million ha, production is 775.85 million metric tons and yield is 3.50 metric ton per ha (Foreign Agriculture Services/USDA, world agriculture production, 2021). The production of wheat crop on three large producing states in India 2020-2021.In Uttar Pradesh is about 35.50 metric tons, Madhya Pradesh is about 17.62 metric tons and last Punjab is about 17.14 metric tons. *(Source : Directorate of Economics & Statistics, Department of Agriculture and*

Farmers Welfare). The objectives of wheat to determine the effect of different concentration of potassium chloride (KCl), Sodium carbonate (Na_2Co_3), Magnesium chloride ($MgCl_2$) and Calcium chloride ($CaCl_2$) on seedling parameters of wheat. And to identify the suitable durations.

Materials and Methods

The experiment was carried out at lab experimentation center of the Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini, Prayagraj (U.P). During rabi 2021-2022 the experimental materials for present investigation consisted of 13 treatments of wheat (*Triticum aestivum* L.) crop are T_0- Control, T_1- KCl (50mM), T_2- KCl (100mM), T_3-KCl (150mM), T_4- Na_2Co_3 (50mM), T_5- Na_2co_3 (100mM), T_6-Na_2Co_3 (150mM), T_7-$MgCl_2$ (50mM), T_8- $MgCl_2$ (100mM), T_9- $MgCl_2$ (150mM), T_{10}- $CaCl_2$ (50mM), T_{11}- $CaCl_2$ (100mM), T_{12}- $CaCl_2$ (150mM). The experiment was laid out in lab Completely Randomized Design with four replications. The data were recorded on ten randomly selected plants of each replication for all characters such as germination percentage(%), speed of germination, root and shoot length(cm), seedling length(cm), fresh root and shoot length(g), dry root and shoot length(g), seedling vigour index-I and ii, test weight, tetrazolium test, electrical conductivity. The statistical analysis was carried out as per the equation suggested : Analysis of variance was carried out as per standard procedure (Fisher, 1936).

Results and Discussion

The Germination of mean performances ranged from 80-93% with the grand mean value of 86.96%. The treatment T_6- Na_2Co_3 (Sodium Carbonate) (150mM) for 12hrs recorded the maximum germination of 93% followed by T_8- $MgCl_2$ (Magnesium Chloride) (100mM) for 12hrs recorded 91%, T_4-Na_2Co_3 (Sodium Carbonate) (50mM) for 12hrs was significantly higher than the other treatments, The speed of germination of mean performance ranged 13-17.5% with the grand mean of 15.07%. The treatment T_6- Na_2Co_3 (150mM) for 12hrs recorded for maximum speed of germination is 17.5% followed by T_8- $MgCl_2$ (100mM) for 12hrs recorded 15.75%, T_4-Na_2Co_3 (50mM) 15.62% for 12hrs was significantly higher than the other treatments, Shoot length(cm) of mean performance ranged from 3.04-4.11(cm) with the grand mean value of 3.63cm. The treatments T_6- Na_2Co_3(150mM) for 12hrs recorded the maximum root length is 4.11cm followed by the treatment T_8-$MgCl_2$ (100mM) for 12hrs recorded for 3.99cm, T_4-$MgCl_2$(50mM) for 12hrs recorded for 3.90cm was significantly higher than the other treatments, root length of mean performance ranged from 4.59-5.98cm with grand mean value is 5.51cm. the treatment T_6-Na_2Co_3(150mM) for 12hrs recorded the maximum root length is 5.98cm, followed by the treatments T_8-$MgCl_2$ (100mM) for 12hrs recorded 5.85cm, T_4-Na_2Co_3 (50mM) 5.76cm for 12hrs was significantly higher than the other treatments, seedling length(cm) of mean performance ranged from 5.98-7.62 with the grand mean value of 9.14cm. The treatments T_6-Na_2Co_3(150mM) for 12hrs recorded the maximum seedling length is 10.10cm followed by the treatments T_8-$MgCl_2$ (100mM) for 12hrs was recorded for 9.84cm, T_4-Na_2Co_3 (50mM) for 12hrs was recorded for 9.66cm was significantly higher than the other treatments, fresh shoot length of mean performance was ranged from 0.33-0.59 with the grand mean 0.43. the treatment T_6-Na_2Co_3 (150mM) for 12hrs recorded the maximum fresh shoot weight is 0.59 which is followed by the treatments T_8-$MgCl_2$(100mM) for 12hrs was recorded by 0.55, T_4-Na_2Co_3 (50mM) 0.53 for 12hrs was significantly higher than the other treatments. Fresh root weight of the mean performance was ranged from 0.03-0.06 with the grand mean value is 0.04. The treatment T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum fresh root weight is 0.06. which is followed by the treatments T_8-$MgCl_2$ (100mM) for 12hrs was recorded by 0.05, followed by T_4-Na_2Co_3 (50mM) 0.05 for 12hrs was significantly higher than the other treatments, Dry shoot weight of the mean performance was ranged from 0.03-0.07 with the grand mean value is 0.05. The treatment T_6-Na_2Co_3 (150mM) for 12hrs recorded the maximum dry root weight is 0.07. which is followed by the treatment T_8-$MgCl_2$ (100mM) for 12hrs was recorded by 0.06, followed by T_4- Na_2Co_3 (50mM) 0.06 for 12hrs was significantly higher than the other treatments, Dry root weight of the mean performance was ranged from 0.01-0.03 with the mean value is 0.02. the treatment T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum dry root weight is 0.03. which is followed by the treatment T_8- $MgCl_2$ (100mM) for 12hrs was recorded by 0.02, T_4-Na_2Co_3 (50mM) 0.02 for 12hrs was significantly higher than the other treatments, Seedling Vigour index -I of the mean performance was ranged from 609.92 - 939.15 with the grand mean value is 796.64. The treatments T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum seedling vigour index-I is 939.15. It is followed by the treatment T_8- $MgCl_2$ (100mM) for 12hrs was recorded by 895.46, followed by T_4-Na_2Co_3 (50mM) 864.81 for 12hrs was significantly higher than the other treatments, Seedling vigour Index -ii of the mean performance was ranged from 11.06-23.155 with the grand mean value is 16.414. the treatment T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum seedling vigour index-ii is 23.155. It is followed by the treatment T_8- $MgCl_2$ (100mM) for 12hrs was recorded by 19.80, T_4-Na_2Co_3 (50mM) 18.645 for 12hrs was significantly higher than the other treatments, Electrical conductivity of the mean performances was ranged from 18.75- 24.60 with the

Table-1 : Mean performances of salinity on germination percentage and seedling growth in wheat.

Treatments	Germination percentage (%)	Speed of germination	Shoot length (cm)	Root length (cm)	Seedling length (cm)	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	Seedling vigour index-i	Seedling vigour index-ii	Electrical conductivity (dsm^{-1})	Test weight (gm)
T_0-Control	80	10.00	3.10	4.59	7.62	0.33	0.03	0.03	0.01	609.92	11.06	18.75	37.48
T_1-KCl (50 mM)	83	10.38	3.57	5.46	9.08	0.37	0.04	0.04	0.02	753.64	13.398	20.775	41.95
T_2-KCl (100 mM)	83.5	10.44	3.60	5.56	9.15	0.41	0.05	0.05	0.01	763.54	13.64	20.95	40.80
T_3-KCl (150 mM)	84	10.44	3.57	5.52	9.12	0.40	0.05	0.05	0.02	761.34	14.918	21.25	43.43
T_4-Na_2Co_3 (50 mM)	89.5	11.19	3.92	5.76	9.66	0.53	0.05	0.06	0.02	864.81	18.54	21.15	44.05
T_5-Na_2Co_3 (100 mM)	86.5	10.81	3.42	5.57	9.03	0.39	0.04	0.04	0.02	780.48	16.64	19.625	42.03
T_6-Na_2Co_3 (150 mM)	93	11.63	4.02	5.98	10.10	0.59	0.06	0.07	0.03	939.15	23.15	24.6	47.33
T_7-$MgCl_2$ (50 mM)	89	11.13	3.62	5.45	9.05	0.43	0.04	0.05	0.02	805.25	12.98	21.15	42.85
T_8-$MgCl_2$ (100 mM)	91	11.38	3.93	5.85	9.84	0.55	0.05	0.06	0.02	895.46	19.80	21.225	45.05
T_9-$MgCl_2$ (150 mM)	87	10.88	3.58	5.50	9.08	0.42	0.04	0.05	0.02	790.00	15.09	20.575	43.50
T_{10}-$CaCl_2$ (50 mM)	88.5	11.06	3.62	5.47	9.09	0.41	0.04	0.04	0.02	804.55	18.02	20.45	43.65
T_{11}-$CaCl_2$ (100 mM)	87	10.88	3.59	5.50	9.10	0.39	0.04	0.05	0.02	791.28	14.91	20.07	40.88
T_{12}-$CaCl_2$ (150 mM)	89	11.13	3.50	5.46	8.96	0.39	0.04	0.05	0.02	796.84	17.40	19.85	40.05
S.E(m)	1.390	0.374	0.364	0.343	0.050	0.0135	0.0078	0.0312	0.0073	12.78	0.82	0.466	0.839
C.V.	3.19	4.97	1.907	1.24	1.09	6.25	3.167	13.46	8.36	3.21	9.98	4.497	1.17
C.D (1%)	3.98	1.07	0.099	0.099	0.143	0.0387	0.002	0.008	0.001	36.70	2.354	0.64	3.94

mean value is 20.76. the treatment T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum EC is 24.60. It is followed by the treatments T_8-$MgCl_2$ (100mM) for 12hrs was recorded by 21.23, T_4- Na_2Co_3 (50mM) 21.15 for 12hrs was significantly higher than the other treatments, Test weight of the mean performances was ranged from 37.48-47.33 with the grand mean value is 42.54. The treatments T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum test weight is 47.33.It is followed by the treatments T_8-$MgCl_2$ (100mM) for 12hrs was recorded by 45.05, T_4-Na_2Co_3 (50mM) 44.05 for 12hrs was significantly higher than the other treatments, Tetrazolium test was the total number of seed in the minimum -192 strained ,white spots-17, strained-42. The treatment T_6-Na_2Co_3 (150mM) for 12hrs was recorded the maximum TZ test is strained -193, white spots-6 and strained -15.

Salinity in the soil affects germination and speed of germination process by several ways such as prevention of water absorption, ionic stress and reduction of enzyme activities within the seeds (Yang *et al.,* 2007). They increased shoot and root length with halopriming treatment may be due to the fact that, halopriming increased nuclear replications in shoot and root. These result are in accordance with (Mavi *et al.,* 2006). The seed priming with Na_2Co_3 showed improved germination and seedling vigour by dormancy breakdown as compared to control (Farooq *et al.,* 2005). The high pH environment surrounding the roots can directly cause some ions imbalance, metabolic disorders and may destroy the structure and function of root cells (Shi and Wang 2005). In seedling length may be explained by the fact that exists the inhibitory effect of salt on cell division and enlargement in growing point (Mccue and Hanson 1990). In fresh shoot weight the different levels of salinity significantly affected the growth attributes by reducing root and shoot length for salinity below 125 mM (Datta *et al.,* 2009). In fresh root weight reported that in the early growth stage salinity caused an increased of root to coleoptile length ratio in the less tolerant cultivars while it was not changed in the more tolerant ones. (Turkyilmaz *et al.,* 2011). In dry shoot weight reported that the seedling dry weight is the ultimate result of all physiological and biochemical activities of the plant. We found that high salinity stress marked reduced this parameter (Akbarimoghaddam *et al.,* 2011). In dry root weight was reported that the seedling dry matter was decreased by increasing salinity (Akabrimoghaddam *et al.,* 2011). In seedling vigour index-I was reported the priming significantly effects plant growth rate and grain yield in plants under high disease pressure (Dale *et al.,* 2009). In seedling vigour index-ii was reported the priming treatments generally led to faster seedling vigour and greater seedling shoot fresh weight than was achieved with non-primed seeds (Pill *et al.,* 2009). In electrical

conductivity it was reported the different levels of salinity, a consequential effect on germination percentage, germination rate, shoot length and dried weight happened of the atmosphere (Mashi and Galeshi 2007). In TZ- test was reported an quick test foe seeds viability evaluation have been a nowadays demand and, among the available methods, TZ-test deserves on outstanding position (Franca-Neto, 1999). In test weight was reported the quality is dependent on the size of embryo and reserved nutrients quantity used for sprouting and growth (Ebadi and Hisoriev 2011).

Conclusions

Here it is concluded that the treatment T_6-Na_2Co_3 (150mM) (Sodium Chloride) for 12hrs was recorded higher in germination percentage, speed of germination shoot and root length, seedling length, fresh shoot and root weight, dry shoot and root weight, seedling vigour index – I and ii, TZ – test, EC- test and test weight followed by the treatment with T_8-$MgCl_2$ (100mM) and the lowest was recorded in T_o-Control. So Sodium chloride (Na_2Co_3 -150mM) is suitable for the seedling growth on wheat.

References

1. Abdel Latef, A. (2010). Changes of antioxidative enzymes in salinity tolerance among different wheat cultivars. *Cereal Research Communications*, 38(1), 43-55.
2. Ahmed, R., Howlader, M.H.K., Shila, A. and Haque, M.A. (2017). Effect of salinity on germination and early seedling growth of maize. *Progressive Agriculture*, 28(1), 18-25.
3. Akbarimoghaddam, H., Galavi, M., Ghanbari, A. and Panjehkeh, N. (2011). Salinity effects on seed germination and seedling growth of bread wheat cultivars. *Trakia journal of Sciences*, 9(1), 43-50.
4. Aliakbar M.M., Maghsoudi K. (2008). Salt stress effects on respiration and growth of germinated seeds of different wheat (*Triticum aestivum* L.) cultivars. *World Journal of Agricultural Science*, 4: 351-358
5. Alom, R., Hasan, M., Islam, M. and Wang, Q.F. (2016). Germination characters and early seedling growth of wheat (*Triticum aestivum* L.) genotypes under salt stress conditions. *Journal of crop science and biotechnology*, *19*(5), 383-392.
6. Bilkis A., Islam M.R., Hafiz M.H.R., Hasan M.A. (2016). Effect of NaCl induced salinity on some physiological and agronomic traits of wheat. *Pakistan Journal of Botony* 48(2): 455-460.
7. Datta J.K., Nag S, Banerjee A., Mondal N.K. (2009). Impact of salt stress on five varieties of wheat (*Triticum aestivum* L.) cultivars under laboratory condition. *Journal Application of Science Environment* 13(3): 93-97.
8. Hag Ghani M., Saffari M., Magsoudi-Moud A.A. (2008). Effect of different levels of NaCl salinity on germination and seedling growth of safflower cultivars (*Carthamus tinctorius L.*), *Journal Agricultural Science Natural Resource*, 45: 449-458.
9. Hussain, S., Khaliq, A., Matloob, A., Wahid, M.A. and Afzal, I. (2013). Germination and growth response of three wheat cultivars to NaCl salinity. *Soil Environ*ment 32(1), 36-43.
10. Jam, B.J., Shekari, F.A.R.I.D., Azimi, M.R. and Zangani, E.S.M.A.E.I.L. (2012). Effect of priming by salicylic acid on germination and seedling growth of safflower seeds under CaCl2 stress. *International Journal of Agricultural Research*, *2*, 1097-1105.
11. Jovoviæ M., V. Tunguz, M. Mirosavljeviæ, N. Pržulj (2018). Effect of salinity and drought stress on germination and early seedlings growth of bread wheat (*Triticum aestivum* L.). Genetika, Vol 50, No.1, 285-298.
12. Ma, L., Li, Y., Yu, C., Wang, Y., Li, X., Li, N. and Bu, N. (2012). Alleviation of exogenous oligochitosan on wheat seedlings growth under salt stress. *Protoplasma*, 249(2), 393-399.
13. Mirzaei, A., Naseri, R., Emami, T. and Jozeyan, A. (2012). Effect of salinity on germination and seedling growth of bread wheat (*Triticum aestivum* L.). *International Journal of Agriculture and Crop Sciences*, *4*, 1089-1091.
14. Mohamed, A.B., El-Banna, M.F., Farouk, S. and Khafagy, M.A. (2019). The role of grain priming and its duration on wheat germination and seedling growth. *Journal of Plant Production*, 10(4), 343-349.
15. Moud AM, Maghsoudi K. (2008). Salt stress effects on respiration and growth of germinated seeds of different wheat (*Triticum aestivum* L.) cultivars. *World Journal of Agricultural Science* 4(3): 351-358.
16. Naguib, N.A., Mohamed, E.A. and EL-Aidy, N.A. (2011). Effect of storage period and packaging material on wheat (*Triticum aestivum* L.) seed viability and quality. *Egyptian Journal of Agricultural Research*, 89(4), 1481-1497.
17. Sozharajan, R. and Natarajan, S. (2014). Germination and seedling growth of *Zea mays* L. under different levels of sodium chloride stress. *International Letters of Natural Sciences*, *7*.
18. Tamimi, S.M. (2016). Effect of seed priming on growth and physiological traits of five Jordanian wheat (*Triticum aestivum* L.) landraces under salt stress. *bioscience and agriculture journal* 11(01), 906-922.
19. Thakur, N., Chrungoo, S., Rana, S., Kaur, S., Kaur, S. and Pathak, A. (2021). Effect Of Copper Nanoparticles On In-Vitro Seed Germination Of Wheat (*Triticum Aestivum* L.) Varieties.
20. Tsegay, B.A. and Gebreslassie, B. (2014). The effect of salinity (NaCl) on germination and early seedling growth of *Lathyrus sativus* and *Pisum sativum var. abyssinicum. African Journal of Plant Science*, 8(5), 225-231.
21. Türkyilmaz B., Aktaº L.Y. and Güven A. 2011. Salinity induced differences in growth and nutrient accumulation in five barley cultivars. *Turkey Journal of Field Crops.* 16(1): 84-92.
22. Yousof F.I. (2013). Effect of rice seed priming with calcium chloride ($CaCl_2$) on germination and seedlings vigor under salinity stress. *Journal of Plant Production*, 4(4), 523-535.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1111-1115 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Comparative Study of Magnetic, Electric and Bio-Filming Seed Treatments on Growth, Yield and Yield Attributes of Chickpea Pusa-362 (*Cicer arietinum* L.)

Ponugoti Kavya*, Bineeta Michael Bara, Prashant Kumar Rai and Rachuri Niyanth
Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj, U.P
**Corresponding Authour Email : ponugotikavya0@gmail.com*

Abstract

The field experiment entitled "Comparative Study of Magnetic, Electric and Bio filming Seed Treatments on Growth, yield and yield attributes of Chickpea Pusa-362 *(Cicer arietinum* L.*)*" was conducted during *Rabi* 2021 at field experimental centre, Department of Genetics and Plant Breeding, SHUATS, Prayagraj, (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with thirteen treatments including control which were replicated thrice. The treatments are as follows, T_O- Control, T1, T2, T3, T4 - Magnetic @ 200, 400, 600, 800 gauss, T5, T6, T7, T8 - Electric @ 100, 200, 300, 400 m Amp, T9, T10, T11, T12 – Bio-filming @ 1% (methyl cellulose, alginate, polyvinyl glycol, no adhesive) respectively. The experiment results revealed that seeds treated with Electric @ 400 m Amp gave better than other treatments *viz*, Field emergence (93.30 %), Plant height (48.37 cm), Days to 50% flowering (52.26), days to maturity (107.88), number of branches per plant (27.18), Number of pods per plant (55.38), Number of seeds per pod (1.80), seed yield per plant (18.93 g), seed yield per plot (283.95 g), seed index (16.92 g) biological yield (511.66 g), Harvest index (35.68 %), Net returns (1,31,020), Gross returns (1,70,370), B:C ratio (3.33) were recorded significantly higher compared to other treatments.

Introduction

Chickpea (*Cicer arietinum* L.) is an ancient crop first taken into cultivation by Neolithic farmers. Today, Chickpea continues to play an important role in agricultural systems in the world, ranking third behind dry bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.) in terms of grain legume production. World chickpea production has remained relatively stable since the 1960s, but recently there have been improvements in productivity, and changes in the regions sown to chickpea. Chickpea (*Cicer arietinum* L.) ranked third important cultivated legume crop in the world after Soyabean and Bean. During 2017-2018, globally it was grown on 149.66 lakh ha area, with the total production of 162.25 lakh tonnes and average productivity of 1252 kg/ha(FAOSTAT, 2019).The major Chickpea producing countries include India, Australia, Pakistan, Turkey, Myanmar, Ethiopia, Iran, Mexico, Canada, and the United States. India is the largest Chickpea producing with a global production. The Chickpea production in India is 112.29 lakh tonnes, while area is 105.61 lakh ha, productivity is 1063kg/ha. Madhya Pradesh is leading state in terms of area and production (Agriculture Statistics at a Glance (2017).Directorate of Economics and Statistics, Department of Agriculture, cooperation and Farmer's welfare). Chickpea is a good source of protein (20 to 22%), and is rich in carbohydrates (around 60%), dietary fibre, minerals and vitamins. Chickpea does not contain any specific major antinutritional factors such as ODAP in grass pea (*Lathyrus sativus* L.), vicin in faba bean (*Vicia faba*), and trypsin inhibitors in Soyabean (*Glycine max*), although it has oligosaccharides which cause flatulence. Chickpea has significant amounts of all the essential amino acids. Starch is the major storage carbohydrate followed by dietary fibre, lipids are present in low amounts but chickpea is rich in nutritionally important unsaturated fatty acids like linoleic and oleic acid. It can be utilized to develop nutritious value added products and hence products can also be used as nutritious food for low income group in developing countries and for patients suffering with life style diseases. Seed priming is a pre-sowing strategy for influencing seedling development by modulating pre-germination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance. Magnetic seed treatment brings numerous valuable biochemical, cellular, and molecular processes. Pre-sowing magnetic seed treatment also increases ascorbic acid contents. Magnetic seed stimulation could be employed to recover seed potency by increasing enzymes and proteins activity. Consequently, without any alteration in the seed's chemical composition, biochemical functions such as ion concentration, electrical charges, and free radicals are enhanced and can make the membrane more permeable. The response of crops towards the magnetic field is associated with the intensity and exposure time of the magnetic field. Exposure of seeds to electric treatment ends their dormancy, improves crop growth and destroys seed borne fungi and insects. The yield may ultimately

increase and the metabolism in seedlings is stimulated, respiration and hydrolytic enzymes activity is intensified. A greater percentage of treated seed sprout sooner than the untreated seeds. It is also possible to increase the power of germination of old seeds. Biopriming is a procedure of seed treatment with natural means that includes integration of seed hydration and salutary microorganism inoculation. It induces seed germination, viability, vigour, factory growth and protection against seed or soil borne pathogen and eventually ameliorate crop yield. Bio-priming of seed uses microbial inoculants of factory growth promoting rhizobacteria and fungi. It's an eco-friendly strategy using named microorganism which produces substances for growth creation and pathogen inhibition. Presently, seed treatment with natural inoculants is being used as a cover to synthetic chemical fungicides and diseases in husbandry for factory and soil health enhancement. Using biocontrol agents with priming agents for seed treatment over simple seed coating has implicit advantages and serves as a better strategy of managing numerous seed and soil-borne conditions. Seed priming results under adverse condition of soil useful in livery and rapid-fire seedling.

Materials and Methods

The field experiment was conducted during *Rabi* season 2021 at the Field Experimentation centre, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. The seed treatments were conducted at the Physics laboratory, Department of Physics, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. The seeds are treated in electromagnetic generator with variable horizontal magnetic strength. Magnetic field passes through the cylinders when the power supply is given. A digital gauss meter is used to monitor the field strength produced in the pole gap of magnetic field generator. The metallic probe made of indium arsenide crystal and encapsulated to non-magnetic sheet is used. Then the seeds are treated with 100,125,150 mT. To expose the seeds to electric field, an electric field generator was fabricated by using sodium chloride as electrolyte with copper (+) and zinc (-) electrodes. A battery of 24V DC was used as the power source for the electrolytic treatment of Barley seeds. The two electrodes were placed vertically inside the plastic tray parallel to each other. In the plastic tray seed material were placed in already prepared electrolyte solution (2% Nacl) in such a way that upper level of electrolyte solution lies below the level of electric cord connecting point. Electric power cords were connected with power supply unit in respective places. An electric current of DC 24 V was passed at required intensities for different duration as per the treatment requirement through the seeds to serve electrotherapy treatment of 100mA, 200mA, 300mA and 400mA for duration of 1 min. Seeds were sown in Petri plates of 4 replications of 25 seeds each under laboratory conditions, Control seeds were kept under the similar condition in the absence of EMF. The observations that are undertaken in the study are ***viz.,*** Field emergence, plant height, number of branches per plant, days to 50% flowering, days to Maturity, number of pods per plant, number of seeds per pod, seed yield per plant, seed index, seed yield per plant, seed index, seed yield per plot, biological yield, Harvest index, Total cost of cultivation, net returns, gross returns, B:C ratio in Chickpea crop. The experiments were conducted on Pusa-362 variety.

Results and Discussion

Growth parameters : As per the data pertained in Table 3 it is clear that at 10 DAS T8 (Electric @ 400 mAmp) was significantly higher over all other treatments with 93.30 % and T7 was statistically at par with T8 (93.00 %) and the lowest was obtained in control (85.20 %). Pourakbar and Hatami (2012) proved that Electric field can stimulate seed germination and growth of some crops. The electric field polarization of the membrane system causes abnormal accumulation of water in the plant and some macromolecular was molecules be aqueous. These factors lead to inflation, excessive storage of macromolecules and lead to break the membrane systems and tissues of irregular shape and thus may increase germination rate. The seeds treated with Electric @ 400 mAmp in T8 varied significantly and recorded higher plant height among other treatments with 48.37 cm and statistically at par values are observed in T7 (48.22 cm). The lowest was observed in control with 42.54 cm. The results are depicted in Table 3. The electric field mostly effects on the transport and metabolism of ions and electrons and have impact on the overall activities of the plants related to metabolism of electrons and ions and thereby effects the plant growth. The results are in accordance with Touati *et al.,* (2013). Significantly a greater Number of branches per plant were observed in T8 with 27.18 branches and T7 with 26.93 branches per plant is statistically at par with T8. The lowest Number of branches per plant were observed in control with 20.39 branches. The data was depicted in Table 3. Filatova *et al.* (2020) stated that implication of electric field can positively increase the cellular metabolism by the application of appropriate intensities of the electric field. Stated that the electric field may not only act on the ion accumulation mechanism but also internal auxin production there by increasing the capacity to produce a greater number of branches. From the data shown in Table 3 days to 50% flowering varied significantly among all treatments. T8 seeds treated with Electric @ 400 mAmp flowered earlier than other treatments (51.67 DAS) and T7 performed at par with T8 (51.67 DAS). The highest days to 50 % flowering was observed in control (T0) with 58.33 DAS.

Table-1 : Analysis of Variance for Comparative Study of Magnetic, Electric and Bio filming Seed Treatment on Growth, Yield and Yield Attributes of Chickpea Pusa-362 (*Cicer arietinum* L.)

S. No.	Characters	Mean sum of squares		
		Replication (d.f = 2)	Treatments (d.f = 12)	Error (d.f = 24)
1.	Field emergence (%) at 4 DAS	0.13	12.85*	0.32
2.	Field emergence (%) at 7 DAS	4.7	18.34*	2.22
3.	Field emergence (%) at 10 DAS	1.14	22.56*	4.32
4.	Plant height at 30 DAS	0.22	1.49*	0.21
5.	Plant height at 60 DAS	0.1	12.18*	0.94
6.	Plant height at 90 DAS	2.27	9.11*	2.04
7.	Plant height at 120 DAS	0.30	16.31*	2.32
8.	Number of branches per plant	0.24	18.18*	0.42
9.	Days to 50% Flowering	2.47	12.82*	0.95
10.	Days to Maturity	0.10	41.87*	10.46
11.	Number of Pods per plant	0.53	19.15*	2.57
12.	Number of Seeds per pod	0.00	0.12*	0.00
13.	Seed yield per plant	0.18	13.87*	0.22
14.	Seed index	0.18	6.62*	0.18
15.	Seed yield per plot	41.55	3121.41*	48.92
16.	Biological yield	105.68	3171.15*	224.59
17.	Harvest Index	0.77	7.9*	1.31

*Indicates significance at 5% level of significance.

Table-2 : Treatments details.

S. No.	Treatments	Duration
T_0	Control	-
T_1	Magnetic – 200 gauss	8 min.
T_2	Magnetic – 400 gauss	8 min.
T_3	Magnetic – 600 gauss	8 min.
T_4	Magnetic – 800 gauss	8 min.
T_5	Electric – 100 m Amp	60 sec.
T_6	Electric – 200 m Amp	60 sec.
T_7	Electric – 300 m Amp	60 sec.
T_8	Electric – 400 m Amp	60 sec.
T_9	Bio filming – 1% (methyl cellulose)	15 min.
T_{10}	Bio filming – 1% (alginate)	15 min.
T_{11}	Bio filming – 1% (polyvinyl glycol)	15 min.
T_{12}	Bio filming – 1% (no - sticker)	15 min.

From the data shown in Table-1 days to maturity varied significantly among all treatments. T8 seeds treated with Electric @ 400 mAmp attained maturity earlier than other treatments (107.33 DAS) and T7 performed at par with T8 (107.67 DAS). The highest days to maturity was observed in control (T0) with 118.67 DAS. Increase amino acid content aids in the production of a wide range of enzymes that promote vegetative growth and reproductive growth. The electromagnetic priming improves the physiological activities of seeds by synthesizing a number of enzymes including dehydrogenase, catalase and amylase. The above-mentioned results are in acceptance with Martinez *et al.* (2017).

Yield parameters : As per the data pertained in Table-3 the seed treatments varied significantly among them. The seeds treated with Electric @ 400 mAmp was significantly higher among all other treatments with 55.38 pods and T7 was statistically at par with T8 with 54.43 pods. The lowest Number of pods were obtained in control with 47.93 pods. Anna podlesna (2019) proved that cellular receptors of plants respond to voltage of certain magnitude and causes physiological and biochemical changes there by showing positive modulation of plant potential and consequent enhancement of productivity. Significantly higher Number of seeds per pod were obtained in T8 Electric @ 400 mAmp (1.80) and statistically at par values were observed in T7 with 1.72 seeds per pod. The control had performed lowest of all treatments with 1.20 seeds per pod. The data pertaining Numbers of seeds per pod (No.) was depicted in Table 3. Treating seeds with electric field increases the water absorbing capacity of plants and increases the capacity of increasing -amylase activity and gibberellic acid content and chlorophyll content and thereby increasing the number of seeds per pod. The results are in acceptance with Joseph *et al.* (2020). From the data shown in Table 3 it is clear that T8 @ Electric @ 400 mAmp had performed better and is significantly higher (18.93 g) over all other treatments and statistically at par values were obtained in T7 with 18.77 g and the lowest seed yield was observed in control with 12.03 g. The seed yield per plant is totally dependent on the number of seeds per pod. As the seeds treated with electric field shows increase in -amylase activity, gibberellic acid content and increase in water uptake capacity also can be observed in the plants treated with electric field. The results are in accordance with Mohammad sarraf *et al.* (2020). Significantly highest amount of seed index was found in

Table-3 : Evaluation of Chickpea on Seed priming through Magnetic, Electric Fields and Bio-filming.

Treatments	Rate of Field Emergence	Plant Height	Days To 50% Flowering	Days to Maturity	Number of Branches	Number of Pods per plant	Number of seeds per pod	Seed yield per plant (gm)	Seed index	Seed yield per plot (gm)	Biological yield (gm)	Harvest index
T_0	1999	46.69	58.33	118.67	20.39	47.93	1.20	12.03	12.41	180.45	413.43	30.40
T_1	2192	49.84	54.67	110.67	23.87	50.67	1.32	16.33	15.34	244.95	453.01	35.10
T_2	2214	51.31	54.00	110.33	23.93	51.33	1.37	16.41	15.69	246.15	459.04	34.91
T_3	2243	51.54	53.00	110.00	24.12	51.79	1.41	16.53	15.77	248	460.12	35.02
T_4	2265	51.66	53.33	110.00	24.33	51.98	1.49	16.68	15.81	250.2	463.22	35.08
T_5	2287	52.43	52.33	108.33	26.66	53.13	1.53	18.42	16.24	276.35	505.62	35.35
T_6	2306	52.87	51.67	108.00	26.81	53.84	1.60	18.61	16.31	279.1	507.32	35.51
T_7	2321	53.17	51.67	107.67	26.93	54.43	1.72	18.77	16.68	281.55	510.23	35.57
T_8	2337	53.44	51.67	107.33	27.18	55.38	1.80	18.93	16.92	283.95	511.66	35.68
T_9	2068	47.84	56.33	115.67	21.38	48.67	1.24	14.31	13.51	214.65	439.00	32.84
T_{10}	2092	48.46	55.67	114.67	21.53	48.83	1.25	14.48	13.60	217.2	444.83	32.83
T_{11}	2164	49.71	55.33	114.33	21.66	49.10	1.27	14.57	13.87	218.55	445.97	32.90
T_{12}	2050	47.30	56.67	116.33	21.22	48.09	1.22	14.27	13.34	214.05	438.29	32.82
F-test		S	S	S	S	S	S	S	S	S	S	S
SEm±		0.88	0.56	1.87	0.37	0.92	0.02	0.27	0.25	4.04	8.65	0.66
CD (P=0.01)		2.57	1.64	5.45	1.09	2.7	0.06	0.79	0.72	11.79	25.25	1.93

Table-4 : Influence of Electric, Magnetic and Bio-Filming on Economics of Chickpea.

Treatments	Concentrations	Total cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio (%)
Control	-	39,350	108270	68920	1.75
Magnetic – 200 gauss	8 min.	39,350	146970	107620	2.73
Magnetic – 400 gauss	8 min.	39,350	147690	108340	2.75
Magnetic – 600 gauss	8 min.	39,350	148800	109450	2.78
Magnetic – 800 gauss	8 min.	39,350	150120	110770	2.81
Electric – 100 m Amp	60 sec.	39,350	165810	126460	3.21
Electric – 200 m Amp	60 sec.	39,350	167460	128110	3.26
Electric – 300 m Amp	60 sec.	39,350	168930	129580	3.29
Electric – 400 m Amp	60 sec.	39,350	170370	131020	3.33
Bio filming – 1% (methyl cellulose)	15 min.	39,350	128790	89440	2.27
Bio filming – 1% (alginate)	15 min.	39,350	130320	90970	2.31
Bio filming – 1% (polyvinyl glycol)	15 min.	39,350	131130	91780	2.33
Bio filming – 1% (no - adhesive)	15 min.	39,350	128430	89080	2.26

T8 (Electric @ 400 mAmp) with 16.92g and T7 with 16.68g is at par with T8 followed by T6 with 16.31 g. The lowest seed index was observed in control with 12.41 g. As per the data pertained in Table 3 the seed treatments varied significantly among them. The seeds treated with Electric @ 400 mAmp was significantly higher among all other treatments with 283.95 g and T7 was statistically at par with T8 (281.55 g). The lowest Seed yield per plot were obtained in control with 180.45 g. Significantly higher biological was obtained in T8 @ Electric @ 400 mAmp with 511.66 g and statistically at par values were obtained in T7 with 510.23 g and control with 413.43 g is the lowest among all other treatments. The major causes of the rise in the weight of each seed were higher yield and growth characteristics which were indirectly brought about by the timely delivery of enzymes, the preservation of hormonal balances and higher metabolic rates. Chickpea seeds responded favorably to electric priming thereby increasing the no. of branches, plant height, number of seeds per pod and hence increasing the biological yield. So, the results are in accordance with Sunita kataria (2020). From the data shown in Table 3 it is clear that T8 @ Electric @ 400 mAmp had performed better and is significantly higher (35.68) over all other treatments and statistically at par values were obtained in T7 with 35.57 and the lowest seed yield was observed in control with 30.40.

Economics : Economics of crop production plays an important role for a farmer, which mainly depends on high yield producing genotypes with a higher gross return, net return and benefit- cost ratio. Economics of genotypes viz, cost of cultivation, gross return, net return and B : C ratio were calculated in Table-4. Observations on the cost of cultivation (39,350 INR/ha) are similar for all the genotypes. Table-4 shows seeds treated with Electric –

400 mAmp recorded with higher gross return (1,70,370 INR/ha) over all the treatments and lower gross return with control (1,08,270 INR/ha). Data on the economics is discussed in Table 4 in which a higher net return (1,31,020 INR/ha) was recorded with seeds treated with Electric – 400 mAmp, whereas a lower net return (68,920 INR/ha) was recorded with control. Data on the economics of genotypes were tabulated in Table-4, which shows a higher benefit-cost ratio (3.33) in seeds treated with Electric – 400 mAmp (T8) and a lower benefit-cost ratio (1.75) was recorded with control.

Conclusions

From the experiments conducted and the observations taken in the filed trails it is concluded that seed priming with Electric @ 400 mAmp recorded significantly higher seed yield per plant (24.88 g), seed yield per plot (746.50 g) and higher net returns (1,31,020 Rs/ha). Since the results are based on the research done in one season further trails are recommended for precise results.

Acknowledgement

We thank for all the staff of Department of physics, SHUATS Allahabad for providing magnetic and electric field apparatus for treating Chickpea seeds and Department of Seed science and technology laboratory staff for their contribution in experimentation.

References

1. Pourakbar, L., Hatami, S. (2012). Exposure of *Satureia hortensis* L. seeds to magnetic fields : Effect on germination, growth characteristics and activity of some enzymes. *Journal of Stress Physiology and Biochemistry.* 8(4) : 191-198.
2. Touati, A.M., Boughanmi, N.G., Salem, M.B. and Haouala, R. (2013). Effects of moderate static magnetic field presowing treatment on seedling growth and oxidative status in two Raphanus sativus L. varieties. *African Journal of Biotechnology*. 12(3): 275-283.
3. Martinez, E., Florez, M., Carbonell, M.V (2017) Stimulatory Effect of the Magnetic Treatment on the Germination of Cereal Seeds. *International Journal of Environment, Agriculture and Biotechnology,* 2(1): 2456-1878.
4. Anna Podlecœna, Jolanta Bojarszczuk, Janusz Podlecœny (2019) Effect of Pre-sowing Magnetic Field Treatment on Some Biochemical and Physiological Processes in Faba Bean (Vicia faba L. spp. Minor) 38:1153–1160.
5. Joseph., H., Rewa Jariyal. K., Utkarsha dorle., H., and Deepti K. (2020). Assesment of electric and magnetic priming on emmer wheat for growth and yield attributes. *Indian Journal of Agricultural sciences.* 4 (7): 456-459.
6. Mohammad Sarraf, Sunita Kataria, Houda Taimourya, Lucielen Oliveira Santos, Renata Diane Menegatti, Meeta Jain, Muhammad Ihtisham and Shiliang Liu 2020. Magnetic Field (MF) Applications in Plants: An Overview.
7. Filatova, I., Veronika, L., Goncharik, S. (2020). The effect of low-pressure plasma treatment of seeds on the plant resistance to pathogens and crop yields. *Journal of physics and applied sciences,* 53(24).

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1116-1118 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Sulphur and Biofertilizers on Nutrient Content and Uptake in Fenugreek (*Trigonella foenum-graecum* L.)

Ashok Kumar Samota[1], P.C. Chaplot[1], J. Choudhary[1], R.H. Meena[2], Narendra Kumar Bhinda[1], Manish Tomar[1], Rajesh Choudhary[1] and Satya Narayan Gurjar[1]

[1]*Department of Agronomy, RCA, MPUAT, Udaipur*

[2]*Department of Soil Science and Agriculture Chemistry, RCA, MPUAT, Udaipur*

Abstract

A field experiment was conducted at Instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) during the *rabi* season 2021-22 to study the effect of sulphur and biofertilizers on nutrient content and uptake in fenugreek (*Trigonella foenum-graecum* L.). Application of 40 kg S ha^{-1} significantly increased N and S content in seed and haulm over application of 10 kg S ha^{-1} and seed inoculation with NPK consortia significantly increased N content in seed and haulm over control. Nutrient uptake significantly increased with increasing levels of sulphur and inoculation of seed with biofertilizers in combination or alone over control.

Key words : *Sulphur, biofertilizers, nutrient content, nutrient uptake, fenugreek.*

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) popularly known by its vernacular name "methi" has been in culinary and medicinal uses due to its restorative and nutraceutical properties for more than 2500 years. Sulphur is the fourth most important mineral nutrient after nitrogen, phosphorus, and potassium, and its deficiency has been especially visible in Rajasthan soils. Sulphur deficiency has been reported as a hidden hunger in several crops, particularly oilseed and pulses, despite the continuous use of high analysis fertilisers like urea and DAP and high yielding variety. It's a component of amino acids like methionine, cysteine, and cystine.

In the recent years, continuous and imbalance application of chemical fertilizers is leading to poor nutrient use efficiency, low yield of crop. At the same time increasing cost of production due to more and more use of costly nutrient sources is becoming unaffordable to the most of farmers. Hence, it has become imperative to search for other complementary and alternative sources of nutrients, among which use of bio- fertilizers of biological origin for integrated nutrient management in fenugreek is an important avenue. In this approach, microbial fertilization with *Rhizobium* as well as PSB & KSB has been found promising to improve soil health and crop production. Bio-fertilizer such as *Rhizobium*, PSB and KSB play an important role in increasing the availability of nitrogen, phosphorus and potassium.

Materials and Methods

The experiment was laid out at the Instructional Farm, Rajasthan College of Agriculture, Udaipur. It falls under agro climatic zone IVa "Sub-Humid Southern Plain and Aravali Hills" of Rajasthan. The soil of experimental field was clay loam in texture, slightly alkaline in reaction (pH 8.4), medium in available nitrogen (277.19 kg ha^{-1}) and phosphorus (18.02 kg ha^{-1}) while high in available potassium status (309.50 kg ha^{-1}). The treatment consisted of four levels of sulphur (10, 20, 30, 40 kg ha^{-1}) and four combinations of biofertilizers (control, *Rhizobium*, *Rhizobium* + PSB, NPK consortia) there by making 16 treatments combinations replicated thrice in FRBD. Fenugreek crop variety PRM-45 was used as test crop. A uniform dose of 40 kg N+ 20 kg P_2O_5 ha^{-1} was applied. Urea and DAP were used as a source of nitrogen and phosphorus, respectively. The nutrient content was determined by the following method N by Nesseler's reagent colorimeter method (Snell and Snell, 1949), P by Ammonium vanadomolybdate yellow colour method (Richards, 1968), K by Flame photometer method (Jackson, 1973) and S by Turbidimetric method using barium chloride gelatin reagent (Tabatabai and Bremner , 1970). The uptake was calculated by multiplying the nutrient concentration values with yield data. The data were statically analysed using standard procedure of ANOVA at 5% level of significance.

Results and Discussion

Effect of sulphur : A significant increase in N and S content in seed and haulm and N, P, K and S uptake in seed, haulm and total by crop were recorded with successive levels of sulphur up to 40 kg ha^{-1} (Table-1 and 2). Improvement in nutritional environment of plants in general seems to be due to greater availability of nutrient from the soil and later on their higher extraction by roots and translocation to plant parts. It is generally believed that the extracted nutrients are used to maintain their

Table-1 : Effect of sulphur levels and bio fertilizers on nutrient content of fenugreek crop.

Treatments	Nutrient content (%)							
	Nitrogen		Phosphorus		Potassium		Sulphur	
	Seed	Haulm	Seed	Haulm	Seed	Haulm	Seed	Haulm
Sulphur levels (kg ha^{-1})								
10	2.70	1.14	0.439	0.195	0.488	1.470	0.283	0.160
20	2.79	1.17	0.442	0.197	0.497	1.484	0.296	0.164
30	2.87	1.19	0.444	0.199	0.504	1.494	0.304	0.168
40	2.93	1.21	0.446	0.201	0.511	1.502	0.311	0.170
S.Em.±	0.02	0.006	0.003	0.001	0.006	0.013	0.002	0.0009
C.D. at 0.05	0.05	0.016	NS	NS	NS	NS	0.006	0.0027
Bio fertilizers								
Control	2.73	1.15	0.437	0.196	0.491	1.481	0.295	0.164
Rhizobium	2.81	1.17	0.442	0.198	0.498	1.487	0.298	0.165
Rhizobium + PSB	2.87	1.19	0.446	0.199	0.505	1.490	0.299	0.166
NPK consortia	2.88	1.20	0.447	0.199	0.507	1.492	0.300	0.166
S.Em. ±	0.02	0.006	0.003	0.001	0.006	0.013	0.002	0.0009
C.D. at 0.05	0.05	0.016	NS	NS	NS	NS	NS	NS

Table-2 : Effect of sulphur levels and bio fertilizers on nutrient uptake by fenugreek crop.

Treatments	Nutrient uptake (kg ha^{-1})											
	Nitrogen			Phosphorus			Potassium			Sulphur		
	Seed	Haulm	Total	Seed	Haulm	Total	Seed	Haulm	Total	Seed	Haulm	Total
Sulphur levels (kg ha^{-1})												
10	39.06	43.07	82.13	6.37	7.36	13.73	7.08	55.30	62.38	4.09	6.04	10.13
20	46.16	49.18	95.34	7.31	8.26	15.57	8.23	62.31	70.54	4.88	6.88	11.76
30	51.11	54.07	105.19	7.92	9.01	16.93	9.00	67.81	76.81	5.42	7.60	13.02
40	55.56	58.91	114.48	8.47	9.72	18.19	9.72	72.93	82.65	5.90	8.29	14.19
S.Em.±	1.08	1.29	1.86	0.19	0.245	0.364	0.244	1.74	1.815	0.14	0.18	0.24
C.D. at 0.05	3.13	3.73	5.38	0.57	0.71	1.05	0.71	5.03	5.24	0.40	0.51	0.70
Bio fertilizers												
Control	42.22	44.27	86.49	6.77	7.54	14.32	7.58	56.87	64.45	4.57	6.32	10.89
Rhizobium	46.67	49.42	96.09	7.35	8.30	15.65	8.28	62.61	70.89	4.96	6.97	11.92
Rhizobium + PSB	51.18	55.55	106.73	7.92	9.22	17.14	9.03	69.18	78.21	5.35	7.74	13.09
NPK consortia	51.83	56.00	107.83	8.03	9.29	17.32	9.14	69.69	78.82	5.41	7.78	13.19
S.Em.±	1.08	1.29	1.86	0.19	0.25	0.36	0.24	1.74	1.82	0.14	0.18	0.24
C.D. at 0.05	3.13	3.73	5.38	0.57	0.71	1.05	0.71	5.03	5.24	0.40	0.51	0.70

critical concentration in plants and thereby for use of developing structures. Thus, higher concentration of nutrients under sulphur fertilization suggests adequate supply of nutrients.

N, P, K and S uptake significantly increased up to 40 kg sulphur ha^{-1}. Application of 40 kg sulphur ha^{-1} was superior over 30, 20 and 10 kg sulphur ha^{-1} in this regard (Table 1 and 2). The trend of nutrient uptake is seemed to similar that of grain, haulm and total yield. Which is due to the fact that nutrient uptake, is the function of yield and nutrient content. Therefore, nutrient uptake by crop was also significantly increased up to 40 kg sulphur ha^{-1}. The result so obtained corroborate with the finding of Meena *et al*. (2011), Verma *et al*. (2017) and Singh. (2017).

Effect of bio fertilizers : It was observed that inoculation with biofertilizers alone or in combination significantly increased nitrogen content in seed and haulm, however, the aforesaid inoculation failed to increases in phosphorus, potassium and sulphur content in seed and haulm. Further all the inoculation treatment recorded significant increase in nutrients uptake by seed, haulm and total by the crop over control. Though seed inoculation with NPK consortia accumulated highest nutrient (107.83 kg N, 17.32 kg P, 78.82 kg K and 13.19 kg S ha^{-1}) compared to least under control (86.49 kg N, 14.32 kg P, 64.45 kg K and 10.89 kg S ha^{-1}) to establish significant superiority over control.

Significant improvement in nutrient contents and uptake by the crop under the influence of microbial inoculation appears to be on accounts of improvement in nutrients by various plant parts. Besides this, higher nodulation might have resulted in improving N status of the plant thus overall improvement in crop growth and nutrient status of plants ultimately led to accumulation of higher nutrient under the influence of NPK consortia. Significant increase in nutrient content and uptake the influence of NPK consortia was also reports by Gohil *et al*. (2021) and Kumar *et al*. (2021).

References

1. Snell, P.D. and Snell, G.T. (1949). Colorimetric method of analysis, 3rd ed. Vol. 2-D, Van Mastr and Co., Inc. New York.
2. Singh, D.P. (2017). Effect of potassium and sulphur on performance of green gram (*Vigna radiata*) in alluvial soil. *Annals of Plant and Soil Research* 19(2): 223-226.
3. Richards, L.A. (1968). Diagnosis and improvement of saline and alkaline soils. United State Department of Agriculture, Handbook No. 60, *Oxford and IBH Pub. Co.* New Delhi.
4. Jackson, M.L. (1973). Soil Chemical Analysis, Wisconsin Prentice Hall of India Pvt. Ltd., New Delhi.
5. Tabatabai, M.A. and Bremner, J.M. (1970). A simple turbidimetric method of determining total sulphur in plant materials. *Agronomy Journal* 62(6): 805-806.
6. Meena, R.P., Meena, B.L. and Dahama, A.K. (2011). Sulphur and phosphorus content and their uptake by fenugreek (*Trigonellafoenum-graecum* L.) under levels of sulphur, phosphorus and phosphate solubilizing bacteria. *International Journal of Seed Spices* 1(1): 18-21.
7. Verma, S.R., Shivran, A., Bhanwaria, R. and Singh, M. (2017). Effect of vermicompost and sulphur on growth, yield and nutrient uptake of fenugreek (*Trigonella foenum-graecum* L.). *Trends in Biosciences* 10(20): 3978-3981.
8. Kumar, S., Sahu, R.K., Thakur, R.K., Yaduwanshi, B. and Mitra, N.G. (2021). Effect of Microbial Inoculants on Plant Attributes and Nutrients Uptake by Soybean in Vertisols. *International Journal of Plant & Soil Science* 33(18): 102-109.
9. Gohil, N.B., Ramani, V.P., Kadivala, V.H. and Kacha, R.P. (2021). Effects of bio-NPK consortium on growth, yield and nutrient uptake by rice under clay loam textured soil. *Journal of the Indian Society of Soil Science* 69(2): 179-186.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1119-1125 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Effect of Zinc and Boron on Growth, Yield attributes and Quality of Chickpea (*Cicer arietinum* L.)

Kartik Salvi[1], S.C. Meena[1], Lokesh Gupta[2], Vinod Sahran[3], Gajanand Jat[1] and Shalani Pilania[4]

[1]*Department of Soil Science and Agricultural Chemistry, RCA, MPUAT, Udaipur, Rajasthan*

[2]*College of Dairy, Food and Technology, RCA, MPUAT, Udaipur, Rajasthan*

[3]*Department of MBBT, RCA, MPUAT, Udaipur, Rajasthan*

[4]*Department of Horticulture, RCA, MPUAT, Udaipur, Rajasthan*

**Corresponding Author Email : kartiksalvi77@gmail.com*

Abstract

To study the effect of "Effect of Zinc and Boron on Soil Properties, Quality and Productivity of Chickpea (*Cicer arietinum* L.)". A field experiment was undertaken during *Rabi* season of 2021-22 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur (Rajasthan). The consisting of four levels of zinc application (control, 10, 15 and 20 kg ha^{-1}) and four levels of boron application (control, 1.5, 2.0 and 2.5 kg ha^{-1}). The experiment was laid out in a factorial randomized block design with three replications. The application of zinc levels up to 15 kg ha^{-1} and boron up to 2.5 kg B ha^{-1} increased significantly (P=0.05) the yield attributes, seed yield, straw yield and biological yield of along with the recommended dose of fertilizer results in significantly (P=0.05) higher productivity of Chickpea.

Key words : *Quality, chickpea, effect of zinc, productivity, boron.*

Introduction

Chickpea (*Cicer arietinum* L.) is the most important ancient pulse crop being traditionally grown during *Rabi* in India and cultivated mainly in semi-arid and warm temperate regions of world where the temperature is 20-30 °C. Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulses in the world. Pulses contain high percentage of quality protein nearly three times as much as cereals (Upadhayay *et al*., 1999). Thus, they are cheaper source of protein to overcome malnutrition among human beings. For vegetarian diet, pulses form the major source of protein. In fact, lysine is the most limiting essential amino acid in cereals which is very well supplemented by the pulse protein. Pulses are known to improve the physical characteristics of soil through tap root system which opens the soil into deeper layers and their ability to use atmospheric nitrogen through biological nitrogen fixation which is economically sound and environmentally acceptable. In addition, they also provide nutritious fodder and feed for livestock. Pulses are drought tolerant and prevent soil erosion due to their deep root and good ground covers, because of these good characters, pulses are called as "Marvel of Nature".

Zinc is one of the essential micronutrient and plays an important role in various enzymatic and physiological activities of the plant. It is also essential for photosynthesis and nitrogen metabolism and important for the stability of cytoplasmic ribosome's, cell division, as co factor to enzymes like dehydrogenase, proteinase and peptidase in the synthesis of tryptophan, a component of some proteins and a compound needed for production of growth hormones (auxin) such as indole acetic acid (IAA).

Boron plays an important role in new cell development in meristematic tissues, proper pollination and fruit or seed formation and nodule formation in legumes. It is also involved in translocation of sugars, synthesis of amino acid, protein, carbohydrate metabolism and movement of N, P, starch and sugar.

Materials and Methods

Experimental site and soil : The experiment was conducted during *rabi* season of 2021-22 at the Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur situated at an altitude of 579.5 metres above mean sea level and at $24^0$34' latitude and $73^0$42' longitude. The region falls under agro-climatic zone-IVa (Sub-humid Southern Plain and Aravalli Hills) of Rajasthan. Soil of the experiment was sandy clay loam in texture, saline in reaction (8.0±0.11), normal in electrical conductivity (0.752±0.01 dS m^{-1}), medium in organic carbon (0.658±0.01%),low in available N (275.32±4.42 kg ha^{-1}), P (22.07±0.21 kg ha^{-1}) and high in available K (415.45±5.17 kg ha^{-1}).

Experimental design and treatments : The experiment was laid out in factorial randomized block and replicated thrice in the plot size of 3.0 m x 2.4 m (7.2 m^2). The consisting of four levels of zinc application (control, 10, 15 and 20 kg ha^{-1}) and four levels of boron application

(control, 1.5, 2.0 and 2.5 kg ha^{-1}). The chickpea var. GNG-2144 was sown in lines 30 cm apart.

Observations recorded : The observations on yield character were recorded as per the standard method. The seed yield, straw yield and biological yield was recorded from net plot area of each treatment. The data obtained from various characters under study were analyzed by the method of analysis of variance as described by Panse and Sukhatme (1985).

Statistical analysis : The data recorded for different parameters were analyzed with the help of analysis of variance (ANOVA) technique for a factorial randomized block design. The results are presented at 5% level of significance (P=0.05).

Results and Discussion

Effect of zinc

Growth characters : The significantly maximum plant height (57.73 cm) at harvest was recorded with the application of 15 kg Zn ha^{-1} (Zn_2) and the minimum plant height was observed under control (Zn_0). The dry matter accumulation $plant^{-1}$ varied significantly by application of various levels of zinc. The significantly increase in dry matter accumulation (31.05 g $plant^{-1}$) was recorded under the application of 15 kg Zn ha^{-1} (Zn_2) over Zn_1 (10 kg Zn ha^{-1}) and control (Zn_0). Whereas, Zn_2 (15 kg Zn ha^{-1}) were found at par with Zn_3 (20 kg Zn ha^{-1}). The increasing levels of zinc upto 15 kg Zn ha^{-1} (Zn_2) significantly increased the number of branches $plant^{-1}$ of chickpea over control but it remained at par with 20 kg Zn ha^{-1} (Zn_3). The maximum number of branches $plant^{-1}$ (10.43 $plant^{-1}$) at harvest was recorded with the application of 15 kg Zn ha^{-1} (Zn_2) and the minimum plant height was observed under control (Zn_0). The application of zinc increased significantly all growth parameters in chickpea *viz*., plant height, as well as dry matter of plant and number of branches at harvest. The highest plant height (57.73 cm), dry matter accumulation and number of branches $plant^{-1}$ (10.44) were observed with the soil application of 20 kg Zn ha^{-1} (Table-1). Sunder (2001) also observed in chickpea such results with the application of zinc. They reported that all the growth attributes like plant height, dry matter accumulation and pods per plant were significantly increased by the application of zinc over control. Zinc plays a pivotal role in cellular growth, differentiation and metabolism which results in vigorous growth of plants and extensive root system leading to increased growth parameters. Similar results were also reported by Halepyati (2001), Dube *et al*. (2001), Meena (2001), Singh and Ram (2001), Saini (2003), Choudhary (2006) and Sammauria (2007). Zinc sulphate application increase number of seeds per plant, the increase might due to formation of pollens, the results are in accordance with Alwad *et al.* (2003) and Texeira *et al.* (2004). Similar results are found by Usman *et al.* (2014).

Yield attributes and yield : The significantly maximum number of pods $plant^{-1}$ (86.39 $plant^{-1}$) was recorded under the application of 15 kg Zn ha^{-1} (Zn_2) over Zn_1 (10 kg Zn ha^{-1}) and control (Zn_0). Whereas, Zn_2 (15 kg Zn ha^{-1}) were found at par with and Zn_3 (20 kg Zn ha^{-1}). The seed weight (g) increased significantly up to 15 kg Zn ha^{-1}(Zn_2) by 23.75 and 18.02 per cent over control (Zn_0), and 10 kg Zn ha^{-1}(Zn_1), respectively. The increasing levels of zinc application increased the seed yield significantly up to 15 kg ha^{-1} (1933) (Zn_2) which was found at par with 20 kg Zn ha^{-1} (Zn_3). The application of 15 kg Zn ha^{-1} (Zn_2) significantly increased the haulm yield of chickpea over control but it remained at par with 20 kg Zn ha^{-1} (Zn_3). The maximum haulm yield at harvest was recorded with the application of 20 kg Zn ha^{-1} (Zn_3) and the minimum plant height was observed under control (Zn_0). The maximum biological yield at harvest was recorded with the application of 20 kg Zn ha^{-1} (Zn_3) and the minimum biological yield was observed under control (Zn_0). The data revealed that the per cent biological yield was in order of 25.81, 35.95 and 37.46 per cent with application of zinc of 10 kg Zn ha^{-1} (Zn_1), 15 kg Zn ha^{-1} (Zn_2) and 20 kg Zn ha^{-1} (Zn_3) over control (Zn_0), respectively. The application of different doses of zinc does not found significant effect on harvest index of chickpea crop. Significant increase in the number of pods $plants^{-1}$, 100 seed weight, seed yield, haulm yield, biological yield and harvest index of chickpea with the increasing levels of zinc up to 15 kg Zn ha^{-1} were recorded (Table-2). Of course, harvest index did not found significant with zinc levels. Saini (2003) also observed such results in chickpea with the application of zinc. He reported that each successive increase in the levels of zinc significantly increased the number of pods per plant, number of seeds per pod, test weight, seed and haulm yield of chickpea. The yield of crop is the cumulative effect of yield attributing characters such as pods per plant and seed index. The increase in haulm yield due to increased plant height, dry matter production and number of branches per plant i.e. growth parameters. This is due to the increased supply of available zinc to plants through its addition to the soil. Zinc is involved in the starch formation, growth promoting substance like auxin, seed maturation and production and also plays a vital role in protein synthesis. Hence on account of their physiological roles they limits the growth. Increased availability have shown marked improvement in growth attributes and indirectly increase seed and haulm yields. Biological yield is the function of seed and haulm yield. These findings are in confirmation to the earlier reports of Chandel *et al.* (1989), Sakal *et al.* (1998), Reddy

Table-1 : Effect of Zinc and Boron application on growth attributes at harvest of chickpea.

Treatments	Plant height (cm)	Dry matter of plant (g plant^{-1})	Number of branches plant^{-1}
Zinc Levels			
Control (Zn_0)	49.97	24.13	7.00
10 kg Zn ha^{-1} (Zn_1)	52.98	29.27	8.51
15 kg Zn ha^{-1} (Zn_2)	57.56	32.01	10.26
20 kg Zn ha^{-1} (Zn_3)	57.73	32.62	10.44
SEm±	0.85	0.470	0.114
CD (P=0.05)	2.45	1.356	0.329
Boron Levels			
Control (B_0)	49.85	25.19	8.00
1.5 kg B ha^{-1} (B_1)	53.76	29.51	9.09
2 kg B ha^{-1} (B_2)	56.67	31.05	9.50
2.5 kg B ha^{-1} (B_3)	57.95	32.27	9.62
SEm±	0.85	0.470	0.114
CD (P=0.05)	2.45	1.356	0.329

Table-2 : Effect of Zinc and Boron application yield attributes and yield of chickpea.

Treatments	Number of pods plant^{-1}	100 seed weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Zinc Levels						
Control (Zn_0)	70.53	19.95	1456	2146.32	3565.58	39.78
10 kg Zn ha^{-1} (Zn_1)	76.30	20.92	1793	2693.02	4486.14	40.01
15 kg Zn ha^{-1} (Zn_2)	86.39	23.82	1933	2914.62	4847.33	39.92
20 kg Zn ha^{-1} (Zn_3)	85.02	24.69	1956	2944.95	4901.23	39.95
SEm±	1.389	0.327	33.89	64.067	86.324	0.546
CD (P=0.05)	4.011	0.94	97.90	185.04	249.32	NS
Boron Levels						
Control (B_0)	70.71	20.27	1458	2147.11	3568.41	39.83
1.5 kg B ha^{-1} (B_1)	78.37	21.97	1792	2692.80	4484.99	39.93
2 kg B ha^{-1} (B_2)	83.81	23.24	1937	2918.06	4855.55	39.98
2.5 kg B ha^{-1} (B_3)	85.34	23.91	1950	2940.93	4891.33	39.91
SEm±	1.389	0.327	33.89	64.067	86.324	0.546
CD (P=0.05)	4.011	0.94	97.90	185.04	249.32	NS

Table-3 : Effect of Zinc and Boron application on quality parameters of chickpea.

Treatments	Protein content in seed (%)	Chlorophyll content 60 DAS (mg g^{-1} fresh leaf weight)
Zinc Levels		
Control (Zn_0)	19.99	2.31
10 kg Zn ha^{-1} (Zn_1)	21.81	2.40
15 kg Zn ha^{-1} (Zn_2)	24.55	2.52
20 kg Zn ha^{-1} (Zn_3)	24.62	2.50
SEm±	0.16	0.01
CD (P=0.05)	0.46	0.04
Boron Levels		
Control (B_0)	20.58	2.26
1.5 kg B ha^{-1} (B_1)	22.74	2.46
2 kg B ha^{-1} (B_2)	23.80	2.48
2.5 kg B ha^{-1} (B_3)	23.86	2.52
SEm±	0.16	0.01
CD (P=0.05)	0.46	0.04

and Ahlawat (1998), Gupta (2001), Sunder (2001), Zada *et al*. (2001), Sharma and Abrol (2002), Wasmatkar *et al.,* (2002), Sunder *et al.* (2003), Meena *et al.,* (2005), Choudhary (2006) and Sharma and Abrol (2007), Usman *et al.* (2014) also reported similar results on green gram.

Quality characteristics : Application of 15 kg Zn ha^{-1} (Zn_2) significantly increased the protein content in seed to the extent of 22.81 and 12.56 per cent, respectively over control, and 10 kg Zn ha^{-1} (Zn_1). However, maximum protein content in seed was recorded with 20 kg Zn ha^{-1} (Zn_3) which was at par with 15 kg Zn ha^{-1} (Zn_2). Significantly increased chlorophyll content at 60 DAS of chickpea. Application of 15 kg Zn ha^{-1} (Zn_2) significantly increased the chlorophyll content of chickpea over control but it remained at par with 20 kg Zn ha^{-1} (Zn_3). The maximum chlorophyll content was recorded with the application of 20 kg Zn ha^{-1} (Zn_3) and the minimum chlorophyll content was observed under control (Zn_0). The data revealed that the per cent increase in chlorophyll content was in order of 3.89, 9.09 and 8.22 per cent by the application of zinc of 10 kg Zn ha $^{-1}$ (Zn_1), 15 kg Zn ha^{-1} (Zn_2) and 20 kg Zn ha^{-1} (Zn_3) over control (Zn_0), respectively. Significant increasing trends of protein content in seed were recorded with the increasing levels of zinc upto 15 kg Zn ha^{-1} **(Table 3)**. This might be due to increase in carbohydrates and fat synthesis on accent of stimulating effect of zinc application on several dehydrogenase, proteinase and peptidase enzyme as it is a constituents of these enzymes. Similar findings were also reported by Gupta (2001), Wasmatkar *et al.,* (2002) and Meena *et al.* (2005). Chlorophyll content in leaves was significantly increased by the application of zinc upto 15 kg Zn ha^{-1} and maximum chlorophyll content in leaves was found at 15 kg Zn ha^{-1}. It may be due to the increase in the availability of zinc to plant might have stimulated the metabolic and enzymic activities. Similar findings were also reported by Sunder (2003) and Saini (2003) and Rathod *et al* (2020).

Effect of Boron

Growth characters : The significantly maximum plant height (57.95 cm) at harvest was observed with the application of 2.5 kg B ha $^{-1}$ (B3) which superior over control (B_0) and 1.5 kg B ha^{-1} (B_1) and the minimum was observed in control (B_0). Whereas, the treatment B_3 (2.5 kg B ha $^{-1}$) and B_2 (2 kg B ha $^{-1}$) were remained at par in plant height. The plant height was increased by 7.84, 13.63 and 16.24 per cent by the application of 1.5 kg B ha^{-1} (B_1), 2 kg B ha $^{-1}$ (B_2) and 2.5 kg B ha $^{-1}$ treatment B_3 over control (B_0), respectively. The significantly increase in dry matter accumulation (32.27 g plant^{-1}) B_2 (2 kg B ha $^{-1}$) and minimum (25.19 g plant^{-1}) dry matter accumulation plant^{-1} was recorded under B_0 (control). Though, the treatment B_3 (2.5 kg B ha^{-1}) and B_2 (2 kg B ha^{-1}) were remained at par with each other. The dry matter accumulation plant^{-1} was increased by 17.14, 23.26 and 28.1 per cent under the application of 1.5 kg B ha^{-1} (B_1), 2 kg B ha^{-1} (B_2) and 2.5 kg B ha^{-1} (B_3) over control (B_0), respectively. The number of branches plant^{-1} was significantly influenced with different doses of boron. The maximum (9.62 plant^{-1}) B_3 (2.5 kg B ha^{-1}) and minimum (8.00 plant^{-1}) number of branches plant^{-1} was recorded under B_0 (control). Though, the treatment B_3 (2.5 kg B ha $^{-1}$) and B_2 (2 kg B ha^{-1}) were remained at par with each other. The dry matter accumulation plant^{-1} was increased by 13.62, 18.75 and 20.25 per cent under the application of 1.5 kg B ha^{-1} (B_1), 2 kg B ha^{-1} (B_2) and 2.5 kg B ha^{-1} (B_3) over control (B_0), respectively. The application of boron increased significantly all growth parameters in chickpea *viz*., plant height, as well as dry matter of plant at harvest and number of branches at harvest upto 2.0 kg B ha^{-1} (Table-1). Boron plays a crucial role in multiplication of cell in meristematic tissues in legumes. These observations are in agreement with other researchers (Kayan *et al*., 2015; Verma *et al*., 2004). It is also involved in sugar translocation (Rathod *et al*., 2020), amino acid synthesis, protein synthesis, carbohydrate metabolism, and nitrogen, phosphorus, starch, and sugar mobilisation. (Rathod *et al*., 2020) in chickpea, (Drostkar *et al*., 2016). According to (Haleema *et al*., 2018), boron deficiency results in wilting and leaf drop. boron application is very crucial when concentration of boron in soil is less than 0.3 mg kg^{-1} (Ahlawat *et al*., 2007). Cell elongation, differentiation, and apical dominance are all factors that contribute to shoot growth. In chickpeas, boron shortage causes blossom drop and, as a result, inferior pods (Srivastava *et al*., 1997). As (Tanaka and Fujiwar, 2008), boron is involved in the retention of flowers, pollen tube growth, seed formation, seed setting, and also plays an important role in transportation of metabolites from source to sink. Boron also increased plant height by formation of new plant cells, elevated level of IAA, development of meristematic tissues, cell elongation and tissue differentiation and sugar transportation.

Yield attributes and yield : The significantly maximum number of pods plant^{-1} (85.34 plant^{-1}) in B_3 (2.5 kg B ha $^{-1}$) and minimum (70.71 plant^{-1}) number of pods plant^{-1} was recorded under B_0 (control). Though, the treatment B_3 (2.5 kg B ha^{-1}) and B_2 (2 kg B ha^{-1}) were remained at par with each other. The number of pods plant^{-1} was increased by 10.83, 18.52 and 20.69 per cent under the application of 1.5 kg B ha^{-1} (B_1), 2 kg B ha $^{-1}$ (B_2) and 2.5 kg B ha^{-1} (B_3) over control (B_0), respectively. The effect of boron on 100 seed weight of chickpea seed are presented in Table-2 which indicates that the 100 seed weight of seed (g) increased significantly up to 2 kg B ha^{-1} ($B_{2)}$. 2 kg boron

prove significantly superior to control and 1.5 kg B ha^{-1} (B_1). Thus when compared with control and 1.5 kg B ha^{-1}(B_1), the application of 2 kg B ha^{-1} ($B_{2)}$ increased 100 seed weight by 14.26 and 12.07 per cent respectively application of 2 kg B ha^{-1}($B_{2)}$ at par with 2.5 kg B ha^{-1}(B_3). The application of varying levels of boron significantly increased seed yield of chickpea, 2 kg boron (B_2) significantly superior to control (B_0) and 1.5 kg (B_1) by 32.85 and 8.09 per cent, respectively. Application of 2 kg B ha^{-1} (B_2) at par with (B_3) 2.5 kg B ha^{-1}. The maximum seed yield was recorded under the application of (B_3) 2.5 kg B ha^{-1}(1950 kg ha^{-1}). The maximum biological yield at harvest was observed with the application of 2.5 kg B ha^{-1} (B_3) which was significantly superior over control (B_0) and 1.5 kg B ha^{-1} (B_1) and the minimum was observed in control (B_0). Whereas, the treatment B_3 (2.5 kg B ha^{-1}) and B_2 (2 kg B ha^{-1}) were remained at par. The biological yield was in order by 25.68, 36.07 and 37.07 per cent with the application of 1.5 kg B ha^{-1} (B_1), 2 kg B ha^{-1} (B_2) and 2.5 kg B ha^{-1} treatment B_3 over control (B_0), respectively (Table-2). The application of boron could not show any significant effect on harvest index of chickpea crop.

Significant increase in the number of pods $plants^{-1}$, 100 seed weight, seed yield, haulm yield, biological yield of chickpea with the increasing levels of boron up to 2.0 kg B ha^{-1} were recorded (Table-2). Boron plays an important role on seed yield of chickpea as it regulates plant hormone level, photosynthetic activity and generative growth in plants which increase yield of chickpea. These conclusions are also in similarity with Mekkei (2020) concluded that foliar application of zinc, boron and molybdenum significantly produced greater seed of chickpea. Similar findings were also reported by Kobraee (2019). Sarker *et al.* (2002) noted the positive effect of haulm yield due to application of B, Zn and Mo. Variation of haulm yield was observed to be significant due to application of boron and molybdenum. Boron is essential micronutrient and essential for cell wall integrity, cell division, nitrogen fixation. Boron aids in carbohydrate metabolism and translocation of sugar in the plant. Similar results have been reported by Krishnaveni *et al*., (2004). Balanced nutrition of both these nutrients might have contributed to improved yield parameters like seed yield, total biomass, No. of pods $plant^{-1}$ and test weight. These findings were in conformity with the results of Rathod., *et al* (2020).

Quality characteristics : Application of boron significant increase in protein content in seed upto 2 kg B ha^{-1} (B_2), boron application of 2 kg Bha^{-1} (B_2) significantly increased the protein content to the order of 15.64 and 4.66 per cent, respectively over control and 1.5 kg B ha^{-1} (B_1) but was found at par with 2.5 kg B ha^{-1}. However, maximum protein content in seed was found at the level of 2.5 kg B ha^{-1} (B_3) (23.86 per cent). The significant maximum chlorophyll content was recorded B_3 (2.5 kg B ha^{-1}) and minimum chlorophyll content was recorded under B_0 (control). Though, the treatment B_3 (2.5 kg B ha^{-1}) and B_2 (2 kg B ha^{-1}) were remained at par with each other. The chlorophyll content was increased by 8.84, 9.73 and 11.50 per cent under the application of 1.5 kg B ha^{-1} (B_1), 2 kg B ha^{-1} (B_2) and 2.5 kg B ha^{-1} (B_3) over control (B_0), respectively. Significant increasing trends of protein content in seed were recorded with the increasing levels of boron upto 2.0 kg B ha^{-1} (Table-3). Similar findings were reported by (Bejandi *et al*., 2012; Islam *et al*., 2018; Kachave *et al*., 2018 and Kobaraee., 2019), who found that adding Mo, Zn, B, K, and S to pulse seeds increased the seed protein content. These micronutrients, Zn and B, are also involved in root growth, protein and carbohydrate synthesis, flower setting (Moeinian *et al*., 2011). Wahid *et al*. (2011) reported that, the increase in protein content due to the combined application of Zn and B was supported by many researchers (Bhuiyan *et al*., 2008). Chlorophyll content in leaves was significantly increased by the application of boron upto 2.5 kg B ha^{-1} and maximum chlorophyll content in leaves was found at 2.5 kg B ha^{-1} (Table-3). These findings are in agreement with other researchers (Moeinian *et al*., 2011). The foliar application of Zn and B influence both chlorophyll and carotenoid content in plants as Zn is an important micronutrient involved Photosynthesis, respiration, chlorophyll biosynthesis, and protein, lipid, carbohydrate, and nucleic acid synthesis and degradation (Auld, 2001 and Nishizawa, 2005) are all biochemical activities that occur in plants. B are essential for basic plant processes such as photosynthesis, protein synthesis, and chlorophyll synthesis (Cakmak, 2008). These results are supported by (Hemantaranjan *et al*., 2000; Sarker *et al*., 2002; Bellaloui, 2011 and Nandan *et al*., 2018). They found that application of B enhance leaf chlorophyll content.

Conclusions

On the basis of experimental finding, it can be concluded that the application of level of zinc up to 15 kg ha^{-1} significantly increased the growth, yield and yield attributing characters and protein content in seed and chlorophyll content were also improved significantly. Boron level up to 2.5 kg B ha^{-1} were also improved significantly these all parameters.

References

1. Ahlawat, I.P.S., Gangaiah, B., Ashraf and Zadid, M. 2007. Nutrient management in chickpea. In: Yadav, S.S., Redden, R., Chen, W., Sharma, B. (eds). *Chickpea breeding and management*. Wallingford, Oxon, UK, *CAB International,* 213-232.

2. Auld, D. S. 2001. Zinc coordination sphere in biochemical zinc sites. *Biometals*, 14: 271–313.
3. Awlad, H.M., Chowdhury, M.A.H. and Talukder, N.M., 2003. Effect of sulphur and zinc on nodulation, dry matter, yield and nutrient content of soybean. *Pakistan Journal of biological sciences*, 6(5): 461-466.
4. Badiyala, D. and Chopra, P. 2011. Effect of zinc and FYM on productivity and nutrient availability in maize (*Zea mays)*-linseed (*Linum usitatissimum)* cropping sequence. *Indian Journal of Agronomy,* 56: 88-91.
5. Bejandi, T.K., Sharifii, R.S., Sedghi, M. and Navar, A. 2012. Effects of plant density, Rhizobium inoculation and microelements on nodulation, chlorophyll content and yield of chickpea (*Cicer arietinum* L.). *Annals of Biological Research*, 3(2): 951- 958.
6. Bhuiyan, M.A.H.D., Khanam, M.E., Ali, M.K., Zaman and Islam, M.S. 2008. Response of lentil to biofertilizer and chemical fertilizers in the farmer's field. *Annual Research Report*, 2007-2008, Soil Science Division, BARI, Gazipur.
7. Cakmak, I., 2008. Enrichment of cereal grains with zinc: agronomic or genetic biofortification? *Plant and soil*, 302(1): 1-17.
8. Chandel, A.S., Tiwari, S.K. and Saxena, S.C. 1989. Effect of micronutrients application on soybean (*Glycine max* L.) grown in U.P. foothills. *Indian Journal of Agricultural Sciences* 59(1): 62-63.
9. Choudhary, M. 2006. Response of clusterbean to sulphur and zinc fertilization. *M.Sc. (Ag.) Thesis, Rajasthan Agricultural University,* Bikaner.
10. Choudhary, M. 2006. Response of clusterbean to sulphur and zinc fertilization. *M.Sc. (Ag.) Thesis, Rajasthan Agricultural University,* Bikaner.
11. Dube, B.K., Sharma, C.P. and Chatterjee, C. 2001. Response of pigeonpea to applied Zn in ustifluvent soils of western Uttarpradesh. *Journal of the Indian Society of Soil Science* 49 (3): 471-475.
12. Gupta, S. K. 2001. Effect of Zn fertilization on the yield and quality of lentil grown on Vertisols of Kota terrain. *66th Annual Convention, National Seminar on Development in Soil Science,* vol. 108.
13. Haleema, B. A. and Hussain, S.A. 2018. Effect of calcium, boron and zinc foliar application on growth and fruit production of tomato. *Sarhad Journal of Agriculture*, 34(1): 19-30.
14. Halepyati, A.S. 2001. Effect of moisture regime and zinc levels on the growth and yield of summer groundnut. *Karnatka Journal of Agricultural Sciences* 14(2): 451-453.
15. Kachave, T. R. and Kausadikar, H. K. 2018. Effect of specialty fertilizer on growth, yield and quality of chickpea. *International Journal of Chemical Studies*, 6(3): 1660-1662.
16. Kahlon, C. S., Sharanappa, Kumar, R. 2006. Nutrient uptake, quality and balance of nutrients as influenced by P, bioinoculants, Zn and S in cowpea. *Environment and Ecology* 245: 220-223.
17. Kobraee, S. 2019. Effect of foliar fertilization with zinc and manganese sulfate on yield, dry matter accumulation, and zinc and manganese contents in leaf and seed of chickpea (*Cicer arietinum* L.). *Journal of Applied Biology and Biotechnology*, 7(03): 20-28.
18. Kobraee, S. 2019. Effect of foliar fertilization with zinc and manganese sulfate on yield, dry matter accumulation, and zinc and manganese contents in leaf and seed of chickpea (*Cicer arietinum* L.). *Journal of Applied Biology and Biotechnology*, 7(03): 20-28.
19. Krishnaveni, A. S., Palchary, A. and Mahendram, S. 2004. Effect of foliar spray of nutrient on growth and yield of green gram (*Phaseolus radiatus*). *Legumes Research*, 27 (2): 149-150.
20. Meena, S.K., 2001. Response of chickpea to S and Zn fertilization on loamy sand soil. *M.Sc.(Ag.) Thesis, Swami Keswanand Rajasthan Agriculture University,* Bikaner.
21. Meena, S.K., Mahendra, S. and HS, M., 2005. Effect of sulphur and zinc fertilization on yield, quality and nutrient content and uptake of chickpea under semi and tropics. *Annals of Agricultural Research New Series*, 26(1): 45-47.
22. Mekkei, M. E. R. 2020. Effect of micronutrients (Zn, B and Mo) foliar application at various growth stages of chickpea (*Cicer arietinum L.*) on yield and yield components. *Journal of Plant Production*, 11(1): 1-6.
23. Moeinian, M.R., Zargari, K. and Hasanpour, J. 2011. Effect of boron foliar spraying application on quality characteristics and growth parameters of wheat grain under drought stress. *American Eurasian Journal of Agriculture and Environmental Sciences,* 10: 593-599.
24. Nandan, B., Sharma, B.C., Chand, G., Bazgalia, K., Kumar, R., and Banotra, M. 2018. Agronomic fortification of Zn and Fe in chickpea an emerging tool for nutritional security–A global perspective. *Acta Scientific Nutritional Health*, 2(4): 12-19.
25. Nishizawa, N. K. 2005. The uptake and translocation of minerals in rice plants. In: Rice is life: scientific perspectives for the 21st century. *Proceedings World Rice*. 82-86.
26. Rathod, S., Channakeshava, S., Basavaraja, B. and Shashidhara, K.S., 2020. Effect of soil and foliar application of zinc and Boron on growth, yield and micro nutrient uptake of Chickpea. *Journal of Pharmacognosy and Phytochemistry*, 9(4): 3356-3360.
27. Reddy, N.R.N. and Ahlawat, I.P.S. 1998. Response of chickpea (*Cicer arietinum* L.) genotypes to irrigation and fertilizers under late sown conditions. *Indian Journal of Agronomy* 43(1): 95-101.
28. Saini, R.K. 2003. Effect of zinc and iron on growth and yield of mothbean in arid western Rajasthan. *M.Sc. (Ag.) Thesis, Rajasthan Agricultural University,* Bikaner.
29. Sakal, R., Sinha, R.B., Singh, A.P. and Bhopal, N.S. 1998. Response of some *Rabi* pulses to B, Zn and sulphur application in farmer's field. *Fertilizer News* 43(11): 37-40.
30. Sammauria, R. 2007. Response of fenugreek to phosphorus and zinc application and their residual effect on succeeding pearlmillent under irrgated condition of western Rajasthan *Ph.D. (Ag.) Thesis, Rajasthan Agricultural University,* Bikaner.
31. Sarker, S.K., Chowdhury, M.K.H. and Zakir, H.M. 2002.

Sulphur and boron fertilization on yield quality and nutrient uptake by Bangladesh soyabean-4. *Journal of Biological Sciences*, 2(11): 729-733.

32. Sharma, V. and Abrol, V. 2002. Effect of P and Zn application on yield and uptake of P and Zn by chickpea under rainfed conditions. *Journal of Food Legumes* 15(1): 59-61.
33. Sharma, V. and Abrol, V. 2007. Effect of P and Zn application on yield and uptake of P and Zn by chickpea under rainfed conditions. *Journal of Food Legumes* 20(1): 49-51.
34. Singh, A.K. and Ram, H. 2001. Effecct of phosphorus and zinc on yield and quality of mungbean. *Annals of Plant and Soil Research* 3: 307-309.
35. Sunder, S. 2001. Effect of phosphorus and zinc on growth, yield and quality of clusterbean in north western Rajasthan. *M.Sc. (Ag.) Thesis, Rajasthan Agricultural University,* Bikaner.
36. Sunder, S., Pareek, B. L. and Sharma, S. K. 2003. Effect of P and Zn on dry matter, uptake of nutrients and quality of clusterbean. *Annals of Agricultural Research New Series* 24(1): 195-196.
37. Tanaka, M. and Fujiwar, T. 2008. Physiological roles and transport mechanisms of boron: perspectives from plants. *European Journal of Physiology,* 456: 671-677.
38. Teixeira, I.R., Borém, A., Araújo, G.A.D.A. and Fontes, R.L.F., 2004. Manganese and zinc leaf application on common bean grown on a" cerrado" soil. *Scientia Agricola*, *61*, 77-81.
39. Upadhayay, R.G., Sharma, S. and Drawal, N.S., 1999. Effect of rhizobium inoculation and graded level of P on the growth and yield of green gram. *Legume research*, *22*, 277-79.
40. Usman, M., Tahir, M. and Majeed, M.A., 2014. Effect of zinc sulphate as soil application and seed treatment on green gram (*Vigna radiata* L.). *Pakistan Journal of Life and Social Sciences*, 12(2), 87-91
41. Verma, C. B., Lallu and Yadav, R. S. 2004. Effect of boron and zinc application on growth and yield of pigeonpea. *Indian Journal of Pulses Research*, 17(2): 149-151.
42. Wahid, M., Ahmad, W., Cheema, M., Saleem, M. and Sattar, A. 2011. Impact of foliar applied boron on yield and yield components of spring maize (*Zea mays* L.) under drought condition. *Soil and Crop Environmental Science*, 382-383.
43. Wasmatkar, R.P., Inyole, G.L. and Rout, P.D. 2002. Effect of different levels of sulphur and zinc on quality and uptake of nutrient of soybean. *Journals of Maharashtra Agricultural University* 27(3): 244-246.
44. Zada, K., Kadar, K.M. and Shah, P. 2001. Micronutrient management for yield and quality of inoculated soybean. *Sarhad. Journal of Agriculture* 17(1): 23-26.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1126-1130 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Impact of Foliar Application of Nano Nitrogen and Nano Zinc on Yield Attributes and Yield of Mustard (*Brassica juncea* L.)

Kriti Sharma[1*], R.H. Meena[1], S.C. Meena[1], Devendra Jain[2], K.D. Ameta[3], Neha Khardia[1] and Deshraj Meena[1]

[1]*Department of Soil Science and Agricultural Chemistry, RCA, MPUAT, Udaipur, Rajasthan*

[2]*Department of MBBT, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*

[3]*Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*

**Corresponding Author Email : kritisharma101095@gmail.com*

Abstract

The aim of this present investigation is to study the effect of foliar application of nano N and Zn on yield attributes and yield of mustard (*Brassica juncea* L.) crop. The field experiment was carried out during October to March 2022 season at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur which lies in agro-climatic zone IV-A of Rajasthan, India. The field was designed in a randomized block design having 10 treatments which were replicated thrice. The treatments include the various combination RDF and nano fertilizers of N and Zn. The application treatment T_6 (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) has significantly increased plant height, the number of siliqua plant^{-1}, seeds siliqua^{-1}, test weight, grain yield and stover yield of mustard.

Key words *: Foliar application, nano fertilizer, yield, mustard.*

Introduction

Indian mustard (*Brassica juncia* L.) is the most important oilseed crop of India, occupying the first rank in area and second in production next to China. Total area under rapeseed- mustard in India is 5.98 million hectares with a production of 8.32 million tonnes and productivity of 1397 kg ha^{-1} (Anonymous, 2019). In terms of acreage, oilseeds occupy 14.1 per cent and rapeseed-mustard alone occupies 3 per cent of the total cropped area in the country. It is second most important edible oilseed crop, contributes 28.6 per cent in the total oilseeds production among the seven edible oilseeds cultivated in India and ranks second after groundnut sharing 27.8 per cent in the India's oilseed economy (Singh *et al*., 2017). It is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat and some non-traditional areas of South India.

Nitrogen (N) is the most critical element limiting agricultural production at a global scale. Despite many efforts, the nitrogen use efficiency (NUE) in agriculture remains in a range of less than 50%. Among mineral nutrients, nitrogen is the first and foremost nutrient required for crop plants as it is the constituent of chlorophyll and many proteins and enzymes and thus plays a significant role during the vegetative growth of crops. Nitrogen is lost through the processes of nitrate leaching, de-nitrification and ammonia volatilization. Loss of mineral nutrients through leaching and runoff to surface and ground water along with abundant volatilization constitute growing concerns owing to economic losses and environmental pollution. Moreover, nitrogen volatilization results in the release of nitrous oxides and thus being the greenhouse gases, contribute to the global warming. It is really unfortunate that modern profit-oriented farming systems encompass nitrogenous fertilizers use efficiency of only 45–50%.

Zinc is considering as fourth most yield limiting nutrient after nitrogen, phosphorus and potassium, respectively in world as well as in Indian soils (Arunachalam *et al*., 2013). It is estimated that 36.5 % of Indian soils are deficient in Zn (Arvind *et al*., 2019). Zinc is one of the essential micronutrient necessary for crop nutrition as it plays an important role in metabolic processes such as carbohydrate, nucleic acid, lipid and protein synthesis as well as their degradation. It is an integral component of nearly 200 enzymes in plants. It is important in synthesis of Indole Acetic acid (IAA) a phytohormone which dramatically regulates the plant growth, chlorophyll synthesis, pollen formation, controlling responsible for tolerance to environmental stress as well as water uptake and transport to plant part.

Foliar application is a technique of feeding plants by spraying liquid fertilizers directly to the leaves, which is accompanied with better absorption in the aerial parts (Nasiri *et al*., 2010; Marzouk *et al*., 2019). The efficacy of foliar fertilization is higher than that of soil fertilizer application under drought and salinity condition due to supply of required nutrient directly to the leaves, its relatively quick absorption, independence of root activity

and soil water availability (Romheld and El-fouly, 1999). Foliar nano zinc, copper and iron fertilizers application on grain crops increases growth parameters of wheat relative to other fertilizer sources (Ghorbanpour *et al*., 2017). Hence, looking to the above facts, the present investigation was carried out to study the impact of foliar application of nano-fertilizers on soil microbial population, biomass-c and productivity of wheat in the sub-humid southern plains of Rajasthan.

Nano-fertilizers are essential to reduce the use of inorganic fertilizers and reduce their antagonistic effects on the environment. Nano-fertilizers are more reactive, can penetrate the epidermis allowing for gradual release, and targeted distribution, and thus reducing nutrients surplus, enhancing nutrient use efficiency. Foliar application of nano fertilizers can overcome these limitations since foliar-applied nutrients on leaves allow nutrients to penetrate the cuticle, be absorbed by leaf cells, and finally transported to the conducting system (Fernández and Eichert, 2009). The efficiency of nanoparticles is determined by their chemical composition, size, surface covering, reactivity and most important the dose at which they are effective (Jyothi and Hebsur, 2017; Shang *et al*., 2019). Nano-fertilizers have better nutrient use efficiency due to their better penetration ability and translocation within plant parts (Ghorbanpour *et al*., 2017; Kopittke *et al*., 2019), moreover, they prevent undesirable loss of nutrient via direct internalization by crops, and thereby, avoid the interaction of nutrients with soil, water, air and microorganisms (Panpattee *et al*., 2016). Nanofertilizers also have controlled release and targeted delivery of effective nanoscale ingredients/nutrients and have the ability to improve plant productivity and minimize environmental pollutants (Fatima *et al*., 2020).

In light of the aforementioned information, the current study was conducted to assess the effects of foliar applications of nano urea and zinc on mustard productivity and nutrient uptake in the sub-humid southern plains of Rajasthan.

Materials and Methods

Study area : The experiment was conducted during *rabi* 2021-22 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur. The region falls under agro-climatic zone-IVA (Sub-humid Southern Plains and Aravalli Hills) of Rajasthan. The climate of the study area is sub-humid with an average minimum and maximum temperature (October-February) ranging between 3.2^{o} to 30.4^{o}C.

Experimental design and treatments : The experiment was laid out in a randomized block design with three replications. The gross plot size was 15 m^2 (5 x 3 m). The experiment consisted of ten treatments *viz*., T_1 (Control), T_2 (100% NPK Zn), T_3 (75% N Zn + 100 % PK), T_4 (50% N Zn + 100 % PK), T_5 (T_2+1st spray of Nano N and Zn at 30 DAS), T_6 (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS), T_7 (75% N Zn + 100 % PK +1st spray of Nano N and Zn at 30 DAS), T_8 (75% N Zn + 100 % PK +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS), T_9 (50% N Zn + 100 % PK +1st spray of Nano N and Zn at 30 DAS), T_{10} (50% N Zn + 100 % PK +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) were applied to mustard var. Giriraj (DRMRIJ 31) in *rabi* session, 2021-22. The recommended dose of fertilizer was 60 kg N, 40 kg P_2O_5, 40 kg K_2O and 5 kg $ZnSO_4$ ha^{-1} and also other agronomic practices recommended for Zone IVa were followed as per Package of Practices, Government of Rajasthan. The seed obtained from the produce of individual plot were recorded as seed yield kg per plot and later it was converted into kg ha^{-1}.

Application protocol of foliar spray : Foliar sprays were given as 1st application at 30 days after sowing and 2nd application at 45 days after sowing in selected treatments with the help of knapsack sprayer with flat fan nozzle. Nano N were applied @ 4 ml l^{-1} water while Nano Zn @ 2 ml l^{-1} water as per scheduled treatments.

Estimation of yield attributes and yield : At harvest, random samples of five plants were collected from each plot for siliqua plant^{-1}, seeds siliqua^{-1} and plant height. The remaining plants were harvested for assessing the total seed yield. The seed yield and stover yield were recorded as yield per plot but later converted to kg ha^{-1}.

Statistical Analysis : The obtained data were statistically analyzed with the techniques of analysis of variance as described by Steel and Torrie, 1960. The comparison in the treatment mean was tested by critical difference (CD) at 5% (P=.05) level of significance.

Results and Discussion

Application of foliar spray of nano N and nano Zn enhanced the plant height, number of siliqua plant^{-1}, seeds siliqua^{-1} and test weight (Table-1). The maximum plant height (217.94 cm), number of siliqua plant^{-1} (364.01), seeds siliqua^{-1} (23.50) and test weight (5.60 g) observed under treatment T_6 (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) as compare to control (T_1). Nano fertilizers or nano-encapsulated nutrients have properties that are effective to crops, release the nutrients on-demand, controlled release of chemical fertilizers that regulate plant growth and enhanced target activity (Nair *et al*., 2010). Foliar application provides for rapid uptake of nutrients during the crop's rapid growth stage, especially in soil that

Table-1 : Effect of foliar application of nano nitrogen and nano zinc on growth, yield attributes and yield of mustard.

	Treatments	Plant height (cm)	Siliqua plant^{-1}	Seeds siliqua^{-1}	Test weight (g)
T_1	Control	184.98	191.00	12.23	4.25
T_2	100% NPK Zn	193.65	319.87	20.61	5.12
T_3	75% N Zn + 100% PK	190.58	283.90	18.27	4.45
T_4	50% N Zn + 100% PK	188.45	246.75	15.90	3.98
T_5	T_2 + 1st spray of Nano N and Zn at 30 DAS	211.05	357.00	22.99	5.53
T_6	T_2 + 1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS	217.94	364.01	23.50	5.60
T_7	T_3 + 1st spray of Nano N and Zn at 30 DAS	208.13	351.33	22.68	5.46
T_8	T_3 + 1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS	212.00	357.00	23.08	5.55
T_9	T_4 + 1st spray of Nano N and Zn at 30 DAS	198.50	328.23	21.34	5.28
T_{10}	T_4 + 1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS	201.00	339.24	21.88	5.34
S Em±		5.958	10.881	0.685	0.067
CD (P= 0.05)		17.702	32.328	2.035	0.200

Table-2 : Effect of foliar application of nano nitrogen and nano zinc on yield of mustard.

	Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
T_1	Control	838.33	1977.30
T_2	100% NPK Zn	1401.83	3114.02
T_3	75% N Zn + 100% PK	1242.67	2801.00
T_4	50% N Zn + 100% PK	1078.00	2428.78
T_5	T_2 + 1st spray of Nano N and Zn at 30 DAS	1556.03	3363.07
T_6	T_2 + 1st spray of Nano N and Zn at 30 DAS + 2nd spray of Nano N and Zn at 45 DAS	1596.17	3510.67
T_7	T_3 + 1st spray of Nano N and Zn at 30 DAS	1532.00	3414.44
T_8	T_3 + 1st spray of Nano N and Zn at 30 DAS + 2nd spray of Nano N and Zn at 45 DAS	1595.22	3500.67
T_9	T_4 + 1st spray of Nano N and Zn at 30 DAS	1451.00	3333.99
T_{10}	T_4 + 1st spray of Nano N and Zn at 30 DAS + 2nd spray of Nano N and Zn at 45 DAS	1486.03	3406.44
S Em±		49.723	139.312
CD (P= 0.05)		147.733	413.918

is lacking in accessible soil nutrients. Foliar application is a quick and effective treatment for plant nutrition. It was evident from the present study that foliar application of Nano N and Zn manipulates growth parameters of mustard, resulting in significant improvement in yield and yield related components.

Application of foliar spray of nano N and nano Zn significantly increase the grain yield. The highest seed yield (1596.17 kg ha^{-1}) and stover yield (3510.67 kg ha^{-1}) is observed under treatment T_6 (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) followed by T_8 (75% N Zn + 100 % PK +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) as compared to control (Table-2). The enhanced growth may be attributed to increased growth hormone and photosynthetic activities due to applications of nano-fertilizers. Moreover, the application of nano Zn enhances the metabolic processes of plants and photosynthesis, resulted increase flowering and grain formation, which ultimately increased the yield attributes. Several research findings have reported that nano-fertlizers promote photosynthesis and plant growth (Wu, 2013; Fatima *et al.,* 2020). Nano-fertilizers viz., nano-NPK is considered as biological pumps of the plants to promote nutrients and water absorption in crop plants (Ma *et al*., 2009). The results obtained in the present study collaborates with the previous reports where foliar spray of nano-fertilizers increased the yield and yield components of wheat crop (Zain *et al.,* 2015; Mer and Ama, 2014). Being a primary element, nitrogen shows prominent effects by increasing the leaf, leaf area, and more use of solar radiation in photosynthesis which tend to enhance vegetative growth and thus improve the biomass and grain yield. Nano nitrogen increased yield and yield attributes of mustard as a result of nano size

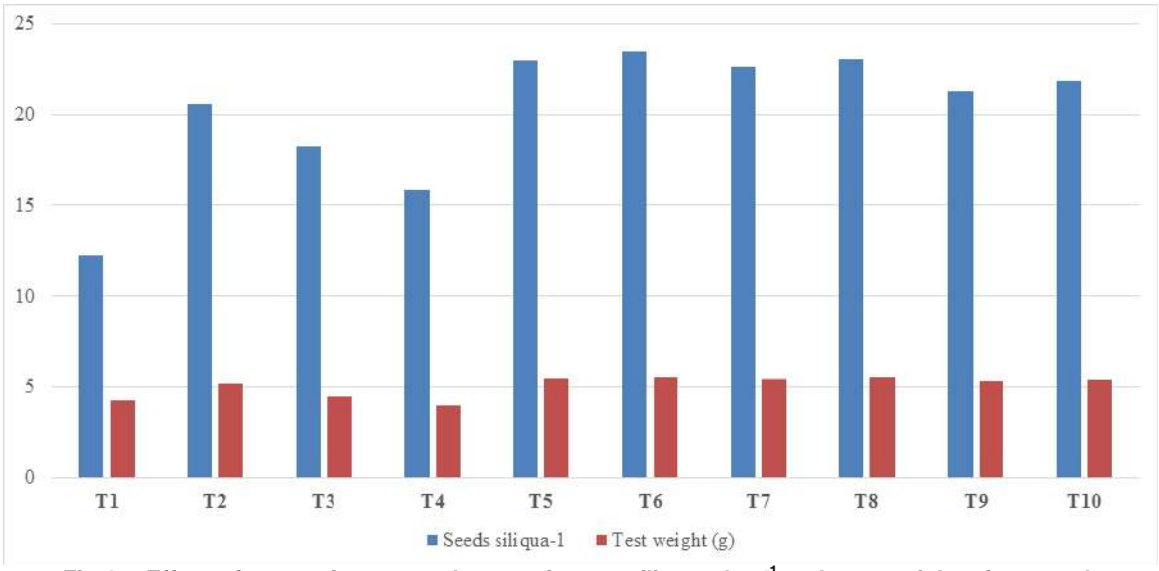


Fig-1 : Effect of nano nitrogen and nano zinc on siliqua plant^{-1} and test weight of mustard.

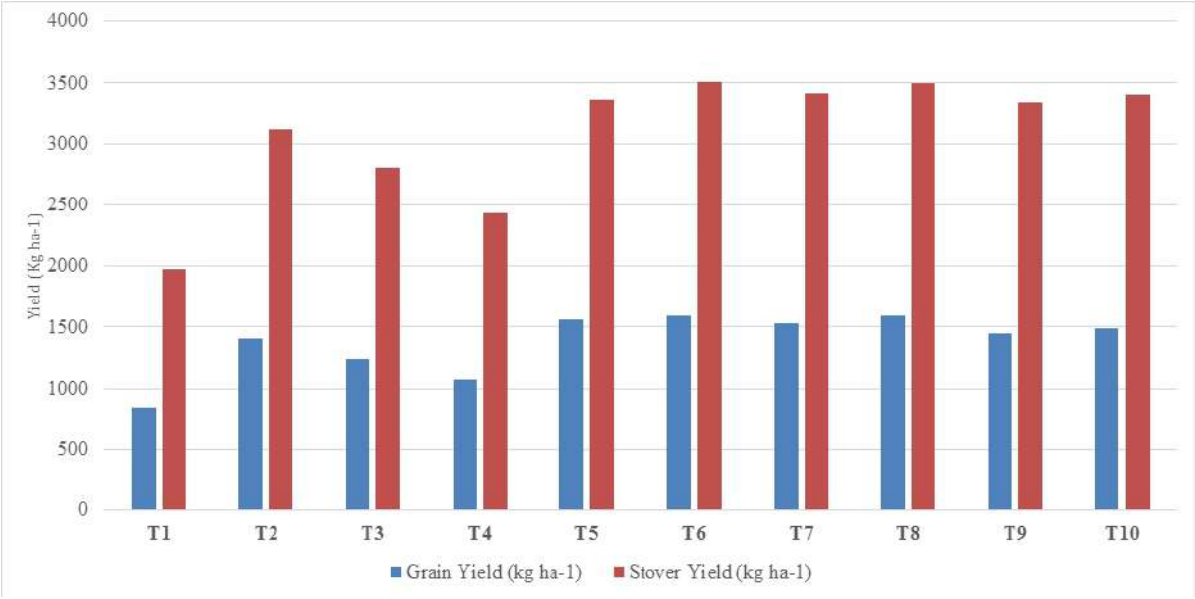


Fig-2 : Effect of nano nitrogen and nano zinc on grain yield and stover yield of mustard.

having high surface area to volume ratio which facilitates faster absorption of nutrients and reduces leaching losses which increases the use efficiency of nitrogen. The use of zinc may have increased grain yield by enhancing pollen and seed production, which would have improved plant reproduction. The current study's findings are comparable to those of Elshayb *et al.*, 2021, who discovered a considerable improvement in rice yield characteristics and yield as a result of combining standard $ZnSO_4$ and ZnO NP applications. According to Drostkar *et al.*, 2016, it was also discovered that foliar application of NPK nano-fertilizers improved chickpea yield and yield attributes by boosting growth hormone activity and improving metabolic processes, which in turn triggered flowering and grain formation.

Conclusions

From the forgoing result, it was concluded that the application of the nano fertilizers significantly affect yield and chemical properties of soil. The application treatment T_6 (100% NPK Zn +1st spray of Nano N and Zn at 30 DAS +2nd spray of Nano N and Zn at 45 DAS) has significantly increased the plant height, siliqua plant^{-1}, seeds siliqua^{-1}, test weight, seed yield, and stover yield of mustard.

References

1. Anonymous, 2019. Rajasthan Agricultural Statistics at a glance, Commissionerate of Agriculture, Jaipur, Rajasthan, 88.
2. Arunachalam, P., Kannan, P., Prabukumar, G., and Govindaraj, M. 2013. Zinc deficiency in Indian soils with

special focus to enrich zinc in peanut. *African Journal of Agricultural Research*, 8(50): 6681-6688.

3. Arvind, R., Singh, S. K., Kumar, V., Singh, S. P., Shukla, A., Nidhi and Yadav, R. C. 2019. Zinc fertilization in rice-wheat cropping system under upland calcareous soil. *Journal of Plant Nutrition*, 42(3): 296-306.
4. Drostkar, E., Talebi, R. and Kanouni, H. 2016. Foliar application of Fe, Zn and NPK nano-fertilizers on seed yield and morphological traits in chickpea under rainfed condition. *Journal of Resources and Ecology*, 4(1): 221-228.
5. Elshayb, O.M., Farroh, K.Y., Amin, H.E. and Atta, A.M. 2021. Green synthesis of zinc oxide nanoparticles: fortification for rice grain yield and nutrients uptake enhancement. *Molecules*, 26(584): 1-17.
6. Fatima, F., Hashim, A., & Anees, S. 2020. Efficacy of nanoparticles as nanofertilizer production: a review. *Environmental Science and Pollution Research*, 28(2): 1292-1303.
7. Fernández, V. and Eichert, T. 2009. Uptake of hydrophilic solutes through plant leaves: current state of knowledge and perspectives of foliar fertilization. *Critical Reviews in Plant Sciences*, 28(1-2): 36-68.
8. Ghorbanpour M, Manika K. and Varma A. 2017. Nanoscience and Plant–Soil Systems.*Springer International Publishing.*
9. Jyothi, T. V. and Hebsur, N. S. 2017. Effect of nanofertilizers on growth and yield of selected cereals-A review. *Agricultural reviews*, 38(2).
10. Kopittke, P. M., Lombi, E., Wang, P., Schjoerring, J. K. and Husted, S. 2019. Nanomaterials as fertilizers for improving plant mineral nutrition and environmental outcomes. *Environmental Science: Nano*, 6(12): 3513-3524.
11. Ma, J., J. Liu and Z.M. Zhang. 2009. Application study of carbon nano-fertilizer on growth of winter wheat. Humic Acid, 2: 14-20.
12. Marzouk, N. M., Abd-Alrahman, H. A., EL-Tanahy, A. M. M., & Mahmoud, S. H. 2019. Impact of foliar spraying of nano micronutrient fertilizers on the growth, yield, physical quality, and nutritional value of two snap bean cultivars in sandy soils. *Bulletin of the National Research* Centre, 43(1): 1-9.
13. Mer, M. and Ama, E.H.E. 2014. Effect of Cu. Fe, Mn, Zn Foliar Application on Productivity and Quality of Some Wheat Cultivars, 283-291.
14. Nasiri, Y., S. Zehtab-Salmasi, S. Nasrullahzadeh, N. Najafi and K. Ghassemi-Golezani, 2010: Effects of foliar application of micronutrients (Fe and Zn) on flower yield and essential oil of chamomile (*Matricaria chamomilla* L.). *The Journal of Medicinal Plants Research.*, 4: 1733-1737
15. Nair, R., S. Varghese, B. Nair, T. Maekawa, Y. Yoshida and S. Kumar. 2010. Nanoparticulate material delivery to plants. *Plant Science.*, 179: 154-163.
16. Panpattee, D.G., Y.K. Jhala H.N. Shelat and R.V. Vyas: Microbial inoculants in sustainable agricultural productivity. *Nano Particles: The Next Generation Technology for Sustainable Agriculture, Springer*, New Delhi, pp. 289-300. (2016).
17. Romheld, V., & El-Fouly, M. 1999. Aplicación foliar de nutrientes: retos y límites en la producción agrícola. *Informaciones agronómicas*, 48.
18. Shang, H., Guo, H., Ma, C., Li, C., Chefetz, B., Polubesova, T., & Xing, B. 2019. Maize (*Zea mays* L.) root exudates modify the surface chemistry of CuO nanoparticles: Altered aggregation, dissolution and toxicity. *Science of the Total Environment*, 690: 502-510.
19. Singh, A. K., Singh, A. K., Choudhary, A. K., Kumari, A. and Kumar, R. 2017. Towards oilseeds sufficiency in India: Present status and way forward. *Journal of Agri Search*, 4(2): 80-84.
20. Steel RGD and Torrie JH. 1960. Principles and procedures of statistics with special reference to the biological sciences, McGraw Hill, New York, :187-287.
21. Wu, M.Y. 2013. Effects of incorporation of nano-carbon into slow-released fertilizer on rice yield and nitrogen loss in surface water of paddy soil. In 2013 *Third International Conference on Intelligent System Design and Engineering Applications,* 5: 676-681.
22. Zain, M., Khan, I., Qadri, R. W. K., Ashraf, U., Hussain, S., Minhas, S. and Bashir, M. 2015. Foliar application of micronutrients enhances wheat growth, yield and related attributes. *American Journal of Plant Sciences*, 6(07): 864.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1131-1133 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Enhancing Productivity and Quality of Barley (*Hordeum Vulgare* L.) Using Silicon in Low Moisture Areas

Surekha Panchal[1], M.K. Kaushik[1], Jagdish Choudhary[1] and Ram Hari Meena[2]
[1]*Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*
[2]*Department of Soil Science and Agricultural Chemistry, MPUAT, Udaipur, Rajasthan*
Corresponding Author Email : surekhapanchal313@gmail.com

Abstract

A field experiment entitled "Enhancing Productivity and Quality of Barley (*Hordeum vulgare* L.) using Silicon in Low Moisture Areas" was conducted on clay loam soil of Instructional Farm, Department of Agronomy, Rajasthan college of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur during *rabi* 2021-2022. The treatments comprising of four irrigation levels (I_1: no irrigation, I_2: one irrigation between 30-35 DAS, I_3: three irrigation between 30-35 DAS and 80-85 DAS and I_4: four irrigation between 30-35 DAS, 60-65 DAS and 90-95 DAS) and four silicon levels (S_1: control, S_2: 100 kg ha^{-1}, S_3: 150 kg ha^{-1} and S_4: 200 kg ha^{-1}), assigned respectively to main and sub plots and those were replicated three times in split plot design. For such experiment barley variety "DWRB 137" was used. Results of experiment revealed that irrigation and silicon on leaf area index at 75 DAS had significant effect, whereas at 50 DAS irrigations levels failed to record any significant effect on leaf area index. Crop phenological parameter such as days to 50 per cent heading and days to boot leaf was not significantly influenced by irrigation and silicon levels. Maximum chlorophyll content at 50 DAS was found under three irrigation levels whereas in silicon levels maximum chlorophyll was found under silicon 200 kg ha^{-1}.

Introduction

Barley (*Hordeum vulgare* L.) is the 4th major grain crop, after wheat, rice and corn throughout the globe. Barley having great adaptability, can grow in all three regions of the world including the temperate, tropical and subtropical even in the presence of adverse climatic conditions like drought, salinity and alkalinity (Neelam *et al*., 2018). Only 6 per cent of barley is used for human consumption, whereas the malting industry utilises about 21 per cent of the crop and more than 70 per cent is used as cow fodder. The rest is used for brewing, medicine, baby food and other things (Caterina *et al*., 2018). Barley is rich source of molybdenum, manganese and selenium along with quality fibre specifically beta-glucan.

Silicon is the second most abundant element in the world after oxygen and it makes up 31 per cent of total soil mass. In contrary, soil solution contains between 3 and 17 per cent silicon, which is absorbed as silicic acid. Silicic acid is the mostly available form of silicon found in soils (Ma *et al*., 2001). Artificially watering plants is one of the most important technique for enhancing production. For a plant to develop properly in terms of vegetative and reproductive growth, there must be sufficient soil moisture. Barley requires 300-400 mm of irrigation water during the crop period, depending upon environmental factors such as rainfall, temperature, wind speed, day length and soil physical chemical attributes. Active tillering stage (30-35 DAS), flag leaf stage (60-65 DAS), booting stage and milking stage are crucial stages of barley irrigation (80-85 DAS). Water is the most vital natural resource on the earth. Water is a limited resource that is essential for agriculture and advancing civilizations in the modern world. One of the most important inputs for agricultural output is regarded to be water. It facilitates a higher productive potential from the land and significant response from applied agricultural inputs *viz*., high yielding varieties and fertilizer etc. (Kukal *et al*., 2014).

Materials and Methods

A field experiment was conducted during *Rabi* 2021-22 at the Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan which is situated at 74^{o} 42' E longitude, 24^{o} 3' N latitude and 581.13 metre of height above mean sea level. The region falls under agro-climatic zone IVa of Rajasthan i.e. Sub Humid Southern Plains and Aravalli Hills. The average rainfall of Udaipur is 637 mm. The soil of experimental site was clay loam having pH 7.7, organic carbon 0.67%, available nitrogen 287.2 kg/ha, phosphorus 22.1 kg/ha and potassium 367.2 kg/ha in the soil. The experiment was laid out in split plot with four irrigation levels (I_1: no irrigation, I_2: one irrigation between 30-35 DAS, I_3: three irrigation between 30-35 DAS and 80-85 DAS and I_4: four irrigation between 30-35 DAS, 60-65 DAS and 90-95 DAS) and four silicon levels (S_1: control, S_2: 100 kg ha^{-1} , S_3: 150 kg ha^{-1} and S_4: 200 kg ha^{-1}), assigned respectively to main and sub plots and those were replicated three times. Barley variety DWRB 137 was used as test crop. Barley variety DWRB 137 was drill sown at 22.5 cm row distance on 12th November, 2021

using 100 kg/ha seed rate. The recommended dose of nitrogen, phosphorous and potash was 60-40-20 kg ha^{-1}, respectively, which was applied through urea, SSP and MOP.

Barley leaves were removed from three randomly selected plants from each experimental unit and categorized as small, medium and large leave. As suggested by Montgomery the leaf area per plant was calculated by multiplying length and width of leaf and summing up area under each category of leaves and multiplied by standard factor 0.796 (Bala Krishnan *et al.,* 1947). Thereafter, LAI was calculated by using the formula given by Watson (1997).

$$\text{Leaf area index} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Ground area occupied per plant (cm}^2\text{)}}$$

A chlorophyll meter was used to obtain readings estimating leaf chlorophyll concentration (SPAD value). Ten plants per treatment were selected randomly and SPAD (Soil Plant Analysis Development) values were recorded from the fully matured leaves counted from the top of the plants, the youngest fully expanded leaf. Data were recorded at 50 DAS.

Results and Discussion

Effect of irrigation and silicon levels on leaf area index : Results revealed that maximum leaf area index (3.34) at 75 days after sowing was recorded under two irrigations, it was statistically at par with three irrigation and one irrigation and significantly higher over no irrigation. In case of silicon level maximum leaf area index (3.33) was found under application of 200 kg ha^{-1} and it was statistically at par with 150 kg ha^{-1} silicon at 50 DAS. Maximum leaf area index (3.33) at 75 days after sowing and it was statistically at par with 150 kg ha^{-1} silicon. Leaf area index at 50 DAS non-significantly influenced by different irrigation levels and at 75 DAS maximum leaf area index was found under application of 200 kg ha^{-1} silicon. Similar results found was reported by Pooja *et al*. (2019) (Table-1).

Effect of irrigation and silicon levels crop phenological parameter : Data present in Table-2 show that crop phenological parameter such as Days to 50 per cent heading and days to boot leaf did not significantly affected by irrigation levels and silicon levels.

Effect of irrigation and silicon levels chlorophyll content at 50 DAS

Irrigation levels : A reference of data shows that maximum chlorophyll content (56.06) at 50 DAS under different irrigation levels was found under three irrigation which was statistically at par with two irrigation.

Table-1 : Effect of irrigation and silicon levels on leaf area index of barley.

Treatment	Leaf area index	
	50 DAS	75 DAS
Irrigation levels		
No irrigation	2.50	3.10
One irrigation	2.56	3.24
Two irrigations	2.57	3.33
Three irrigations	2.56	3.29
SEm±	0.03	0.04
CD (P=0.05)	NS	0.14
Silicon levels (kg ha^{-1})		
Control	2.43	3.18
100	2.50	3.13
150	2.61	3.31
200	2.64	3.33
SEm±	0.02	0.02
CD (P=0.05)	0.06	0.06

Table-2 : Effect of irrigation and silicon levels on crop phenological parameter of barley.

Treatments	Days taken to boot leaf stage	Days taken to 50 per cent heading
Irrigation levels		
No irrigation	59.11	68.60
One irrigation	59.77	68.73
Two irrigations	60.88	69.45
Three irrigations	60.99	70.30
SEm±	0.62	0.65
CD (P=0.05)	NS	NS
Silicon levels (kg ha^{-1})		
Control	59.61	68.67
100	60.17	69.25
150	60.25	69.33
200	60.72	69.83
SEm±	0.59	0.62
CD (P=0.05)	NS	NS

Table-3 : Effect of irrigation and silicon levels on total chlorophyll content of barley (SPAD reading).

Treatments	Chlorophyll content
Irrigation levels	
No irrigation	52.20
One irrigation	55.47
Two irrigations	56.03
Three irrigations	56.06
SEm±	0.71
CD (P=0.05)	2.455
Silicon levels (kg ha^{-1})	
Control	50.52
100	55.63
150	56.65
200	56.96
SEm±	0.61
CD (P=0.05)	1.781

Table-4 : Effect of irrigation and silicon levels on nutrient content (%) in grain and straw of barley.

Treatments	Nutrient content (%)							
	Nitrogen		Phosphorus		Potassium		Silicon	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Irrigation levels								
No irrigation	1.763	0.198	0.3277	0.1439	0.4616	1.2904	2.1010	1.2189
One irrigation	1.767	0.201	0.3281	0.1453	0.4625	1.2907	2.1105	1.2400
Two irrigations	1.769	0.202	0.3288	0.1461	0.4632	1.2911	2.1135	1.2646
Three irrigations	1.772	0.204	0.3294	0.1469	0.4635	1.2920	2.1202	1.2650
S.Em±	0.013	0.002	0.0034	0.0022	0.0070	0.0083	0.0294	0.0148
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Silicon levels (Kg ha^{-1})								
Control	1.749	0.1979	0.3265	0.1449	0.4619	1.2837	1.8229	1.2132
100	1.769	0.1994	0.3280	0.1453	0.4623	1.2921	1.9681	1.2515
150	1.773	0.2038	0.3289	0.1458	0.4632	1.2939	2.2645	1.2684
200	1.781	0.2040	0.3307	0.1463	0.4635	1.2943	2.3897	1.2854
SEm±	0.010	0.0021	0.0026	0.0009	0.0034	0.0090	0.0155	0.0058
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	0.0453	0.0169

Silicon levels : A reference of data shows that maximum chlorophyll content (56.96) at 50 DAS under different silicon levels were found under silicon 200 kg ha^{-1} which was statistically at par with silicon 150 kg ha^{-1} and significantly higher over control.

Effect of irrigation and silicon levels on nutrient content in grain and straw of barley

Irrigation levels : Nitrogen, Phosphorus, Potassium and Silicon in grain and straw under different irrigation levels failed to record any significant effect.

Silicon levels : Nitrogen, Phosphorus and Potassium record non-significant effect in grain and straw of barley whereas silicon content significantly influenced with application of silicon. Maximum silicon content (2.3897%) in grain found under application of 200 kg ha^{-1} silicon and it was statistically at par with silicon 150 kg ha^{-1}, significantly higher over control by 31.09 %, data represent that maximum silicon content in straw (1.2854%) was recorded it was significantly higher over remaining treatment.

References

1. Balakrishnan, K., Sundaram, K.M., Natarajaratnam, N. and Vijayaraghavan, H. 1947. Note on the estimation of leaf area in maize by non-destructive method. *Madras Agricultural Journal* 74: 160-162.
2. Caterina, T.; Vera, A.; Emilia, L. and Roberto L. R. 2018. Economic analysis of barley market and related uses, *Department of Economics, University of Foggia,* Italy P-34.
3. Kukal, S.S., Singh, Y., Jat, M.L. and Sindhu, H.S. 2014. Improving water productivity of wheat-based cropping systems in South Asia for sustained productivity. *Advances in Agronomy* 127: 157-230.
4. Mer, M. and Ama, E.E. 2014. Effect of different irrigation regime on grain yield and quality of some Egyptian bread wheat cultivars. *Journal of Agriculture Food and Applied Science* 2(9): 275-282.
5. Neelam, B., Singh, A., Khippal, Mukesh and Satpal. 2018. Effect of different nitrogen levels and bio-fertilizers on yield and economics of feed barley. *Wheat and Barley Research* 10(3): 214-218.
6. Pooja, C.R., Sharma, S.K., Jat, G., Choudhary, R.S., Yadav, S.K. and Jain, R.K., 2019. Growth, yield and uptake of wheat (*Triticum aestivum* L.) as influenced by doses of silicon and its time of application under organic farming. *International journal of chemical studies*, 7:4498-4501.
7. Watson, D. K. 1947. Comparative physiological studies on the growth of field crops, variation in NAR and leaf area between species and varieties. *Annuals of Botany* 11: 41-76.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1134-1138 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Application of Bio-Inoculants, Salicylic Acid and Plant Growth Regulators on Growth and Yield Attributing Characteristics of Mustard (*Brassica juncea* L.) Var. PA5232

Madhav Reddy*, Bineeta M. Bara and Abhishek Kumar Pal
Department of Genetics and Plant Breeding, Naini Agriculture Institute SHUATS, Prayagaj, U.P.
**Corresponding Author Email : pudurumadhavreddy43@gmail.com*

Abstract

The field experiment was conducted to assess the "Application of Bio-inoculants, Salicylic acid and Plant growth regulators on growth and yield attributing characteristics of mustard (*Brassica juncea* L.) var PA5232" in the experimental field of seed science and technology at department of genetics and plant breeding, SHUATS, Prayagraj Uttar Pradesh during the month of December to april 2021-2022. The experiment was laid out in randomized block Design (RBD) comprising 12 treatments replicated thrice. The results depicted that seed treatment showed significant variation of all the characters that were recorded and performed well on comparison to the untreated (control). Seed treatment with Azotobacter 50g/kg for 24 hours was found beneficial for obtaining higher yield and yield attributing characters viz. umber of siliqua per plant (154.66), seed yield per plant (4.23g), seed yield per plot (53.86 g), biological yield (33.53 g), harvest index (12.63%). However Economics of cultivation in terms of net return of Rs.435610 and 385280 and B:C ratio 9.1 and 8.91 were considerably higher in treatment of Atobacter 50g/kg at par with NAA@40PPM. Thus treating with Azotobacter 50g/kg for 24 hours was found to be so productive and can be suggested for cultivation for commercial scale.

Key words : *PSB, Azotobacter, Salicylic acid and NAA.*

Introduction

Mustard (*Brassica juncea* L.) is an important oilseed crop belonging to family Cruciferous. Indian mustard or brown mustard is natural amphidiploids having chromosome number (2n=36). India is the third largest country in edible oil economy after USA and China. Oilseed crops such as Soyabean, mustard, groundnut and sunflower are the major source of edible oils (Uikey, 2017).

In india total oilseeds edible oil industry association central organization for oil industry and trade (COOIT 2021) Anonymous released estimates of mustard seed production for 2021-2022 crop year at an all time high of 109.50 lakh tones, up 29% from previous year. Output of mustard seeds which is grown in rabi season, stood at 85 lakh tones in the previous year.

India imports about 60-65 % of its total domestic demand for edible oil in 2020-2021 oil year, the countrys import remained stable at 13 million tonnes. However, in value terms imports touched 1.17 lakh crore from nearly RS 72,000 crore in the previous year.

Biofertilizers are reported to enhance the yield of Indian mustard which mainly attributed to better N nutrition through N_2 fixation. Growth stimulating chemicals are used to modify the growth and development of the mustard plant to increase yield and also to improve the quality of product. NAA is an important synthetic Auxin. Influence of NAA on oil content and quality of mustard has not been started but the study was undertaken with following objectives that the increase seed yield and nutritive value of the mustard value (Ingle and Pdole 2017)

As majority area under cultivation is under organic there is more chance of enhancing the productivity of mustard through use of Bio- fertilizers. therefore in this experiment the trail was conducted by using bio-ferilizers like Azotobacter, PSB. Mustard responds favourably to bio fertilizers. In the view of the escalating price of fertilizers and its effects on soil health, there is a need to focus on integrated nutrient supply systems that improves production with reduced cost of cultivation.

Azotobacter is an effective bio-fertilizer because it provides N without over dosing situations such as ammonia , nitrate amino acids which are inorganic nitrogen additions (Bhattacharjee R, Dey U.2014) Bio fertilizers are reported to enhance the yield of Indian mustard which is mainly attributed to better N nutrition through N_2 fixation.

Despite of this statistical facts. India still continuous to be a major impact of oilseeds to meet the demand of its ever burgeoning population. Oilseed sector plays a pivotal role in forming the economy of nation. Being a major source of edible oil in India , it is very important to boost up yield and quality of crop. However the yield tends to be stagnant under conventional management by organic treatments needs to be upgraded with time and requirement of users , in India fertilizer application is little or non existent as compared to global consumption of

fertilizers which ultimately leads to poor productivity of crop and damages the soil health . hence being bio inoculants increases yield and quality of crop and these doesn't have any negative impact on soil as well as human .

Keeping this in view the present experiment entitled "Application of Bio-inoculants, salicylic acid and Plant growth regulators on growth and yield attributing characteristics of Mustard (*Brassica juncea* L.) Variety PA5232" was conducted with following objectives.

To find out suitable seed treatments for Mustard.

To estimate cost benefit cost ratio of Mustard.

Materials and Methods

Description of study area : The experiment was conducted during the Rabi season 2021-2022. The soil of experimental plot was sandy loam in texture, (PH 7.1) In order to study the" Application of Bio- inoculants, salicylic acid and Plant growth regulators on growth and yield attributing characteristics of Mustard (*Brassica juncea* L.) var PA5232" The experiment was conducted using Randomized Block Design(RBD) consisting of 13 treatments with three replications in field condition in the experimental field of seed science of technology at the department of Genetics and Plant Breeding , Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and sciences (SHUATS), Prayagraj (U.P.)

Experimental Design and Treatment Details.

T0-control

T1, T2, T3-PSB @50, 100, 150 g/kg for 12 hours

T4, T5, T6- Azotobacter@ 50, 100, 150 g/kg for 12 hours

T7, T8, T9-Salicylic acid@ 0.1, 0.3, 0.5 MM for 12 hours

T10- NAA@ 40 PPM for 6 hours

T11-NAA@ 40PPM for 12 hours

T12-NAA@ 40PPM for 24 hours

From the sowing till the physiological maturity and harvest the observations were recorded on different growth parameters viz. field emergence percentage, days to 50% flowering, plant height at 30,60 and 90 days , number of branches per plant , number of siliqua per plant, number of seed per siliqua, Seed yield per plant(g), seed yield per plot(g), days to 50% maturity, biological yield (g) , harvest index (%) were recorded and statistically analyzed using analysis of variance was carried out according to the procedure of Randomized Block Design (RBD) for each character as per methodology advocated by Panse and Sukhatme.

Results and Discussion

Growth parameters : The maximum germination percentage (%) on $4^{th,}$ 7^{th} , 10^{th} day was recorded in treatments T_{4-} Azotobacter 50g/kg for 24 hours is (107.57%) and followed by T_{12-} NAA@40 PPM for 24 hours which was significantly superior over all other treatments and whereas the lowest was found in treatments T_{0-} Control (74.75%) on 4^{th} , 7^{th} & 10^{th} day. Similar results was observed by Bora *et al* in mustard stated that treating seeds with Azotobater along with sulphur, zinc and vermicompost recorded the highest germination percentage.

Days to 50% flowering in mustard was observed that significantly minimum days in days to 50% flowering found in treatment T_{4-} Azotobacter 50g/kg for 12 hourswhere seeds may be considered as the best treatment for early period in days to 50% flowering (39.66) followed by T_{12} – NAA@ 40 PPM for 12 hours and maximum days for 50% flowering was recorded by T_{0-} control (47.66) days. Similar results were confined by Beenisheetal *et al* in mustard, yadav *et al* in Black gram state that Azotobacter along with PSB and Rhizobium .

The highest plant height in our experiment found on 30,60 90 DAS was recorded in treatment T_{4-} Azotobacter 50g/kg for 12 hours (24.47cm) on 30 days and (115.82 cm) on 60 days and (172.40cm) on 90 days after sowing which was found significantly superior over all other treatments. Whereas lowest plant height was recorded in treatment T_{0-} control with (11.78cm) on 30 days,(66.97cm) on 60 days and (133.44cm) on 90 days .Similar results were confined by Hadiyal *et al* In mustard.Bandhu raj in maize.

In case of branches maximum number of branches was recorded in treatment T_{4-} Azotobacter 50g/kg for 12 hours (12.66) followed by T_{12}- NAA @ 40PPM for 24 hours(11.6) whereas minimum number of branches were recorded in treatment T_0- control (7.93). Similar results was observed by Saini *et al* in rapeseed- mustard stated that Azotobacter along with Nitrogen. Beenishetal *et al* told that Azotobacter along with S + Z + vermicompost. Hadiyal *et al* in mustard

Yield parameters : The number of siliqua per plant and number of seed per siliqua are significantly maximum in treatment T_4- Azotobacter 50g/kg for 12 hours(154.66) and (10.93) respectively and minimum number of siliqua per plant and seed per siliqua were recorded in treatment T_{0-} Control (112.33) and (5.93) . Similar results were confined with work of Singh *et al* in mustard. Chandan *et al* in mustard stated that Azotobacter along with 75% RDF+vermicompost. Hadiyal *et al* in mustard.

Table-1 : Analysis of variance for response of treatments on growth and yield parameters in mustard.

Characters	Mean Sum of Squares		
	Replications (df=2)	Treatments (df=12)	Error (df=24)
Field emergence %	11373.45	1026.24*	43.68
Days to 50% flowering	0.49	15.36*	0.54
Plant height at 30 DAS	13.33	42.92*	1.98
Plant height at 60 DAS	26.78	590.66*	18.45
Plant height at 90 DAS	8.60	465.12*	0.46
Number of branches per plant	1.12	3.93*	0.20
Number of siliqua per plant	29.91	455.03	27.55
Number of seeds per siliqua	1.21	4.59*	0.43
Seed yield per plant (g)	0.06	1.99*	0.03
Seed yield per plot (g)	2.64	74.25*	2.17
Days to maturity	5.33	280.26*	2.75
Biological yield	22.11	26.21*	2.78
Harvest index (%)	16.84	35.00*	4.70

At 5% level of significance.

Table-2 : Effect of treatments on mean performance of mustard for growth and yield parameters.

Treatments	Field emergence	Plant height at 30 DAS	Plant height at 60 DAS	Plant height at 90DAS	Days to 50% flowering	Number of branches per plant	Number of siliquae per plant	Number of seed per siliqua
T_0	74.75	11.78	66.97	133.44	47.66	7.93	112.33	5.93
T_1	82.94	13.30	72.9	136.19	42.66	10.33	121.66	7
T_2	88.34	15.7	84.86	144.76	42.33	9.53	121	7.93
T_3	78.57	13.69	78.97	134.29	43.66	9.93	130.6	8.4
T_4	107.57	24.47	115.82	172.40	39.66	12.66	154.66	10.93
T_5	88.59	16.93	88.82	146.10	44.66	10.8	127.06	7.93
T_6	93.04	18.28	102.72	163.22	41	11.06	140.86	9.06
T_7	81.88	13.77	77.49	155.68	44.33	9.86	122.13	8.46
T_8	79.46	16.12	80.99	141.18	41.33	9.86	133.2	8.06
T_9	92.11	15.84	86.26	152.23	41.66	9.8	123	8.53
T_{10}	84.89	16.54	90.12	144.2	42.33	10.33	119.66	8.2
T_{11}	86.76	15.58	96.82	151.44	45.66	9.46	119.2	8.26
T_{12}	99.01	23.92	107.16	166.84	40.33	11.6	147.33	10.06
Grand mean	87.53	16.61	88.45	149.38	42.87	10.24	128.67	8.36
F Test	S	S	S	S	S	S	S	S
S.Em	3.82	0.81	2.48	0.39	0.43	0.26	3.03	0.38
C.D.	11.14	2.37	7.24	1.15	1.24	0.76	8.84	1.10
CV	3.59	8.48	4.86	0.46	1.72	4.38	4.08	7.55

As number of siliquae increases the yield increases. significantly maximum seed yield per plant and seed yield per plot and seed yield per hectare was found in treatment T_4-Azotobacter 50g/kg for 12 hours(4.23g) , (53.86gm) and (483.6kg) followed by NAA@40PPM. Minimum seed yield in mustard was recorded in untreated control seeds in treatment T_0. It reveals that Azotobacter decreases the flower drop, Siliqua forming and increased number of Siliquae and seed yield. Similar results was observed by Chandan *et al* in mustard stated that Azotobacter along with 75% RDF + vermicompost. Kumar *et al* in mustard used aztobacter along with vermicomppost and NPK. Singh *et al* in Indian mustard, Hadiyal *et al* in mustard, Bandhu Raj in maize.

Significantly maximum percent of harvest index was observed in the treatment T_4- Azotobacter 50g/kg for 12 hours with grand mean (12.63). The minimum percent of harvest index per plot is found in untreated seed treatment T_0- (5.57). Similar results were observed by Beenish *et al* stated that Azotobcater along with 75% N + vermicompost have significant effect on harvest index in Mustard.

Table-3 : Effect of treatments on mean performance of mustard for growth and yield parameters.

Treatment	Days to maturity	Seed yield per plant (g)	Seed yield per plot (g)	Biological yield (g)	Harvest index (%)
T_0	124.00	1.3	36.63	23.3	5.57
T_1	108.33	1.6	42.1	23.9	6.72
T_2	115.66	2.43	39.16	23.53	10.34
T_3	118.33	2.73	43.43	25.96	10.54
T_4	93.00	4.23	53.86	33.53	12.63
T_5	104.00	2.76	45	26.36	10.50
T_6	101.66	3.26	46.76	29.2	11.20
T_7	108.33	3.3	40.36	28.53	11.56
T_8	115.66	2.5	39.83	24.3	10.32
T_9	102.00	2.23	41.43	27.33	8.17
T_{10}	113.33	3.13	47.63	26.46	11.84
T_{11}	120.00	2.93	46.1	25.2	11.63
T_{12}	95.00	3.7	48.36	30.56	12.10
Grand mean	109.17	2.77	43.9	26.78	10.24
F Test	S	S	S	S	S
S.Em	0.96	0.11	0.85	0.78	0.36
C.D.	2.79	0.31	2.48	2.27	1.05
CV	1.52	6.57	3.36	5.03	6.07

Table-4 : Cost of cultivation of 1 hectare mustard crop.

Treatment	Treatment		Cost of cultivation	Net returns	Gross return	Benefit cost ratio
T_0	Control		38766	246610	207834	5.36
T_1	PSB	50g/kg	38863.5	280000	2441136.5	6.2
T_2	PSB	100g/kg	38951	304220	265269	6.81
T_3	PSB	150g/kg	39038.5	307300	268261.5	6.87
T_4	Azotobacter	50g/kg	38841	377020	338179	8.7
T_5	Azotobacter	100g/kg	38906	340340	301434	7.75
T_6	Azotobacter	150g/kg	38971	378490	339519	8.71
T_7	Salicylic acid	0.1mm	28793.6	270620	331826.4	8.55
T_8	Salicylic acid	0.3mm	38828.8	302260	26343.12	6.78
T_9	Salicylic acid	0.5mm	38864	289170	250306	6.44
T_{10}	NAA	40PPM	43116	316260	273144	6.34
T_{11}	NAA	40PPM	43116	296940	253824	5.89
T_{12}	NAA	40PPM	43116	338520	295404	6.85

Conclusions

Bio inoculants along with manures promote germination early growth rapid seed germination and seed development. It is concluded that Azotobacter gave best results to enhance early seed emergence, plant height, early flowering and good seed yield. Therefore it can be concluded that application of Azotobacter @508/kg for 12 hours significantly recorded highest seed yield (583.6kg/hac), higher gross returns (RS 338179/ha), net returns (RS 377020/ha) and benefit cost ratio (8.7) as compared all other treatments . Since all these findings are based on the research done in *rabi* season in SHUATS, U.P.

Acknowledgement

I express my thankfulness to my advisor Dr. Bineeta M Bara and all the faculty members of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbotom University of Agriculture, Technology and Sciences, Prayagraj -211007, Uttar Pradesh. for providing essential facilities to undertake the studies.

References

1. Uikey M., Nawalakhe S.M. and Kothikar R.B. (2017). Effect of different meterological weeks on yield parameters of mustard. *Intl. J. Adv. Sci. Eng. Technol.,* 5: 87-88.
2. Anonymous 2021. www. COOIT commoditiescontrol.com
3. Ingle K.P., Padole D.A. (2017). Phosphate solubilizing microbes : An overview. *International Journal Current Microbiology and Applied Science,* 6(1): 844-852.
4. Bhattacharjee R., Dey U. (2014). Biofertilizer, a way towards organic agriculture: A review. *African Journal of Microbiology Research*. 8(24): 2332-2343.
5. Panse V.G., Sukhatme P.V. (1967). Statistical Mehods for Agricultural Workers, 2nd Edition, *Indian Council of Agricultural Research*, New Delhi.
6. Priyanki Bora, N.J. Ojha and K. Kurni, (2022). Growth and yield performance of late sown Toria (*Brassica rapa* subsp Toria) under integrated nutrient management practices in *Assam. Journal of Oilseed Brassica*, 13(1): 41-44.
7. Obida Beenish, Latief Ahmed, Ashaq Hussain and Eugenia P. Lal (2018).Organic Manure and Biofertilizers effect on the Growth and Yield of Indian Mustard (*Brassica juncea* L.) Varieties. *Current Journal of Applied Sciences and Technology* 30(4): 1-7.
8. Sandeep Yadav, Suresh Kumar, Kumar Anshuman, Nandan Singh, Anurag Srivastava (2021). Studies on effect of different biofertilizers on yield and economics chickpea. *The Pharma Innovation*. 10(4): 541-545.
9. Hadiyal J.G., Kachhadiya S.P., Ichchhuda P.K. and Kalasaria R.N. (2017). Response of Indian mustard (*Brassica juncea* L.) to different levels of organic manures and bio-fertilizers *Journal of Pharmacognosy and phytochemistry* 6(4): 873-875.
10. Bandhu Raj Baral and Parbati Adhikari (2013). *SAARC J. Agri.,* 11(2): 141-147.
11. Saini L.B., George P.J., Bhandan S.W. (2017). Effect of nitrogen management and biofertilizers on growth and yield of rapeseed (*Brassica campestris* var toria) *Int. J. Curr. Microbiol. App. Sci*. 6(8): 2652-2658.
12. Singh R., Singh A.K., Kumar P. (2014) Performance of Indian mustard (*Brassica juncea* L.) in response to integrated nutrient management. *J. Agri. Sear.* 1(1): 9-12.
13. Chandan S., and Ram, D. (2018). PSM and Azotobacter population in rhizospore soil of mustard as influenced by organic and inorganic sources. *Environ. & Ecol*. 26; 43-36.
14. Kumar S., Kumar S., Kumar A., Singh O. (2016). Productivity, Profitability and quality of Indian mustard (*Brassica juncea*) as influenced by fertilizer levels and integrated nutrient management. *Indian J. Agron.* 61(2): 231-236.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1139-1145 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Assessment of Bottle Gourd Germplasm for Morpho-Phenological, Growth and Fruit Yield Characters under Semi-Arid Conditions of Haryana, India

D.S. Duhan, Jagat Singh and Vikas Gill*
Department of Vegetable Science, CCS Haryana Agricultural University, Hisar-125004, Haryana
**Corresponding Author (Vikas Gill) Email : gillvikas44@gmail.com*

Abstract

This experiment was conducted to assess the relative performance of selected set of bottle gourd germplasm comprising of 24 F_1 hybrids, 8 inbreds, 3 testers and 2 standard checks for thirteen traits pertaining to morpho-phenological, growth and fruit yield characters. The crop was sown under randomized block design (RBD) in three replications at Vegetable Research Farm, CCS Haryana Agricultural University, Hisar during the *Spring Summer* season of 2017-18 and 2018-19. Genotypes NDBG-104 (51.11; 64.11), GH-34 (51.12; 65.00) and hybrids HBGH-1 (49.06;58.00) and HBGH- 8 (50.93; 59.00) were found superior in terms of earliness for days to first female flowering, days to first fruit harvest respectively whereas, GH-38 (57.16) and HBGH-18 (64.88) took maximum days to first female flowering and IC-92363 (71.49) and HBGH-18 (73.84) took maximum days to first fruit harvest. Further, NDBG-104 (10.39), GH-34 (10.53) and hybrids HBGH-8 (10.37) and HBGH- 11 (10.60) were found superior for nodes to first female flower whereas, GH-38 (14.15) and hybrid- HBGH-19 (14.78) gave least desirable values for the same. Similarly, IC-92420 (300.7 q/ha) and Punjab Komal (286.7 q/ha) from parents & testers group while HBGH-8 (353.8 q/ha) and HBGH-11 (344.6 q/ha) from selected set of hybrids gave maximum fruit yield per hectare.

Key words : *Morpho-phenological, genotypes, hybrids, testers, mean performance and fruit yield.*

Introduction

Lagenaria siceraria usually referred to as bottle gourd may be a tropical and subtropical commercial vegetable crop belonging to family *Cucurbitaceae*. It bears white flowers and hence called white flowered gourd, Lauki and many a times- Calabash. Its cultivated species is an annual, monoecious, highly cross pollinated and evening anthesis plant which, is native to tropical Africa. It's a natural diploid with 2n = 2x = 22 chromosomal pairs.

It is mainly grown for its fruit which is edible at tender stage but it has several other uses as well, adding to its importance. Hard shells of its mature fruits are used for making domestic utensils, floats for fishing nets *etc*. It can also be used for making sweets like halva, *kheer* and *burfi*. Other than the culinary uses, it is also very well known for its medicinal uses and health benefits. Its tender fruit juice is very useful in urinary disorder, excessive thrust and insomnia. The pulp is good for overcoming constipation, cough, night blindness and as an antidote against certain poisons. The plant extract is used as a cathartic and the seeds are used in dropsy. The fruit contain 95.54 per cent moisture, vitamin C (10.1 g), vitamin A (16 IU), thiamine (0.029 g), riboflavin (0.022 g), niacin (0.320 g), carbohydrates (3.39 g), fats (0.02 g) and potassium (150 mg) per 100 g fresh weight (USDA, 2018).

A well characterized germplasm is pre-requisite for any crop improvement or strategic conservation programme to succeed in desired direction and quantum. Due to the quick, intuitive and simply distinguishable nature of morpho-phenological, growth and fruit yield traits, they are employed most of the times to characterize and evaluate the available genotypes. Hence, in the present investigation, various inbreds, testers and F_1 hybrids were assessed to identify the best parents yielding great hybrid combinations.

Materials and Methods

The present investigation was carried out at Vegetable Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar during the *Spring-Summer* season of 2017-18 and 2018-19. The experimental location stands at 29º 43' in the North and 76º 58' East, at 243 meters elevation above mean sea level and the tract of research station is characterized by sub-tropical and semi-arid climate with mean maximum temperature ranging between 35 to 41ºC in summers and mean minimum temperature ranging between 6-9ºC in winters. The selected germplasm consists of thirty-seven genotypes (8 inbred lines, 3 tester, 24 F_1 hybrids and 2 standard hybrid checks) procured from various sources. The crop was sown in randomized block design in three replications. The investigation involved thirteen parameters which were further categorized into 3 groups (morpho-phenological, growth and fruit yield) for easy understanding. Five plants were randomly selected for recording of various growth characters and likewise ten fruits were picked randomly to record fruit characters in every genotype for each replication. Mean values of

Table-1 : Pooled Analysis of Variance (ANOVA for both seasons).

Characters	Mean Sum of Squares		
	Treatments	Replications	Error
Degree of freedom (df)	36	2	72
Days to 1st male flowering	50.92***	0.10 NS	0.72
Days to 1st female flowering	50.81***	0.09 NS	0.56
Days to first fruit harvest	60.17***	0.44 NS	0.88
Vine length	31773.31***	2.14 NS	74.43
ltNumber of fruits/vine	5.52***	0.12 NS	0.09
Yield per hectare	5817.96***	2.71 NS	16.81
Number of primary branches	12.32***	0.01 NS	0.06
Nodes to 1st male flower	4.73***	0.02 NS	0.14
Nodes to 1st female flower	5.84***	0.01 NS	0.15
Length of fruit	27.58***	0.02 NS	0.17
Diameter of fruit	1.30***	0.01 NS	0.14
Average fruit weight	38460.87***	1352.78 NS	2091.71
Crop maturity	69.19***	0.27 NS	9.52

*, ** - Significant at 5% and 1% level of significance respectively.

observations were computed using OP Stat software and analysis of variance was done using the method suggested by Fisher (1963) and later described by Panse and Sukhatme (1967).

Results and Discussion

Results from analysis of variance (Table-1) revealed highly significant differences among genotypes for all the three categories of characters, which unveiled the presence of considerable variability in the accession being investigated, that can be utilized in crop improvement programmes by selecting genotypes through characters studied hereby.

Mean/average values, standard error and coefficient of variation drawn from analyzing the recorded observations for morpho-phenological traits are presented in Table-2 (A & B). The *per se* performance of observations reveals that HBGH-1 (45.06) was earliest genotype for days to first male flowering followed by NDBG-104 (46.33), HBGH-17 (46.61) and HBGH-8 (46.74) whereas, HBGH-18 (61.22), HBGH-19 (59.94), HBGH-23 (57.55) and HBGH-13 (56.11) took maximum days for the same. Similar trend was exhibited for days to first female flowering where HBGH-1 (59.06), Pusa Samridhi (50.83), HBGH-8 (50.93) and NDBG-104 (51.11) were earliest while HBGH-18 (64.88), HBGH-19 (64.61), HBGH-23 (61.61) and HBGH-13 (60.84) were last to flower. For days to first fruit harvest - HBGH-1 (58.00), HBGH-8 (59.00) and HBGH-17 (59.89) took minimum days whereas; HBGH- 19 (74.17), HBGH-18 (73.84) and HBGH-10 (73.56) took maximum days. Genotypes namely, HBGH-8 (9.22), IC-92420 (9.43) and HBGH-22 (9.45) took minimum number of nodes to produce male flowers whereas; HBGH- 19 (13.55), HBGH-6 (13.54) and HBGH-3 (13.49) took maximum number of nodes for the same. Similar trend was exhibited for nodes to first female flowering where HBGH-8 (10.37), NDBG-104 (10.39) and GH-34 (10.53) took maximum nodes while HBGH-19 (14.78), HBGH-13 (14.77) and HBGH- 6 (14.76) took minimum number of nodes. Genotypes HBGH-8 (111.67), HBGH-17 (113.33) and Punjab Komal (115.00) were earliest to attain crop maturity whereas; IC-92363 (131.67), GH-38 (130.33) and HBGH-6 (129.83) took maximum days to attain crop maturity and hence gave maximum number of pickings. Leela and Singh (2020) and Harika *et al.* (2012) reported the presence of significant variability in their respective set of germplasm for similar characters in bottle gourd.

Mean performance values for various growth parameters are presented in Table-3. The *per se* performance of genotypes reveal that maximum vine length was observed in IC-92420 (736.57) followed by IC-92414 (725.98) and GH-38 (715.60) whereas; HBGH-23 (375.10), HBGH- 13 (382.50) and HBGH-4 (392.27) recorded the minimum vine length amongst the given accession. For number of primary branches per vine - HBGH-8 (14.11), Pusa Samridhi (14.01) and HBGH-11 (13.69) recorded maximum value whereas; HBGH-7 (8.14), HBGH-19 (8.23) and HBGH-21 (8.34) recorded minimum mean values. Fruit length and diameter are very imperative traits to decide yield besides market preference, purpose of use and means of handling. Longest fruits were recorded in HBGH-24 (35.49), HBGH-15 (35.02) and NDBG-104 (33.83) whereas minimum length of fruits was recorded in HBGH-6 (23.96), HBGH-19 (24.43) and GH-38 (24.78). Similarly fruit with maximum diameter were observed in HBGH-3 (10.00), HBGH-4 (9.85) and HBGH-10 (9.74) while minimum fruit

Table-2 : Mean values of various genotypes pertaining to morpho-phenological characters.

Character / Genotypes	DMF			DFF			DFH		
	2017-18	2018-19	Overall	2017-18	2018-19	Overall	2017-18	2018-19	Overall
GH 32	49.22	48.11	48.67	53.33	52.77	53.05	67.33	65.78	66.56
GH 34	46.89	47.66	47.28	50.33	51.90	51.12	64.66	65.33	65.00
GH 37	52.44	46.11	49.28	51.67	51.33	51.50	65.67	66.11	65.89
GH 38	47.78	49.33	48.55	56.89	57.43	57.16	69.33	69.78	69.56
IC-92363	49.33	49.00	49.17	57.33	55.63	56.48	71.66	71.33	71.49
IC-92372	50.33	50.22	50.28	53.67	56.90	55.28	67.67	65.66	66.67
IC-92414	48.44	47.89	48.17	55.00	54.10	54.55	67.33	69.44	68.39
IC-92420	47.33	48.11	47.72	51.66	54.87	53.27	65.00	66.89	65.95
Pb. Komal	47.78	46.78	47.28	52.33	51.13	51.73	66.33	65.67	66.00
NDBG-104	46.33	46.33	46.33	49.56	52.67	51.11	63.66	64.55	64.11
P. Samridhi	48.44	49.00	48.72	49.89	51.77	50.83	65.22	64.67	64.95
HBGH-1	46.67	43.44	45.06	49.44	48.67	49.06	58.67	57.33	58.00
HBGH-2	48.33	46.78	47.56	53.56	52.87	53.21	62.78	60.56	61.67
HBGH-3	51.33	46.22	48.78	54.67	51.57	53.12	73.11	62.44	67.78
HBGH-4	56.33	52.89	54.61	60.22	58.43	59.33	69.43	67.67	68.55
HBGH-5	50.44	47.44	48.94	53.78	52.67	53.22	62.89	60.56	61.72
HBGH-6	49.66	50.33	50.00	53.11	56.80	54.96	62.67	65.78	64.22
HBGH-7	46.44	48.56	47.50	50.65	53.90	52.28	59.44	62.78	61.11
HBGH-8	48.00	45.48	46.74	51.10	50.77	50.93	58.33	59.66	59.00
HBGH-9	53.11	51.55	52.33	57.56	56.57	57.06	66.33	65.22	65.78
HBGH-10	56.45	52.44	54.45	59.89	57.80	58.84	76.67	70.44	73.56
HBGH-11	51.78	48.11	49.94	54.22	53.90	54.06	63.11	62.67	62.89
HBGH-12	53.44	50.33	51.89	57.22	56.33	56.78	66.56	67.78	67.17
HBGH-13	57.33	54.89	56.11	61.11	60.57	60.84	70.78	71.33	71.06
HBGH-14	50.67	50.56	50.61	53.56	55.23	54.40	63.44	64.89	64.17
HBGH-15	55.78	53.00	54.39	59.56	58.57	59.06	68.33	69.55	68.94
HBGH-16	49.22	49.11	49.17	53.11	54.67	53.89	62.87	63.67	63.27
HBGH-17	46.89	46.33	46.61	50.44	51.77	51.11	59.22	60.55	59.89
HBGH-18	61.44	61.00	61.22	64.22	65.53	64.88	72.89	74.78	73.84
HBGH-19	59.67	60.22	59.94	63.56	65.67	64.61	73.11	75.22	74.17
HBGH-20	47.33	47.67	47.50	51.22	53.43	52.33	60.55	62.56	61.56
HBGH-21	53.65	54.11	53.88	57.88	58.23	58.06	67.33	68.89	68.11
HBGH-22	55.78	53.00	54.39	59.22	57.77	58.49	69.44	68.56	69.00
HBGH-23	59.32	55.78	57.55	62.55	60.67	61.61	71.54	69.33	70.44
HBGH-24	48.67	48.00	48.33	52.43	53.30	52.87	61.78	62.44	62.11
PH-3 (C)	53.34	50.90	52.12	57.67	56.90	57.29	64.67	65.11	64.89
HBGH-35 (C)	52.44	49.44	50.94	55.66	54.77	55.22	62.89	63.55	63.22
C.D.	1.39	1.89		1.23	1.75		1.53	1.72	
SE(m)	0.49	0.67		0.44	0.62		0.54	0.61	
SE(d)	0.70	0.95		0.62	0.88		0.77	0.86	
C.V.	1.67	2.33		1.37	1.94		1.42	1.60	

DMF: Days to first male flower opening; DFF: Days to first female flower opening; DFH: Days to first fruit harvest.

diameter was recorded in HBGH-15 (7.72), GH-32 (7.89) and GH-38 (8.05). Results on similar lines were recorded by Kandasamy *et al.* (2019) and Singh and Singh (2020) for growth related traits in bottle gourd whereby they emphasized that variation in genotypes was mainly because of fruit length and fruit girth.

The data depicted in Table-4 represents the mean values of characters pertaining to fruit yield in the selected germplasm. Number of fruits per vine and average fruit weight specifically decides the bottle gourd yield. Perusal of observations recorded reveals that genotype HBGH-8 had maximum number of fruits per vine (10.78) and simultaneously, maximum average fruit weight (1040.00) yielding the maximum yield per hectare (353.80) amongst all the genotypes in the given accession. On a similar note

Table-2 : Mean values of various genotypes pertaining to morpho-phenological characters.

Character / Genotypes	NMF			NFF			CM		
	2017-18	2018-19	Overall	2017-18	2018-19	Overall	2017-18	2018-19	Overall
GH 32	10.37	10.57	10.47	11.10	11.22	11.16	121.67	124.00	122.83
GH 34	10.45	10.17	10.31	10.20	10.87	10.53	118.33	113.00	115.67
GH 37	9.77	9.60	9.68	11.83	10.75	11.29	120.00	123.33	121.67
GH 38	12.07	11.87	11.97	14.43	13.87	14.15	128.67	132.00	130.33
IC-92363	12.65	12.40	12.52	14.40	13.70	14.05	130.00	133.33	131.67
IC-92372	10.17	10.05	10.11	11.25	11.45	11.35	118.00	120.67	119.33
IC-92414	10.75	10.63	10.69	12.27	11.77	12.02	122.67	125.00	123.83
IC-92420	9.50	9.37	9.43	11.05	10.90	10.97	114.00	120.33	117.17
Pb. Komal	9.90	9.67	9.78	11.66	11.07	11.37	117.67	112.33	115.00
NDBG-104	9.58	9.47	9.52	10.33	10.45	10.39	120.00	123.33	121.67
P. Samridhi	10.03	10.12	10.07	11.90	13.23	12.57	125.33	129.33	127.33
HBGH-1	12.60	12.85	12.72	13.55	13.40	13.48	123.00	126.67	124.83
HBGH-2	10.27	9.97	10.12	11.83	11.97	11.90	127.00	123.00	125.00
HBGH-3	13.57	13.40	13.49	14.45	14.70	14.58	115.00	121.67	118.33
HBGH-4	9.97	9.77	9.87	11.77	11.65	11.71	117.00	114.67	115.83
HBGH-5	10.20	9.95	10.08	11.80	11.70	11.75	121.33	128.00	124.67
HBGH-6	13.63	13.45	13.54	14.85	14.67	14.76	128.00	131.67	129.83
HBGH-7	12.10	11.87	11.99	13.90	13.81	13.85	121.00	124.00	122.50
HBGH-8	9.30	9.15	9.22	10.30	10.45	10.37	110.33	113.00	111.67
HBGH-9	10.81	10.67	10.74	12.45	12.63	12.54	122.00	119.33	120.67
HBGH-10	11.21	10.97	11.09	12.56	12.75	12.65	118.00	123.00	120.50
HBGH-11	10.05	9.97	10.01	10.50	10.70	10.60	113.00	118.33	115.67
HBGH-12	10.47	10.21	10.34	12.70	12.77	12.74	121.00	116.00	118.50
HBGH-13	12.30	11.85	12.08	14.73	14.80	14.77	122.00	126.33	124.17
HBGH-14	10.75	10.60	10.68	12.40	12.73	12.56	119.33	122.00	120.67
HBGH-15	11.20	10.93	11.07	12.27	12.20	12.24	123.00	126.33	124.67
HBGH-16	12.38	11.92	12.15	13.87	13.77	13.82	127.00	129.33	128.17
HBGH-17	10.27	10.45	10.36	12.25	11.77	12.01	115.00	111.67	113.33
HBGH-18	12.47	12.57	12.52	14.35	14.20	14.28	124.33	127.67	126.00
HBGH-19	13.60	13.50	13.55	14.80	14.75	14.78	124.00	128.67	126.33
HBGH-20	10.19	10.24	10.22	12.25	11.87	12.06	117.00	120.67	118.83
HBGH-21	12.37	12.45	12.41	14.23	14.33	14.28	125.33	129.00	127.17
HBGH-22	9.33	9.57	9.45	10.83	10.67	10.75	126.00	121.67	123.83
HBGH-23	9.95	10.17	10.06	11.52	11.25	11.38	117.00	115.33	116.17
HBGH-24	10.83	10.93	10.88	12.83	12.87	12.85	115.00	122.33	118.67
PH-3 (C)	10.65	10.77	10.71	12.39	11.97	12.18	117.33	120.67	119.00
HBGH-35 (C)	10.57	10.60	10.59	12.05	12.15	12.10	114.33	119.00	116.67
C.D.	0.61	0.29		0.65	0.27		5.04	4.89	
SE(m)	0.22	0.10		0.23	0.10		1.78	1.73	
SE(d)	0.31	0.14		0.32	0.14		2.52	2.45	
C.V.	3.41	1.61		3.18	1.34		2.56	2.45	

MF: Nodes to first male flower; NFF: Nodes to first female flower; CM: Crop maturity (days)

Table-3 : Mean values of various genotypes pertaining to growth characters.

Characters/ Genotypes	VL			NBV			LF			DF		
	2017-18	2018-19	Overall	2017-18	2018-19	Overall	2017-18	2018-19	Overall	2017-18	2018-19	Overall
GH 32	674.40	683.83	679.12	12.70	9.35	11.03	30.00	29.25	29.63	7.97	7.82	7.89
GH 34	548.20	581.23	564.72	14.40	10.20	12.30	28.70	29.10	28.90	8.33	8.28	8.31
GH 37	677.50	703.17	690.33	13.75	10.98	12.37	32.62	32.02	32.32	9.17	8.62	8.90
GH 38	732.63	698.57	715.60	9.67	8.47	9.07	25.35	24.20	24.78	8.40	7.70	8.05
IC-92363	547.20	569.80	558.50	9.77	8.27	9.02	25.50	24.37	24.93	9.17	8.73	8.95
IC-92372	658.23	617.93	638.08	14.15	10.10	12.13	29.62	29.70	29.66	8.20	8.05	8.12
IC-92414	739.60	712.37	725.98	14.05	10.07	12.06	33.70	32.60	33.15	8.05	8.61	8.33
IC-92420	729.30	743.83	736.57	14.32	9.77	12.04	31.40	31.13	31.27	8.35	8.10	8.22
Pb. Komal	546.90	570.47	558.68	13.80	10.77	12.28	30.55	31.20	30.88	9.13	8.87	9.00
NDBG-104	487.33	463.47	475.40	15.93	11.20	13.57	33.62	34.05	33.83	8.73	8.48	8.61
P. Samridhi	497.33	501.13	499.23	14.25	13.77	14.01	32.57	34.57	33.57	8.74	9.11	8.93
HBGH-1	453.20	458.70	455.95	12.98	8.53	10.76	29.80	27.63	28.72	8.49	8.45	8.47
HBGH-2	511.83	505.30	508.57	12.10	11.23	11.67	32.22	31.93	32.08	7.97	8.59	8.28
HBGH-3	623.43	617.80	620.62	9.42	8.03	8.73	28.20	27.60	27.90	10.17	9.82	10.00
HBGH-4	389.13	395.40	392.27	11.57	11.63	11.60	30.10	30.47	30.28	10.13	9.58	9.85
HBGH-5	487.27	497.73	492.50	12.75	10.83	11.79	31.60	31.33	31.47	9.27	8.34	8.80
HBGH-6	513.60	502.50	508.05	9.47	9.63	9.55	24.55	23.37	23.96	9.27	9.58	9.42
HBGH-7	609.40	612.60	611.00	8.97	7.30	8.14	29.10	27.23	28.17	8.90	8.82	8.86
HBGH-8	548.50	553.20	550.85	14.57	13.65	14.11	32.60	33.20	32.90	8.16	8.23	8.20
HBGH-9	526.90	531.80	529.35	13.87	10.80	12.33	27.94	27.24	27.59	8.67	8.61	8.64
HBGH-10	614.33	607.90	611.12	13.83	10.53	12.18	33.68	32.80	33.24	9.75	9.72	9.74
HBGH-11	439.53	443.10	441.32	14.15	13.23	13.69	34.26	33.12	33.69	9.17	8.94	9.06
HBGH-12	458.60	462.30	460.45	14.30	10.60	12.45	26.40	27.97	27.18	10.03	9.40	9.72
HBGH-13	378.20	386.80	382.50	9.40	8.93	9.17	26.60	25.10	25.85	9.33	8.73	9.03
HBGH-14	623.03	608.93	615.98	11.90	10.43	11.17	29.10	28.23	28.67	9.80	8.22	9.01
HBGH-15	537.80	529.50	533.65	12.37	11.20	11.78	36.54	33.50	35.02	7.60	7.84	7.72
HBGH-16	394.50	403.60	399.05	9.74	9.27	9.50	33.68	31.17	32.42	8.90	8.58	8.74
HBGH-17	422.53	423.80	423.17	13.27	10.63	11.95	27.80	26.90	27.35	8.95	9.15	9.05
HBGH-18	524.63	526.50	525.57	9.13	8.67	8.90	29.30	27.83	28.57	8.67	8.82	8.75
HBGH-19	493.70	449.40	471.55	9.37	7.10	8.23	25.44	23.42	24.43	9.47	9.27	9.37
HBGH-20	613.17	589.70	601.43	12.80	11.30	12.05	31.48	28.90	30.19	8.45	8.52	8.49
HBGH-21	423.10	432.80	427.95	9.15	7.53	8.34	28.14	26.23	27.19	8.13	8.34	8.24
HBGH-22	505.60	511.90	508.75	14.45	12.90	13.68	30.48	31.07	30.77	9.46	9.05	9.26
HBGH-23	367.90	382.30	375.10	13.83	11.17	12.50	31.06	31.92	31.49	8.77	7.96	8.37
HBGH-24	689.70	673.20	681.45	12.10	11.37	11.73	36.48	34.50	35.49	9.37	9.65	9.51
PH-3 (C)	579.20	564.60	571.90	12.78	12.00	12.39	32.17	30.10	31.13	9.70	9.43	9.57
HBGH-35 (C)	558.30	549.70	554.00	12.20	12.33	12.27	32.30	30.67	31.48	8.40	8.73	8.57
C.D.	14.09	8.31		0.42	0.36		0.69	0.47		0.63	0.30	
SE(m)	4.99	2.94		0.15	0.13		0.24	0.17		0.22	0.10	
SE(d)	7.06	4.16		0.21	0.18		0.34	0.24		0.32	0.15	
C.V.	1.59	0.94		2.09	2.10		1.38	0.97		4.33	2.07	

VL: Vine length at the time of final harvest (cm); NPB: Number of primary branches; LF: Length of fruit (cm); DF: Diameter of fruit (cm).

Table-4 : Mean values of various genotypes for characters pertaining to fruit yield.

Characters/ Genotypes	NFV			AFW			YPH		
	2017-18	2018-19	Overall	2017-18	2018-19	Overall	2017-18	2018-19	Overall
GH 32	7.00	7.30	7.15	789.00	838.00	813.50	251.20	243.50	247.35
GH 34	6.90	7.70	7.30	922.67	974.67	948.67	238.50	250.40	244.45
GH 37	7.50	7.87	7.68	873.00	905.33	889.17	244.30	251.57	247.93
GH 38	7.30	6.23	6.77	736.67	653.33	695.00	235.50	220.50	228.00
IC-92363	6.50	6.67	6.58	676.67	570.00	623.33	228.50	219.17	223.83
IC-92372	7.00	7.87	7.43	824.00	866.67	845.33	243.80	251.17	247.48
IC-92414	6.70	7.10	6.90	878.33	926.67	902.50	267.50	253.70	260.60
IC-92420	6.90	7.33	7.12	885.67	915.00	900.33	295.50	306.03	300.77
Pb. Komal	6.70	7.70	7.20	865.00	916.67	890.83	284.50	289.07	286.78
NDBG-104	7.20	7.97	7.58	1030.00	973.33	1001.67	275.60	267.40	271.50
P. Samridhi	6.43	6.90	6.67	913.33	1013.33	963.33	285.00	287.80	286.40
HBGH-1	6.93	6.57	6.75	779.00	690.00	734.50	251.20	249.80	250.50
HBGH-2	8.90	8.33	8.62	818.00	873.33	845.67	328.50	325.30	326.90
HBGH-3	6.60	6.27	6.43	810.33	740.00	775.17	237.33	241.60	239.47
HBGH-4	9.20	9.77	9.48	1025.00	943.67	984.33	338.70	339.07	338.88
HBGH-5	9.10	9.07	9.08	1053.33	1006.67	1030.00	329.50	323.70	326.60
HBGH-6	5.70	5.53	5.62	752.00	710.00	731.00	204.60	198.20	201.40
HBGH-7	6.30	6.23	6.27	729.67	695.00	712.33	234.90	239.30	237.10
HBGH-8	10.83	10.73	10.78	1046.67	1033.33	1040.00	356.20	351.40	353.80
HBGH-9	7.50	8.13	7.82	855.33	806.67	831.00	284.10	279.80	281.95
HBGH-10	6.90	7.03	6.97	720.00	694.67	707.33	266.30	258.50	262.40
HBGH-11	10.20	10.43	10.32	858.00	923.33	890.67	344.60	344.70	344.65
HBGH-12	8.20	8.83	8.52	820.00	866.67	843.33	295.53	291.60	293.57
HBGH-13	6.00	5.83	5.92	723.33	690.00	706.67	227.73	220.30	224.02
HBGH-14	7.30	6.77	7.03	755.00	776.67	765.83	268.50	263.90	266.20
HBGH-15	7.80	7.53	7.67	760.00	710.00	735.00	291.30	288.70	290.00
HBGH-16	7.10	6.83	6.97	866.00	798.33	832.17	253.80	247.10	250.45
0HBGH-17	8.50	9.07	8.78	860.00	886.67	873.33	307.20	302.80	305.00
HBGH-18	6.30	6.33	6.32	663.33	713.33	688.33	231.70	227.40	229.55
HBGH-19	4.60	4.43	4.52	560.00	543.33	551.67	178.20	173.60	175.90
HBGH-20	8.30	8.20	8.25	847.00	890.00	868.50	299.60	295.70	297.65
HBGH-21	5.90	5.73	5.82	708.33	673.33	690.83	221.90	226.50	224.20
HBGH-22	10.30	10.23	10.27	1004.67	990.00	997.33	347.60	331.30	339.45
HBGH-23	9.20	9.97	9.58	910.00	896.67	903.33	335.50	296.47	315.98
HBGH-24	7.40	8.27	7.83	723.33	770.00	746.67	289.50	293.60	291.55
PH-3 (C)	8.20	8.33	8.27	745.00	788.33	766.67	309.70	309.30	309.50
HBGH-35 (C)	8.60	9.20	8.90	853.33	840.00	846.67	321.20	316.70	318.95
C.D.	0.51	0.30		74.60	32.41		6.69	4.86	
SE(m)	0.18	0.11		26.41	11.47		2.37	1.72	
SE(d)	0.26	0.15		37.34	16.22		3.35	2.44	
C.V.	4.17	2.43		5.52	2.41		1.49	1.10	

NFV: Number of fruits per vine; AFW: Average fruit weight (g); YPH: Yield per hectare (q)

genotype HBGH-19 recorded minimum number of fruits per vine (4.52) along with minimum average fruit weight (551.67) thereby giving minimum yield per hectare (175.90) amongst all the genotypes. Results obtained in this experiment are supported by the findings of Tirumalesh and Mandal (2018), Kumar *et al.* (2018) and Kandasamy *et al.* (2019) in their respective studies on germplasm evaluation in bottle gourd. Other promising genotypes with high number of fruits per vine are HBGH-11 (10.32) and HBGH-22 (10.27) and those with high average fruit weight are HBGH-5 (1030.00) and NDBG-104 (1001.67).

References

1. Fischer, R.A. and Yates, F. (1963). Statistical Tables for Biological, Agricultural and Medical Research, Oliver and Boyd Edinburgh. pp. 55-57.
2. Harika, M.; Gasti, V.D.; Shantappa, T.; Mugle, R.; Shirol, A.M.; Mastiholi, A.B. and Kulkarni, M.S. (2012). Evaluation of bottle gourd genotypes [*Lagenaria siceraria* (Mol.) Standl.] for various horticultural characters. *Karnataka Journal of Agricultural Sciences*, 25(2): 241-244.
3. Kandasamy, R.; Arivazhagan, E. and Bharathi, S.S. (2019). Evaluation of growth and yield characters in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). *Journal of Pharmacognosy and Phytochemistry*, 8(3): 4653-4655.
4. Kumar, S.; Thakur, V.; Tiwari, R. and Chormule, S.R. (2018). Evaluation of genotypes for quantitative traits in bottle gourd (*Lagenaria siceraria* (Molina) Standl.). *Journal of Pharmacognosy and Phytochemistry*, 7(3): 841-843.
5. Leela, N.C. and Singh, D. (2020). Evaluation Trial on Bottle Gourd [*Lagenaria siceraria*]. Under Prayagraj Agro-Climatic Conditions. *International Journal of Agriculture, Environment and Biotechnology*, 13(4): 517-520.
6. Panse, V.G. and Sukhatme, P.V. (1967). Statistical methods for agricultural workers. ICAR, New Delhi.
7. Singh, N. and Singh, H. (2020). Evaluation of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] genotypes for various growth and yield characters. *Asian Journal of Horticulture*, 15(1): 4-6.
8. Tirumalesh, M. and Mandal, J. (2018). Evaluation of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] genotypes during post-rainy season in Red and Laterite Zone of West Bengal. *Journal of Crop and Weed*, 14(3): 185-188.
9. USDA National Nutrient Database for Standard Reference, release 1. The national agricultural library (2018). https://ndb.nal.usda.gov/ndb/.

Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 10 : 1146-1151 (Special Issue-II) July 2022, Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Multivariate Analysis Revealing Genetic Divergence in Bottle Gourd [*Lagenaria siceraria* (Mol.) Standl.] Genotypes

D.S. Duhan, Vikas Gill* and Jagat Singh
Department of Vegetable Science, CCS Haryana Agricultural University, Hisar-125004, Haryana
**Corresponding Author (Vikas Gill) Email : gillvikas44@gmail.com*

Abstract

Thirty-seven genotypes of bottle gourd were evaluated for thirteen quantitative traits pertaining to growth and fruit yield characters to differentiate the germplasm and assess its morphological diversity. The genotypes were sown under randomized block design (RBD) in three replications at Vegetable Research Farm, CCS Haryana Agricultural University, Hisar during the *Spring Summer* season of 2017-18. Results obtained from analysis showed that almost all the characters exhibited high degree of variability. Correlation coefficients revealed that fruit yield was found significantly and positively correlated with number of fruits per vine (0.932), average fruit weight (0.712), number of primary branches per vine (0.602) and length of fruit (0.539). Further, Principal Component Analysis (PCA) unveiled that the first two principal components (PC's) accounted for 63.95% of the total variability out of which 44.66% is from first PC only. Hierarchical cluster analysis divided the selected germplasm into four clusters, where cluster-4 (17) comprises maximum genotypes followed by cluster-3 (9), cluster-2 (7) and cluster-1 (4). Genotypes under cluster-1 gave best results for days to first female flowering (51.93), days to first fruit harvest (65.8), vine length (617.63), number of primary branches (14.15), nodes to first female flowering (11.28) and average fruit weight (886.77).

Key words : *Genetic divergence, genotypic correlation coefficient, principal component analysis & hierarchical clustering.*

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is an important cucurbitaceous vegetable crop belonging to family Cucurbitaceae and is native to tropical Africa. It is an annual, monoecious naturally diploid crop with chromosome number 2n = 2x = 22 and highly cross-pollinated in nature. It is known by various other names like Calabash, Lauki, white flowered gourd and evening anthesis gourd.

Bottle gourd is grown over an area of 193 thousand hectares yielding 3171 thousand metric tonne of production at national level (Anonymous, 2022.a) whereas, Haryana contributes 12.46% of national area 24050 hectares and 11.07% of national production 351.17 metric tonne (Anonymous, 2022.b). In the recent years, bottle gourd has attained a status of high- value crop occupying a pride place among vegetables in Indian cuisine because of its multifarious uses. It is mainly grown for its edible fruits which at tender stage are cooked as a vegetable, whereas, hard shells of mature fruits are used for domestic utensils, floats for fishing nets *etc*. It can be used for making sweets like halva, *kheer* and *burfi*. Along with culinary importance bottle gourd is also very well known for its medicinal uses with several health benefits like overcoming constipation, cough, night blindness, as a cathartic, in urinary disorder and insomnia.

Prior knowledge of divergence within the accession along with its key features plays an integral role in any crop development programme. Such information would largely help the plant breeder to choose ideal parents for the hybridization having broad genetic base with considerable genetic divergence. This study aimed at revealing the genetic distinctness among the selected accession to successfully categorize it and simultaneously assign genotypes to specific heterotic groups for creating segregating progenies with maximum genetic variability for further breeding purposes.

Materials and Methods

The present experiment was carried out at Vegetable Research Farm Chaudhary Charan Singh Haryana Agricultural University, Hisar during the *Spring-Summer* season of 2017-18. The experimental location stands at 29º 43' in the North and 76º 58' East, at 243 meters elevation above mean sea level and the tract of research station is characterized by sub-tropical and semi-arid climate. All the other fruit quality analysis was done in the laboratories of Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. The selected germplasm consists of thirty-seven genotypes (7 inbred lines, 4 tester, 24 F_1 hybrids and 2 standard hybrid checks) procured from various sources. The crop was sown in randomized block design in three replications. The investigation involved thirteen parameters which were observed and recorded. Five plants were randomly selected for recording of various growth characters and likewise ten fruits were picked randomly to record fruit characters in every genotype for each replication.

Table-1 : Mean, range and variance of 37 genotypes of Bottle Gourd for quantitative traits.

Characters	Mean	Range		Variance	SE Mean	CV
		Max.	Min.			
Days to 1st male flowering	51.29	62.33	45.33	16.73	0.49	1.66
Days to 1st female flowering	55.12	65.00	48.67	16.75	0.43	1.36
Days to first fruit harvest	66.02	77.00	57.33	19.76	0.54	1.42
Vine Length (cm)	543.94	777.70	361.80	10566.29	4.98	1.58
Number of fruits/vine	7.51	11.10	4.40	1.81	0.18	4.16
Yield per hectare (q)	275.81	358.50	172.50	1933.72	2.36	1.48
Number of primary branches	12.36	16.15	8.76	4.09	0.14	2.09
Nodes to 1st male flower	10.98	13.94	8.85	1.53	0.21	3.40
Nodes to 1st female flower	12.48	15.20	9.85	1.90	0.22	3.17
Length of fruit (cm)	30.40	36.80	24.20	9.14	0.24	1.38
Diameter of fruit (cm)	8.90	10.57	7.30	0.38	0.22	4.32
Average fruit weight (g)	828.14	1100.00	530.00	12123.05	26.40	5.52
Crop maturity	120.53	133.00	107.00	19.89	1.78	2.56

Statistical Package for Social Sciences (SPSS-13.0) software was used to analyze the observations recorded under the study. Variability in the selected germplasm was estimated using the values of coefficients of variation (CV) as indicator. Method suggested by Pearson was employed in computing the correlation coefficients among quantitative characters under the purview of study. Further, for better interpretation and understanding of trends and patterns – Principal Component Analysis (PCA) was performed over the recorded observations. Lastly, hierarchical cluster analysis was also done to group the genotypes in various clusters based on Euclidean distance using Wards method by cluster function in MS Excel software.

Results and Discussion

Highly significant differences among genotypes for all the quantitative characters were recorded in analysis of variance, which unveiled the presence of considerable variability in these genotypes of bottle gourd. Range, mean/average values and coefficient of variation (CV) drawn from analyzing the recorded observations are presented in Table-1. Among the thirteen parameters evaluated, average fruit weight recorded maximum value for CV (5.52) whereas, days to first female flowering recorded minimum value for CV (1.36). Further wide range in observations among the genotypes marks the presence of high genetic divergence in the accession.

Perusal of correlation coefficient values (Table-2) revealed that characters namely - number of fruits per vine (0.932), average fruit weight (0.712), number of primary branches per vine (0.602) and length of fruit (0.539) are significantly and positively correlated with fruit yield at 5% level of significance, inferring that these characters could be positively exploited and must be focused upon while selecting for yield improvement programmers on similar grounds as reported by Kumari *et al.* (2019). Whereas, nodes to first male flowering (-0.785), nodes to first female flowering (-0.702), days to crop maturity (- 0.531), days to first fruit harvest (- 0.321) and vine length at the time of final harvest (- 0.191) were found significantly and negatively correlated with fruit yield. Days to first fruit harvest was found positively correlated with - days to first male flowering (0.713), days to first female flowering (0.789), nodes to first male flowering (0.297), nodes to first female flowering (0.305), diameter of fruit (0.289) and crop maturity (0.270). Number of fruits per vine was found positively correlated with number of branches per vine (0.513), length of fruit (0.413) and average fruit weight (0.697) whereas, it reported highly negative correlation with nodes to first male flowering (-0.703), nodes to first female flowering (-0.658) and days to crop maturity (-0.468). Length of fruit also had significantly positive correlation with number of fruits per vine (0.413), number of primary branches (0.489) and vine length (0.145). Janaranjani and Kanthaswamy (2015), Rehan *et al.* (2020), Chouhan *et al.* (2020) and Kumari *et al.* (2021) reported similar trends in correlation analysis in their respective association studies on bottle gourd.

In layman's language Principal component analysis (PCA) is a statistical procedure that converts a set of observations of possibly correlated variables into a set of linearly uncorrelated variables (called principle components) that accounts for most the variation in observed variables. PCA was used in this study to look for any possible clusters within the given set of bottle gourd

Table-2 : Correlation coefficients among various traits under the study.

Character	01 DMF	02 DFF	03 DFH	04 VL	05 NFV	06 NPB	07 NMF	08 NFF	09 LF	10 DF	11 AFW	12 CM	13 YPH
1	1.000**	0.937**	0.713 **	-0.363 *	-0.017	-0.249	0.201	0.256	-0.101	0.332 *	-0.297	0.082	-0.040
2		1.000 **	0.789 **	-0.273	-0.066	-0.369*	0.307	0.380 *	-0.229	0.260	-0.401 *	0.257	-0.094
3			1.000 **	0.015	-0.321	-0.243	0.297	0.305	-0.242	0.289	-0.354 *	0.270	-0.321
4				1.000 **	-0.194	0.101	-0.095	-0.087	0.145	-0.215	-0.171	-0.125	-0.191
5					1.000 **	0.513 **	-0.703 **	-0.658 **	0.413 **	-0.002	0.697 **	-0.468 **	0.932 **
6						1.000 **	-0.861 **	-0.895 **	0.489 **	-0.170	0.675**	-0.497 **	0.602 **
7							1.000 **	0.945 **	-0.534 **	0.182	-0.760**	0.532 **	-0.785 **
8								1.000 **	-0.554 **	0.260	-0.781**	0.588 **	-0.702 **
9									1.000 **	-0.259	0.375 *	-0.424 **	0.539 **
10										1.000 **	-0.052	-0.133	0.001
11											1.000 **	-0.393 **	0.712**
12												1.000 **	-0.531 **
13													1.000 **

*Significant at 5% level and **Significant at 1% level

DMF: Days to first male flower opening; DFF: Days to first female flower opening; DFH: Days to first fruit harvest; VL: Vine length at the time of final harvest (cm); NFV: Number of fruits per vine; NPB: Number of primary branches; NMF: Nodes to first male flower; NFF: Nodes to first female flower; LF: Length of fruit (cm); DF: Diameter of fruit (cm); AFW: Average fruit weight (g); CM: Crop maturity (days); YPH: Yield per hectare (q)

germplasm. PCA generated a altogether new set of 13 orthogonal variables (PC's). The first five principal components of data accounted for 87.27 percent of the overall variance with >1 Eigen value in the given set of accession (Table-3). Similarly Mahapatra *et al.* (2022), Abhishek *et al.* (2020), Kumar *et al.* (2019), Visen *et al.* (2015) and Deepthi *et al.* (2015) reported moderate to high level of diversity in their accessions. Rest of the PC's had smaller Eigen values and contributed less towards total variability. Highest Eigen value was recorded for first PC (5.81) accounting 44.65 percent of the total variability. Figure-1 represents the loading plot of all the thirteen parameters under the purview of this study which gives an idea of correlation between a variable and principal component (PC).

Further, the genotypes were divided into four clusters based on the germplasm variability as determined by hierarchical cluster analysis (dendrogram) on quantitative traits (Figure-2). Ward's Clustering technique was utilised in this study and accessions were divided into four groups namely Cluster-I, Cluster-II, Cluster-III and Cluster-IV comprising of 4, 7, 9 and 17 respectively (Table-5). The cluster-I comprises of accessions with least number of days to first male and female flowering, comparatively longer vine lengths, high number of primary branches, very low number of nodes to first male and female flower, longer fruits with medium diameter and with highest average fruit weight. Bhagwat *et* al. (2022), Abhishek *et al.* (2020), Chetariya *et al.* (2017) and Deepthi *et al.* (2015) reported results on similar grounds and grouped their accession into clusters with varying degree of diversity among them. Based upon the reported results it can inferred that genotypes belonging to the cluster-I are early yielders, shows more vegetative growth and are comparatively high yielders.

Conclusion

Based on the reported results it can be concluded that there exists extensive genetic diversity amongst the evaluated set of germplasm. And genotypes that comprises cluster-I (*i.e.* HBHG-13, HBGH-18, HBGH-19 and HBGH-21) surpasses rest all the genotypes in terms of earliness and average fruit weight. Hence these cultivars are an important source of diversity which must be exploited in future crop improvement programmes.

Acknowledgement

This experiment was supported by all the researchers and funding from Chaudhary Charan Singh Haryana Agricultural University Hisar, Haryana, India. We hereby thank and acknowledge - Head Department of Vegetable Science and all other faculty members of department for their valuable contributions and insights.

Table-3 : Eigen values, accumulated variance and correlation between original variables and the first six Principle Components (PC's) representing variability of bottle gourd accessions.

Characters	PC-1	PC-2	PC-3	PC-4	PC-5
Days to 1st male flowering	0.407	0.851	0.165	- 0.079	0.094
Days to 1st female flowering	0.522	0.787	0.198	- 0.153	0.055
Days to first fruit harvest	0.536	0.578	0.460	0.034	- 0.283
Vine Length (cm)	- 0.060	- 0.475	0.709	0.308	- 0.003
Number of fruits/vine	- 0.759	0.408	- 0.230	- 0.074	0.149
Number of primary branches	- 0.837	0.077	0.229	0.020	- 0.317
Nodes to 1st male flower	0.907	- 0.168	- 0.168	0.030	0.184
Nodes to 1st female flower	0.917	- 0.102	- 0.197	0.048	0.199
Length of fruit (cm)	- 0.626	0.065	0.343	- 0.114	0.489
Diameter of fruit (cm)	0.219	0.425	- 0.329	0.728	- 0.134
Average fruit weight (g)	- 0.813	0.126	- 0.233	- 0.072	- 0.294
Crop maturity	0.592	- 0.147	- 0.099	- 0.562	- 0.305
Yield per hectare (q)	- 0.823	0.401	- 0.160	- 0.054	0.172
Eigen Value	5.805	2.508	1.271	1.003	0.756
Cumulative Variability (%)	44.657	63.950	73.728	81.445	87.266

Table-4 : Mean performance of parents & hybrids in individual clusters for yield & its related traits.

Character	Cluster-1	Cluster-2	Cluster 3	Cluster-4
Days to 1st male flowering	48.577	48.632	52.241	58.022
Days to 1st female flowering	51.937	53.600	55.874	61.692
Days to first fruit harvest	65.874	65.392	65.174	71.027
Vine Length (cm)	617.636	553.414	521.951	454.907
Number of fruits/vine	6.925	6.628	8.613	5.700
Number of primary branches	14.150	10.002	13.108	9.262
Nodes to 1st male flower	10.057	12.714	10.354	12.658
Nodes to 1st female flower	11.287	14.207	11.923	14.527
aultLength of fruit (cm)	31.420	28.025	31.541	27.370
Diameter of fruit (cm)	8.518	9.042	9.038	8.900
Average fruit weight (g)	886.777	764.334	862.038	663.747
Crop maturity	119.741	124.667	118.450	123.915
Yield per hectare (q)	265.100	235.118	312.560	214.882

Table-5 : Distribution of 37 genotypes of Bottle Gourd in different clusters.

Cluster	No. of Genotypes	Genotypes included	Source of Genotype
1	4	HBGH-13; HBGH-18; HBGH-19; HBGH-21	CCS HAU Hisar
2	7	GH-38; HBGH-1; HBGH-3; HBGH-6; HBGH-7; HBGH-16; IC-92363;	CCS HAU Hisar NBPGR, New Delhi
3	9	GH-32; GH-34; GH-37; IC-92372; IC-92414; IC-92420; NDBG-104; Punjab Komal; Pusa Samridhi;	CCS HAU Hisar NBPGR, New Delhi NDUA&T Faizabad PAU Ludhiana IARI, New Delhi
4	17	HBGH-2; HBGH-4; HBGH-5; HBGH-8; HBGH-9; HBGH-10; HBGH-11; HBGH-12; HBGH-14; HBGH-15;HBGH-17; HBGH-20; HBGH-22; HBGH-23;HBGH- 24; HBGH-35 (C); PH-3 (C);	CCS HAU Hisar ____ ____ ____ IARI, New Delhi

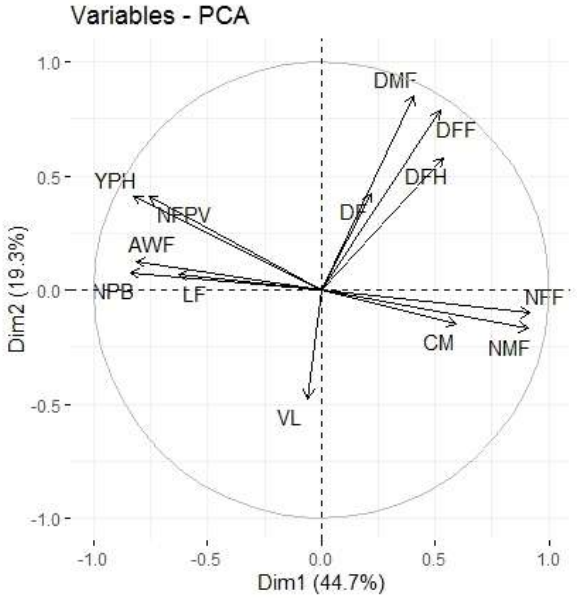


Figure-1 : Loading plot of all the 13 quantitative traits under the study.

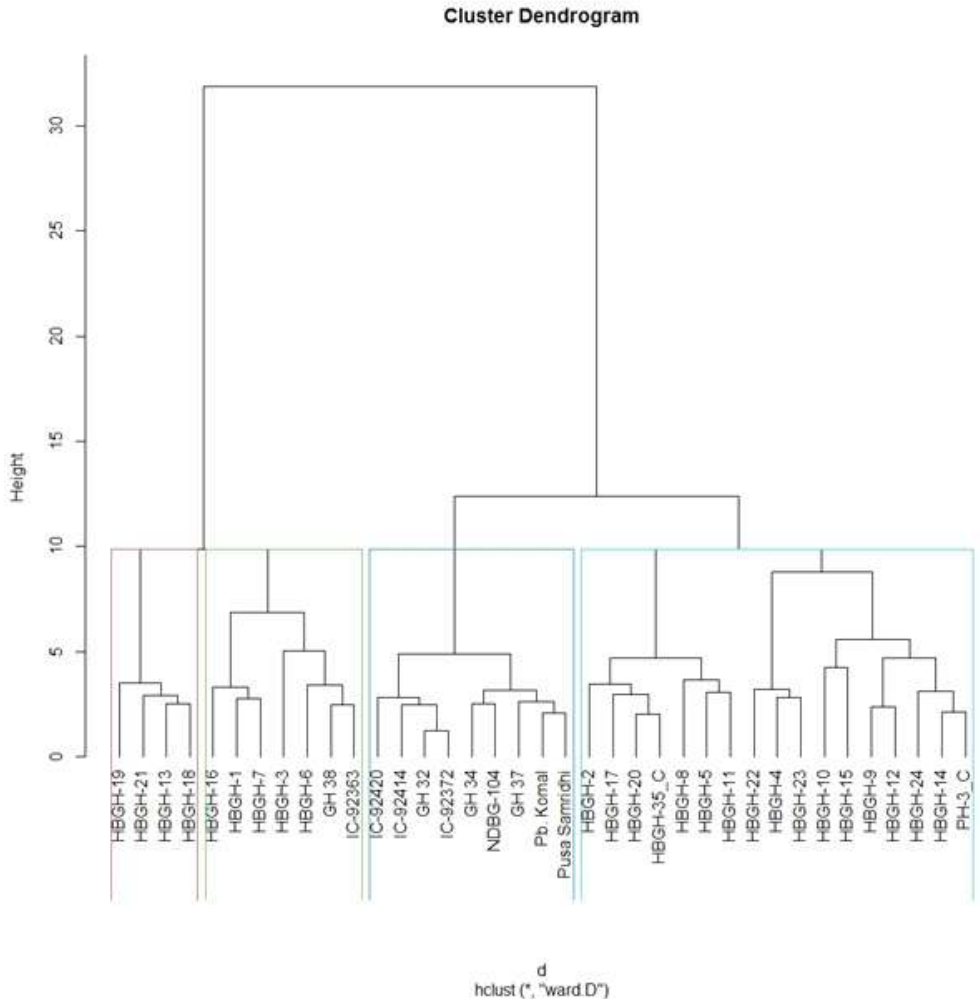


Figure-2: Dendrogram classifying the given accession into four clusters.

References

1. Anonymous (2022.a). A 2nd Advance estimates of area and production of horticultural crops in India. www.indiastat.com, Ministry of Agriculture and Farmers Welfare, Government of India.
2. Anonymous (2022.b). A 1st Advance estimates of area and production of horticultural crops in Haryana. www.indiastat.com, Ministry of Agriculture and Farmers Welfare, Government of India.
3. Abhishek, Rajput, V.; Kumar, J. and Tomar, S. (2020). Genetic divergence analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl]. *Plant Archives,* 20(1): 520-522.
4. Bhagwat, A., Hanchinamani, C.N.; Basavaraja, N.; Kulkarni, M.S.; Nishani, S. and Rathod, V. (2022). Genetic diversity studies in bottle gourd (*Lagenaria siceraria* (Mol.) Standl) genotypes. *The Pharma Innovation,* 11(3): 1496-1499.
5. Chetariya, C. P. and Vaddoria, M. A. (2017). Genetic divergence analysis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Journal of Applied and Natural Science*, 9(4): 1949–1953.
6. Chouhan, G.S.; Kushwah, S.S.; Singh, O.P. and Sharma, R.K. (2020). Genetic variability and correlation analysis for fruit yield and quality traits in bottle gourd. *Ind. J. Hort.,* 77(2): 287-292.
7. Deepthi, B.; Reddy, P.S.S.; Rao, M.P. and Asho, P. (2015). Genetic divergence study in bottle gourd (*Lagenaria siceraria*). *Vegetable Science*, 42(2): 88-89.
8. Janaranjani, K.G. and Kanthaswamy, V. (2015). Correlation studies and path analysis in Bottle Gourd. *J. Hort.,* 2(1): 1-4.
9. Kumari, K.; Kant, K. and Kumar, R. (2021). Correlation studies and path analysis in bottle gourd. *The Pharma Innovation,* 10(10): 557-560.
10. Kumari, S.; Srivastava, R.; Gangopadhyaya, K.K. and Rana, J.C. (2019). Diversity analysis of bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) germplasm by multivariate analysis. *Vegetable Science*, 46(1&2): 50-55.
11. Mahapatra, S.; Sureja, A.K.; Behera, T.K. and Verma, M. (2022). Assessment of genetic diversity of ninety-one bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] genotypes from fourteen different agro-climatic zones of India using agro-morphological traits and SSR markers. *Mol Biol Rep* (2022).
12. Rehan; Singh, M.K.; Kumar, M.; Malik, S.; Farswan, K. and Sharma, A. (2020). Estimation of character association and path coefficient in bottle gourd (*Lagenaria siceraria*). *J. Pharmacogn Phytochem.* 9(5): 2051-2054.
13. Visen, V.K.; Thakur, P.; Sharma, D. and Nair, S.K. (2015). Genetic divergence studies in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Plant Archives*, 15(2):1175-1178.