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Studies on Effect of Different Levels of Potassium Application on Soil Nutrient Status of Foxtail Millet in Alfisols of Eastern Dry Zone of Karnataka

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Abstract

Field experiment was conducted in Alfisols of Eastern dry zone of Karnataka to study the effect of different levels of potassium application on soil nutrient status. Foxtail millet is used as the test crop for two years (2016-17) and (2017-18) to study the response of potassium and twelve treatments were replicated thrice in RCBD. The treatments include absolute control, RDF as per UAS, Bangalore package (40:40:0 kg of N:P_2O_5:K_2O + 6 tonnes of FYM), 5 levels of potassium (10, 20, 30, 40 and 50 kg K_2O ha^{-1}) with recommended nitrogen and phosphorus. Additional 10 kg N (50 kg) and 5 kg P_2O_5 (45 kg) was added to RDF and maintained same levels of potassium. The pooled data of experimental results cleared indicated that the application of recommended N, P_2O_5 + 40 kg K_2O ha^{-1} along with 6 tonnes of FYM (T_6) significantly recorded the higher straw and grain yields of 38.15 q ha^{-1} and 22.66 q ha^{-1}, respectively in foxtail millet followed by T_{11} (50 kg N + 45 kg P_2O_5 + 40 kg K_2O ha^{-1} + 6 t FYM), which recorded the 37.05 q ha^{-1} of straw yield and 21.76 q. Non-significant effect of different potassium levels was recorded on pH, EC and organic carbon. There was significant increase in available N, P_2O_5, K_2O and S status with application of increased levels of potassium along with nitrogen, phosphorus and FYM after harvest of foxtail millet. Calcium and magnesium status in harvest soils of foxtail millet was found to be non-significant due to potassium levels. Application of graded levels of potassium noticed a significant difference in DTPA extractable Fe, Mn, Cu and non-significant difference was recorded in Zn status of post-harvest soil of foxtail millet.

Key words : *Foxtail millet, potassium, alfisols.*

Introduction

As we know that intensive cropping with high yielding varieties makes considerable demand on the soil nutrients and application of nitrogen alone is not a prescription to obtain higher yields without other nutrients supplement. Balanced use of plant nutrients through fertilizers is the answer to overcome the deficiency of nutrients. Therefore, quite likely that even those soils which are considered sufficient in available potassium may not be able to maintain soil fertility for long time. However, till recently, little attention was being paid to the K application to field crops. In fact, crop removal of potassium often equals or exceeds that of nitrogen. RehanulHasan (2012) estimated that 13.7 million tonnes of K_2O year-1 is being removed by crops in India against the fertilizer consumption of only 1.57 million tonnes of K_2O. After considering all the organic and inorganic additions, a net deficit of 7.05 million tonnes K_2O $year^{-1}$ has been estimated which means a depletion in Indian soils at the rate of 37.5 kg K_2O ha^{-1} $year^{-1}$. Potassium (K) essentially plays a major role in plant physiological processes. Therefore, it is required in large amounts for proper growth and reproduction in plants. It is considered vital after nitrogen as far as nutrients needed by plants is concerned. It is also termed “the quality nutrient” for its contributing factor in a number of biological and chemical processes in plants. By understanding the soil nutrient status and corrective fertilizer management practices to support high yields of high quality crops require a balanced fertilizer application.

However, long-term intensive cropping without its application resulted in low to medium status and reduced potassium supply to crop plants and consequently crop yields. High crop K removal than K addition by farmers and imbalanced use of NPK fertilizers contributed to large-scale K mining and K deficiency in soils and crops (Ramamurthy *et al.,* 2017). Balanced and adequate fertilization is essential for increasing crop yields and ensuring sustainable agriculture. Foxtail millet being low nutrient demanding crop, but responds well for addition of potassium. Depleted soil potassium status due to higher crop removal as equal as or higher than nitrogen, without application of potassium fertilizers and cultivation of improved varieties of foxtail millet needs balancing potassium through external fertilizers. The present

investigation on effect of different levels of potassium application on nutrient status of foxtail millet was carried out in the farmer's field of Devapalli village, Chintamanitaluk, Chikkaballapura district, which comes under eastern dry zone of Karnataka.

Materials and Methods

In Alfisols of Karnataka, being not recommended the potassium for foxtail millet as per UAS Bengaluru POP based on the soil test values from 1980s, the present experiment was laid to work out the potassium effect on soil nutrient status of foxtail millet by testing the different levels of potassium in low potassium soils of farmer's field of Devapalli village, Chintamanitaluk, Chikkaballapura district of Eastern Dry Zone of Karnataka for two years from 2016 to 2018. A composite surface (0-15 cm) soil sample was drawn from the experimental site before initiation of experiment and analyzed for physico-chemical properties (Table-1).

The two experiments were conducted with twelve treatments and three replications using RCBD during *kharif* 2016 and 2017 with foxtail millet (SiA–3156) as a test crop. Foxtail millet cv. SiA-3156 was grown as a test crop during kharif seasons of 2016 and 2017. It is a medium duration variety that attains maturity in 85 -90 days and is pure line from 2871, developed by RARS, Nandyal, ANGRU during 2012 for the Karnataka, Andhra Pradesh, Tamil Nadu, Bihar, Gujarat, Madhya Pradesh and Uttarakhand.

Recommended doses of nitrogen (40 kg ha^{-1}), phosphorus (40 kg P_2O_5 ha^{-1}), potassium (0 kg K_2O ha-1) and 6 t ha-1 of FYM were applied to plots. Different doses of potassium are applied to plots as per the treatments. Treatment details include absolute control (T_1), POP based on UAS (B) package (T_2), Rec. N P_2O_5 + 10 kg K_2O ha^{-1} (T_3), Rec. N P_2O_5 + 20 kg K_2O ha^{-1} (T_4), Rec. N P_2O_5 + 30 kg K_2O ha^{-1} (T_5), Rec. N P_2O_5 + 40 kg K_2O ha^{-1} (T_6), Rec. N P_2O_5 + 50 kg K_2O ha^{-1} (T_7), 50 kg N + 45 kg P_2O_5 + 10 kg K_2O ha^{-1} (T_8), 50 kg N + 45 kg P_2O_5 + 20 kg K_2O ha^{-1} (T_9), 50 kg N + 45 kg P_2O_5 + 30 kg K_2O ha^{-1} (T_{10}), 50 kg N + 45 kg P_2O_5 + 40 kg K_2O ha^{-1} (T_{11}) and 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1} (T_{12}). The panicles of foxtail millet were harvested separately from the plots and dried under sun in the threshing yard. The panicles were threshed, winnowed, cleaned and weight was recorded. The straw was harvested separately from the plots and dried under sun in the threshing yard. The dry weight of the straw was recorded and expressed in q ha_{-1}. All physical and chemical parameters were analysed by adopting standard procedure. The experimental data on yield, physical and chemical parameters are subjected to analysis by using Fisher's method of 'Analysis of Variance' (ANOVA) as outlined by Gomez and Gomez (1984). The level of significance was used in F test at 5 per cent.

Results and Discussion

Effect of different levels of potassium on yield of foxtail millet : The yield of crops differed significantly during first (2016-17) and second (2017-18) year of experiments and the pattern of response to different levels of potassium application was similar in both the years. Hence, the experimental data of two years is pooled and the results obtained are presented with appropriate reasons.

Potassium is one among the three primary nutrients required by the crops to complete their life cycle (Majumdar *et al.,* 2012). In true sense it carries the meaning that potassium plays key role in enhancing the yield attributes and it ultimately reflected in significant increase in the grain yield. In the present study, the grain yield obtained due to graded levels of K is in the ascending order of $T_1 > T_2 > T_{11} > T_6$ (Table-2). Application of recommended N, P_2O_5 + 40 kg K_2O ha^{-1} (T_6) recorded higher grain (22.66 q ha^{-1}) and straw (38.15 q ha^{-1}) yield which was on par with T_{11} (21.76 and 37.05 q ha^{-1} of grain and straw yield) as compared to RDF as per UAS (B) package of practice (T_2) which recorded 13.38 q ha^{-1} of grain and 26.15 q ha^{-1} of straw yield. The lowest grain yield (10.38 q ha^{-1}) and straw yield (18.03 q ha^{-1}) was noticed in the absolute control (T_1). Increase in grain yield was due to more number of productive tillers $hill^{-1}$, panicle length and panicle weight. This clearly indicates that the response of foxtail millet with respect to grain and straw yield was more due to application of different levels of potassium from 10 to 40 kg K_2O ha^{-1}, beyond it crop yield was declined at 50 kg K_2O application. This showed that crop needs optimum nutrition for crop growth and development. This clearly indicated that the blanket recommendation of 100 per cent RDF as per UAS (B) recommendation without potassium for foxtail millet crop is of no use in enhancing the yield especially in low P and K soils, where modification in the RDF is required through evaluation of different levels of potassium. These results are in conformity with findings of Dakshina Murthy *et al.* (2015), who reported that grain yield was increased by 11.5% and 6.3% due to increase in recommended dose of N from 100% (120 kg ha^{-1}) to 125% and 150%. Increase in P & K doses from 100 to 125% (P from 60 to 75 and K from 40 to 50 kg ha^{-1}) improved grain yield of rice significantly in Krishna Godavari delta regions of Andhra Pradesh. However, as the potassium levels increased from 0 to 40 kg K_2O ha^{-1}, increase in grain and straw yield was noticed. This might be attributed to the role of potassium in activation of several enzymes, energy

Table-1 : Physico-chemical properties of the experimental location.

Sl. No.	Physico-chemical properties of soil	Values obtained
1.	Sand (%)	64.20
2.	Silt (%)	19.50
3.	Clay (%)	16.10
4.	Textural class	Sandy loam
5.	Maximum Water Holding Capacity (%)	36.00
6.	Bulk density (Mg m^{-3})	1.44
7.	pH (1:2.5)	6.59
8.	EC (1:2.5) (dSm^{-1})	0.41
9.	CEC (c mol (p^+) kg^{-1}	14.37
10.	Soil organic carbon (SOC) (%)	0.47
11.	Available N (kg ha^{-1})	136.42
12.	Available P_2O_5 (kg ha^{-1})	16.62
13.	Available K_2O (kg ha^{-1})	119.84
14.	Exchangeable Ca (meq 100 g^{-1})	8.13
15.	Exchangeable Mg (meq 100 g^{-1})	3.13
16.	Available S (mg kg^{-1})	19.69
17.	DTPA extractable Zn (mg kg^{-1})	0.43
18.	DTPA extractable Fe (mg kg^{-1})	5.40
19.	DTPA extractable Mn (mg kg^{-1})	6.59
20.	DTPA extractable Cu (mg kg^{-1})	0.81

transformation and biochemical reactions for plant growth and development.

Potassium application increases the cytokinin synthesis and photosynthates, which ultimately increases the grain yield of foxtail millet. Application of higher doses of K showed the significant difference in 2 years experiment but application of 50 kg K2O ha-1 has no effect over the 40 kg K_2O ha^{-1}. From the present experiment, it is cleared that application of 40: 40: 40 kg N, P_2O_5 and K_2O ha^{-1} increased the yield of foxtail millet as compared to only NP. Similar results were noticed by Ramachandrappa *et al.* (2013) where application of recommended N, P_2O_5 and 150 per cent recommended K (50: 40: 37.5 kg ha^{-1}) to finger millet has increased the mean grain and straw yields as compared to treatments having no K application. Similar findings were also reported by Dwivedi *et al.* (2016).

Effect of different levels of potassium on post-harvest soil pH, EC and organic carbon : From the experimental results it is clear that, the potassium did not influence the soil pH, electrical conductivity and organic carbon after harvest of the foxtail millet in both the years (Table-3). The reason might be due to the soil pH did not change in the short period of time with the agronomic practices. There was no significant difference observed with respect to post harvest soil pH among the treatments. However, the pH values were slightly decrease in the plots which received with the nitrogen through urea and FYM as compared to initial pH value of 6.59. The pH value was relatively lower due in urea treated plots due to the acidifying effect of N fertilizers (Chawla and Chhabra, 1991) and also due to decomposition of organic matter has been known to release of organic and inorganic acids with concomitant increases in soil acidity (Agbede, 2009).

No significant difference in EC of soil was observed due to application of different levels of potassium fertilizers. The EC values ranged from 0.44 to 0.48 dSm^{-1} (Table-3) and slight variation in the electrical conductivity as compared to initial (0.41 dSm^{-1}) might be due to the application of muriate of potassium at different levels from 10 to 50 kg ha^{-1}, which increased salt concentration in soil. These results are in confirmation with the findings of Aryaet al. (2009) and also release of soluble salts from FYM upon decomposition might also cause higher EC values. These findings are in accordance with that of Chawla and Chhabra (1991). The organic carbon content of soil after harvest of foxtail millet ranged from 0.38 to 0.45 per cent (Table-3). The slight decrease in soil organic carbon was noticed in all the treatments as compared to initial organic carbon content (0.47%) in soil. However, in general application of nitrogen, phosphorous, potassium and FYM increased the organic carbon content of the soil compared to absolute control (T_1, 0.38%). Due to increased crop growth and addition of biomass to the soil by roots and crop residues and also due to incorporation of FYM into the soil. Further, same level of FYM was applied to all treatments except absolute control. Similar results are quoted by Muhammad *et al.* (2011).

Effect of different levels of potassium on available nitrogen, phosphorus and potassium : The lowest (126.53, 17.11 and 132.75 kg ha^{-1}) and the highest (153.11, 38.93 and 166.56 kg ha^{-1}) available N, P_2O_5 and K_2O contents in the soil after harvest of foxtail millet were recorded by T_1 (absolute control) and T_{12} (50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1}), treatments. The nitrogen, phosphorus and potassium status were higher in T_{12}, followed by T_7 (147.28, 37.70 & 164.17 kg ha^{-1} of N, P_2O_5 and K_2O, respectively (Table-4). These treatments are superior as compared to (T_2) POP of UAS (B), which clearly indicates that higher potassium levels are beneficial to nitrogen and phosphorus availability by its synergism. Among the different levels of potassium applied to the foxtail millet crop in the both the years, the highest potassium dose (50 kg ha^{-1}) recorded higher nitrogen, phosphorus and potassium contents in post-harvest soil, might be due to crop responded up to 40 kg ha^{-1} of potassium application with respect to biomass production and crop yield.

Due to higher dose of potassium application along with FYM might have improved the microbial activity to fix more nitrogen and even though, the mineralization of

Table-2 : Effect of different levels of potassium on grain and straw yield of foxtail millet.

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	10.67	10.08	10.38	18.50	17.56	18.03
T_2	13.34	13.42	13.38	27.45	24.86	26.15
T_3	13.68	14.49	14.08	29.41	27.47	28.44
T_4	14.09	15.82	14.96	31.46	31.49	31.48
T_5	17.82	18.64	18.23	32.80	35.82	34.31
T_6	22.25	23.07	22.66	37.78	38.52	38.15
T_7	18.21	19.19	18.70	33.25	34.98	34.12
T_8	14.68	15.07	14.88	30.74	30.96	30.85
T_9	15.12	17.29	16.20	31.73	31.18	31.45
T_{10}	17.40	20.07	18.73	32.31	33.63	32.97
T_{11}	21.20	22.31	21.76	36.92	37.18	37.05
T_{12}	19.97	20.90	20.44	32.94	33.95	33.44
SE.m ±	0.73	0.61	0.52	0.98	0.89	0.66
CD @ 5%	2.14	1.79	1.51	2.88	2.62	1.92

Table-3 : Effect of different levels of potassium on pH, EC and organic carbon in post-harvest soil of foxtail millet.

Treatments	pH			Electrical conductivity (dSm^{-1})			Organic carbon (%)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	6.12	6.11	6.11	0.42	0.45	0.44	0.39	0.37	0.38
T_2	6.06	6.12	6.09	0.40	0.47	0.44	0.40	0.39	0.40
T_3	6.29	6.11	6.20	0.46	0.49	0.47	0.44	0.40	0.42
T_4	6.38	6.19	6.29	0.47	0.43	0.45	0.46	0.42	0.44
T_5	6.28	6.23	6.26	0.47	0.46	0.46	0.47	0.43	0.45
T_6	6.34	6.19	6.27	0.47	0.46	0.46	0.45	0.40	0.43
T_7	6.31	6.17	6.24	0.48	0.49	0.48	0.47	0.41	0.44
T_8	6.33	6.14	6.23	0.46	0.46	0.46	0.44	0.40	0.42
T_9	6.25	6.19	6.22	0.47	0.48	0.48	0.46	0.43	0.45
T_{10}	6.31	6.21	6.26	0.44	0.44	0.44	0.45	0.42	0.44
T_{11}	6.19	6.18	6.19	0.43	0.46	0.45	0.43	0.41	0.42
T_{12}	6.10	6.20	6.15	0.46	0.47	0.46	0.44	0.41	0.43
SE.m ±	0.09	0.05	0.05	0.02	0.01	0.01	0.02	0.01	0.01
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

FYM released the inorganic nitrogen from organic forms in to soil. N in organic form is less prone to leaching and volatilization losses, hence the available nitrogen content increased in the soil. The lower available N, P_2O_5 and K_2O recorded in recommended N, P_2O_5 and K_2O @ 40 kg ha^{-1} (T_6) might be due to higher NPK uptake as influenced by the application of potassium with FYM in both the years. Application of potassium along with NP fertilizers and FYM resulted in better nutrient availability and higher nutrient uptake by the crop. Similar results were also reported by Pragyan *et al.*, (2017). The soil available phosphorus was higher in T_{12} which received N (50 kg), P_2O_5 (45 kg) and K_2O (50 kg ha^{-1}) along with FYM @ 6 tonnes ha-1 might be due to the release of organic acids during microbial decomposition of FYM which helped in solubilizing the native phosphates, thus increasing the available phosphorus status. The applied organic matter led to the formation of coating on the sesquioxide clay minerals, because of which the phosphate fixing capacity of soil was reduced in FYM treated plots (Pallavi *et al.,* 2016).

Available K was depleted with either no K (T_1 & T_2) or reduced dose of K fertilizer. Continuous omission of K in crop nutrition caused mining of its native pools which resulted in decreased crop yields. The available K decreased with advancement in crop growth and the lowest being recorded at harvest due to crop removal in T_6 & T_{11}. Among treatments, the combined application of FYM @ 6 t ha^{-1} with 50 kg N, 45 kg P_2O_5 and 50 kg K_2O (T_{12}) recorded higher soil available potassium. Such enhanced soil available K status might be due to the application of FYM that generally contains higher amounts of K (0.5% K_2O) and the reduction of K fixation, release of K from inter lattice space of clay minerals due to interaction of organic matter with clay (Robiul *et al.*, 2009). Organic acids of different strength and composition produced during decomposition of applied organic manures could possibly solubilize the fixed potassium from clay matrix resulting in an increased availability of K for crop and direct effect of applied potassium fertilizers during crop growth. Similar results were also recorded by Gajanand *et al.* (2014).

Table-4 : Effect of different levels of potassium on available nitrogen, phosphorus and potassium in post-harvest soil of foxtail millet.

Treatments	Available N			Available P_2O_5 (kg ha^{-1})			Available K_2O		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	125.44	127.62	126.53	16.21	18.00	17.11	132.78	132.72	132.75
T_2	130.81	133.54	132.18	19.70	21.47	20.58	144.67	145.08	144.87
T_3	132.71	137.14	134.93	21.96	27.35	24.65	145.33	148.48	146.91
T_4	134.00	140.64	137.32	24.98	30.84	27.91	147.86	153.29	150.58
T_5	138.51	143.19	140.85	26.90	32.61	29.76	157.20	158.62	157.91
T_6	140.37	148.40	144.39	30.70	35.36	33.03	161.02	163.17	162.09
T_7	142.69	151.87	147.28	34.86	40.55	37.70	163.13	165.20	164.17
T_8	131.84	135.43	133.63	25.24	31.85	28.55	142.93	144.46	143.70
T_9	135.38	138.29	136.84	28.34	32.89	30.62	148.73	149.99	149.36
T_{10}	140.73	142.77	141.75	32.24	34.81	33.52	152.80	154.73	153.76
T_{11}	144.34	147.64	145.99	34.96	36.62	35.79	158.58	162.51	160.54
T_{12}	150.66	155.57	153.11	36.57	41.28	38.93	166.05	167.08	166.56
SE.m ±	1.85	2.48	1.79	1.57	1.13	1.09	1.86	1.63	1.23
CD @ 5%	5.44	7.28	5.24	4.59	3.32	3.20	5.46	4.79	3.60

Table-5 : Effect of different levels of potassium on exchangeable calcium, magnesium and available sulphur in post-harvest soils of foxtail millet.

Treatments	Exchangeable Calcium			Exchangeable Magnesium (mg kg^{-1})			Available Sulphur		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	7.34	7.15	7.25	5.19	5.02	5.11	21.64	22.78	22.21
T_2	7.71	7.25	7.48	5.23	5.44	5.34	25.33	27.33	26.33
T_3	7.09	6.99	7.04	4.96	5.08	5.02	28.33	31.69	30.01
T_4	7.00	6.85	6.93	4.72	5.03	4.88	30.75	32.16	31.45
T_5	6.87	6.78	6.83	4.57	4.88	4.73	31.27	34.16	32.72
T_6	6.72	6.66	6.69	4.39	4.61	4.50	33.47	34.94	34.20
T_7	6.43	6.38	6.41	4.23	4.44	4.34	36.36	36.75	36.55
T_8	7.24	7.15	7.20	5.10	5.00	5.05	30.55	31.89	31.22
T_9	7.12	7.05	7.08	5.00	5.02	5.01	31.80	33.22	32.51
T_{10}	7.04	6.86	6.95	4.85	4.70	4.78	34.08	34.91	34.50
T_{11}	6.88	6.96	6.92	4.66	4.54	4.60	35.30	35.22	35.26
T_{12}	6.72	6.80	6.76	4.28	4.36	4.32	39.13	38.00	38.56
SE.m ±	0.81	0.48	0.56	0.45	0.46	0.41	1.75	1.51	0.97
CD @ 5%	NS	NS	NS	NS	NS	NS	5.14	4.43	2.85

Effect of different levels of potassium on exchangeable calcium, magnesium and available sulphur in post-harvest soils of foxtail millet : Exchangeable calcium and magnesium content in soil after harvest of foxtail millet was relatively higher in the plots that were not treated with K fertilizers, but treated with only N and P_2O_5. The higher exchangeable calcium (7.48 and 7.25 meq 100 g^{-1} of soil) and magnesium (5.34 and 5.11 meq 100 g^{-1} of soil) were recorded in T_2 (POP as per UAS (B) package without K application) and T1 (absolute control), respectively (Table-5), followed by low potassium applied treatments viz., T_8, T_3, T_9 and T_4. As the potassium doses increased, the calcium and magnesium status was decreased, it may be due to higher potassium levels in soil which was antagonistic to Ca and Mg. Similar results were quoted by Manjunatha (2011).

The available sulphur in soil after harvest of foxtail millet in both the cropping sequence was significantly higher on application of N (50 kg) + P_2O_5 (45 kg) + K_2O @ 50 kg ha^{-1} + FYM @ 6 t ha^{-1} (T_6) (40.06 mg kg^{-1}), which was on par with T_7 (recommended N, P_2O_5 + K_2O @ 50 kg ha^{-1} + FYM @ 6 t ha^{-1}) (36.55 mg kg^{-1}) followed by T_{11} (35.26 mg kg^{-1}) and T_6 (34.20 mg kg^{-1}) and these are superior over T_2 (POP as per UAS (B) package), (26.33 mg kg^{-1}). Lower available sulphur in post-harvest soil was recorded in absolute control (T_1 : 22.21 mg kg^{-1}). After harvest of foxtail millet crop, the increased available sulphur content was recorded in the soil. It may be due to addition of FYM which directly added the sulphur to the available pool in the soil and addition of sulphur through single super phosphate to the crop, which may be increased its content in soil, since, it is inorganic nutrient source. In addition, increased sulphur content in soil with increased dose of potassium might be due to the synergistic relationship of potassium with sulphur

Table-6 : Effect of different levels of potassium on Fe, Mn, Zn and Cu in post-harvest soils of foxtail millet.

Treatments	DTPA Fe			DTPA Mn			DTPA Zn			DTPA Cu		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	2.01	2.23	2.12	6.57	6.40	6.49	0.68	0.77	0.73	1.03	0.39	0.71
T_2	2.08	2.28	2.18	6.75	6.54	6.64	0.78	0.82	0.80	1.06	0.42	0.74
T_3	2.19	2.74	2.46	9.24	8.62	8.93	0.82	0.80	0.81	1.34	0.44	0.89
T_4	2.58	2.71	2.64	9.40	8.96	9.18	0.74	0.79	0.77	1.37	0.45	0.91
T_5	2.54	2.79	2.66	9.47	8.98	9.23	0.72	0.82	0.77	1.27	0.45	0.86
T_6	2.77	2.91	2.84	10.02	9.19	9.60	0.70	0.78	0.74	1.27	0.51	0.89
T_7	3.21	2.88	3.05	9.96	10.08	10.02	0.82	0.86	0.84	1.63	0.58	1.10
T_8	2.38	2.78	2.58	8.78	8.98	8.88	0.72	0.76	0.74	1.20	0.59	0.90
T_9	2.87	2.96	2.91	9.35	8.41	8.88	0.78	0.81	0.79	1.30	0.62	0.96
T_{10}	3.00	2.86	2.93	9.33	8.89	9.11	0.85	0.82	0.83	1.43	0.57	1.00
T_{11}	3.10	2.86	2.98	10.04	9.39	9.72	0.80	0.75	0.78	1.48	0.61	1.04
T_{12}	3.35	2.95	3.15	10.53	10.33	10.43	0.78	0.84	0.81	1.72	0.66	1.19
SE.m ±	0.13	0.02	0.06	0.18	0.17	0.13	0.05	0.03	0.03	0.02	0.02	0.02
CD @ 5%	0.37	0.06	0.18	0.53	0.50	0.38	NS	NS	NS	0.06	0.05	0.05

(Bhagyalakshmi *et al.,* 2010). The available sulphur in soil differed significantly due to application of graded levels of potassium along with FYM which might be due to oxidation of elemental S and mineralization of S from FYM (organic source), residues and from the native soil.

Effect of different levels of potassium on DTPA extractable micronutrients (Fe, Mn, Zn and Cu) in post-harvest soil of foxtail millet : Available Zn concentration was non-significant amongst the different treatments. The Zn in initial soil was low than the critical limits and no fertilization of Zn to the tested crop. The value varied from 0.73 to 0.84 mg kg^{-1} (Table-6). However, increases in available Zn was observed only under plots receiving FYM and NPK + FYM over unfertilized control and initial soil, which may be due to that, FYM not only supplies large amounts of Zn to the soil, but also promotes biological and chemical reactions that result in the dissolution of non-available Zn. The application of potassium levels with NP was non-significant may be possibly due to Zn precipitation by high levels of P_2O_5 application. These results are in confirmation with the findings of Sidhu and Sharma, (2010).

DTPA extractable Fe, Mn and Cu status in soil after harvest of foxtail millet crop found to be significant with different levels of potassium application. However, highest DTPA extractable Fe (3.15 mg kg^{-1}), Mn (10.43 mg kg^{-1}) and Cu (1.19 mg kg^{-1}) recorded in T_{12} : 50 kg N + 45 kg P_2O_5 + 50 kg K_2O ha^{-1} + FYM @ 6 t ha^{-1} which was on par with T_7 (Rec. N P_2O_5 + 50 kg K_2O ha^{-1} + FYM @ 6 t ha^{-1}) with the values of 3.05, 10.02 and 1.10 mg kg^{-1} of Fe, Mnand Cu, respectively (Table-6)

The potassium applied treatments (T_3 to T_{12}) recorded higher DTPA extractable Fe, Mn and Cu as compared to no potassium applied treatments T_2 (POP as per UAS (B)) and T_1 (absolute control). T_2 and T_1 recorded the least 2.18, 6.64 and 0.74 mg kg^{-1} and 2.12, 6.49 and 0.71 mg kg^{-1} of Fe, Mn and Cu, respectively. Available Fe concentrations were higher in the NPK + FYM applied treatments than the others, due to chelation of FYM. The data indicated that the increased Mn might have been related to changes in the soil microenvironment that resulted in the release of plant available Mn. Due to addition of FYM, soil pH was lower and organic matter levels were higher compared to the control. The lower pH may have resulted in the release of non-available Mn from soil minerals. In addition, the decomposition of organic matter provided protons to the soil solution and also decreased soil Eh values. These changes resulted in the dissolution and reduction of Mn, thus increasing its availability. Application of higher levels of potassium with N and P_2O_5 in addition to FYM incorporation had synergistic significant effect on available copper in the soil. Ramachandrappa *et al.* (2014) observed that higher copper in soils where increased dose of potassium was applied with nitrogen to finger millet.

Conclusion

Non-significant effect of different potassium levels was recorded on pH, EC and organic carbon content in post-harvest soils. There was significant increase in available N, P_2O_5, K_2O, and S status with application of increased levels of potassium along with nitrogen, phosphorus and FYM after harvest of foxtail millet. Calcium and magnesium status in harvest soils was found to be non-significant due to potassium levels. Application of graded levels of potassium noticed a significant difference in DTPA extractable Fe, Mn, Cu and non-significant difference was recorded in Zn status of post-harvest soil of foxtail millet. it can be concluded that

application of different levels of potassium increased the grain and straw yield of foxtail millet and also increased the nutrient status of soil which leads to increased soil fertility in dry land situation.

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Climate Change and Food Security : A Next Generation Issue

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Abstract

Agriculture represents a core part of Indian economy and provides foods and livelihood to more than 70 per cent population of nation. Indian agriculture is extremely vulnerable to weather and climate conditions. Climate change impacting basic human needs and directly affects livelihoods of people (both urban and rural). In more recent times, climate change phenomenon is regarded as a major threat to food securityin various developing countries. The focus mainly is on natural resources, especially land and water due to the increasing population. Rising temperatures and changes in rainfall patterns have direct effects on agricultural productivity and water availability for irrigation. These changes conditions have implication for food and nutrition security, health status, water, sanitation and biodiversity which is needed for enhance the production and incomes. Increased temperature and related heat and drought are known to negatively affect animals and plant health and production. Due to these situations the cost of food production will increase and translate into higher food prices which in turn is likely to impact on food security. To develop climate-resilient strategies and make adequate policy interventions, there is also a need for integrated assessment of the impact of climate change on India's food security and food accessibility.

Key words : *Agriculture, climate change, food security and impact.*

Introduction

Agriculture is the important sector for food security which provide livelihood to most of the India'sworkforce. Indian agriculture is extremely vulnerable to weather and climate conditions, thereby India's food production is highly vulnerable to climate change largely because the sector continues to be highly sensitive to monsoon variability. About 65 percent of India's cropped area is rain-fed. Climate change impacting basic human needs and directly affects livelihoods of people. In more recent times, climate change phenomenon is regarded as a major threat to food security of the nation. The focus mainly is on natural resources, especially land and water due to increase in population. Climate is the primary determinant of agricultural productivity and in this respect, climate and food availability is fundamentally interlinked. Climate change has become one of the leading risks to food security, with droughts and floods expected to result in production and price volatility. Climate change will affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability. It will have an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. There have been many emerging issues in the context of food security in India. Climate change has both direct and indirect impacts on agricultural production systems. Direct impacts include effects caused by a modification of physical characteristics such as temperature levels and rainfall distribution on specific agricultural production systems. Indirect effects are those that affect production through changes on other species such as pollinators, pests, disease vectors and invasive species. To develop climate-resilient strategies and make adequate policy interventions, there is also a need for integrated assessment of the impact of climate change on India's food security and food accessibility.

Climate Change : Climate refers is the characteristic conditions of the earth's lower surface atmosphere at a specific location; weather refers to the day-to-day fluctuations in these conditions at the same location. The Intergovernmental Panel on Climate Change (IPCC), and the United Nations Framework Convention on Climate Change (UNFCC) refer to Climate Change as any change in climate over time whether due to natural variability or because of human activity, which alters the composition of the global atmosphere. Thus, climate change can be defined as the slow change in the composition of the global atmosphere, which is caused directly and indirectly by various human activities in addition to natural climate variability over time. Climate is the long-term average of individual weather situations, taken over sufficiently long periods of time. Whereas weather impacts our daily lives, climate influences our decisions about where to live, where, what and how to grow food, which consequently have direct influences on how communities and economies develop and thrive.The phenomenon of climate change is global, but its impacts are varied and

mainly detrimental to the largely tropical arid and semi-arid areas.

Climate change and agriculture : All production systems and household livelihood strategies must adapt to the diverse impacts of climate change. Agriculture is important for food security in two ways: it produces the food to the people and also provides the primary source of livelihood for 36 percent of the world's total workforce. In the heavily populated countries, this share ranges from 40 to 50 percent, and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture (ILO, 2007). Nearly 70 per cent of people in developing countries, live in rural areas, where agriculture is the largest supporter of livelihoods. Agriculture, forestry and fisheries are all sensitive to climate. Their production processes are therefore likely to be affected by climate change. Climatic variables like temperature, radiation, precipitation, humidity, have direct impact on the productivity of agriculture, forestry, and fishery systems. According to the Food and Agriculture Organization (2016), both biophysical and social vulnerabilities determine the net impact of climate change on food security.

Climatic and atmospheric conditions determine vegetative growth and animal production and their development implying agricultural production needs optimum climatic conditions to achieve its potential output. Forests are useful ecosystems that are essential for water catchment and carbon sinks, in addition to providing food, pasture for animal use, among others. Forest loss and degradation through agriculture contribute to climate change. Agriculture is not only a victim of the situation but also a cause of climate change. It releases and absorbs greenhouse gases but the balance shows how agriculture is contributing to mitigate or increase climate change.

Climate change may affect the agriculture sector in the following ways :

Reduction in crop yields and agriculture productivity

Higher cost on food distribution system

Reduction in soil fertility and soil health

Outmigration and low availability of labour for agriculture

Low livestock productivity and high production cost

Thus, these changes in agricultural production will impact on food security.

Climate change and food security : Food security is one of the important concerns interlinked with climate change but the relationship between climate change and food security is complex, most studies focus on food security as a food availability. Climate change affects food security in complex ways. It impacts crops, livestock, forestry, fisheries and aquaculture, and can cause grave social and economic consequences in the form of reduced incomes, eroded livelihoods, trade disruption and adverse health impacts. Food security is a multi-dimensional concept and a developmental issue. Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996).FAO stressed that "food security depends more on socio-economic conditions than on agroclimatic ones, and on access to food rather than the production or physical availability of food". The pillars of food security are: availability, access, utilization and stability.

(i) Food production and availability : Climate change presents an additional stress on India's long-term food security challenges as it affects food production in many ways. For one, it may cause significant increases in inter-annual and intra-seasonal variability of monsoon rainfall. Climate affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes and thus demand for agricultural produce. The impact of climate change on water availability will be particularly severe for India because large parts of the country already suffer from water scarcity, to begin with, and largely depend on groundwater for irrigation. About 54 percent of India faces high to extremely high-water stress.

(ii) Access to food : Economic and physical access to food means being in employment with stable livelihoods and having the financial resources to access food. Possible food price increases and declining rates of income growth resulting from climate change may reverse this trend. Market factors and the prices of food as well as one's purchasing power is important to enable one access food. There are relatively few models which assess the impact of climate change on access to food. According to the Fourth Assessment Report of the IPCC, depending on the climate change scenario, 200 to 600 million more people globally could suffer from hunger by 2080 (Yohe et al., 2007). It is more difficult to find similar, modelling based studies on the impact of climate change on food access and nutrition specifically focusing on India.

(iii) Food utilization : The global threat is that climate change could lead to a reduction of production and consumption of certain foods that play a critical role in the diets of poor rural and indigenous populations such as fish, fruits 43 and vegetables, and wild food. Food consumption and utilization in the body depends on one's physiological needs, health status, and availability of access to clean water, sanitation, hygienic conditions and

health care. Consuming enough protein and energy (food quantity), and micro-nutrients for a balanced and nutritious diet (food quality, diet diversification) to attain better nutritional status. Climate change might affect utilization through incomes and consumption behaviour

(iv) Stability of food supplies : Fluctuation in crop yields and local food supplies will adversely affect the stability of food supplies. Climatic fluctuations will be most pronounced in semi-arid and sub-humid regions and are likely to reduce crop yields and livestock numbers and productivity. Extreme events, including excessive high temperature at crucial periods in agricultural growth, droughts and floods, are a threat to stability of food access and utilization.

The main problem of Indian agriculture is low productivity. To meet India's growing food demand, there is an acute need for increasing productivity in all segments of agriculture. But given the vulnerability of Indian agriculture to climate change, farm practices need to be reoriented to provide better climate resilience. Actions by different stakeholders are needed in the short term to enable responses in the short, medium and long term. Some medium- and long-term responses will need immediate enabling action and planning, and immediate investment, for instance, forestry, livestock breeding, seed multiplication, research and development, innovation and knowledge transfer to enable adaptation. Greatly expanded efforts to respond to climate change are needed immediately to safeguard the capacity of food systems to ensure global good security. A paradigm shift towards agriculture and food systems that are more resilient, more productive, and more sustainable is required.

Ensuring food security and nutrition during climate change : Ensuring food security and good nutrition in a changing climate will require to build resilience at all levels, from households and agricultural systems to broader levels, mobilizing a wide range of instruments. In a recently released report, FAO, IFAD and the World Food Programme (WFP) showed that it would be possible to end extreme poverty and hunger by 2030, by combining public investment in social protection with public and private efforts to raise investment levels in productive sectors. These actions will need to be supplemented by disaster risk reduction and disaster risk management strategies to address the risks of extreme events, prioritizing the reduction and proactive management of risks rather than reacting to events.

Adaptation and Mitigation through Policies and Institutions

The intergovernmental panel on climate change : Recognizing climate change as a potential global problem, WMO and UNEP established IPCC in 1988; the first IPCC Assessment Report was completed in 1990. Since then, IPCC has issued three more reports, each deepening the scientific understanding of climate change processes and their implications for the earth system. The fourth IPCC Assessment Report, released in September 2007, generated much public interest and raised climate change issues to the top of the international political agenda.

The united nations framework convention on climate change : UNFCCC was negotiated and adopted in New York in time for signature at UNCED in Rio de Janeiro in June 1992. UNFCCC entered into force in 1994, and provides the overall policy framework for addressing climate change issues. All the governments that have ratified it belong to the Conference of the Parties (COP), which meets annually to review global climate policy and oversee implementation of agreed mitigation and adaptation measures. In 1997 the Kyoto Protocol to UNFCCC was adopted. This is an international and legally binding agreement to reduce greenhouse gases emissions worldwide, which entered into force in 2005 on ratification by the required number of parties to UNFCCC.

Agenda 21 and sustainable agriculture and rural development : The concept of sustainable development was introduced in the 1987 report of the World Commission on Environment and Development (the Brundtland Report) as a means of shifting attention away from narrow sectoral interests towards an approach that embraces environmental, social and economic goals. This report provided the scientific underpinnings for UNCED. Popularly known as the Earth Summit. At the Earth Summit, world leaders adopted two formal treaties with binding provisions–UNFCCC and the United Nations Convention on Biological Diversity (CBD)–and three non-binding statements on the relationship between sustainable environmental practices and the pursuit of social and socio-economic development: the Rio Declaration, the Statement on Forest Principles, and Agenda 21 (CIESIN, 1996).

These plans and programmes include the National Watershed Development Project for Rain fed Areas (NWDPRA), Soil Conservation for Enhancing Productivity of Degraded Lands in the Catchments of River Valley Project and Flood Prone River (RPV&FPR), Reclamation of Alkali Soil (RAS), Watershed Development Project in Shifting Cultivation Areas (WDPSCA), Desert Development Programme (DDP), Integrated Waste–Land Development Programme (IWDP), National Afforestation and Eco-Development Project (NAEP), National Project on Development & Use of Bio-fertilizers(NPD&UB),

National Project on Organic Farming (NPOF), the National Employment Guarantee Scheme (NREGS), National Food Security Mission (NFSM) and Rastriya Krishi Vikas Yojana (RKVY). These specific measures are basically adaptation measure with a focus on specific areas such as agriculture, water resources, health and sanitation, forests, coastal-zone infrastructure and extreme weather events.

Appropriate policies and institutions at national and international levels are needed to enable, support and complement adaptation small-scale food producers. Dedicated policies and institutions are needed for the prevention and management of specific risks and vulnerabilities collective management of natural resources, including land and water requires specific institutions, often at local level.Gender specific support services are needed, recognizing the differentiated roles of household members in production, consumption and the reproduction of the family. National and regional markets are important to support adaptation actions. Policies will be needed to reduce financial risks, lower transaction costs, facilitate monetary transactions, and facilitate long-term investments. The vulnerability to climate change of the agriculture sectors and of food security calls for better recognizing their importance and specificities in national climaterelated instruments like adaptations plans, and for integrating climate change concerns in food security and agricultural policies. Strengthened regional and international cooperation to facilitate exchanges of knowledge on production systems and on adaptation options and undertake vulnerability assessments.

Conclusions

Achieving food security in the context of climate change calls for an improvement in the livelihoods of the poor and food-insecure to not only help them escape poverty and hunger but also withstand, recover from, and adapt to the climate risks they are exposed to. Climate change has far reaching effects for agriculture and other economic activities which ensure the availability and accessibility of food. The more climate sensitive economic activities are also direct sources of livelihood especially for the poor. Developing a food security strategy that enhances availability through various climate smart agricultural responses and enhanced and diversified livelihood sources are necessary paths for development. Actions by different stakeholders are needed in the short term to enable responses in the short, medium and long term. Greatly expanded efforts to respond to climate change are needed immediately to safeguard the capacity of food systems to ensure global good security. A paradigm shift towards agriculture and food systems that are more resilient, more productive and more sustainable is required. Hence, it is in the best interest of all farmers to adopt farming systems that help them adapt to the changing conditions and contribute to mitigation of climate change.

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Bioremediation of Heavy Metals Contaminated Substrates through Cultivated Mushroom (*Pleurotusflorida*) and Assessment of Tolerable Limits of Heavy Metals in Terms of Growth Potential

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Abstract

The technology of bioremediation becomes a new area of research with features of low cost, high efficiency, no secondary pollution and wider applicability.Oyster mushroom (*Pleurotusflorida*) may be used as a tool in bioremediation of heavymetals. In this study, the heavy metal uptake potential of the mushroom, *Pleurotusflorida*, was studied in artificially contaminated substrate(in-vivo) and compost(in-vitro) with ten heavy metals viz: copper, zinc, lead, arsenic, cadmium, chromium, aluminum, magnesium, manganese and cobalt in the form of sulphate at concentration of 10, 25, 50 and 100 ppm. It was found that $CrSO_4$, $Al_2(SO_4)_3$, $MgSO_4$ and $MnSO_4$ didn't have any adverse effect on mycelial growth in all 4 concentrations whereas, heavy concentrations (25 ppm and above) of salts $CuSO_4$, $AsSO_4$, CdSO4 and $CoSO_4$ found toxic for mycelial growth of *Pleurotusflorida.* Average yield of mushroom fruit bodies for a heavy metal in all four concentrations viz. 10, 25, 50 & 100 ppm followed this sequence from higher to lower i.e. Mg>Zn>Cu>Mn>Co>Cr>As>Cd>Pb>Al and 523.24, 468.24, 467.82, 454.47, 419.25, 328.72, 288.07, 285.49, 268.34 and 256.05gm respectively. Yields were found good but in decreasing order with increase in concentration of heavy metal in inoculated substrate. Heavy metal accumulation in mycelium varied significantly with the type of metal and total concentration of metals in the inoculated substrate. The most abundant metal found in mycelium of *Pleurotusflorida*was Magnesium followed by Manganese, Zinc & Cadmium respectively..These results suggested that *Pleurotusflorida* may be effective in promoting the bioremediation of heavy metal-contaminated substrates.

Key words*: Bioaccumulation, Pleurotusflorida, fruiting body, hazardous heavy metals.*

Introduction

One of the major problems facing today by the industrialized world is the contamination of soil, ground water, sediments, surface water and air with hazardous and toxic chemicals. The most common soil contaminants constitute heavy metals, pesticides and hydrocarbons. Among these, heavy metals owe a major share due to their cytotoxicity, mutagenicity, and carcinogenic nature (Damodaran *et al.,* 2014). The ever-increasing contamination of aquatic bodies and soil by heavy metals is an issue of serious concern and challenge world-wide (Pandey, 2010). In contrast to organic pollutants, metals are not mineralized by microorganisms but can be oxidized or reduced, transformed to different redox stages, or complexed by organic metabolites (Kumar and Sharma 2006).

Some metals are subject to bioaccumulation and may pose a risk to human health when transferred to the food chain (Malik 2014). Many technologies are currently used to clean up heavy metal contaminated soils. The most commonly used ones are soil removal and land filling, stabilization/solidification, physio-chemical extraction, soil washing, flushing and phytoremediation. None of these techniques are completely accepted as best treatment option (Yamamoto *et al.*, 1993) because either they offer a temporary solution, or simply immobilized the contaminant or costly when applied to large areas.

Because removing heavy metals by waste microbial biomass may be economically feasible, a large number of materials was investigated recently for use in developing low-cost biosorbents from industrial and agricultural wastes. In addition to this, cultivated and wild mushrooms have the ability to tolerate excessively high concentration of heavy metals as compare to vascular plants (Das, 2005).

Till date we know that mushrooms are popular valuable foods because they are low in calories, carbohydrates, fat, and sodium: also, they are cholesterol-free. Besides, mushrooms provide important nutrients, including selenium, potassium, riboflavin, niacin, vitamin D, proteins, and fiber. But nowdaysOyster mushrooms, also have been applied to break down the various organiccontaminants and have important biotechnology and environmental applications. The lack of such information on above cultivated mushroom made an impetus to undertake the present investigation. It is

anticipated that bioremediation will make great progress in near future (Weng *et al*., 2009).

Purpose of this study was to investigate the bioremediation potential of *Pleurotusflorida* in contaminated substrate with heavy metals and effect of these heavy metals on the development of fruitingbodies with a view to the possible use ofthis mushroom for bioremediation of metalcontaminated substrates.

Materials and Methods

Location : The study was conducted at Mushroom Research Laboratory (AICMIP), Department of Plant Pathology, Rajasthan College of Agriculture, MPUAT, Udaipur. Accumulated concentration of heavy metals by mushroom mycelium and fruit bodies were recorded with the help of Atomic Absorption Spectrophotometer (AAS)-Department of Soil Science Lab-RCA, MPUAT, Udaipur.

Preparation of spawn and culture : The pure culture of *Pleurotusflorida* were obtained from All India Coordinated Mushroom Improvement Project, Department of Plant Pathology, RCA, MPUAT, Udaipur and maintained on 2% Malt Extract Agar (ME) medium and kept at 20 ± 1^0 C temperature during the experimentation. Master **s**pawn of *Pleurotusflorida* was prepared in 500 ml. reagent bottles. Ten kilograms healthy wheat grains were dipped overnight and then boiled in 8.5 litre of water up to semi-cooked conditions for 20-25 minutes. After boiling the excess water was drained off. Then grains were allowed to surface dry by spreading on blotting paper sheets for 2-3 hrs. These seeds were mixed with gypsum (calcium sulphate Ca SO_4) 2 per cent and lime (calcium carbonate $CaCO_3$) 4 percent on grain weight basis to adjust the pHof the grains at 7.0-8.0 and to check the coagulation and clumping of the grains. About 250gm grains were filled in each glass bottles, plugged tightly and sterilized at 15 lb psi (1.045 kg cm^2) pressure (126.5^0 C) for two hours. After cooling to room temperature each bottle was kept in laminar air flow cabinet and given UV light exposure for 15-20 min. Then the bottles were inoculated with mycelial bits of *Pleurotusflorida* culture and incubated at 24 ± 1^0 C in incubator for 20-25 days till adequate growth was obtained. The fully grown bottles were kept at 25^0 C.

Effect of various concentration of heavy metals on the mycelial growth of *Pleurotusflorida* : To assess the effect of various concentrations of heavy metals at 10, 25, 50 and 100 ppm on the mycelial growth, 2% ME (Malt Extract) liquid media was prepared. Different quantities of above liquid media and stock solution (100 ppm) of heavy metals (prepared separately by adding 0.50 g heavy metal in 500 ml water) were poured into 100 ml flasks to fill it up to 30 ml level. The same procedure was adopted for all 10 heavy metals copper sulphate ($CuSO_4$), zinc sulphate ($ZnSO_4$), lead sulphate ($PbSO_4$), arsenic sulphate $(AsSO)_4$, cadmium sulphate ($CdSO_4$), chromium sulphate ($CrSO_4$), aluminum sulphate $[Al_2(SO_4)_3]$,magnesium sulphate ($MgSO_4$), manganese sulphate ($MnSO_4$) and cobalt sulphate ($CoSO_4$) with 4 replicates. For control, only 30 ml liquid medium was taken without heavy metals. These flasks were sterilized at 138 kPa pressure at 126.5°C for 20 min. inoculated with mycelial bits of *P. florida* and incubated at 28±1°C in incubator for 30 days to observe the mycelial growth. Finally, they were observed after one month to see the effect of various concentrations of heavy metals on the mycelial growth. For that purpose, filtration of mycelia from liquid media was needed. For filtration, pre-weighted Whatman filter paper no. 42 was used. Observations were recorded by weighing filter papers before filtration and after filtration to get net weight of mycelia.

Effect of various concentration of heavy metals on the fruiting bodies of *Pleurotusflorida* :To assess the effect of various concentrations of heavy metals on the fruit body of Pleurotusflorida, it was cultivated as per commercial cultivation technology (Garcha and Kiran, 1981). All 10 heavy metal salts were added with irrigation water in above mentioned concentrations. Solution (100 ml) with known salt and its concentration was sprayed on each bag and tagged accordingly to take further observations of effect of heavy metals concentrations on fruiting body growth. It was evaluated with the parameters like weight of mycelial growth, total mushroom yield, total number of mushroom fruiting bodies, average weight of fruit bodies, average size of fruit bodies and biological efficiency. In different treatments, number of days taken for spawn run varied in a range of 22-26 days, 1st harvest in a range of 37-45 days and last harvest in a range of 71-91 days.

The observations were taken for following parameters :

Total mushroom yield (g/2 Kg compost).

Total number of mushroom fruit bodies in 2 Kg compost.

Average weight of fruit bodies.

Average size of fruit bodies.

Biological Efficiency (%)

Biological efficiency : Biological efficiency was calculated by the following formula.

$$\text{Biological efficiency (\%)} = \frac{\text{Fresh weight of mushrooms}}{\text{Dry weight of substrate}} \quad 100$$

For 2 kg compost, dry weight of substrate is 500 gm.

Table-1 : Effect of various concentrations of heavy metals on the mycelial growth of *Pleurotusflorida*

S. No.	Treatments (ppm)	Mycelial growth (mg)			
		10	25	50	100
1.	$CuSO_4$	0.36	0.16	0.15	0.05
2.	$ZnSO_4$	0.36	0.31	0.09	0.05
3.	$PbSO_4$	0.39	0.23	0.10	0.08
4.	$AsSO_4$	0.31	0.10	0.09	0.07
5.	$CdSO_4$	0.32	0.08	0.07	0.05
6.	$CrSO_4$	0.38	0.32	0.30	0.27
7.	$Al_2(SO_4)_3$	0.39	0.29	0.23	0.18
8.	$MgSO_4$	0.43	0.37	0.34	0.33
9.	$MnSO_4$	0.39	0.38	0.29	0.21
10.	$CoSO_4$	0.23	0.10	0.08	0.06
11.	Control	0.44			
	SEm ±	0.005			
	CD (P<0.05)	0.015			

Average of four replications.

Method to find out the accumulated concentration of heavy metals in mushroom mycelium (*in vivo*) and fruit bodies (in vitro) : Accumulated concentration of heavy metals by mushroom mycelium and fruit bodies were recorded with the help of Atomic Absorption Spectrophotometer (Paraskevi *et al*., 2007).

Sample preparation : One gm of dried mushroom mycelium and 10 gm of dried fruiting body was weighed and placed in a porcelain crucible. Then this porcelain crucible was placed in a cool muffle furnace and ashed at 500 °C for 2 hrs. Then it was cooled, and the ash was dissolved in 5-mL and 50-mL of 20% HCl for mycelium and fruiting body respectively. The solution was filtered through an acid washed filter paper into a 50-mL and 100-mL volumetric flask, respectively. The solution was diluted to 50 ml and 100-mL respectively with deionized water and mixed well.

Statistical analysis : The data recorded were subjected to statistical analysis and the differences exhibited by the treatments in various experiments were tested for their significance as per the methods suggested by Gomez and Gomez (1984).

Results and Discussion

Effect of heavy metals on the mycelial growth of *Pleurotusflorida* : Mycelialgrowth of *Pleurotusflorida* varied significantly with the type of metal and total concentration of metals in the inoculated substrate. In case of $CuSO_4$,at 10 ppm 0.36 mg of mycelial growth recorded followed by 0.16 mg at 25 ppm. Weight of mycelial growth recorded for 100 ppm was only 0.05 mg. It indicates that $CuSO_4$ at higher concentrations effected mycelial growth of *Pleurotusflorida.*

$ZnSO_4$ at 10 and 25 ppm gave good mycelial growth whereas, at 50 and 100 ppm growth was very less. In case of $PbSO_4$, at 10 ppm concentration mycelial growth was recorded 0.39 mg while, at 100 ppm 0.8 mg mycelial growth was observed. For $AsSO_4$ and $CdSO_4$ treatments, very good mycelial growth was observed at 10 ppm concentration whereas, there was not much significant difference in the mycelial growth at 25, 50 and 100 ppm.

For $CrSO_4$ completely different observations were recorded than above five salts. Mycelial growth was recorded high from 10 to 100 ppm concentrations for Chromium Sulphate in a range of 0.38 to 0.27 mg respectively. For $Al_2(SO_4)_3$, mycelial growth at 10 ppm recorded 0.39 mg, one among highest growth observed in all treatments. Further, $MgSO_4$ was the only such salt which showed least effect on mycelial growth of *Pleurotusflorida*in all concentrations.

$MnSO_4$ was also found in line with $MgSO_4$ as far as its effect on mycelial growth was concerned. In presence of $CoSO_4$, Mycelial growth reduced substantially at higher concentrations. Only 0.10, 0.08 and 0.06 mg growth were recorded respectively for 25, 50 and 100 ppm concentrations.

It could be concluded from above results (Table-1) that $CrSO_4$, $Al_2(SO_4)_3$, $MgSO_4$ and $MnSO_4$ didn't have any adverse effect on mycelial growth in all 4 concentrations whereas, heavy concentrations (25 and above) of salts $CuSO_4$, $AsSO_4$, $CdSO_4$ and $CoSO_4$ found toxic for mycelial growth of *Pleurotusflorida.*

Thus, mycelial growth of *Pleurotusflorida* can tolerate heavy metals toxicity up to certain extent. Moreover, the concentration of heavy metal salts in medium tolerated by mycelial growth of *Pleurotusflorida* depends upon type of heavy metal salts. These results are in agreement of Kapoor *et al.,* 1999; Tobin, 2001;

Table-2 : Effect of various concentrations of heavy metals on the fruit bodies production of *Pleurotusflorida*.

S. No.	Treatment (ppm)	Total Mushroom Yield (g.)/2kg wet substrate	Total No. of Mushroom fruit bodies (Nos.)	Average weight of fruit body (g.)	Average size of fruit bodies (length x breadth) (cm.)		Biological Efficiency %
					Pileus Size	Stipe Size	
1.	$CuSO_4$ - 10	574.56	152	3.78	4.5x3.5	2.0x1.5	114.91
2.	$CuSO_4$ - 25	499.84	142	3.52	4.5x3.5	2.0x1.0	99.97
3.	$CuSO_4$ - 50	429.18	138	3.11	4.5x3.0	2.0x1.0	85.84
4.	$CuSO_4$ - 100	367.71	119	3.09	4.0x3.5	1.5x1.0	73.54
5.	$ZnSO_4$ - 10	636.32	164	3.88	5.0x3.5	2.0x1.0	127.26
6.	$ZnSO_4$ - 25	530.91	153	3.47	4.5x3.5	2.0x1.0	106.18
7.	$ZnSO_4$ - 50	356.04	129	2.76	4.0x3.0	1.5x1.0	71.21
8.	$ZnSO_4$ - 100	349.68	124	2.82	4.0x3.0	1.5x1.0	69.94
9.	$PbSO_4$ - 10	366.98	118	3.11	4.0x3.5	1.5x1.0	73.40
10.	$PbSO_4$ - 25	295.92	108	2.74	4.0x3.0	1.5x1.0	59.18
11.	$PbSO_4$ - 50	235.62	99	2.38	3.5x3.0	1.5x1.0	47.12
12.	$PbSO_4$ - 100	174.84	94	1.86	3.5x2.5	1.0x0.5	34.97
13.	$AsSO_4$ - 10	391.62	122	3.21	4.0x3.5	1.5x1.0	78.32
14.	$AsSO_4$ - 25	336.74	113	2.98	4.0x3.5	1.0x0.5	67.35
15.	$AsSO_4$ - 50	218.28	102	2.14	3.5x3.0	1.0x0.5	43.66
16.	$AsSO_4$ - 100	205.64	97	2.12	3.5x3.0	1.0x0.5	41.13
17.	$CdSO_4$ - 10	381.25	125	3.05	4.0x3.5	1.5x0.8	76.25
18.	$CdSO_4$ - 25	302.10	114	2.65	4.0x3.0	1.5x0.8	60.42
19.	$CdSO_4$ - 50	260.40	105	2.48	4.0x3.0	1.0x0.5	52.08
20.	$CdSO_4$ - 100	198.22	106	1.87	3.5x2.5	1.0x0.5	39.64
21.	$CrSO_4$ - 10	443.76	129	3.44	4.5x3.5	1.5x1.0	88.75
22.	$CrSO_4$ - 25	308.20	115	2.68	4.0x3.0	1.5x0.8	61.64
23.	$CrSO_4$ - 50	298.32	113	2.64	4.0x3.0	1.5x0.8	59.66
24.	$CrSO_4$ - 100	264.60	108	2.45	4.0x3.0	1.0x0.5	52.92
25.	$Al2(SO_4)_3$ - 10	337.44	114	2.96	4.0x3.0	1.0x0.8	67.49
26.	$Al2(SO_4)_3$ - 25	307.09	107	2.87	4.0x3.0	1.0x0.5	61.42
27.	$Al2(SO_4)_3$ - 50	219.52	98	2.24	3.5x3.0	1.0x0.5	43.90
28.	$Al2(SO_4)_3$ - 100	160.14	102	1.57	3.0x2.5	0.8x0.5	32.03
29.	$MgSO_4$ - 10	693.94	157	4.42	5.0x4.0	2.0x1.0	138.79
30.	$MgSO_4$ - 25	510.51	143	3.57	4.5x3.5	2.0x1.0	102.10
31.	$MgSO_4$ - 50	476.77	139	3.43	4.5x3.5	1.8x0.8	95.35
32.	$MgSO_4$ - 100	411.75	135	3.05	4.0x3.5	1.5x0.8	82.35
33.	$MnSO_4$ - 10	518.30	146	3.55	4.5x3.5	2.0x1.5	103.66
34.	$MnSO_4$ - 25	489.06	143	3.42	4.0x3.5	2.0x1.5	97.81
35.	$MnSO_4$ - 50	423.95	139	3.05	4.0x3.5	1.5x1.0	84.79
36.	$MnSO_4$ - 100	386.56	128	3.02	4.0x3.5	1.5x1.0	77.31
37.	$CoSO_4$ - 10	495.00	132	3.75	4.5x3.5	2.0x1.5	99.00
38.	$CoSO_4$ - 25	445.77	127	3.51	4.5x3.5	2.0x1.0	89.15
39.	$CoSO_4$ - 50	383.18	119	3.22	4.5x3.0	2.0x1.0	76.64
40.	$CoSO_4$ - 100	353.05	115	3.07	4.0x3.5	1.5x1.0	70.61
41.	Control	675.12	174	3.88	5.0x3.5	2.0x1.0	135.02
SEm ±		9.666	2.935	0.073			
CD (P<0.05)		27.193	8.256	0.205			

Average of three replications.

Baldrian, 2003; Mathialagan *et al.,* 2003, Say *et al*., 2004; Ahmad *et al*., 2005; Joshi *et al.,* 2011.

Effect of heavy metals on fruit bodies yield of *Pleurotusflorida* : The results showed that, in case of $CuSO_4$ mushroom yield of *Pleurotusflorida*decreased with increase in concentration of heavy metals from 10 to 100 ppm. For $CuSO_4$ at 10 ppm, 574.6 gm of mushroom yield per 500 gm dry weight of wheat straw recorded followed by 499.8 gm at 25 ppm. Further, there was reduction in the mushroom yield at 50 and 100 ppm with yield recorded as 429.2 & 367.7 gm respectively. For $ZnSO_4$, at 10 ppm 636.32 gm fruit body yield was observed i.e. one of the highest yields among other treatments. Although less mushroom yield was recorded in case of $PbSO_4$, $AsSO_4$ and $CdSO_4$ in comparison to $CuSO_4$ and $ZnSO_4$

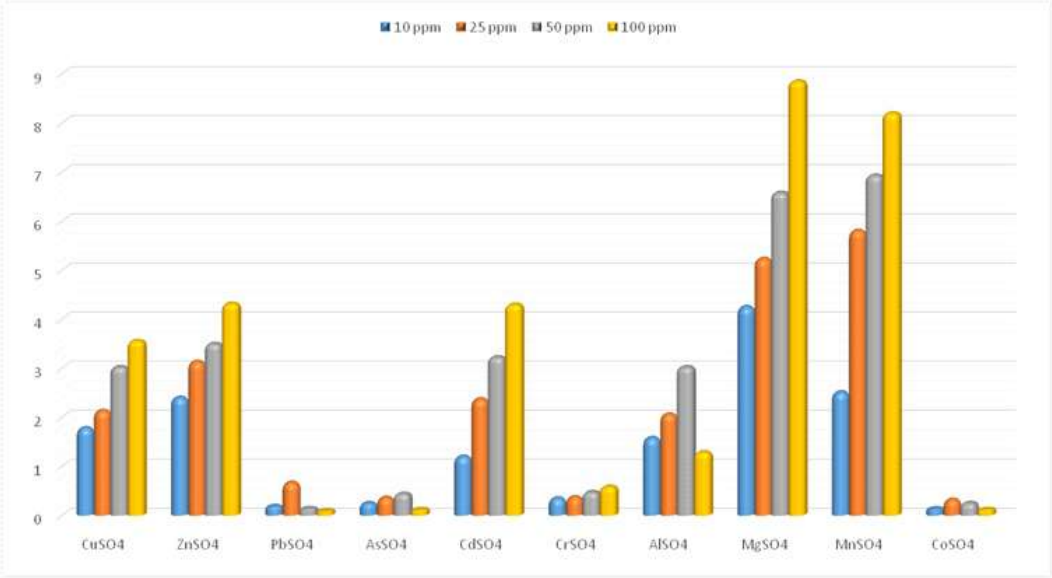

Fig.-1 : Accumulation (in ppm) of heavy metals in the mycelium of *Pleurotusflorida.*

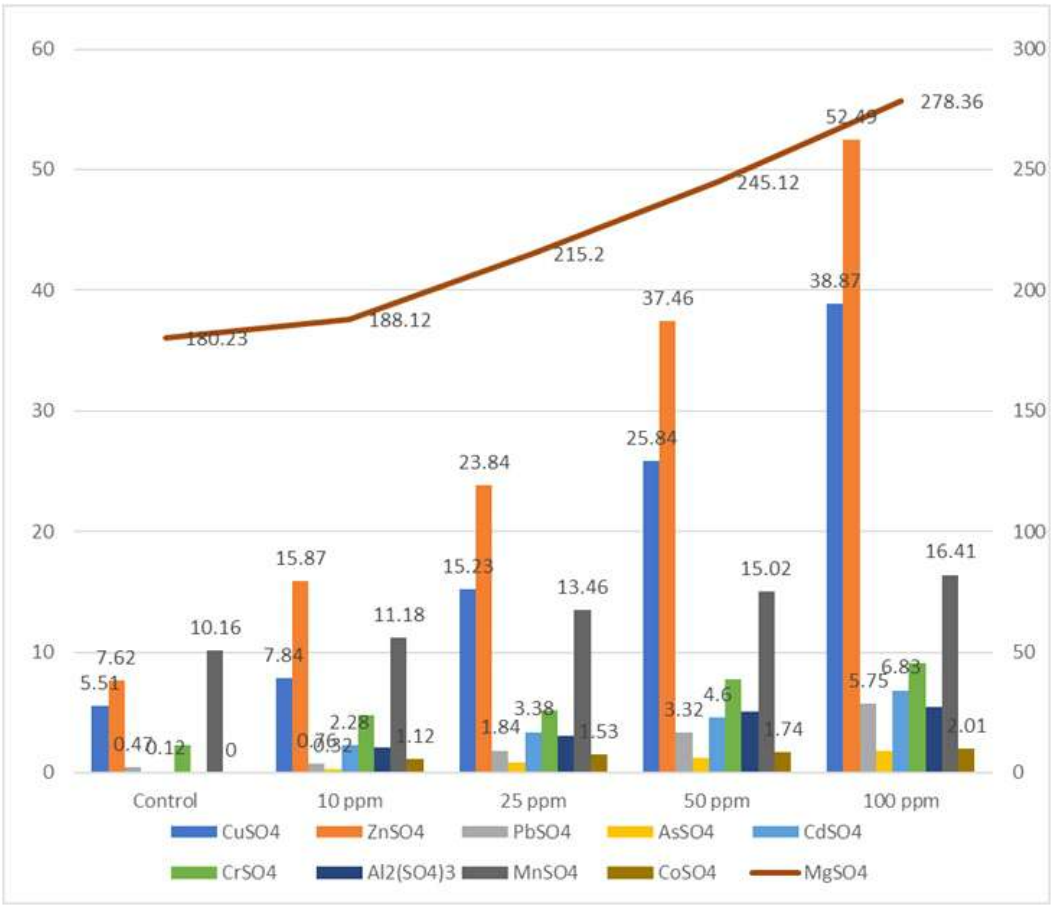

Fig.-2 : Accumulation (in ppm) of heavy metals in the fruiting body of *Pleurotusflorida*.

treatments, trend was similar between yield and heavy metal concentration.

For, Chromium Sulphate at 10 ppm concentration, *Pleurotusflorida*showed higher yield i.e. 443.76 gm. Whereas, for rest three concentrations (100, 50 and 25) *Pleurotusflorida* showed average fruit body yield. It depicts that *Pleurotusflorida* showed less effect of Chromium Sulphate on its yield even at higher concentrations of heavy metal salt. In case of $Al_2(SO_4)_3$ at 100 ppm, *Pleurotusflorida* showed poor yield i.e. 160.14 gm in comparison to 10, 25 & 50 ppm.

Further, for $MnSO_4$ and $MgSO_4$ at all four concentrations, *Pleurotusflorida* showed higher yields i.e., above 400 gm except $MnSO_4$ at 100 ppm whereas, yield recorded was in average category (386.56 g). $MnSO_4$ was found in line with $MgSO_4$ as far as its effect on fruit body yield was concerned. Yields were found good but in decreasing order with increase in concentration of heavy metal in inoculated substrate for both these salts. For Magnesium at 10 ppm yield was highest among all heavy metal concentrations i.e., 693.9 gm. Further, in case of $CoSO_4$, *Pleurotusflorida* showed higher yield i.e. 445.77 and 495.00 grams at 25 and 10 ppm concentrations respectively and also at 100 & 50 ppm it showed average yield i.e. 353.05 to 383.18 gmrespectively (Table-2).

Further, a common trend was observed for all heavy metal treatments invariably. Total Mushroom yield decreased with an increasing concentration of the heavy metals. Also average yield of fruit bodies for a heavy metal in all four concentrations viz. 10, 25, 50 & 100 ppm followed this sequence from higher to lower i.e. Mg>Zn>Cu>Mn>Co>Cr>As>Cd>Pb>Al and 523.24, 468.24, 467.82, 454.47, 419.25, 328.72, 288.07, 285.49, 268.34 and 256.05gm of fruit bodies yield respectively. This was probably because the fruit bodies had a threshold concentration that they can tolerate. These results are in confirmation of Oghenekaro *et al*., 2008; Ogbo and Okhuota, 2008 and 2011. From Africa, Oghenekaro *et al*., (2008) studies the effects of three heavy metals that is lead, zinc and copper on the growth of *Pleurotus tuber regium*.Fruit bodies were formed only in the copper contaminated substrate at concentration of 1.0 and 2.0g/250g of substrate.

In continuation the results of table-2, effect of heavy metals on the total number of mushroom fruit bodies had been recorded. effect of heavy metals on the total number of mushroom fruit bodies has been recorded. In case of $CuSO_4$, there was prominent difference observed in total number of mushroom fruit bodies at 50 ppm and 100 ppm i.e., 138 and 119 respectively.

Further, in case of $ZnSO_4$, At 10 ppm, maximum 164 total numbers of mushroom fruit bodies were recorded, it is one of the highest total numbers of mushroom fruit bodies count among all other treatments of *Pleurotusflorida.* With the reduction in duration of crop, mushroom yield & total number of fruit bodies were also reduced. Some heavy metals at different concentrations also affected average weight of fruit bodies by reduction in average size of fruit bodies. The average weight of fruit bodies were recorded in a range of 1.57-4.42 gm..The average weight of fruit body and average size of fruit body decreased with increase in the concentration of heavy metals from 10 to 100 ppm.

Biological efficiency were found in a range of 73.54%-114.91% for Copper, 69.94%-127.26% for Zinc, 34.97%-73.40% for Lead, 41.13%-78.32% for Arsenic, 39.64%-76.25% for Cadmium, 52.92%-88.75% for Chromium, 32.03%-67.49% for Aluminum, 82.35%-139.79% for Magnesium, 77.31%-103.66% for Manganese, 70.61%-99.00% for Cobalt and 135.02% for control.(Table 2)

*Pleurotusflorida*was not only successful to maintain its mycelial growth but also was able to form fruit bodies even for higher concentration of heavy metal salts. However, fruit bodies yield reduced in some cases like higher concentration of Lead, Cadmium and Aluminum, *Pleurotusflorida*survived and accumulated heavy metal salts in its fruit bodies. Thus, studies on survival of *Pleurotusflorida*in presence of heavy metal salts in substrate have a greater significance to use *Pleurotusflorida*as bioremediation agent. From our study, it is revealed that *Pleurotusflorida*is able to act as bioremediation agent for removal of heavy metal salts from contaminated soils even if their concentrations are present up to 100 ppm in these soils.

The extracellular nature of the degradative enzymes enables fungi to tolerate higher concentrations of toxic chemicals than would be possible if these compounds had to be brought into the cell (Bing *et al.,* 2012). Therefore, to complement bioremediation of heavy metals through cultivated mushroom not only absorption of heavy metals by mushroom fruit bodies were studied but also effect of spent compost on soil reclamation were included in this study to provide effective solution of major problem faced by industrialized world i.e. heavy metal contamination of soils.

Heavy metal accumulation in mycelium : It was clearly seen from the results (Fig-1) that in most of the cases as the concentration of heavy metals in medium increases, the accumulation of heavy metals in the mycelium of *Pleurotusflorida*increases and vice versa. Further, it was also observed that maximum accumulation was found in 100 ppm of $MgSO_4$ followed by $MnSO_4$ for same concentration. Moreover, minimum accumulation of heavy metals was observed in $PbSO_4$, $AsSO_4$ $CoSO_4$ and $CrSO_4$ for all the concentrations tested.

The accumulation of heavy metal in mushroom mycelium varied with the type of metal and total concentration of metals in the substrate. The most abundant metal found in mycelium of *Pleurotusflorida*was Magnesium followed by Manganese, Zinc and Cadmium respectively. The least abundant metals found in mycelium of *Pleurotusflorida*were Lead, Arsenic and Cobalt followed by Chromium.

Heavy metal accumulation in fruiting bodies : In case of 10 ppm concentration of salt in artificially inoculated substrate, maximum accumulation of $MgSO_4$ (188.12 ppm) was observed followed by $ZnSO_4$ (15.87 ppm), $MnSO_4$ (11.18 ppm) and $CuSO_4$ (7.84 ppm), whereas minimum accumulation was found of $AsSO_4$ (0.32 ppm), $PbSO_4$ (0.76 ppm), $CoSO_4$ (1.12 ppm), $Al_2(SO_4)_3$(2.13 ppm) and $CdSO_4$ (2.28 ppm). For $CrSO_4$ (4.81 ppm), average absorbance was observed.

Although $PbSO_4$ (1.84 ppm), $CoSO_4$ (1.53 ppm) and $AsSO_4$ (0.87 ppm) were accumulated minimum on 25 ppm, they improved their position in comparison to 10 ppm concentration of salts in substrate. In case of 50 ppm concentration, accumulation of $MgSO_4$ (245.12 ppm) further increased. Likewise $ZnSO_4$, $CuSO_4$ and $MnSO_4$ were accumulated heavily by fruit bodies of *Pleurotusflorida*with 37.46, 25.84 and 15.02 ppm respectively.

Moreover, if we bring control in picture, it could be seen from (Fig-2) that good amount of some heavy metals like $CuSO_4$ (5.51 ppm), $ZnSO_4$ (7.62 ppm), $CrSO_4$ (2.27 ppm), $MgSO_4$ (180.23 ppm) and $MnSO_4$ (10.16 ppm) were found in fruit bodies of *Pleurotusflorida*from control treatment also while, $AsSO_4$, $Al_2(SO_4)_3$and $CoSO_4$ were found absent. So, it could be concluded from (Fig-2) that with increase of heavy metal concentration in inoculated substrate, there was certain increase in accumulation of heavy metals in fruit bodies of *Pleurotusflorida.*

Conclusion

In our study, result shows that *Pleurotusflorida*not only survived in contaminated substrates with heavy metals but also accumulated heavy metals concentration in mycelium and fruiting body. This was probably due to the fact that the mushroom mycelium excretes enzymes that break down complex substances into simpler molecules and accumulate heavy metals into their fruiting bodies. Similar results were also found by other workers (Garcia *et al.,* 1998; Gast *et al*., 1988; Tüzen *et al.,* 1998a, b; Sesliand Tuzen, 1999; Demirbas, 2001, 2002; Kalac and Svoboda, 2000; Isildak *et al.,* 2004; Cocchi *et al.,* 2006; Paraskavi*et al.,* 2007; Fangkun *et. al.,* 2011).Thus**,** it can be concluded that *Pleurotusflorida*is able to act as bioremediation agent for removal of heavy metal salts from contaminated soils even if their concentrations are present up to 100 ppm in these soils. Therefore, it is revealed that *Pleurotusflorida* had the potential to bioabsorb heavy metals and played a significant role in bioremediation of heavy metal polluted environment, which have been considered as an eco-friendly alternative for remediation for heavy metal contamination. Thus, there is a need for further research towards the exploitation of potential of mushroom as bioremediation tool and its safety aspects for consumption as product.

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Secondary and Micronutrients Status in Coffee (*Coffeaarabica* L.) Soils under Different Land Use (Mixed and Mono Shade) System of Andhra Pradesh and Odisha

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Abstract

Coffee cultivation in the non-traditional areas (Andhra Pradesh and Odisha) is verily natured and stimulated a revolution among the life of the tribesby revitalizing the barren land through adoption of natural coffee cultivation in harmony with nature. In this region (northern highland hill of Visakhapatnam district of Andhra Pradesh and Koraput district of Odisha) coffee is cultivated under two different land use viz. with mixed (jungle trees) and mono (silver oak) shade trees. High rainfall, acidic soil reaction, chemical environment and nutrient availability especially secondary and micronutrients exert significant role in producing good quality coffee beans under different shade trees environment. Hence, to assess the secondary and micronutrient status in coffee plantations under mixed and mono shade land use system is important for gathering the baseline data on fertility status within the coffee ecosystem. Therefore, a comprehensive study on secondary and micronutrient status under mixed and mono shade land use system was undertaken. The study revealed that, under mixed shade coffee plantations available calcium in soilwas not deficient.Whereas, coffee area under mono shade ecosystem were found to have lower levels of calcium (<600 mg kg^{-1}) in about 3% samples. A total of 13.64% of the mixed shade and 26.7% of mono shade coffee soils were deficient (<180 mg kg^{-1}) in magnesium status. Zinc deficiency under mixed shade coffee soils was 9% and under mono shade system it was 10%. The majority of the coffee growing soils of both mixed and mono shade tree soils had adequate levels of sulphur, iron, copper and manganese status in natural coffee ecosystem.

Key words : *Coffee, secondary nutrient, micronutrients, Andhra Pradesh, Orissa*

Introduction

The climate of the northern highland hill of Visakhapatnam and Koraput district in Andhra Pradesh and Odishaof India are generally cooler and wetter than the surrounding plains and most of these hills are home to coffee plantations and enclaves of dry forest. Ancient Indian agriculture, our ancestors practiced natural farming in harmony with nature. However, with the progress of science in agriculture and the need for more food for the growing population, the easy way of living without organics, moved towards use of chemical fertilizers and pesticides are became inevitable. The coffee cultivation in NTA region is verily natured and also stimulated a revolution among the tribes living by revitalizing the barren land for natural coffee farming under mixed and mono shade trees land use for its sustainable use and protection. Coffee farming in NTA is the unique practice in India under different land use system of mixed shade (Jungle/ native trees) and mono shade treesof silver oak. Coffee produced from NTA region is recognized as natural coffee of India and opens the gate for global markets with Geographical Indication (GI) tag of 'Araku Arabica Coffee'. To protect the uniqueness e and to produce good quality coffee of natural coffee suitablythe soil health plays a significant role. Soils of the Eastern Ghats developed under hot humid tropical climate are generally favorable for the plant growth and development. Whereas, acidic soil reaction, chemical environment and nutrient availability especially secondary and micronutrients that exerts the influence on coffee production. Hence, to assess the these nutrient status in coffee soils under mixed and mono shade trees land use are very important for gathering baseline data on the nutrient status and which can help in making decisions on the use of green manure, cover crops, organics and bio fertilizers, to improve soil health without affecting the way of its natural coffee cultivation and also to understand the nutrient cycling,prospective of soil to produce coffee within coffee eco system is important for the sustainability. Strategies to improve soil health, conserve soil resources, establish a sustainable coffee production model under natural farming have received growing attention in this region. Hence, comprehensive secondary and micronutrient status under different land use system was undertaken in coffee soils of NTA (Andhra Pradesh and Odisha).

Materials and Methods

This study was conducted in Vishakhapatnam district of Andhra Pradesh and Koraput district of Odisha

respectively (Figure-1). These two districts are represents the major coffee growing areas of NTA. Red and lateritic soils are the predominant soils type and developed under the temperature regime is 'isohyperthermic,' and most of the soils moisture regime is 'ustic' and a very small portion belongs to xeric in the study area. These two districts experience higher rainfall and hot per-humid, hot moist sub-humid and hot humid tropical climates, respectively. Sampling in each district was done within the mandals in wide transect with elevation of 900 to 1100 mmasl across the each coffee growing mandals. The coffee cultivated in this region is under mixed shade of jangle tree species viz. *Syzygiumcumini,* Syzigium Cumini, *Micheliachampaca, Schleicheraoleosa, Mangiferaindica, Pterocarpus-marsupium, Samaneasaman, Terminalicaalata, Artocarpusheterophullus,* Artocarpusintegrifilia*, Spondiaspinnta, Spondiasmangifera, Toona ciliate, Albizziaodoritissima, Burseraserrata, Dalbergiasissoo* and *Ficus species*etc are seen along with deciduous tree species such as *Terminalia species Gmelinaarboria* and *Grewiatiliefolia* in the Eastern Ghats where Coffee is cultivated. In addition to the above men made grown tree species, *Gravillearobusta*, *Acrocarpusraxinifolios* and *Maesopsisemini* were also planted in the coffee estatesbut the (*Gravillearobusta*) silver oak is the major mono shadetree under coffee cultivation.

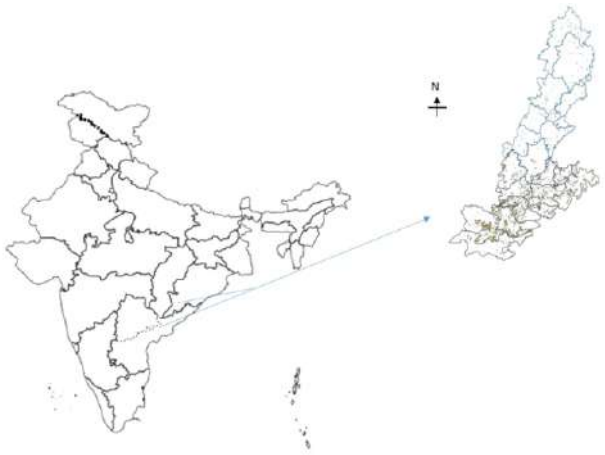

Fig-1. Nontraditional coffee growing area of Andhra Pradesh and Odisha of India.

Vishakhapatnam district lies in the north-eastern hills of the Eastern Ghats and Regional Coffee Research Station (RCRS), RV. Nagar belonging to the Vishakapatnamdistrict, receives an average annual rainfall of 2,000 mm, mainly from the south west monsoon during June to September (Table-1). Similarly, the Technology Evaluation Center (TEC), Koraput (Coffee Board of India) belongs to Koraput district of Odisha which receives an average annual rainfall of 1800-1900 mm during the monsoon season (Table-1).

Major area of coffee cultivated under mixed shade treesunder Andhra Pradesh belongs to Chintapalli, G. Madugala G.K Veedi and Koyyurumandals of Vishakpatnam district. Whereas, coffee cultivated in Arakuvalley, Anathgiri, Peddabayllu, Hukumpeta, Dumbaragudda and Paderumandals of Andhra Pradesh and Koraput (Odisha) are mainly under mono shade trees.

Mandal wise a total of 226 composite random surface soil samples with depth of 22 cm were drawn from predominant coffee growing different land use of mixed (110) and mono (116) shade trees under coffee plantation separately to cover entire region. Along with the soil samples, general cultivation practices adopted by the growers were also gathered during the collection of soil samples. All collected soil samples first air-dried under shade/ then powdered gently with a wooden mallet and sieved through 2 mm sieve then packed in clean polyethylene containers at Soil Testing Laboratory (STL), Regional Coffee Research Station (RCRS), Narsipatnam, Andhra Pradesh. Due to non-available facility to analyse the soil samples for secondary and micronutrients at RCRS, Narsipatnam the soils were analysedat Central Coffee Research Institute, Chikamagaluru (CCRI) of Karnataka for available Ca and Mg and it was determined by extracting soil with neutral normal ammonium acetate (Jackson, 1973). The available sulphur was extracted from the soil using 0.15 per cent calcium chloride solution ($CaCl_2.2H_2O$) and sulphur in the extract was determined by turbidimetry as outlined by Black (1965) using Spectrophotometer at 420 nm. Zinc, iron, copper and manganese in soil was extracted by 0.1 HCL then the extractant was determined by using atomic absorption spectrophotometer (AAS) under suitable measuring conditions (Page *et al.,* 1982).

Results and Discussion

Present article highlights the status of secondary and micronutrients status in coffee soils of NTA under different land use systems (mixed and mono shade trees). Calcium is the most important secondary nutrient for plants and it is required in much smaller quantities compared to major nutrients nitrogen (N), phosphorous (P) and potassium (K). The nutrient is a structural component of plants cell and tissues which pays a major role in plant metabolism.The highest available Ca under mixed shade land use ofNTA coffee soils was recorded 2689 mg kg^{-1}at Chintapallimandaland the lowest available Ca under mixed shade land use of NTA coffee soils was recorded at 660 mg kg^{-1} at Chintapallimandal (Table 2). The highest available Ca under mono shade trees land use of NTA coffee soils was recorded 2641 mg kg^{-1} at Dumbriguddamandal and the lowest available Ca under

Table-1 : The climatic condition of RCRS, RV, Nagar (Andhra Pradesh) and TEC, Koraput (Odisha) for the year 2019 and 2020.

Months	Rainfall at RCRS during 2019	Rainfall at RCRS during 2020	Rainfall at TEC during 2019	Rainfall at TEC during 2020
January	6.6	10.4	1.8	0
February	0	17.4	0	2.2
March	12.2	38.6	5.8	41
April	113.4	136.6	40.8	49.4
May	80.4	214.2	82.4	129.6
June	143.4	342	225.2	104
July	337	225.4	484.2	187.9
August	499.8	594.2	564.2	141
September	436.8	418	273.2	657
October	233	249.4	169.2	383
November	36.4	147.2	24.6	127.6

mono shade trees land use of NTA coffee soils was recorded at 519 mg kg^{-1} at Arakuvalleymandal(Table 3). However, none of the soils samples were found deficient in available Ca under mixed shade land use of coffee plantation (Chintapalli, GV.Veedi, Koyuuru and G. Madugala) and only 3 % of the samples were tested low levels of Ca (<600 mg kg^{-1}) under mono shade trees land use of coffee plantation soils (Figure 2). However, available calcium present in mono shade treesland use coffee soils was ranged from 519 to 2640 mg kg^{-1} (Table-4) and under mixed shade land use of coffee soils was ranged from 660 to 2689 mg kg^{-1} respectively (Table 4). Little higher values of Cawas observed under mixed shade coffee soils. Similar results were reported in Kodagu coffee soils of Karnataka by Nesper *et al.,* 2019. The leaf litter of the shade trees under coffee cultivation enriches the soil organic matter, conserves soil moisture and improves the plant available nutrients in soils (Chandrappa 2005).

For photosynthesis Mg is most important plant nutrientand it is a component of chlorophyll that helps in plant food production. A total of 13.64 % mixed shade land use system of coffee soils are found deficient in available Mg (low levels <180 mg kg^{-1}) and about 26.7 % of the tested mono shade trees land use coffee soils are found deficient in Mg of (Figure-2). However, the deficiency of available Mg is observed in both mixed and mono shade land use of coffee plantations in NTA. Available Mg present in mono shade land use coffee plantation soils was ranged from 66.9 to 431.2 mg kg^{-1} and in case of mixed shade land use coffee soils was ranged from 107.5 to 682.5 mg kg^{-1} respectively (Table-4). Magnesium deficiency in mono shade land use of coffee soils may be due slower rate decomposition rates of *G. robusta* leaf litter similar results were reported in coffee soils ofKodaguin Karnataka by Nesper*et al.,*(2019)and absence and use dolomite lime stone in NTA region.

Sulphur is constituent of protein and enzymes for plants and it is one of the most important quality nutrientto coffee and which play a key role in coffee aroma and taste. Soil samples tested for available sulphur under mono and mixed shade trees land use of coffee plantation soils were at adequate in NTA region (Figure-2). However, available sulphur present in mono shade trees land use of coffee plantation soils ware ranged from 5.88 to 61.21 mg kg^{-1} and coffee under jungle shade trees was ranged from 6.2 to 72.6 mg kg^{-1} respectively (Table-4). The highest available S under mixed shade land use of NTA coffee soils was recorded 72.6 mg kg^{-1} at Koyoorumandal and the lowest available S under mixed shade land use of NTA coffee soils was recorded 6.2 mg kg^{-1} at Chintapallimandal (Table-2). The highest available S under mono shade trees land use of NTA coffee soils was recorded 40.7 mg kg^{-1} at Dumbriguddamandal and the lowest available S under mono shade trees land use of NTA coffee soils was recorded 1.20 mg kg^{-1} at Hukumpetamandal (Table-3). The different shade trees present in the coffee eco system conserve soil by reducing soil erosion and improve the nutrient status (Perfecto *et al.* 1996). Parallel results by Beer *et al.,* 1998 and Romero *et al* 2002 in shade grown coffee.

Generally a very little quantity of micronutrients are required for coffee plants but absence of one nutrient in soil will put coffee under risk for its productivity. Cu is one of the important micronutrient needed for plants for lignin synthesis and enzymes activation. Deficiency of the nutrient cause male flower sterility, delayed flowering and senescence. However, plant available Cu in tested samples under mono shade trees land use of coffee plantation soils was from 0.21 to 20.79 mg kg^{-1} with an average of 5.2 mg kg^{-1} and under mixed shade land use coffee plantation soils was from 0.50 to 21.30 mg kg^{-1} with an average of 4.2 mg kg^{-1} respectively (Table-4). Mixed shade land use of coffee growing soils haveadequate supply of available Cu in NTA soils (Figure-2). Similar results were also reported in coffee soils of Hassan (Aseef

Table-2 : Available secondary and micronutrient status under mixed shade trees land use of coffee soils of NTA.

Mandal	Ca (mg kg^{-1})		Mg (mg kg^{-1})		S (mg kg^{-1})		Cu (mg kg^{-1})		Zn (mg kg^{-1})		Fe (mg kg^{-1})		Mn (mg kg^{-1})	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Chinthapalli	660 - 2689	1635	108 - 683	243	6.2 - 60.3	23.8	0.8 - 21.3	4.3	0.2 - 41.6	8.2	4.4 - 107.5	14.5	4.6 - 112.4	23.2
G. K Veedi	1342 - 2455	2055	185 - 376	250	8.1 - 14.6	20.5	2.2 - 7.1	4.2	0.6 - 4.7	1.5	7.6 - 8.4	27.1	7.4 - 15.6	25.2
Koyooru	1985 - 2599	2420	177 - 272	204	18.4 - 72.6	44.0	2.4 - 3.5	3.0	1.5 - 4.8	2.6	6.8 - 13.8	9.5	21.8 - 27.1	23.9
G. Madugala	888 - 2505	1566	159 - 294	240	8.3 - 61.7	22.8	0.5 - 11.0	4.1	0.6 - 2.8	8.2	3.0 - 6.1	14.3	0.5 - 11.9	27.0

Table-3 : Available secondary and micronutrient status under mono shade tree land use of coffee soils of NTA.

Paderu	595 - 2403	1425	130 - 293	212	2.0 - 12.4	21.7	1.0 - 20.8	10.6	0.4 - 2.8	6.2	2.3 - 5.2	8.0	2.5 - 10.4	19.7
Peddabyalu	660 - 2606	1618	156 - 431	218	4.2 - 10.5	21.8	0.2 - 9.2	3.0	0.6 - 7.8	2.3	3.4 - 3.8	10.3	12.1 - 41.8	24.4
Hukumpeta	595 - 2606	1705	102 - 266	197	1.2 - 11.2	24.8	0.4 - 11.0	3.4	0.3 -2.4	3.1	1.3 - 3.4	13.8	6.0 - 51.5	26.5
Arakuvalley	519 - 2191	1463	177 - 275	217	1.5 - 13.5	26.4	3.3 - 6.2	4.5	1.3 - 5.6	2.4	3.1 - 7.7	20.2	3.8 - 17.6	21.5
Anathgiri	671 - 2097	1319	67 - 246	174	5.0 - 12.2	18.5	3.9 - 10.6	6.3	0.5 - 3.3	1.9	4.7 - 8.9	33.7	3.6 - 10.9	18.3
Dumbrigudda	1134 - 2641	2291	154 - 221	190	5.9 - 40.7	26.1	2.5 - 6.5	4.0	0.7 - 2.7	1.6	7.3 - 31.3	15.9	5.6 - 19.7	21.4
Koraput	2378 - 2539	2449	176 - 279	204	6.6 - 16.8	26.9	0.4 - 6.0	3.5	0.5 - 2.3	1.3	3.7 - 4.0	33.7	0.5 - 15.9	18.3

et al 2005) and Chikmagalur(Hariyappa*et al* 2009) districts Karnataka. The coffee cultivation in NTA is not an intensive but it is cultivated under natural condition under two tire shade trees andadoption of shade trees in coffee plantation helps to build up organic matter in the soils and increases the plant available nutrients by recycling of nutrients (Chandrappa 2005). Cu deficiency is very negligible even under mono shade trees land use of coffee growing soils is may be due to rich in organic matter by leaf litter as well as native Cu status of the soil and similar results were repeated by Beer *et al.,* 1998 and Romero *et al* 2002 in shade grown coffee.

Plant available Zn in tested samples under mono shade trees land use of coffee growing soils was from 0.29 to 22.40 mg kg^{-1} with an average of 3.40 mg kg^{-1} and under mixed shade land use of coffee growing soil was from 0.2 to 41.6 mg kg^{-1} with an average of 7.4 mg kg^{-1} respectively (Table-4). The deficiency of available Zn was observed under mixed shade land use of coffee growing soils was 9 % and mono shade trees land use of coffee soils was 10 % respectively (Figure-2). The highest available Zn under mixed shade land use of NTA coffee soils was recorded 41.6 mg kg^{-1} at Chintapallimandal and the lowest available Zn under mixed shade land use of NTA coffee soils was recorded 0.2 mg kg^{-1} at Chintapallimandal (Table-2). The highest available Zn under mono shade trees land use of NTA coffee soils was recorded 7.8 mg kg^{-1} at Peddabyalumandal and the lowest available Zn under mono trees shade land use of NTA coffee soils was recorded 0.30 mg kg^{-1} at Hukumpetamandal (Table-3). Parallel results were also reported in shade grown coffee soils of Hassan (Aseef *et al* 2005) and Chikmagalur (Hariyappa *et al* 2009) districts of Karnataka soils. Plant available Fe in the tested samples under mono shadetrees land use of coffee growing soils was from 2.28 to 111.3 mg kg^{-1} with an average of 13.7 mg kg^{-1} and under mixed shade land use of coffee growing soils was from 3.0 to 116.1mg kg^{-1} with an average of 15.0 mg kg^{-1} respectively (Table-3). The majority of the coffee growing soils of NTA in both mixed and mono shade trees land use soils have adequate levels of iron status. The soils of Eastern Ghats are developed under the hot humid climatic regimes and rich in iron ore (Bhaskara Rao and Lakshmipathi Raju 1984) and comparable results regarding iron status in shade grown coffee soils were also reported by Nesper*et al.,* 2019 in Kodagu, Hariyappa*et al* 2009 in Chikmagalurand Aseef *et al* (2005) in Hassan districts, of Karnataka.

The Mndeficiency was recorded only 8.0 % of soils under mono shade trees land use of coffee growing soils system and 7 % of the tested soil samples were under mixed shade land use of coffee growing soils. The deficiency of Mn in tested soils are under mixed shade

Table-4 : Available secondary and micronutrients status of mono and mixed shade trees of coffee soils in NTA.

Nutrients	Mixed shade land use of coffee plantation soils	Mono shade tree land use of coffee plantation soils		
	Range	Mean	Range	Mean
Ca (mg kg^{-1})	660 - 2689	1684	519-2641	1649
Mg (mg kg^{-1})	108 - 683	240	67- 431	205
S (mg kg^{-1})	6.24 - 72.64	24.32	5.88 - 61.21	23.36
Cu (mg kg^{-1})	0.48 - 21.32	4.18	0.21 - 20.79	5.20
Zn (mg kg^{-1})	0.23 - 41.57	7.44	0.29 - 22.40	3.45
Fe (mg kg^{-1})	2.99 - 116.1	14.95	2.28 - 111.3	13.74
Mn (mg kg^{-1})	6.55 - 112.4	24.61	6.02 - 51.47	23.25

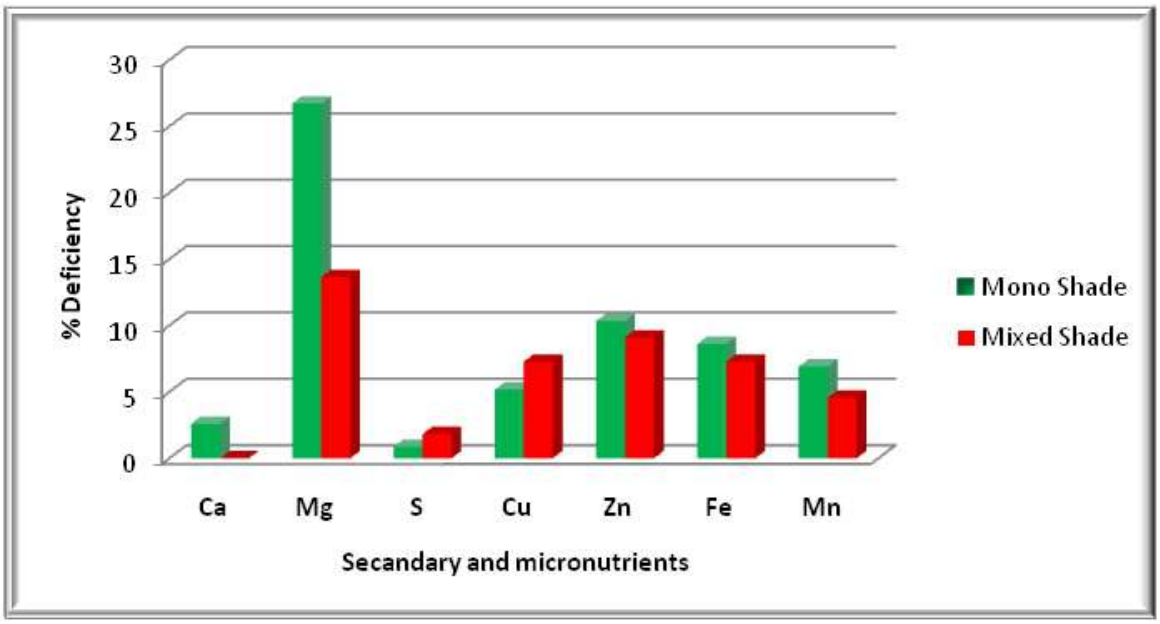

Fig.-2 : Available secondary and micronutrients status of mono and mixed shade treesland use of coffee soils in

land use coffee system are very negligible (Figure-2). Similarly plant available Mn in tested samples under mono shade treesland use of coffee growing soil was from 6.02 to 51.50 mg kg^{-1} with an average of 23.30 mg kg^{-1} and under mixed shade land use of coffee growing soils was from 4.60 to 112.4mg kg^{-1} with an average of 24.60 mg kg^{-1} respectively (Table-4). Genrally coffee soils are acidic and the solubility of Mn is more. Analogous, results with respect to Mn status in coffee soils was reported in traditional coffee growing region of Karnataka (Hassan, Chikamagalur and Kodagu) by Aseef*et al* (2005), Hariyappa *et al* (2009) and Nesper *et al.,* 2019. However, shade trees in coffee eco system prevent the soil erosion on a sloping terrain; they enrich the soil by recycling nutrients from deeper layers, protect the coffee plant from seasonal fluctuations in temperature, and play host to diverse flora and fauna which pay important role in mineralization of plant available nutrients (Chandrappa 2005, Perfecto *et al.*1996; Komar, 2006).

Conclusions

Soil analysis results of nontraditional coffee growing areas (NTA) were indicted a variation with respect to micronutrient status under mixed and mono shade trees land use of coffee soils which could be due to the difference in the quantity of leaf litter of the different shade trees species, rate of decomposition of leaf litter (mono and mixed shade trees) and also native soil fertility status of the coffee plantation. However, except Zn and Mg all the secondary and micronutrients status in NTA soils either mono or mixed shade trees land use of coffee soils were in adequate levels. The adequate level of secondary and micronutrients in these soils may be due to stabilized hot humid climatic regimes and highly weathered highlands in enclaves with Eastern Ghats forestand also rich in iron ore. Along with above reasons the mixed shade land use of coffee generate a large volume of leaf litter in coffee soils and which ensures fairly high levels of organic matter. This high volume of organic matter not only

supplies the mineral nutrients to coffee plants but also enhances the soil productivity than the mono shade trees land use of coffee plantations of NTA. Adopting and practicing coffee cultivation under mixed shade land use have benefits to coffee and conserve soil health.

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Bio-efficacy of Glufosinate Ammonium 13.5% SL on Non Cropped Area Weeds

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Abstract

A field experiment was conducted during *Summer* season of 2019 and 2020 at College of Agriculture, V. C. Farm, Mandya to know the bio-efficacy of glufosinate ammonium 13.5% SL on non cropped weeds. The experiment consists of seven treatments replicated thrice in a randomized complete block design. Among the various treatments, hand weeding recorded significantly higher weed control efficiency during both the years of experimentation and it was found at par with herbicide treatment *viz.,* post-emergence application of Glufosinate Ammonium 13.5% SL @ 4166 ml/ha at 15, 30 and 45 days after treatment (DAT). Among the weed management practices, post-emergence application of Glufosinate Ammonium 13.5% SL @ 4166 ml/ha found effective in control of all types of weeds and registered lower weed density (No. m^{-2}), dry weight of weeds (g m^{-2}) and higher weed control efficiency (%).

Key words : *Glufosinate ammonium, weed density, weed dry weight and weed control efficiency.*

Introduction

Weeds are the major vegetation in the non-cropped area like, waste lands, road sides, non-residential areas, railway tracts, water bodies etc. weeds in the non-cropped areas reduced the aesthetic value, the value of the site, reduces the storage capacity of water bodies, increases the water loses by hindering the flow of water in the canals, reduces the visibility of moving vehicles in the roads and highways *etc*. the also give shelter to many of the crop pest and diseases during the off season. They also served as a seed bank for crop weed establishment in the cropped areas. Hence the effective management of weeds in the non-cropped area is very important to enhance the value of the property, reduce the pest and diseases load on crop plants and to enhance the water utilization efficiency in canal water.

By keeping above information in view, the present investigation was carried out to study efficacy of Glufosinate ammonium 13.5% SL on weeds of no cropped area weeds.

Materials and Methods

A field experiment was conducted during Summer season of 2019 and 2020 to know the bio-efficacy of glufosinate ammonium 13.5% SL on non cropped area weeds. The field study was conducted at the College of Agriculture, V.C. Farm, Mandya (12^0 34.3' N latitude, 76^0 49.8' E longitude and at an elevation of 697 m above mean sea level), under the jurisdiction of University of Agricultural Sciences, Bengaluru. The soil of the experimental site was red sandy loams classified as *Alfisols* with bulk density and particle density of 1.15 g/cc and 2.65 g/cc, respectively. The soil pH was 6.5 (neutral in reaction). It was low in available nitrogen and phosphorus and high in potassium (Table-1). Seven treatments *viz.* Glufosinate Ammonium 13.5% SL @ 1667 ml/ha (POST), Glufosinate Ammonium 13.5% SL @ 2500 ml/ha (POST), Glufosinate Ammonium 13.5% SL @ 3333 ml/ha (POST), Glufosinate Ammonium 13.5% SL @ 4166 ml/ha (POST) and Glufosinate Ammonium 13.5% SL @ 3000 ml/ha (POST). These weed control treatments were compared with hand weeding thrice at 20 and 40 DAS and weedy check. These seven treatments were laid out in complete randomized block design with three replications.

The gross plot size was 5.0 m x 5.0 m. The post-emergence herbicides were sprayed at 4-8 leaf stage of weeds by using knapsack sprayer fitted with deflector nozzle mixed with water @ 5000 liter/ha. Hand weeding was carried out as per the treatment schedule. All other agronomic and plant protection measures were adopted as per the recommended packages of UAS, Bangalore.

The data on weed density and weed dry weight (at 15, 30 and 45 DAA) were recorded with the help of quadrate (0.5 m X 0.5 m). The normality of distribution was not seen in case of observation on weeds hence, the values were subjected to square root transformation () prior to statistical analysis to normalize their distribution. The weed control efficiency was worked out on the basis of weed dry matter production using the formula suggested by Mani *et al.* (1973). All the data obtained in the study were statistically analyzed using F-test, the procedure given by Gomez and Gomez (1984), Critical

difference values at P=0.05 were used to determine the significance of differences between means.

$$WCE\ (\%) = \frac{\text{Dry matter production of weeds in unweeded plot} - \text{Dry matter production of weeds in treated plot}}{\text{Dry matter production of weeds in unweeded plot}} \times 100$$

Table-1 : Soil physico-chemical properties of experimental site.

Parameter	Values
EC (dsm^{-1})	0.35
Soil pH	6.52
Organic matter (%)	0.382
Available nitrogen (kg/ha)	225.2
Available phosphorus (kg/ha)	28
Available potassium (kg/ha)	125

Results and Discussion

Weed flora : The major weed flora observed in the non cropped area experimental field was *Digitaria sanguinalis* L. (Crab grass), *Dactyloctenium aegyptium* L. (Crowfoot grass), *Cynodon dactylon* L. Pers. (Bermuda grass) and *Echinochloa colonum* L. (Barnyard grass) among the grasses; *Parthenium hysterophorus* L. (Congress grass), *Phyllanthus niruri* (Gale of the wind), *Euphorbia hirta* (Garden spurge), *Ageratum conyzoides* (Billy Goat weed), *Sida acuuta* and *Stachytarpeta indica* (*Blistering ammania*) among the broad leaved weeds and *Cyperus rotundus* L. (Purple nut sedge) among the sedge. The similar weeds in non-cropped area were reported by Holm *et al.* (1975).

Weed density (No./m^2) and dry weight (g/m^2) : All the weed control treatments significantly reduced the density and dry weight of all the total weeds (Grasses, Sedges and BLW) as compared to weedy check (Table-2, 3 and 4).

The total weed population significantly lower due to post-emergence application of Glufosinate Ammonium 13.5% SL @ 4166 ml/ha (0.00, 12.33 and 26.33 and 0.00, 0.00 and 20.33 no. m^{-2}, at 15, 30 and 45 DAT during 2019 and 2020, respectively) and it was comparable with hand weeding treatment and Glufosinate Ammonium 13.5% SL @ 3333 ml/ha (0.00, 15.33 & 29.67 and 0.00, 5.00 and 21.67 no. m^{-2}, at 15, 30 and 45 DAT during 2019 and 2020, respectively). The next best treatment was post-emergence application of Glufosinate Ammonium 71% SG @ 3000 g/ha. While, the highest total weed population was observed in weedy check (Table-2). Glufosinate ammonium is a broad spectrum weed killer and it inhibits the glutamine synthetase leading to complete breakdown of ammonia metabolism. This leads to accumulation of nitrate in the weeds and this eventually kill the weeds. These results are in line with earlier findings of Bhan and Sushilkumar (1996), Hack *et al.* 1994 and Gangavislakshi and Sushilkumar (2008) Table-2.

The total dry weight of weeds also varied significantly among the weed control treatments. Among the herbicide treatments, post emergence application of Glufosinate Ammonium 13.5% SL @ 4166 ml/ha recorded significantly lower total dry weight of weeds (0.00, 9.13 and 30.30 and 0.00, 5.39 and 33.94 g/m^2, at 15, 30 and 45 DAT during 2019 and 2020, respectively) and it was comparable with treatments like, hand weeding twice (0.00, 0.00 and 29.47 and 0.00, 0.00 and 27.13 g/m^2, at 15, 30 and 45 DAT during 2019 and 2020, respectively) and Glufosinate Ammonium 13.5% SL @ 3333 ml/ha (0.00, 11.59 and 33.37 and 0.00, 6.99 and 38.43 g/m^2, at 15, 30 and 45 DAT during 2019 and 2020, respectively). The next best herbicide treatment was post-emergence application of Glufosinate Ammonium 71% SG @ 3000 g/ha. While, the highest total dry weight of weeds was observed in weedy check (Table-3). The findings were in conformity with earlier findings of Sushilkumar and Varshney (2008), Sushilkumar *et al.* (2003) and Yaduraju *et al.* (2006) (Table-3).

Among the herbicide treatments, total weed control efficiency was higher with Glufosinate Ammonium 13.5% SL @ 4166 ml/ha (100, 92.03 and 83.68 % and 100, 94.57 and 85.24 % at 15, 30 and 45 DAT during 2019 and 2020, respectively) and was comparable with hand weeding twice treatment (100, 100, and 84.13 % and 100, 100 and 88.20% at 15, 30 and 45 DAT during 2019 and 2020, respectively) and Glufosinate Ammonium 13.5% SL @

Table-2 : Total weed population (No. 1.0 m^{-2}) as influenced by Glufosinate Ammonium 13.5% SL in non-cropped area.

Tr. No.	15 DAT		30 DAT		45 DAT	
	2019	2020	2019	2020	2019	2020
Glufosinate Ammonium 13.5% SL@ 1667	4.93(23.33)	4.6(20.33)	6.04(35.67)	6.35(39.33)	7.87(61.00)	8.23(66.67)
Glufosinate Ammonium 13.5% SL@ 2500	4.46(19.00)	4.03(15.33)	5.65(31.00)	5.77(32.33)	7.53(55.67)	7.94(62.00)
Glufosinate Ammonium 13.5% SL@3333	1.00(0.00)	1.00 (0.00)	4.04(15.33)	3.5(11.33)	5.54(29.67)	5.44(28.67)
Glufosinate Ammonium 13.5% SL@4166	1.00(0.00)	1.00 (0.00)	3.65(12.33)	3.1(8.67)	5.22(26.33)	5.13(25.33)
Glufosinate Ammonium 71% SG@3000	3.69(12.67)	3.4(10.67)	5.91(34.00)	5.94(34.33)	7.89(61.33)	8.16(65.67)
Hand weeding (15 & 30 Days)	1.00(0.00)	1.00 (0.00)	1.00(0.00)	1.00 (0.00)	5.38(28.00)	4.61(20.33)
Weedy check (Control)	9.2(83.67)	9.63(91.67)	11.24(125.33)	11.69(135.67)	12.41(153.00)	13.61(184.33)
S.Em±	0.16	0.30	0.22	0.25	0.21	0.18
CD (P=0.05)	0.28	0.53	0.39	0.44	0.37	0.32

Figures in parenthesis are original values

Table-3 : Total dry weight (g/m^{-2}) as influenced by Glufosinate Ammonium 13.5% SL in non-cropped area.

Tr. No.	15 DAT		30 DAT		45 DAT	
	2019	2020	2019	2020	2019	2020
Glufosinate Ammonium 13.5% SL@ 1667	3.23(9.49)	2.81(6.94)	5.53(29.79)	5.12(25.21)	8.54(71.98)	9.28(85.2)
Glufosinate Ammonium 13.5% SL@ 2500	2.92(7.51)	2.52(5.33)	5.19(25.99)	4.69(21)	8.16(65.72)	8.92(78.67)
Glufosinate Ammonium 13.5% SL@3333	1.00(0.00)	1.00 (0.00)	3.54(11.59)	2.82(6.99)	5.86(33.37)	6.28(38.43)
Glufosinate Ammonium 13.5% SL@4166	1.00(0.00)	1.00 (0.00)	3.18(9.13)	2.52(5.39)	5.59(30.30)	5.91(33.94)
Glufosinate Ammonium 71% SG@3000	2.47(5.11)	2.25(4.05)	5.45(28.67)	4.69(20.99)	8.59(72.86)	8.91(78.47)
Hand weeding (15 & 30 Days)	1.00(0.00)	1.00 (0.00)	1.00(0.00)	1.00 (0.00)	5.52(29.47)	5.3(27.13)
Weedy check (Control)	7.33(52.81)	6.51(41.45)	10.75(114.65)	10.01(99.26)	13.66(185.62)	15.2(229.97)
S.Em±	0.16	0.08	0.21	0.18	0.22	0.22
CD (P=0.05)	0.28	0.15	0.37	0.31	0.39	0.39

Figures in parenthesis are original values

Table-4 : Weed control efficiency (%) as influenced by Glufosinate Ammonium 13.5% SL in non-cropped area.

Tr. No.	15 DAT		30 DAT		45 DAT	
	2019	2020	2019	2020	2019	2020
Glufosinate Ammonium 13.5% SL@ 1667	82.02	83.26	74.01	74.61	61.22	62.95
Glufosinate Ammonium 13.5% SL@ 2500	85.77	87.14	77.33	78.85	64.59	65.79
Glufosinate Ammonium 13.5% SL@3333	100.00	100.00	89.89	92.96	82.02	83.29
Glufosinate Ammonium 13.5% SL@4166	100.00	100.00	92.03	94.57	83.68	85.24
Glufosinate Ammonium 71% SG@3000	90.32	90.22	74.99	78.85	60.75	65.88
Hand weeding (15 & 30 Days)	100.00	100.00	100.00	100.00	84.13	88.20
Weedy check (Control)	-	-	-	-	-	-

3333 ml/ha (100, 89.89 and 82.02% and 100, 92.96 and 83.29% at 15, 30 and 45 DAT during 2019 and 2020, respectively). Followed by Glufosinate Ammonium 71% SG @ 3000 g/ha (Table-8). These results are in agreement with earlier findings of Robert (2018), Finch (2014), Singh *et al*. (2004) and Walia *et al.* (2002) Table-4.

On the basis of two years (2019 and 2020) data, it was concluded that post-emergence application of Glufosinate Ammonium 13.5% SL @ 4166 ml/ha found most effective and controlling the weeds present in the non-cropped area.

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Identification of Micronutrient Rich Rice Genotypes Developed by ANGRAU, Andhra Pradesh

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Abstract

Twenty popular rice varieties developed by ANGRAU, including sixteen released and four pre-released varieties obtained from Regional Agricultural Research Station (RARS), Maruteru during *Kharif* – 2019, were screened for micronutrient content (iron and zinc), proximate composition,Among the varieties investigated for mineral content six varieties namely Swarna, Sri Dhruthi, Indra, MTU 1210, MTU 1224 and MTU 1262 were under a high iron category. Five varieties Swarna, Sri Dhruthi, Indra, MTU 1224and MTU 1262, were under the high zinc category. Moreover, varieties such as Swarna, MTU 1224 and MTU 1262 have high iron and zinc levels. Mineral content (Iron and Zinc) decreased during polishing. The per cent loss during polishing was given according to the grain type. It is revealed that the percent loss of iron was more in medium slender grains (61.90-74.02%) followed by long bold (64.66-73.88%) and long slender (62.77 -72.52 %) at 5% and 10%, respectively

Introduction

Rice (*Oryza sativa* L.) has a unique position being a staple food crop for half of the world and Asia accounts for over 90 per cent of the world's production of rice, mainly in China, India and Indonesia. Among all the Asian countries, India is the prominent rice growing country accounting for about 20 per cent of all world rice production. In India, rice is grown in 44.7 per cent of the total cropped land and accounts for 70.3 per cent of the total food grain production in India (Madhubabu *et al.* 2020). It is incredibly encapsulated into the cultural and traditional heritage of various societies of humanity.

Micronutrient deficiencies or "hidden hunger" affect about 38 per cent of pregnant women and 43 per cent of preschoolers worldwide and is most widespread in economically developing nations. Over 30 per cent of the population worldwide is anaemic. Global studies approximated that half of these deficiencies are due to iron-deficiency anaemia. The significant occurrence of stunting among children is due to zinc deficiency. A risk of compromised cognitive development and physical capability was seen in about 165 million children with stunted growth. Conventional breeding striving to develop iron-enriched polished rice faces significant challenges due to the slight difference in iron concentration in polished grains among rice germplasm (Kurniawan *et al.,* 2015).

The micronutrients in the rice kernel are mostly concentrated in the outer layers. Therefore, polishing can directly damage most micronutrients because of removing outer layers loaded with micronutrients. As rice was not a concentrated source of essential micronutrients, namely Fe and Zn, biofortification, including traditional plant breeding and genetic modification, are available options to generate advanced varieties with elevated quantity and quality of Fe and Zn (Huang *et al.,* 2015a).

Keeping the importance of micronutrients (Iron and Zinc), the present investigation was done to know the micronutrients (Iron and Zinc) content in popular rice varieties developed by ANGR Agricultural University which enable to recommend the varieties with high micronutrinet content for commercial cultivation.

Materials and Methods

The experiment material used for the study was 20 popular rice varieties which were collected from Regional Agricultural Research Station (RARS), Maruteru and West Godavari District. The salient features of genotypes are mentioned in Table-1. After threshing and cleaning, the seed from individual varieties were dried under shade until moisture content reaches to 14%.A random sample of 250 g paddy was subjected to dehusking using 'Satake' laboratory huller (Type THU 35A).followed by polishing the dehusked brown rice (0% polishing) at two levels *i.e* 5% and 10% polishing. A sample of 150 g of dehusked brown rice was subjected to polishing using 'Satake' rice polisher (Type TM05) for a period of 60 sec to get 5% polishing and 1min 25 sec for 10% polishing. The milled rice samples (0%, 5% and 10% polished samples) were ground to 100 mesh with a cyclotech grinder. Approximately 0.5g of rice flour was weighed and placed into a crucible and then carbonized at 250^{0}C on an electro thermal plate until the sample turned black but not smoking completely. The crucibles with samples were dry-ashed by heating in a muffle furnace at 550°C (about 10-12 h) after sample incineration until a white residue was obtained. The residue was carefully transferred into a 50 ml volumetric flask after it was dissolved with 5 ml of 6 M HCl and then diluted to 50 ml with double distilled water.

Table-1 : Released varieties.

S. No.	Name of the variety	Grain Type
1.	Amara (MTU1064)	MS
2.	Badava Mahsuri (PLA 1100)	MS
3.	Bhavapuri Sannalu (BPT 2270)	MS
4.	Chandra (MTU 1153)	LS
5.	Cottondora Sannalu (MTU 1010)	LS
6.	Indra (MTU1061)	MS
7.	Ksheera (MTU 1172)	MS
8.	Nellore Mahsuri (NLR34449)	MS
9.	Pushyami (MTU1075)	LS
10.	Samba Mahsuri (BPT 5204)	MS
11.	Sri Dhruthi (MTU 1121)	MS
12.	SrikakulamSannalu (RGL 2537)	LB
13.	Swarna (MTU 7029)	MS
14.	Tarangini (MTU 1156)	LB
15.	Varam (MTU 1190)	MS
16.	Vijetha (MTU 1001)	MS
17.	MTU 1210 (Sujatha)	MS
18.	MTU 1224 (Maruteru Samba)	MS
19.	MTU 1239 (Sravani)	MS
20.	MTU 1262 (MaruteruMahsuri)	MS

The diluted solutions were subjected to analysis of micronutrients iron (Fe) and zinc (Zn) by inductively coupled plasma mass spectroscopy. Concentration was expressed in mg %. A minimum of three replications from each of the genotype were analyzed for iron and zinc content.

Results and Discussion

The analysis of variance for iron and zinc estimates obtained after 0, 5 and 10 per cent polishing, (P values at a 5% level of significance) presented in Table-2. It was found that $p<0.05$ for all the mean values which shows that there is a significant variation among iron and zinc content of varieties, among the levels of polishing (0%, 5%, 10%) and between varieties, nutrients and levels of polishing.

The results of mean values of iron (ppm) and zinc (ppm) content determined in the grains of different rice varieties at different polishing (0%, 5% and 10%) levels are given in Table 3. Iron and zinc content were higher in brown rice compared to polished rice (5% and 10%). In this study, the varieties presented a wide range for iron (1.88 to 22.95 ppm) and zinc (7.84 to 34.07 ppm) among all the varieties at different polishing levels. The iron and zinc content of the test genotypes were classified into three distinct groups as mentioned hereunder Table-4.

Among the 20 varieties evaluated, three varieties were classified as low iron and zinc categories, 11 varieties under medium iron, 12 varieties under medium zinc categories and six varieties under high iron, five under high zinc categories. Three varieties were categorized as high iron and zinc category.

Iron and zinc content of brown rice (0% polishing) : All the varieties have shown a significant variance of iron and zinc content at 0, 5% and 10% polishing. Among the varieties screened for iron content, higher iron content was found in MTU 1224 (22.95 ppm)mean iron content ranged from 7.25 ppm (PLA 1100) to 22.95 ppm (MTU 1224), with a general mean of 17.78 ppm in brown rice where seed polishing was not done. Similar results, Fe concentration in brown rice varied from 6.5 (Jayati) to 23.1 (Shah Pasand) ppm with a mean of 12.7, which was reported by Bollinedi*et al.* (2020) in brown rice of 192 Indian rice germplasm accessions. Mean zinc content showed a wide range of values from 13.62 to 34.07 ppm among all the varieties. The highest zinc content was observed in Chandra (34.07 ppm) and the lowest in BadavaMahsuri (13.62 ppm) A study conducted by Banerjee *et al*. (2010) showed wide variation for micronutrient levels among the 46 rice varieties assessed, ranging from 4.8 to 22.7 ppm for grain Fe and 13.95 to 41.73 ppm for grain zinc content.

Rice varieties having higher iron, zinc and both iron and zinc are mentioned in Table-4. Out of 20 rice varieties, only six varieties were under the high iron category,MTU 1210, MTU 1224, MTU 1262, MTU 7029, MTU 1121 and MTU 1061 while MTU 1224, MTU 1262, MTU 1153, MTU 7029, BPT 5204 were the high zinc containing varieties. Moderate zinc and iron-containing varieties include MTU 1153, followed by MTU 1224, MTU1064 and BPT 5204. Varieties such as MTU 7029, MTU 1224 and MTU 1262 were noted to be having both high iron and zinc contents. High iron-containing varieties (>10 ppm) also had higher zinc content, but high zinc containing varieties (>20 ppm) did not have higher iron content.

Iron and zinc content of 5 per cent polished rice : In the present investigation, it was discerned that the mean iron content ranged from 2.71 ppm to 8.74 ppm, with a general mean of 6.70 ppm. Higher iron content was found in released variety MTU 1224 (8.74 ppm) and the lowest was noted in Chandra (2.71 ppm). Mean zinc content showed a wide range of values from 9.63 to 24.63 ppm among all the varieties. The highest zinc content was observed in Chandra (24.63 ppm) and the lowest in BadavaMahsuri (9.63 ppm). The general mean was 16.73 ppm. In the study of Liu *et al.* (2017), the mean value of zinc concentration in rice at 4.2 degrees of milling was observed to be 20.09 ppm.

Iron and zinc content of 10 per cent polished rice : After subjecting the rice grains to 10% polishing, the mean of iron content ranged from 1.88 ppm to 5.96 ppm with an overall mean of 4.64 ppm. Higher iron content was again found in released variety MTU 1224 (5.96 ppm) and the

Table-2 : ANOVA for iron and zinc content.

Source	SS	Df	MSS	F	P-value
Variety	417.80	19	21.99	67.88	<0.05
Nutrients	10212.13	1	10212.13	31524	<0.05
Levels	3505.48	2	1752.74	5410.64	<0.05
Variety * Nutrients	239.93	19	12.63	38.98	<0.05
Variety * Levels	50.29	38	1.32	4.09	<0.05
Nutrients * Levels	71.22	2	35.61	109.93	<0.05
Variety * Nutrients * Levels	83.85	38	2.21	6.81	<0.05
Error	77.75	240	0.32		
Corrected Total	14658.45	359			

MSS – Mean sum of squares, SS- Sum of squres, df – Degrees of freedom

Table-3 : Mean performance of iron and zinc (ppm).

S. No.	Name of the variety	Micronutrient					
		Iron (ppm)			Zinc (ppm)		
		% Polishing					
		0	5	10	0	5	10
1.	Amara (MTU1064)	17.87	6.80	4.64	21.9	15.48	12.62
2.	Badava Mahsuri (PLA 1100)	7.25	2.76	1.88	13.62	9.63	7.84
3.	Badavapuri Sannalu (BPT 2270)	18.49	7.04	4.80	19.62	13.87	11.30
4.	Chandra (MTU 1153)	7.29	2.71	2.00	34.07	24.63	20.58
5.	Cottondora Sannalu (MTU 1010)	18.65	6.94	5.12	21.45	15.51	12.96
6.	Indra (MTU1061)	20.97	7.98	5.44	18.80	13.29	10.83
7.	Ksheera (MTU 1172)	19.75	7.52	5.13	28.55	20.18	16.45
8.	Nellore Mahsuri (NLR34449)	17.64	6.72	4.58	19.67	13.9	11.33
9.	Pushyami (MTU1075)	7.35	2.73	2.01	14.75	10.66	8.91
10.	Samba Mahsuri (BPT 5204)	18.47	7.03	4.79	30.65	21.67	17.66
11.	Sri Dhruthi (MTU 1121)	21.24	8.09	5.51	21.10	14.91	12.15
12.	Srikakulam Sannalu (RGL 2537)	18.04	6.37	4.71	14.70	10.75	8.65
13.	Swarna (MTU 7029)	22.85	8.70	5.93	32.87	23.24	18.94
14.	Tarangini (MTU 1156)	18.88	6.67	4.93	19.75	14.45	11.43
15.	Varam (MTU 1190)	17.9	6.81	4.65	21.55	15.23	12.42
16.	Vijetha (MTU 1001)	18.77	7.15	4.87	33.75	23.86	19.15
17.	MTU 1210	20.77	7.88	5.39	20.55	14.53	11.84
18.	MTU 1224	22.95	8.74	5.96	33.20	23.47	19.45
19.	MTU 1239	18.85	7.18	4.89	19.45	13.75	11.20
20.	MTU 1262	21.60	8.22	5.61	30.55	21.60	17.60
	Mean	17.78	6.70	4.64	23.53	16.73	13.67
	SD	4.79	1.84	1.23	6.82	4.81	3.97
	SE	1.07	0.41	0.27	1.53	1.08	0.89
	CV	26.94	27.46	26.51	28.98	28.75	29.04
	Lowest Range	7.25	2.57	1.88	13.62	9.84	7.84
	Highest Range	22.95	8.54	5.96	34.07	24.93	20.58

lowest was observed in MTU 1153 (1.88 ppm). In 10 per cent polished rice, the drastic iron reduction was observed and the available iron content in the rice is meagre.Mean zinc content showed a wide range of values from 7.84 ppm to 20.58 ppm among all the varieties. The highest zinc content was observed in MTU 1153 (20.58 ppm), followed by MTU 1224 (20.45) and the lowest in PLA 1100 (7.84 ppm).

In the present study, the varieties such as MTU 1224, MTU 7029, MTU 1262, MTU 1121 had shown less reduction or loss in iron and MTU 1153, MTU 1224, MTU 1001, MTU 7029 had shown less reduction in zinc on polishing.

Performance of rice varieties for iron and zinc based on grain type and polishing : Table-5 showed mean values of iron and zinc (ppm) content in different grain types at 0, 5 and 10 per cent polishing levels. The medium slender grain type varieties showed higher iron followed

Table-4 : Classification of micronutrient content.

Micronutrients	Grades	Content (ppm)
Iron	Low	<10
	Moderate	10 – 20
	High	>20
Zinc	Low	<15
	Moderate	15-30
	High	>30

Table-4.1 : Iron and Zinc content of rice varieties.

High Iron		
S. No.	**Variety**	**Iron (ppm)**
1.	MTU 1224	22.95
2.	Swarna (MTU 7029)	22.85
3.	MTU 1262	21.60
4.	Sri Dhruthi (MTU 1121)	21.24
5.	Indra (MTU1061)	20.97
6.	MTU 1210	20.77
High Zinc		
S. No.	**Variety**	**Zinc (ppm)**
1.	Chandra (MTU 1153)	34.07
2.	MTU 1224	33.02
3.	Swarna (MTU 7029)	32.87
4.	Samba Mahsuri (BPT 5204)	30.65
5.	MTU 1262	30.55

High Iron and Zinc

S. No.	Variety	Iron (ppm)	Zinc (ppm)
1.	MTU 1224	22.95	33.02
2.	MTU 7029	22.85	32.87
3.	MTU 1262	21.60	30.55

medium slender type (19.02 ppm) and the lowest mean was absorbed in long slender grain type (11.10 ppm) as shown in Table-5.The mean content of zinc was varied between 13.62-33.75 ppm for medium, slender grain type followed by 14.75-21.45 ppm for long slender, 14.70-34.07 ppm for long bold varieties. Neelamraju et al. (2012) reported Zn concentration from 27 ppm in Jyothi to 67 ppm in O. rufipogon.

Iron and zinc content of 5% polished rice : Medium, slender grain type varieties showed the highest iron content with a mean value of 7.24 ppm, followed by long slender (5.56 ppm) and long bold (4.47 ppm).Long bold grain type showed higher zinc mean value of 17.84 ppm, followed by medium slender (17.24 ppm) and long slender (13.48 ppm).

Iron and zinc content of 10% polished rice : Medium slender have a higher mean value (4.94 ppm) followed by long slender (4.10 ppm) long bold (3.31 ppm) grain type varieties.Long bold grain type has higher zinc mean value of 14.36 ppm, followed by medium slender (14.05 ppm) and long bold varieties (3.31 ppm).

Per cent loss : Iron content decreased drastically as per cent polishing increased from 0 per cent to 10 per cent in that order. Similarly, zinc content also exhibited the same trend of decrease from 0 per cent to 10 per cent polishing, but the decrease is not as prominent as iron **(**Fig. 1 and 2).

From Table-6it was noted that the per cent loss was more in medium, slender grains (61.90-74.02 %) followed by long bold (64.66-73.88%) and long slender (62.77 -72.52 %) at 5 and 10 per cent, respectively. During polishing, the loss was higher at a 10% polishing level (> 70%) among all the varieties studied. 67.24 -79.09 per cent of Fe were removed after 100 seconds of milling (DOM 15%) as reported by Liu *et al*. (2017).

Zinc per centage loss showed very low among all grain types, at 5 and 10% polishing than iron. At 5% and 10% level the per cent loss was between 29.29-42.37%

Table-5 : Mean values of iron and zinc (ppm) as per grain type.

Grain type	% polishing	Iron (ppm)			Zinc (ppm)		
		Mean	**SE**	**Range**	**Mean**	**SE**	**Range**
MS	0	19.02	0.95	7.25-22.95	24.39	1.67	13.62-33.75
	5	7.24	0.36	2.76-8.74	17.24	1.18	9.63-23.86
	10	4.94	0.25	1.88-5.96	14.05	0.96	7.84-19.45
LS	0	14.96	3.81	7.35-18.88	18.65	2.01	14.75-21.45
	5	5.56	1.42	2.73-7.02	13.48	1.46	10.66-15.51
lpar	10	4.10	1.05	2.01-5.18	11.27	1.22	8.91-12.96
LB	0	12.67	5.38	7.29-18.04	24.39	9.69	14.70-34.07
	5	4.47	1.91	2.56-6.37	17.84	7.09	10.75-24.93
	10	3.31	1.41	1.90-4.71	14.36	5.71	8.65-20.07

MS – Medium Slender, LS – Long Slender, LB – Long Bold

by long bold, long slender, whereas long slender varieties showed higher zinc followed by medium slender and long bold among all the varieties at all polishing levels.

Iron and zinc content of brown rice (0 % polishing) : The mean iron content (ppm) in brown rice of medium, slender grain type ranged between 7.25-22.95 ppm, long slender 7.35-18.88 ppm and 7.29-18.04 ppm for long bold varieties. The highest mean iron content was noted in

Table-6 : Per cent loss of iron and zinc.

S. No.	Grain type	% loss			
		Iron		Zinc	
		5% polishing	10% polishing	5% polishing	10% polishing
1.	LS	62.77	72.52	27.69	39.58
2.	LB	64.66	73.88	26.81	41.09
3.	MS	61.94	74.04	29.31	42.37

LS – Long Slender, LB – Long Bold, MS – Medium Slender

(MS), 27.69-39.58% (LS), 28.81-41.09% (LB). As the per cent polishing increased, the iron content showed a decreasing trend. At 10% polishing, more than 70% iron content was lost during processing because the iron is present only in the outer layer of rice, whereas zinc polishing could not influence per cent loss. The effect of milling time on iron and zinc contents of varieties was less at a 5% polishing level than at 10% polishing level, indicating a strong correlation between iron concentration and milling time, which was similar to the report by Raza*et al.* (2019).Iron showed drastic reduction as polishing time increased, but zinc decreased slightly. The results manifested that iron is deposited in a high concentration in the outer layer of brown rice, whereas zinc is equally deposited over the rice grain in all varieties as per the report of Kumar *et al*. (2017).

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Research at Glance on Cowpea at Agriculture Research Station (MPKV), Pandharpur

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Pulses and Oilseed Crop Research and Training Center, Pandharpur, Solapur, Maharashtra

Abstract

Pulse and Oilseed Crops Research and Training Centre, Pandharpur was started on 10th June,1981under Mahatma Phule Krishi Vidyapeeth, Rahuri, funded by Indian Council of Agricultural Research (ICAR) for increase in the production of Pulse and Oilseed Crops. Then it was funded by State Government 29th March, 2006.The total area of 12 hectares Since 1981several recommendations and varieties were made available and transferred farmers. The Research station comes under scarcity zone, $E_4\{C_1D_3\}D_1E_2$ is 3.0 km away from Pandharpur City at 18^{0}N latitude and 75^{0}E longitude with altitude, 463 meters form mean sea level with Average rainfall, 610 mm/45, Min-Max Temp- 8.4$^{0\,c}$ to 42.8^{0c}, Rainfall zone –I and Farming situation= 5. Due to un even and scattered type of rainfall situation and as per the farmers demand this research station started research under Pulses and Oilseed Crops specially on Arid legume Cowpea, Horse gram and zMoth bean and Cluster bean crops and released four varieties of cowpea form 2006 to 2020) Phule Pandhari ii) Phule Vithai iii) Phule Rkhumai and iv) Phule Sonali, determinate, early, Synchronous maturity (2020-2021) and are moderately resistance to pest and diseases. Similarly more than twenty recommendations made for the benefit dry land farmers and those under cultivation on farmers field.

Key words *: Resistance, quality, cowpea, determinate.*

Introduction

Cowpea is an important and popular nutritive food legume in India comprising four cultivated subspecies are recognized *Vigna unguiculata* subsp. *cylindrica* Catjang, *Vigna unguiculata* subsp. *dekindtiana, Vigna unguiculata* subsp. *sesquipedalis* Yardlong bean and *Vigna unguiculata* subsp. *unguiculata* Black-eyed pea. These cultivated species are indeterminate types early and long duration types.

Determinate : Determinate are called, Fixed, Shuttled, Specified type of plants they stop growing when fruit/pods are setting on the terminal or top bud and matures at the same time (2-3 week) then die.

Indeterminate : Indeterminate are called Viney types plants they wii grow and produce fruit/pods until they killed by other natural calamities. They grow up to 6-7 ft. through the season (Agrawal *et al.*, 1980).

Cowpeas are an important source of protein in developing countries, especially where they are eaten in a variety of ways (Dovlo *et al.,* 1976). A number of studies have been directed toward improving traditional cowpea those were long duration. In order over come the study under taken to develop a early determinate with high yielding suitable for dryland and irrigated condition with nutritive values.

Cowpea (*Vigna unguiculata*) is an important source of plant protein crop. Cowpea is starch-protein seeds offering a wider pattern of utilization than any other legume (Henshaw, 2000). Because of it's special features and great demand, there was an urgent need to develop early dwarf high yielding, determinate with synchronous maturity white seeded cowpea. Hence, efforts are being made to develop and modify the cowpea genotype to a determinate with better yield.

Materials and Methods

A crosses were carried out at Pulses and Oilseed Crop Research and Training Centre, Pandharpur during the every year The F_2 population was grown The selections were made in F_2 as well as further segregating populations when F_5 generation stage was achieved. At this stage the population was homogeneous. Among the several selections made in segregating populations, a strains Phule Pandhari, Phule Vithai ,Phule Rkhumai and Phule Sonali were early, dwarf, bushy/ Indeterminate, determinate with synchronous maturity were found to promising under testing in university Multilocation as well as Coordinated Trials. The experiment was laid in randomized block design with three replications having plot size of 1.80 x 4.0 m with spacing of 45 cm between rows and 15 cm between plants with 14 genotypes.

The promising performance, these strains were released and recommended for cultivation on farmers

field in cowpea growing areas of Western Maharashtra and in Southern India.

Results and Discussion

Variety released :

(I) Phule Phandhari : (PCP 9706)

Distinguishing characteristics :

(i) Year of Release : 2006-2007

(ii) Parentage : VCM 8 x V 575

(iii) Yield (Q/ha) : 8-9 Q/ha

(iv) Seed Coat colour : Brown shiny

(v) Released : Western Maharashtra

(iv) Special Characters : High yielding, short duration erect growth habit, pale green leaf & stem colour, brown shiny grains, suitable for multiple cropping system Good grains of quality Crude protein (%)-23.77, IVPD-72.80 Methionine (g/16g N)-0.72.

Over all mean performance of genotype Phule Pandhari with 22.79% increase over check is recommended for cultivation for dry land conditions.

(II) Phule Vithai :

(i) Year of Release : 2015-2016

(ii) Parentage : VCM-8 x Konkan safed

(iii) Yield (Q/ ha^{-1}) : 11 to 12 q

(iv) Seed Coat colour : Off white Shining

(v) Moderately resistant to : YMV , Collor rot

(vi) Release : Release for cultivation in Western Maharashtra

Special Characters : High yielding, Early (70-80 DAS) erect growth habit (Non viney), Dark green leaf & stem colour, Off white shiny grains, suitable for multiple cropping system Good grains of quality Crude protein (%)-21.26, Methionine (g/16g N) -0.70.

Over all mean performance of genotype Phule Vithai with 39.32 % and 16.60 % increase over checks and better performance in Coordinated trials It was recommended (2015-2016) for cultivation for dry land conditions

(III) Phule Rakhumai :

(i) Year of Release : 2015-2016

(ii) Parentage : Pusa dofasli x VCM 8

(iii) Yield (Q/ha^{-1}) : 9 to 10 q

(iv) Seed Coat colour : White Shining

(iv) Moderately resistant to : YMV, Collor rot

(v) Release : Released for cultivation in Western Maharashtra.

Table 1 : Performance at Station and Regional trials.

Trail	Year of testing	Seed yield kg/ha (pooled mean)			
		Number of Trials	Proposed Variety Phule Pandhari	Check Varieties	
				VCM 8	Pusa falguni
Station and Regional Varietal Trials	1999-2007	19	1372	874	615

Table 2 : Performance in Arid Legume Coordinated Varietal trials (2005-2006).

Coordinated Varietal trials	Year of testing	No. of trials	Proposed Variety Phule Pandhari (PCP 9706)	Zonal Checks		
				VCM 8	Pusa falguni	GC 3 (NC)
IVT North zone	2005-06	9	847	830	839	857
South zone	2005-06	8	841			831
	Mean	17	844			844
Over all mean		36	1072			873
% Increase over (Yield kg/ha)				29.16	27.77	22.79

Special Characters : High yielding, Early (71-77 DAS) erect growth habit (Non viney), Dark green leaf & stem colour, White shiny grains, suitable for multiple cropping system Good grains of quality Crude protein (%)-26.12,

Table 3 : Overall mean performance of *Phule Vithai.*

Sr. No.	Description	Variety	Location/trial	Mean Seed yield (kg/ha)	% increase over corresponding respective check
1.	Phule Vithai		16	1201*	
		VCM 8	16	862	39.32
2.			16	1201	
		Phule Pandhari	16	1030*	16.60
3.	Phule Vithai	Northern Zone		740**	
		GC 3	11	632**	17.08
		South Zone		728	
		RC 101	07	643	13.21

Table 4 : Over all mean performance of Cowpea variety Phule Rrakhumai.

Sr. No.	Name of the trial	Year	Seed yield (Kg ha^{-1}) and No of Locations			% Increase over Yield (kg ha^{-1})	
			Phule Rrakhumai	GC 03 Ch 1	RC 101 Ch 2	Ch 1	Ch2
1.	IVT	2012-13	940/7	839/7	643/6	12.03	46.18
2.	AVT I	2013-14	1008/8	839/8	700/8	20.14	44.0
3.	AVT II	2014-15	856/6	794/7	667/7	7.80	28.33
	Weighted Mean		942/ (21)	825/22	673/21	14.2	40.0

Table-5 : Over all mean performance of *Phule Sonali.*

Sr. No.	Description	Variety	Location/trial	Mean Seed yield (kg/ha)	% increase over corresponding respective check
1.	Phule Sonali (2017)	Phule Sonali	07	1361	
		Phule Vithai (Ch1)		1210	11.09
		Phule Rakhumai (Ch 2)		1139	16.31
2.	Phule Sonali (2018)	Phule Sonali	05	1425	
		RC 101 (Ch 1)		1193	16.28
		Phule Rakhumai (Ch 2)		874	38.66
3.	Station Trial (2018)	Phule Sonali	01	1392	
		RC 101 (Ch 1)		942	32.32
		Phule Rakhumai (Ch 2)		991	28.80
4.	South Zone (IVT 2017)	Phule Sonali		1108	
		PCP 0306-1 (ch 1)		1040	6.9
		GC 3 (ch 2)		1046	5.9

*Overall mean of 13 trials conducted within the state only.
**Overall mean of 09 trials conducted South Zone at National level (AICRP on Arid legume trial).
Over all mean performance of genotype Phule Sonali with 11.09 %, 16.31%, 38.66 and 32.32 % increase over checks and better performance in Coordinated trials It was recommended (2020-2021) for cultivation in Western Maharashtra.

Digestibly (%) : (87.26), Cooking time (Mini.) : (41.7), Tannin (mg/g) 0.31.

Over all mean performance of genotype Phule rakhumai with 14.2 % and 40.0 % increase over checks and better performance in Coordinated trials It was recommended (2015-2016) Sothern Zone of India for cultivation.

(III) Phule Sonali :

(i) Year of Release : 2020-2021

(ii) Parentage : RC 101 x Phule Vithai

(iii) Yield (Q/ha^{-1}) : 11 to 13 q

(iv) Seed Coat colour : White Shining

(v) Moderately resistant to : YMV, *Cercospora*, collar rot, leaf spot.

(vi) Release : Released for cultivation in Western Maharashtra.

Special Characters : Determinate and Uniform maturing,

Early R= 58-60 (DAS), Irrigated = 72-75 (DAS) Erect growing, Non-viny, Bold,White shiny seeded, Dark green leaf &stem colour, Crude protein (%) -(24.28), Digestibly (%) : (87.26), Cooking time Mini.) : (40.0), Tannin (mg/g) 0.42, Methionine (mg/g) : 90, Cooking time (Min.) : 40.

Determinate

Phule Sonali

Marker
Purple colour on wing

White Bold seed

Conclusions

Over all mean performance of genotypes Phule Phandhari, Phule Vithai, Phule Rakhumai and Phule Sonali were early, determinate, dwarf, Bushy, high yield potential under protective irrigation and rain fed condition moderately resistance to pest and diseases and also fetches higher market prices were recommended and released for growing in Western Maharashtra and South India.

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The authors are thankful to all concerned scientists and the technical staff who helped in screening and evaluation in various trials at different locations.

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Milk Production in India and World : An Overview

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Abstract

In this paper we have study about milk production and consumption in India and world. This study is based on secondary data, in this study it is concluded India is the largest milk producer in the world. In 2018-19 India produce 196 million ton of milk it is the 23% of the global milk production (850MT).It is revealed in the study India milk production growth rate have been calculated about 5% in this decade compare with global milk production growth rate 2%. Availability of milk per person per day is about 375 grams compare to world per person per day 309 grams in 2017-18. In India have largest population of cow and buffalo about 34% and 50% of the world. These data show good scenario of Indian milk production but there is apathetic fact that is low productivity of milk per animal about 5 litter that is below global average per animals (7 Litter)while Israel and US have 33 and 28 litter per animals. In future if India will increase per animal productivity like Israel and US then milk flood will come in the whole world.

Key words : *Milk production, productivity, consumption and growth rate.*

Introduction

India is such a great country where people believe that cow is such a Kamdhenu which is inhabited by all kinds of Gods and Goddesses, therefore, 81% of the total milk production in the world produce by the cow remaining 15% from buffalo and 4% by goat. It is correct to say that the backbone of the Indian economy is agriculture and animal husbandry is the backbone of agriculture.

As we know India ranks first in milk production in the world But India is less than the global average milk production per animal in milk production. Israel has milk production of 33 litters per animal whereas in India this quantity is only 5 litters per animal milk production.

In order to increase per animal milk production, it becomes necessary that we should also provide a balance diet to our milch animals in our country so that milk productivity can be increased. According to FAO balanced ration formulation in India increased daily income from rearing livestock by about 10%. Similarly, using currently available feed resources, (Blummel et al. 2009 estimated that milk yield per animal in India could be increased from the national average of 3.6 to 9 L/d by using better-formulated diets. FAO (2012). Balanced feeding for improving livestock productivity—Increase in milk production and nutrient use efficiency and decrease in methane emission. However, without proper nutrition, the potential for higher production cannot be met and imported genetics are underutilized (Marshall *et al.* 2019). Nutrient deficiencies lead to increased disease occurrence and reproductive problems. Therefore, information on nutrient concentrations of feed resources and the genetic potential of animals is important in formulating appropriate diets.As per the results of Integrated Sample Survey, the average milk production from a cow was 1,700 kg during the period 2018-19," the minister said a written reply. The average milk production from a cow in the country has increased from 1,259 kg during 2009-10 to 1,700 kg during 2018-19, he said.

Milk and dairy foods provide variety to the diet and make significant contributions to meeting the needs for high-quality protein, calcium, magnesium, selenium, riboflavin, vitamin B12, and pantothenic acid (vitamin B5) in at-risk populations, particularly children, pregnant women, and the elderly.

Objectives of the Study :

To study of present status of milk production in India and world

To identify various challenges and opportunity in dairy industry in India.

Material and Methods

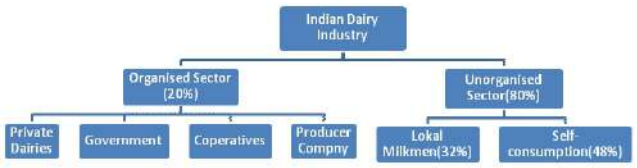
The study has been conducted mainly on the basis of secondary data and literature survey. Data have been found out from various journals, research papers, annual reports,NSSOAH&D, Newspaper articles, and R.B.I, NABARD annual report,

Result and Discussion

Present status of milk production in India and World

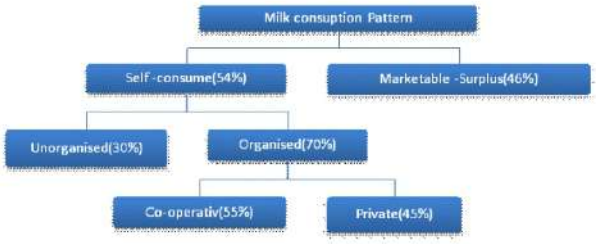
Structure of dairy industry in India : India is the world's largest milk producer and accounts for 23% of the total milk production of the world. The Indian dairy sector is the

largest contributor to the agriculture Gross Domestic Product (GDP).The Indian dairy industry is divided into the organized and unorganized sector. The unorganized sector consists of traditional milkmen, vendors and self-consumption at home, and the organized sector consists of Government, Producer Company, cooperatives and private dairies. As per the Annual Report for FY19 of Dept. of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare, GOI, co-operatives & private dairies still procure only about 20% of the milk produced in the country, while 32% is sold in the unorganized market and about 48% is consumed locally but most of the developed nations, 90% of the surplus milk is processed through organized sector remaining 10% unorganized.



Source : Dept. of Animal Husbandry, dairying & fisheries, Ministry of Agriculture & Farmers Welfare, GOI.

Milk consumption pattern in India : Out of the total production of milk in India, 54% is consumed by farmers and their families themselves. The rest is sold to consumers / institutions or we can say marketable surplus. Out of the marketable milk, 30% is sold directly to consumers by local milkmen and vendors. Only 70% of marketable milk is purchased either by the private players (45%) and cooperatives (55%).



Source : Company, ICICI Securities

Top 10 Milk Producing States in India : In the table no.1 shows top ten milk producing state of India about their milk production status. Highest milk producing state have U.P its production have observed 16.25% fallowed by Rajasthan (12.6%) M.P. (8.47%) A.P.(8.01%) etc. These top ten states have 81.3% share of total milk production (187.7 MT) in India remaining 18.6% share have other state of India.

Global Milk Production Scenario : India is the world's first largest milk production in the world, Table-2 shows information about milk production of top 10 countries of the world. In the year 2019 the total milk production of the world is 852 million ton in which India share has 196 billion ton around 23% share of the total milk production of the world fallowed by U.S. 99 MT, Pakistan 47MT and Brazil 35MT etc. In this table these top ten country milk production share have observed about 63.50 % remaining country percentage share only 36.50 that is very low. The global milk production is given as follows :

World's top ten milk producing countries Percentage of global production (2019)

Present Overview of Indian Dairy Sector : India ranks first among the world's milk producing nations since 1998 and has the largest bovine population in the world. Milk production in India during the period 1950-51 to 2017-18, has increased from 17 million tonnes (MT) to 176.4 MT as compared to 165.4 MT during 2016- 17 recording a growth of 6.65%. FAO reported 1.46% increase in world milk production from 800.2 MT in 2016 to 811.9 MT in 2017. The per capita availability of milk in the country which was 130 grams per day during 1950-51 has increased to 374 grams per day in 2017-18 as against the world estimated average consumption of 294 grams per day during 2017. This represents sustained growth in the availability of milk and milk products for our growing population.

Milk production Annual growth rate and per capita availability of milk in India : According to Press Information Bureau Government of India stated that milk production has increased significantly from 137.7 million tonnes in 2013-14 to 187.75 million tonnes in 2018-19, thereby indicating an increase by 36.35%. Similarly, the per capita availability of milk increased from 307 grams in 2013-14 to 394 grams in 2018-19. Annual growth rate of Milk Production during the period 2009-14 was 4.2%, which has increased to 6.4% during 2014-19 (these data shows in table no 3). The annual growth rate of world milk production has increased by 1.2% during 2014-19.The per capita availability of milk during 2016-17 was 352 gm per day as against world average of 299 gm per day.

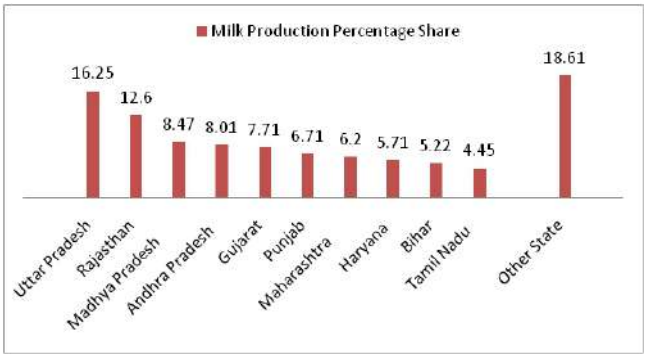
Species wise milk production and their proportion of total milk production in India : Exotic cows across India had the highest yield of milk per animal at the rate of over 11.6 kilograms per day on an average during financial year 2019. Goats yielded the least milk per animal at a mere 0.45 kilograms per day across the country that year. But exotic cows across India have lowest percentage in total milk production only 1%. Indigenous buffalo across India had the highest Proportion of milk percentage (35%).

World top ten country cow milk production and consumption : World milk production (81% cow milk, 15% buffalo milk, and 4% for goat, sheep and camel milk

Table-1 : Top 10 Milk Producing States in India as per 2018-19.

S. No.	Rank	Name of State/UT	Milk Production in (Million Tonnes)	Percentage Share
1.	1	Uttar Pradesh	30.519	16.25
2.	2	Rajasthan	23.668	12.60
3.	3	Madhya Pradesh	15.911	8.47
4.	4	Andhra Pradesh	15.044	8.01
5.	5	Gujarat	14.493	7.71
6.	6	Punjab	12.599	6.71
7.	7	Maharashtra	11.655	6.20
8.	8	Haryana	10.726	5.71
9.	9	Bihar	9.818	5.22
10.	10	Tamil Nadu	8.362	4.45
11.		Total of top ten State	152.795	81.39
12.		Other State	34.954	18.61
13.		All India Total	187.749	100

Source : Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare, GoI.



Top 10 Milk Producing States Percentage Share in India as

combined) In the table no 5 data shows highest cow milk produce by Europium country (EU28) 157.50 MT then US 101.04 MT India have third position 93.8 MT. But in Consumptions India had the highest consumption of cow milk 81 MT per year fallowed by EU 33.40 MT, US grew by 1.3% in 2019 to about 852 Mt. In India, the largest milk producer in the wo21.20 MT.

Top 5 countries, India and world average milk production per year/per had : A cow number vary greatly between countries, and so does cow productivity, due to differences in breeding, feeding and production systems. These characteristics of Indian dairy farming are manifested in low productivity. An international comparison based on FAO statistics in table no 6 shows that milk production per head of cattle per day amounts to 33 kg in the Israel fallowed US 28 kg, UK 22 Kg,. US ,UK 22 kg, Germany and France 21 & 19 Kg as compared with just 5.0 kg in India (see graph above) in 2018, India milk production is belowto world average 7 kg Productivity (milk yield).

Various challenges and opportunity in dairy industry in India

Challenges :

The most biggest challenge in India dairy sector is unorganised about 80%, while 32% is sold in the unorganized market and about 48% is consumed locally but most of the developed nations, 90% of the surplus milk is processed through organized sector remaining 10% unorganized

Although India ranked first in milk production but the productivity of milk in rural areas is very less. For example, Israel has six times and US five times more productivity than India. The cold storage and supply chain infrastructure bottlenecks are ubiquitous in entire farm sector in India. There is a need to develop these infrastructure facilities

Animals need dry or green fodder throughout the year but the scarcity of fodder and water adversely impacts their overall milk production and productivity.

Another challenge is imbalances in supply and demand have caused large fluctuations in the output of the Dairy Product Production industry

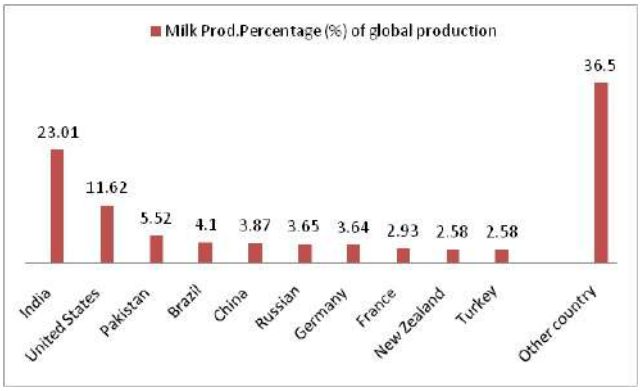
Animals contribute in climate change as they produce methane and carbon dioxide gases but changing climate is adversely affecting the livestock production and reproduction. The focus should be given on small dairy farmers who lack availability of nutritious feed, timely institutional credits, fodder availability in off seasons of the year, timely quality veterinary care etc.

Lack of technological dairy information sources is one of the reasons of low milk production for the farmers of rural areas.

Table-2 : World's top ten milk producing countries (2019).

S. No.	Rank	Countries Name	Milk Production (in million tonnes)	Percentage (%) of global production
1	1	India	196	23.01
2	2	United States	99	11.62
3	3	Pakistan	47	5.52
4	4	Brazil	35	4.10
5	5	China	33	3.87
6	6	Russian	31	3.65
7	7	Germany	31	3.64
8	8	France	25	2.93
9	9	New Zealand	22	2.58
10	10	Turkey	22	2.58
11		Total of Top Ten Country	541	63.50
12		Other country	311	36.50
13		Total global production*	852	100

Source : UNFAO



World's top ten milk producing countries Percentage of global production (2019)

Table-3 : Last 10 year milk production, Annual growth rate and per capita availability of milk in India.

Year	Production (Million Tonnes)	Annual growth rate	Per Capita Availability (gms/day)
2009-10	116.4	3.74	273
2010-11	121.8	4.64	281
2011-12	127.9	5.01	290
2012-13	132.4	3.52	299
2013-14	137.7	3.97	307
2014-15	146.3	6.24	322
2015-16	155.5	6.28	337
2016-17	165.4	6.30	355
2017-18	176.3	6.60	375
2018-19	187.7	6.47	394

Source : Basic Animal Husbandry Statistics, DAHD&F, GoI FY 3019://www.statista.com

Opportunities : Although in India have all above challenges but in Indian dairy industry have lot of opportunity also that is given below :

India is the largest milk producer in the world. In 2018-19 India produce 196 million ton of milk it is the 23% of the global milk production (850MT).

India milk production growth rate have been calculated about 5% in this decade compare with global milk production growth rate 2%.

In India have largest population of cow and buffalo about 34% and 50% of the world.

Focus on buffalo milk based specialty Dairy industry in India is also unique with regard to availability of a large proportion of buffalo milk. Thus, India can focus on buffalo milk based specialty products, like Mozzarella cheese, tailored to meet the needs of the target consumers.

The Indian dairy industry is projected to grow at a CAGR of 15% Y-O-Y to reach INR 9.4 trillion by 2020.

India is the largest milk-consuming country in the world. Currently, the per capita milk availability is 375 gram per person which surpasses world per capita milk availability of 260 gram per person in 2017-18.

Creates jobs for the large section of unemployed educated youth expected to generate 1.2 crore new jobs in a few years.

Creates market opportunities for the indigenous products through product diversification and innovative marketing.

The dairy industry is also set to witness Rs. 130-140 billions of investment in the next two years.

Import of value-added products and export of lower value products With the trade liberalisation, despite the attempts of Indian companies to develop their product range, it could well be that in the future, more value-added products will be imported and lower value products will be exported. The industry has to prepare themselves to meet the challenges.

Table-4 : Species wise milk production per had and their proportion in total milk production in India.

Rank	Species (FY-2019)	Prod.in kg/animal	Species (FY-2017-18)	Proportion of milk by species (%)
1	Exotic cows	11.67	Indigenous buffalo	35
2	Cross-bred cows	7.85	Cross-bred cows	26
3	Indigenous buffalo	6.34	Non-descript buffalo	14
4	Non-descript buffalo	4.35	Indigenous cows	10
5	Indigenous cows	3.85	Non-descript cows	10
6	Non-descript cows	2.50	Goat	4
7	Goat	0.46	Exotic cows	1
			Total Milk	100%

Note : Proportion of milk by species (2017–18) Dairy in India, https://en.wikipedia.org/wiki/
Source : https://www.statista.com/ Average yield of milk per animal in India FY 2019 by species.

Table-5 : World top ten country cow milk production and consumption.

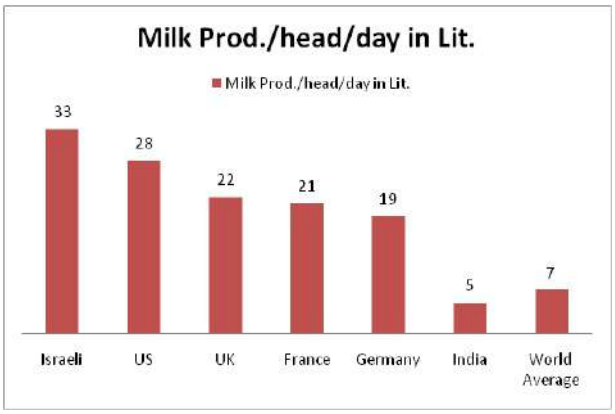
Rank	Production		Consumption	
	Countries	Production (Million Tonnes)	Countries	Consumption (Million Tonnes)
1	EU (28)	157.50	India	81.00
2	US	101.02	EU	33.40
3	India	93.80	US	21.20
4	China	33.00	China	12.00
5	Russia	31.65	Brazil	11.00
6	Brazil	23.51	Russia	7.20
7	New Zealand	22.00	Ukraine	4.55
8	Mexico	12.75	Mexico	4.20
9	Argentina	11.35	Japan	4.00
10	Canada	9.95	Canada	2.38

Source : https://www.statista.com/ https://www.mitsui.com/mgssi/en/index.html

Table-6 : Top 5 country, India and world average milk production per year/per had.

Rank	Country	Milk Prod./head/ year in Lit.	Milk Prod./head/ day in Lit.
1	Israeli	12, 025	33
2	US	10200	28
3	UK	7900	22
4	France	7800	21
5	Germany	7000	19
6	India	1928	5
7	World Average	2500	7

Source : FAO statistics 2019



Top 5 countries, India and world average milk production per /per had/Day

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Effects of Ethephon on Defoliation of Pomegranate (*Pumica granatum* L.) cv. Bhagwa

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Abstract

A field experiment was conducted during 2016-17 with different doses of ethephon in the orchard of pomegranate on farmer's fields. Five years old pomegranate cv. Bhagwa trees of uniform size and growth were selected. Experiment comprised five treatments, replicated for thrice in RBD. Ethephon was applied in doses of 750, 1000, 1250 and 2500 ml/ha during stress period. All treatments caused significant defoliation over the control. However, application of ethephon exhibited defoliation to the extent of 85.50% to 100% after 7 days of spraying. Spraying of ethephon @ 2500 ml/ha was most effective for quick defoliation followed by dose of 1250 ml/ha and 1000 ml/ha. Therefore, it is recommended that ethephon may be applied @ 2500 ml/ha or @1250 ml/ha for quick defoliation in pomegranate.

Key words : *Ethephon, ethrel, defoliation, pomegranate, cv. Bhagwa*

Introduction

Pomegranate (*Punica granatum* L.), of family Punicaceae, is one of the favourite table fruits in the world, for its refreshing juice with nutritional and medicinal properties. Owing to its wide adaptability is grown in tropical, sub-tropical and even in temperate regions over an area of 233.93 thousand hectares with annual production of 2844.52 thousand metric tonnes (Horticultural Statistics at a Glance-2018). Plants can be thrown in rest period when irrigation facilities are generally inadequate. Extracts of different parts of pomegranate plant and fruit have revealed hypotensive, antispasmodic and anthelmintic properties. Juice of the fruit is used for making jelly (Anar rub). Dried seeds are sold as Anardana and rind may be used in tooth powder, in medicine and cosmetics.

Pomegranate is commercially cultivated mainly in Maharashtra and parts of Karnataka where good quality fruits are produced due to dry and hot climate. However, in Madhya Pradesh, it occupies an area of 9.68 thousand hectares with annual production of 114.27 thousand metric tonnes. It has been currently introduced as an alternate commercial fruit crop in Nimar region of M.P. There are three distinct flowering seasons, viz., January-February (*Ambia bahar*) June-July (*Mrig bahar*) and September-October (*Hasta bahar*). The choice of flowering/fruiting depends on the availability of irrigation water, market demand and pests/disease incidence. However, the crop of only one flowering season is taken in a year. Defoliation in pomegranate is an important practice for synchronized flowering (Chandra *et al.*, 2011). An attempt has been made here to test different concentrations of ethephon for the efficacy towards defoliation.

Materials and Methods

Experiment was conducted in *Mrig Bahar* season during 2016-17 on farmer's fields to assess the effectiveness of the different concentrations of Ethephon for quick defoliation. The five years old pomegranate cv. Bhagwa plants with spacing of 4.5 x 3 m were the experimental material. The experiment was laid down in randomized block design with three replications. Four different doses viz. 750, 1000, 1250 and 2500 ml/ha, and control were the treatments. Plants were sprayed over complete canopy (internal and external) with approximately five litters of solution. Uniform cultural practices were adopted during the experiment. For uniform defoliation plants were treated before the start of *Mrig Bahar* season. Spray of Ethephon 39% SL was done as per treatment schedule by knapsack sprayer fitted with hollow cone nozzle. For observations randomly selected five twigs per plant were tagged. The observations were recorded one day before application for number of leaves on tagged twigs. The post treatment observations were recorded on 7^{th} and 14^{th} day after application and the data of per cent defoliation was worked out. Later on plants were regularly observed for initiation of twig sprouting. After 21 and 28 days of application tagged twigs were recorded for sprouting and based on the data per cent twig sprouting was calculated. Observations for fruit set per twig were made 45 days after application. The data recorded was analysed using Web Agri Stat Package (WASP) developed by the ICARGOA.

Results and Discussion

Effect of ethephon 39% SL on defoliation and twig sprouting : The data presented in Table 1 revealed that percent defoliation 7 days after application was in the

Table-1 : Evaluation of Ethephon 39% SL on defoliation and twig sprouting.

Treatment	Dose Formulation (ml/ha)	Dosage Formulation (ml/lit.)	Percentage defoliation		Percentage twig sprouting	
			7 DAT	14 DAT	21 DAT	28 DAT
Untreated control	-	-	7.34	15.27	26.67	33.33
Ethephon 39% SL	750	1.5 ml/ liter	85.50	89.19	73.33	80.00
Ethephon 39% SL	1000	2 ml/ liter	90.85	96.64	80.00	86.67
Ethephon 39% SL	1250	2.5 ml/ liter	93.70	100.00	86.67	100.00
Ethephon 39% SL	2500	5 ml/ liter	100.00	100.00	93.33	100.00
CD (0.05)	2.465	0.999	1.862		1.022	

DAT : Days After Treatment

range of 85.50 to 100.00%. However, in comparison the natural defoliation in control treatment was only 7.34%. The defoliation increased to 89.19 to 100% in the Ethephon 39% SL treatments and only 15.27% in control, when recorded 14 days after treatment. However, defoliation in the treatments of Ethephon 39% SL @ 1250 and 2500 ml/ha was 100%. Similarly, twig sprouting 21 days after treatment was in the range of 73.33 to 93.33%. While in comparison the natural twig sprouting in control was only 26.67%. The sprouting further increased to 80.00 to 100% in the Ethephon 39% SL treatments and only 33.33% in control when observed 28 days after treatment. However, twig sprouting in the treatments of Ethephon 39% @ 1250 and 2500 ml/ha was 100%. It is observed that lower dose of Ethephon 39% SL @ 750 ml/ha was less effective. Ethephon is commonly used to induce thinning of fruitlets or to facilitate the fruit harvesting process (John-Karuppiah and Burns, 2010). In the presence of ethylene, the cells within the fruit pedicel AZ produce cell wall degrading enzymes, thereby inducing the disintegration of the separation layer in the AZ and ultimately leading to the detachment of the fruit (Leslie *et al.,* 2007). The use of ethephon promoted significant defoliation as occurred with other abscission agents (Hartmond *et al*., 2000b and Li *et al*., 2008). Indeed, defoliation increased with higher doses. However, as observed in the present study that despite loss of leaves, the capacity of the trees to intercept light was not severely affected (Li *et al*., 2006) because trees may partially compensate defoliation by increasing the capacity for photosynthesis of the leaves that remain in the canopy.

Conclusions

All the treatments were found effective in defoliating the plant and early twig sprouting as compared to control. However, Ethephon 39% SL @ 1250 and 2500 ml/ha were most effective for defoliation and early twig sprouting.

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Management of Leaf Curl Virus Disease in Chilli (*Capsicumannuum* L.)

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Abstract

A field experiment was conducted for the management of leaf curl virus disease in chilli in the Kharif season of 2019 and 2020 on the ten farmers' field in Khargone (M.P.). Treatments comprised T_1 Farmers' practice (Use of different insecticides *viz*., cypermethrin, profenophos etc. with mixing two or more than two insecticides and spraying once in a week) and T_2 IDM module (Treatment of seeds with Imidacloprid 70% WS @ 10 g/kg seed, raising of seedlings under insect proof net house (40 mesh nylon net), dipping seedling roots inImidacloprid 17.8% SL @ 0.3 ml/liter of water for 30 minutes, growing two rows of maize as barrier crops, installation of yellow sticky trap @ 25/ha, initial rouging of infected plants soon after infection, spray of Neem oil 3000 ppm @ 3 ml/liter two times at 10 days interval starting at 15 days after transplanting + need based spray of insecticides *viz*.Imidacloprid 17.80% SL 150 ml/ha, Pyriproxyfen 10% EC 500 ml /ha and Fenpropathrin 30% EC 250 ml/ha in rotation of 15 days interval, till fruit formation). The minimum disease incidence of 7.96% and 6.51% were recorded in T_2 in the year 2019 and 2020 respectively with maximum yields of 50.30 q/ha and 51.30 q/ha. However, in the farmers practice (T_1) yields were 41.30 q/ha and 38.80 q/ha with the maximum disease incidence of 26.92% and 23.38% respectively. Protection in IDM module recorded as 70.42% and 72.18% in 2019 and 2020 respectively which enhanced productivity 21.79% and 32.21%. Besides, highest benefit cost (B:C) ratio of 2.36 and 2.38 under IDM module whereas it was 1.82 and 1.70 under farmers' practice in 2019 and 2020, respectively.

Keywords : *Chilli, percent disease incidence, integrated disease management, leaf curl virus disease*

Introduction

Chilli (C*apsicum annuum* L.) is an important spice crop, which are used in green as well as ripe dried form for its pungency. It is widely cultivated inwarm temperate, tropical and subtropical regions of the world. It is used widely in culinary, pharmaceutical, cosmetics and beverage industries throughout the world (Tiwari *et al*., 2005). It is rich in vitamin C,A,B, oleoresin and red pigment. India is one of the major producers, exporters and consumers of chillies in the world. However, the productivity is very low in comparison to other chilli growing countries.Venkatesh*et al.* (1998) reported that chilli leaf curl virus (Chi LCV) caused by leaf curl begomovirus transmitted by whitefly (*Bemesiatabaci*). Therefore, it is necessary to check the population level of vectors by different means (mechanical, biological, chemical, etc.) in such a manner that the vectors could not damage the crop economically.Earlier some workers conducted studies on viral diseases on chilli considering the destructive nature, the extent of yield losses due to leaf curl ranged from 25 to 80% (Ilyas & Khan, 1996). Optimum temperature for disease development is 30 to 35°C and relative humidity above the 85%. Owing to leaf curl disease farmers are switching over to some other profitable crops (Salane *et al*., 2006). The chilligrowers always protect the crop from any type of damage caused by insects-pests and others. Pesticides are important commonly tools to curb these insect-pests. The farmers often use excessive quantity of pesticides without proper diagnosis which causephytotoxicity in fruits (Joia *et al*., 2001), insecticide resistance, pest resurgence and environmental pollution (Singh and Kumar, 1998). Surveys conducted by the KrishiVigyan Kendra, Khargone (M.P.) in fields of chilli growers, leaf curl disease came out as the major problem which is spread by the whitefly. Therefore, the management of the vector was important in this study. Considering the seriousness of leaf curl and higher doses of pesticides used,Integrated Disease Management module was assessed to optimize the quality chilli production with an improved benefit cost ratio.

Materials and Methods

The field experiment was conductedduring Kharif season 2019 and 2020 on ten farmers' field in Khargone (M.P.). The treatments comprised T_1 Farmers' practice (Use ofdifferent insecticides viz., cypermethrin, profenophos etc. with mixing two or more than two insecticides and spraying once in a week) and T_2 IDM module (Treatment of seeds with Imidacloprid 70% WS @ 10 g/kg seed, raising of seedlings under insect proof net house (40 mesh nylon net), dipping seedling roots in Imidacloprid 17.8% SL @ 0.3 ml /liter of water for 30 minutes, growing two rows of maize as barrier crops, installation of yellow sticky

Table-1 : Effect of IDM approach against Chilli leaf curl virus disease.

Treatments	2019-20		2020-21	
	Mean per cent disease incidence	Per cent protection over farmers' practice	Mean per cent disease incidence	Per cent protection over farmers' practice
T_1	26.92		23.38	
T_2	7.96	70.42	6.51	72.18
t-value	15.481605		13.404658	

The result is significant at $p < 0.05$

Table-2 : Effect of IDM module onyield of chilli.

Treatments	2019-20		2020-21	
	Mean yield dry chilli (q/ha)	Per cent gain over farmers' practice	Mean yield dry chilli (q/ha)	Per cent gain over farmers' practice
T_1	41.30		38.80	
T_2	50.30	21.79	51.30	32.21
t-value	14.230249		7.945017	

The result is significant at $p < 0.05$

Table-3 : Effect of IDM module oneconomic parameters.

Treatments	Cost of cultivation (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		Benefit Cost : ratio	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	249237	250310	454300	426800	205063	176490	1.82	1.70
T_2	234678	238996	553300	567600	318622	328604	2.36	2.38

trap @ 25/ha, initial rouging of infected plants soon after infection, spray of Neem oil 3000 ppm @ 3 ml/liter two times at 10 days interval starting at 15 days after transplanting + need based spray of insecticides viz., Imidacloprid 17.80% SL 150 ml/ha, Pyriproxyfen 10% EC 500 ml/ha and Fenpropathrin 30% EC 250 ml/ha in rotation of 15 days interval, till fruit formation). The area of experimental plotswas 0.40 ha. Seeds were sown in plastic cavity trays filled with sterilised coco peat, All the trays were placed in insect proof net house and watered regularly. Thirty days old seedlings of chilli hybrid Navtejwere transplanted on raised beds with the spacing of 1.20 m X 0.40 m.Recommended practices were followed.The percentage disease incidence was recordedat 30, 60, 90, 120 and 150 days after transplanting under natural infection at random. Percent disease incidence worked out as per Nene, 1972.

$$\text{Per cent Disease Incidence (\%)} = \frac{\text{Number of infected plants / plot}}{\text{Total no. of plants observe / plot}} \quad 100$$

Various parameters were compared as per paired "t" test of significance.

Results and Discussion

Effect of IDM module on per cent disease incidence : Chilli leaf curl disease incidence during 2019 and 2020 is presented in Table-1. The leaf curl symptoms observed were curling of leaves, light and dark green mosaic, vein clearing, puckering of leaflets, stunting and bushy appearance due to reduced internodal length with partial to complete sterility.It is apparent from the Table 1 both the treatments were significantly different and the minimum 7.96% disease incidence was observed under T_2 which was 70.42% protected the disease incidence over T_1 (farmers' practice) during 2019. Similarly, both the treatments significantly differed from each other during 2020. The disease protection may be attributed to the seed treatment with Imidaclopridand seedling treatment with Imidacloprid, destruction of infected plants and foliar sprays of Neem oil at 15 days after transplanting and subsequent need based spray of insecticides viz., Imidacloprid, Pyriproxyfen and Fenpropathrin in rotation at the interval of 15 dayswhich kept the vector population at low level particularly at early stages of crop growth and resulted in low disease incidence. The present findings are also in accordance with the reports of Fugrro *et al.* (2005), Kumar and Bhansali (2005). Kumar and Kumar (2017) also revealed that leaf curl of chilli was reduced to a great extent by following Integrated Disease Management (IDM) package comprising biological, cultural, physical and need based use of systemic insecticides.

Effect of IDM module on yield : The highest yield (50.30 q/ha) was observed under T_2 with 21.79% gain over farmers' practice during 2019 and 51.30q/ha with 32.21% gain over farmers' practice during 2020 (Table-2). The lowest yield was recorded in farmers' practice during 2019 and 2020 respectively. Healthy plant (not having the viral disease symptoms) always yields better and do not become a source of inoculum. Hewson *et al.* (1998) stated

that level of control and crop yield from IDM programme are often better than conventional method. Mondal and Mondal (2012) concluded that average yield in the IDM villages were better as compared to control in non-IDM villages. Pandey *et al.* (1998) were also concluded similar findings.

Effect of IDM module on economics of chilli : Yield economics is another important point for the successful cultivation of any crop. The cost of cultivation was worked out by adding the costs incurred on agronomic practices. The total cost of cultivation was recorded as Rs 234678/ha (T_2 IDM module) and Rs 249237/ha (T_1farmers' practice) during 2019. Similarly, during 2020 the total cost per hectare on IDM module was Rs 238996 and Rs250310on farmer practice (Table 3). The highest net return of Rs 318622/ha and BC ratio 2.36 were recorded in T_2. However,net return of Rs 205063/ha was recorded in T_1 with B ratio of 1.82 (2019). Similarly, highest net return Rs328604/ha with BC ratio 2.38 in T_2 and Rs 176490/ha with BC ratio 1.70 in farmers' practice were recorded during 2020. Cost of cultivation was lesser in IDM practices in comparison to farmers' practice due to reduced number of sprayings of pesticides with optimum quantity of pesticides. Average pesticide expenditure of IDM trained farmers was significantly lower than that of non-IDM farmers (Mondal & Mondal, 2012). Pandey*et al.* (2005) were in conformity of such findings while dealing with tomato leaf curl.

Conclusions

Thus, it may be concluded that the IDM modules for leaf curl disease in chilli are more effective technology over farmers practice. Income ofchilli growers may be increased with unique eco-friendly IDM module for leaf curl disease.

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Perception of Adolscents on Balanced Dietin Ayodhya

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Abstract

A balanced diet is one which provides all the nutrients in required amounts and proper proportions. Eating a balanced diet is key in maintaining good health and keeping your body in optimum condition. A healthy diet has been recognized as one of the most important factors associated with the maintenance of human health as well as to help preventing the development of some chronic diseases. A balanced diet is made up of foods from the five food groups: starchy carbohydrates, fruits and vegetables, protein, dairy and healthy fats. Each provides the range of vitamins and minerals our bodies need to function efficiently. A balanced diet protects the body against all forms of malnutrition, provides immunity and also some non communicable chronic diseases, such as obesity, type-II diabetes, heart diseases, or cancer. In the current post covid era people have become more conscious of food and are now more aware of the positive or negative associations between diet and health. Nonetheless, even those consumers who are aware of these implications often end up making unhealthy food choices. How people interpret the concept of healthy eating is variable and reflects personal, social, and cultural involvements, along with the particular person's living environment. Therefore, this work aimed at studying the perceptions of a sample of adolscents of Ayodhya about balanced diet.

Research Methodology

Planning of the Survey : Planning of survey includes selection of topic and preparation of a short questionnaire covering almost all the areas. From this questionnaire those question which seem too relevant in context of the mentioned topic are selected.

Area of survey : Sample was collected from 10th, 11th Class girls and boys of Faizabad public school, Ayodhya.

Sample size : This study was conducted on 50 girls and 50 boy's students of Faizabad Public School.

Sampling tools and Technique : In the survey work, the sampling technique used was "simple Random Sampling". Population was divided in two group's i.e. girls and boys.

General Information : This section consisted of general question such as Name of the Respondents, age, education, sex.

Data Collection : Data for this study was collected by mean of Questionnaire. The questionnaire was filled by the students themselves. Questions were explained to the students whenever required.

Results and Discussion

Maximum 60% respondents did not have not knowledge about balanced diet while 40% Respondents have knowledge. While 70% female Respondents have knowledge in comparison to 30% of females who lacked knowledge (Table-1). Maximum 60% male respondents never think about balanced diet while 70% female respondents think balanced diet when they eat (Table 2). Maximum 64% Male Respondents have right opinion about Balanced Diet, 26% respondents said that tasty and flavour diet is balanced diet while 70% Female Respondents have right opinion (Table 3). Maximum 64% male respondents took decision about what to eat, 20% respondents never took decision about what to eat whereas 16% female respondents took decision all times about what to eat (Table-4). Male respondents (60%) preferred both fast food and balanced type food in school lunch box, 28% male respondents preferred balanced food while 12% respondents preferred fast-food in school lunch box. While in female Respondents maximum 44% prefer both type food followed by females that preferred balanced diet and 16% who preferred fast food (Table-5). A total of 32% male respondents preferred chips, candy, or fruits roll in snacks and 20% respondents likely preferred. In maximum 32% female respondents some times, 20% respondents not very likely (Table-6). Maximum 64% male respondents took4 litre water per day, and 16% respondents took 2 litre water per day, while in 58% female respondents took 4-litre water per day (Table-7).

Perceptions of healthy eating can be considered as one of the many factors influencing people's eating habits. People's perception toward food choices is influenced by diverse factors, such as the biological need of nutrients and energy, hunger, socioeconomic status, demographic variables, personal taste, lifestyles, health factors,

Table-1 : Distribution of Respondents according to their knowledge about balanced-diet.

Knowledge about Balance diet	Male	Percent-age	Female	Percent-age
Yes	20	40%	35	70%
No	30	60%	15	30%
Total	50	100%	50	100%

Table-2 : Distribution of respondents According to their Thinking about balanced diet when they are eat

Thinking about Balanced Diet	Male	Percent-age	Female	Percent-age
Yes	20	40%	35	70%
No	30	60%	15	30%
Total	50	100%	50	100%

Table-3 : Distribution of Respondents according to their opinion about Balanced-diet

Opinion about Balanced Diet	Male	Percent-age	Female	Percent-age
Nutritious Diet	32	64%	35	70%
Tasty or flavor	13	26%	6	12%
Always a very big meal	5	10%	9	18%
Total	50	100%	50	100%

Table-4 : Distribution of Respondents according to their decision about what to eat.

Decision About What To eat	Male	Percent-age	Female	Percent-age
Never	10	20%	8	16%
Some times	32	64%	12	24%
All times	8	16%	30	60%
Total	50	100%	50	100%

Table-5 : Distribution of respondents According to their preference of lunch box in school.

In Lunch Box	Male	Percent-age	Female	Percent-age
Fast food	6	12%	8	16%
Balanced diet	14	28%	20	40%
Both	30	60%	22	44%
Total	50	100%	50	100%

emotions, security, convenience, food prices, ethical concerns, cultural and religious influences, or nutrition knowledge (Liu *et al.* 2017; Sami *et al.* 2017; Cînpeanu *et al.* 2019). Thereexist a lack of knowledge on perceptions

Table-6 : Distribution of Respondents who prefer to eat Chips, cookies, Candy or fruits roll in snakes.

Category	Male	Percent-age	Female	Percent-age
Very likely	16	32%	12	24%
Some what likely	12	24%	16	32%
Likely	10	20%	12	24%
Not very likely	12	24%	10	20%
Total	50	100%	50	100%

Table-7 : Distribution of Respondents how much drinking water per day.

Category	Male	Percent-age	Female	Percent-age
2 litre	8	16%	16	32%
4 litre	32	64%	29	58%
4-6 litre	10	20%	5	10%
Total	50	100%	50	100%

of healthy eating. Paquette (2005) was of the view that more data are needed on the perceptions of healthy eating in general, on the influence on perceptions of messages from diverse sources such as food companies, and, most important, on the role of perceptions of healthy eating as a determinant of food choice. Individual factors identified include knowledge, attitudes and food preferences; only the latter have been identified as a strong determinant of healthy eating in both children and adolescents (Taylor *et al., 2005*).

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Effect of Soya Protein and Stabilizer Concentrations on Sensory Parameters of Protein Enriched Carambola-Guava Blended Pre-Biotic Nectar

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Abstract

The present investigation was carried out to study the effects of soya protein and stabilizer concentration on microbial and sensory parameters of protein enriched carambola-guava blended pre-biotic nectar which was prepared using twelve treatment combinations comprised of three levels of soya protein (P_1-0.50 %, P_2 -1.00 % and P_3 - 1.50 %) and four levels of stabilizer (S_1-0.00 %, S_2-0.25 %, S_3-0.50% and S_4-0.75 %). The results of present investigation revealed that carambola-guava blended pre-biotic nectar prepared with 15% guava pulp with 5 % carambola, 0.20 % fibre addition, 1.00 % soya protein and 0.50 % stabilizer remained shelf stable on the basis microbial and sensory quality up to two months storage in glass bottle.

Key words : *Fruit beverage, soya protein, stabilizer, fibre, sensory quality, blending*

Introduction

Guava fruit is a rich source of vitamin C, vitamin A, vitamin B_2, (riboflavin) and minerals like calcium, phosphorus and iron. The carambola fruit beverages are not preferred by the consumer due to their inherent acidic and astringent taste. The acceptance of carambola beverages can be increased by blending with guava fruits having acceptable taste and flavour. Although fruits are rich in fibre but the juice extraction through the juice extractor generally reduces the fibre content of juice. These fibres are known to cure several degenerative diseases. Therefore, there is need to optimize fibre concentration for preparation of pre-biotic blended nectar from carambola and guava. These fibers are known to cure several degenerative diseases. Now-a-days, the protein energy malnutrition is a major problem particularly among the growing children who need more proteins for their growth. Fruits are poor source of the proteins and consumption of fruits or fruit based products by the consumers may leads to protein deficiency. In view of bridging up the gap between requirement and availability of protein, there is urgent need to add soya protein into the fruit beverages to fulfill the protein requirement.

Materials and Methods

Nectar was prepared as per FPO specification containing 20 % pulp, 15 °Brix (TSS) and 0.30% acidity. A total of 12 treatments were used for preparation of protein enriched carambola-guava blended pre-biotic nectar using different concentration of soya protein and stabilizer as detailed in Table-1.

Sugar syrup was prepared by adding table sugar to boiling water. The strength of sugar syrup was measured using hand refractometer. Carambola-guava blended pre-biotic nectar was prepared by mixing of blended carambola (05%)-guava pulp (15%), soya protein (soya protein concentrate as soya protein source). Soya protein and stabilizer (sodium alginate) were added below 80°C into sugar syrup to maintain desired TSS and homogenized. Then the mixture was boiled up to 95±1°C and required quantity of citric acid was added to maintain 0.30% acidity. The prepared nectar was filled into pre-sterilized glass bottles (200 ml) and sealed air tight with crown caps. The product was then pasteurized at 95±1°C in boiling water for 30 minutes followed by cooling and storage at room temperature for three months and utilized for analysis of microbial and sensory characteristics.

Selection of Carambola and Guava fruits

Sorting and washing

Cutting

Extraction of Carambola pulp and Guava pulp

Straining of pulp

Blending of pulp

Addition of fibre

Addition of protein as per treatment

Addition of stabilizer as per treatment

Adjustment of Acidity and TSS

Heating

Bottling

Heat Processing

Cooling and Storage (Ambient Temperature)

Fig-1 : Principal steps for preparation of soya protein enriched pre-biotic nectar.

Treatment Details

Factor 1 : Soya protein concentrations (P) **:**

P_1 : 0.50%

P_2 : 1.00%

P_3 : 1.50%

Factor 2 : Stabilizer (Sodium alginate) concentrations (S)**:**

Stabilizer (S)	Concentration (%)
S_1	0.00
S_2	0.25
S_3	0.50
S_4	0.75

Table-1: Detail of treatments used to optimize protein source and stabilizer concentrations for preparation of protein pre-biotic nectar.

Treatment Combinations	Protein Source Concentrations (soya protein)	Stabilizer (%)
T_1-P_1S_1	0.50%	0.00
T_2-P_1S_2	0.50%	0.25
T_3-P_1S_3	0.50%	0.50
T_4-P_1S_4	0.50%	0.75
T_5-P_2S_1	1.00%	0.00
T_6-P_2S_2	1.00%	0.25
T_7-P_2S_3	1.00%	0.50
T_8-P_2S_4	1.00%	0.75
T_9-P_3S_1	1.50%	0.00
T_{10}-P_3S_2	1.50%	0.25
T_{11}-P_3S_3	1.50%	0.50
T_{12}-P_3S_4	1.50%	0.75

Microbiological parameters of the processed products : Total plate count (TPC) of samples were estimated aseptically by inoculating 0.1 ml of serially diluted sample in petri-plates containing LB agar medium prepared according to Ranganna (1997). The samples (1 ml) after dilution (10^{-3}) were spread over the LB agar plates in laminar air flow. Then the plates were incubated at 37°C for 24 h followed by colony count. The results of the total plate count (TPC) were expressed as CFU/ml of sample.

Organoleptic evaluation of the processed products : The samples in which observed microbial count were not provided to the sensory panelist for the taste and flavor as illustrated in tabular form such methodology earlier by Akinola *et al*. (2018) for giving sensory score to the products.

Sr. No	TPC (CFU/ml)	Sensory score (9 point Hedonics Scale)
1.	$<1 \times 10^3$	5
2.	$1\text{-}2 \times 10^3$	4
3.	$2\text{-}4 \times 10^3$	3
4.	$4\text{-}6 \times 10^3$	2
5.	$>6 \times 10^3$	1

Sensory panelists (7-9 members) comprised of faculty members and PG students of Department of Post-Harvest Technology, NAU, Navsari (Gujarat) were used for sensory analysis throughout the entire period of storage. Coded samples of products were served. Plain tap water was provided to the panelists for mouth rinsing in between the sensory evaluation.

Results and Discussion

Effect on colour : The effect of soya protein and stabilizer concentrations on colour of soya protein enriched carabola guava blended pre-biotic nectar during three month storage period has been presented in Table-2. The results shows decrease in mean colour from initial value of 7.89 to 6.71 during three month storage. The interaction of soya protein concentration, stabilizer concentrations and storage depicted variation in colour from 6.46 to 8.04 during three month storage period, with maximum decrease in colour from 7.75 to 6.46 in nectar prepared using 1.50% soya protein with 0.75% stabilizer ($P_3S_4M_1$ to $P_4S_4M_4$) and minimum from 8.30 to 7.50 in nectar prepared by using 0.50% soya protein with 0.25% stabilizer ($P_1S_2M_1$ to $P_1S_2M_4$). The decrease in score during storage might be attributed due to changes in chemical constituents and non-enzymatic reactions. The decrease in sensory colour score during storage in the present investigation are in line with the observation reported by Kale *et al.* (2012) soya milk blended orange juice RTS and Arshad *et al.* (2018) in protein fortified jackfruit jam.

Effect on flavour : Data obtained during flavour of soya protein enriched carambola-guava blended pre-biotic nectar have been presented in table-3. The decrease in mean flavor score from initial value of 8.11 to 4.39 during three month storage. The interaction of soya protein, stabilizer concentrations and storage depicted variation in flavour from 3.59 to 8.13 during three month storage period, with maximum decrease in taste from 8.00 to 3.59 in nectar prepared using 1.50% soya protein with 0.25 % stabilizer ($P_4S_2M_1$ to $P_4S_2M_4$) and minimum from 8.25 to 4.95 in nectar prepared by 1.00% soya protein with 0.75% stabilizer ($P_2S_4M_1$ to $P_2S_4M_4$). The decrease in flavour

Table-2 : Effect of soya protein concentration and stabilizer concentrations on colour score (9 point Hedonic scale) of soya protein enriched carambola-guava blended pre-biotic nectar during storage period.

Treatments	Colour score (9 point Hedonic scale)				
	Initial (M_1)	One month (M_2)	Two month (M_3)	Three month (M_4)	Mean
T_1-P_1S_1	8.04	7.79	7.58	6.92	7.58
T_2-P_1S_2	7.96	7.75	7.50	6.88	7.52
T_3-P_1S_3	7.96	7.67	7.46	6.80	7.47
T_4-P_1S_4	7.92	7.59	7.42	6.74	7.42
T_5-P_2S_1	8.00	7.71	7.38	6.88	7.49
T_6-P_2S_2	7.92	7.67	7.34	6.75	7.42
T_7-P_2S_3	7.88	7.63	7.34	6.67	7.38
T_8-P_2S_4	7.80	7.50	7.29	6.60	7.30
T_9-P_3S_1	7.88	7.67	7.30	6.64	7.37
T_{10}-P_3S_2	7.80	7.63	7.25	6.59	7.32
T_{11}-P_3S_3	7.79	7.60	7.21	6.54	7.29
T_{12}-P_3S_4	7.75	7.50	7.17	6.46	7.22
Mean	7.89	7.64	7.35	6.71	7.40

Table-3 : Effect of soya protein concentration and stabilizer concentrations on flavour score (9 point Hedonic scale) of soya protein enriched carambola-guava blended pre-biotic nectar during storage period.

Treatments	Flavour score (9 point Hedonic scale)				
	Initial (M_1)	One month (M_2)	Two month (M_3)	Three month (M_4)	Mean
T_1-P_1S_1	8.13	8.00	7.88	4.67	7.17
T_2-P_1S_2	8.17	8.05	7.92	4.70	7.21
T_3-P_1S_3	8.17	8.09	7.92	4.75	7.23
T_4-P_1S_4	8.21	8.13	7.96	4.85	7.29
T_5-P_2S_1	8.17	8.04	7.94	4.80	7.24
T_6-P_2S_2	8.21	8.09	7.94	4.84	7.27
T_7-P_2S_3	8.25	8.13	7.96	4.88	7.31
T_8-P_2S_4	8.25	8.21	8.00	4.95	7.35
T_9-P_3S_1	7.96	7.79	7.50	3.54	6.70
T_{10}-P_3S_2	8.00	7.80	7.54	3.55	6.72
T_{11}-P_3S_3	8.00	7.84	7.55	3.59	6.75
T_{12}-P_3S_4	7.75	7.50	7.17	3.59	6.50
Mean	8.11	7.97	7.77	4.39	7.06

score during storage might be attributed to loss of volatile aromatic compounds (Baramanray *et al*., 1995 and Choudhary *et al.,* 2008). Similar results were found Bhat and Singh (2014) for whey-guava blended beverage.

Effect on body : Data pertaining body score of soya protein enriched carambola-guava blended pre-biotic nectar presented in Table-4. The storage of nectar resulted in decrease in mean body from initial value of 8.13 to 6.26 during three month storage. The interaction of soya protein concentrations, stabilizer concentrations and storage depicted variation in body from 6.04 to 8.04 during three month storage period, with maximum decrease in body from 8.13 to 6.04 in nectar prepared using 1.50 % soya protein with 0.75 % stabilizer ($P_4S_4M_1$ to $P_4S_4M_4$) and minimum from 8.04 to 6.33 in nectar prepared by 0.50% soya protein ($P_1S_1M_1$ to $P_1S_1M_4$). Decrease in body score may be due to separation and sedimentation of nectar due to increase in protein concentrations addition in nectar. Similar results were also reported by (Anon 2016) in mango-noni blended nectar and Ahmad (2017) in mango products.

Effect on taste : The data regarding taste score of soya protein enriched carambola-guava blended pre-biotic nectar presented in table-5. Taste value ofcarambola-nectar was decreased in mean taste from initial value of 8.27 to 4.39 during three month storage. The decrease in taste during storage is due to protein concentrations. The interaction of soya protein concentrations, stabilizer concentrations and storage depicted variation in body from 3.59 to 8.21 during three month storage period, with maximum decrease in taste from 8.27 to 3.59 in nectar prepared using 1.50% soya protein with 0.75 % stabilizer ($P_4S_4M_1$ to $P_4S_4M_4$) and minimum from 8.38 to 4.95 in nectar prepared by 1.00% soya protein with 0.50% stabilizer ($P_2S_3M_1$ to $P_2S_3M_4$). However, the higher concentration of whey protein along with different

Table-4 : Effect of soya protein concentration and stabilizer concentrations on body score (9 point Hedonic scale) of protein enriched carambola-guava blended pre-biotic nectar during storage period.

Treatments	Body score (9 point Hedonic scale)				
	Initial (M_1)	One month (M_2)	Two month (M_3)	Three month (M_4)	Mean
T_1-P_1S_1	8.04	7.80	7.67	6.33	7.46
T_2-P_1S_2	8.08	7.84	7.70	6.29	7.48
T_3-P_1S_3	8.13	7.88	7.75	6.21	7.49
T_4-P_1S_4	8.08	7.84	7.75	6.08	7.44
T_5-P_2S_1	8.13	7.96	7.80	6.33	7.56
T_6-P_2S_2	8.20	8.00	7.84	6.38	7.61
T_7-P_2S_3	8.25	8.08	7.88	6.44	7.66
T_8-P_2S_4	8.21	8.04	7.84	6.42	7.63
T_9-P_3S_1	8.04	7.88	7.54	6.08	7.39
T_{10}-P_3S_2	8.08	7.92	7.55	6.21	7.44
T_{11}-P_3S_3	8.17	7.96	7.59	6.25	7.49
T_{12}-P_3S_4	8.13	7.92	7.59	6.04	7.42
Mean	8.13	7.93	7.71	6.26	7.50

Table-5 : Effect of soya protein concentration and stabilizer concentrations on taste score (9 point Hedonic scale) of soya protein enriched carambola-guava blended pre-biotic nectar during storage period.

Treatments	Taste score (9 point Hedonic scale)				
	Initial (M_1)	One month (M_2)	Two month (M_3)	Three month (M_4)	Mean
T_1-P_1S_1	8.21	8.04	7.88	4.67	7.20
T_2-P_1S_2	8.29	8.08	7.92	4.70	7.25
T_3-P_1S_3	8.29	8.17	8.00	4.75	7.30
T_4-P_1S_4	8.30	8.13	7.96	4.85	7.31
T_5-P_2S_1	8.30	8.17	8.00	4.80	7.32
T_6-P_2S_2	8.34	8.21	8.08	4.84	7.37
T_7-P_2S_3	8.38	8.21	8.17	4.88	7.41
T_8-P_2S_4	8.34	8.25	8.13	4.95	7.42
T_9-P_3S_1	8.13	7.88	7.67	3.54	6.81
T_{10}-P_3S_2	8.13	7.92	7.72	3.55	6.83
T_{11}-P_3S_3	8.21	7.96	7.76	3.59	6.88
T_{12}-P_3S_4	8.27	7.92	7.80	3.59	6.90
Mean	8.27	8.08	7.92	4.39	7.17

stabilizer concentration observed to have maximum decrease which might be attributed to higher microbial load. Higher protein concentration may be the congenial food for the growth of the microbes. The values of present investigation are almost in conformed to that reported Bhat and Singh (2014)for whey-guava blended beverage and Vaghasiya (2015) for Aloe verabased health drink.

Overall acceptability : The perusal of data pertaining to effect of soya protein and stabilizer concentrations during three month storage period on over all acceptability of soya protein enriched carambola-guava blended pre-biotic nectar has been presented in Table 6. The storage of carambola-guava nectar resulted in decrease in mean overall acceptability from initial value of 8.11 to 5.44 during three month storage. Interaction of blending levels, fibre concentrations and storage depicted variation in overall acceptability from 4.92 to 8.19 during three month storage period, with minimum decrease in over all acceptability from 8.19 to 5.73 in nectar prepared by 1.00 % soya protein with 0.50 % stabilizer ($P_2S_3M_1$ to $P_2S_3M_4$) during two months as well as three months storage. Maximum decrease in over all acceptability from 8.06 to 4.92 was noticed in nectar prepared by 1.50 % soya protein with 0.75 % stabilizer ($P_4S_4M_1$ to $P_4S_4M_4$) during two months as well as three months storage. The decrease in overall sensory score of pre-biotic blended nectar during storage could be correlated to changes in colour, taste and body of pre-biotic blended nectar. The values of present investigation are almost in conformed to that reported by Devi *et al.* (2017) for whey-pineapple juice and Arshad *et al.* (2018) for protein fortified jackfruit jam.

Total plate count : The perusal of data pertaining to total plate count of soya protein enriched carambola-guava blended pre-biotic nectar in table-6 shows that nectar prepared using different soya protein concentration and stabilizer concentration of protein enriched carambola-

Table-6 : Effect of soya protein concentration and stabilizer concentrations on overall acceptability score (9 point Hedonic scale) of soya protein enriched carambola-guava blended pre-biotic nectar during storage period.

Treatments	Over all acceptability score (9 point Hedonic scale)				
	Initial (M_1)	One month (M_2)	Two month (M_3)	Three month (M_4)	Mean
T_1-P_1S_1	8.10	7.91	7.75	5.65	7.35
T_2-P_1S_2	8.13	7.93	7.76	5.64	7.37
T_3-P_1S_3	8.14	7.95	7.78	5.63	7.38
T_4-P_1S_4	8.13	7.92	7.77	5.63	7.36
T_5-P_2S_1	8.15	7.97	7.78	5.70	7.40
T_6-P_2S_2	8.17	7.99	7.80	5.70	7.42
T_7-P_2S_3	8.19	8.01	7.84	5.73	7.44
T_8-P_2S_4	8.15	8.00	7.81	5.72	7.42
T_9-P_3S_1	8.00	7.81	7.50	4.95	7.07
T_{10}-P_3S_2	8.00	7.82	7.51	4.98	7.08
T_{11}-P_3S_3	8.04	7.84	7.53	4.99	7.10
T_{12}-P_3S_4	8.06	7.80	7.53	4.92	7.08
Mean	8.11	7.91	7.70	5.44	7.29

Table-7 : Effect of soya protein, and stabilizer concentrations on TPC (x103 CFU/ml) of soya protein enriched carambola-guava blended pre-biotic nectar during storage period.

Treatments	TPC (x103 CFU/ml)			
	Initial (M_1)	One month (M_2)	Two month (M_3)	Three month (M_4)
T_1-P_1S_1	-	-	-	0.33
T_2-P_1S_2	-	-	-	0.30
T_3-P_1S_3	-	-	-	0.25
T_4-P_1S_4	-	-	-	0.15
T_5-P_2S_1	-	-	-	0.20
T_6-P_2S_2	-	-	-	0.16
T_7-P_2S_3	-	-	-	0.12
T_8-P_2S_4	-	-	-	0.05
T_9-P_3S_1	-	-	-	1.46
T_{10}-P_3S_2	-	-	-	1.45
T_{11}-P_3S_3	-	-	-	1.41
T_{12}-P_3S_4	-	-	-	1.41
Mean	-	-	-	

guava blended pre-biotic blended nectar have not found microbial contamination during initial two months At the third month of storage all treatments were found having microbial contamination. Thus, all nectar samples were safe for consumption up to two month storage. Similar results were found by Maya *et al.* (2016) for whey based orange beverage and Arshad *et al.* (2018) for protein fortified jackfruit jam.

Conclusions

From the present investigation, it can be concluded that the soya protein enriched carambola-guava blended pre-biotic blended nectar prepared by using 15% guava pulp with 5% carambola, 0.20 per cent fiber with addition of 1.00% soya protein and 0.50% stabilizer remained shelf stable on the basis of microbial and sensory quality up to two months in glass bottles at ambient temperature.

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A Study on the Knowledge Regarding Hygiene during Menstruation among Rural Women

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Abstract

The study was planned to assess the knowledge of rural women regarding hygiene during menstruation.The study was conducted in village Kharbadiyaof Girwa block of Udaipur district of Rajasthan. For this, a sampleof 50 rural women was selected randomly. The data was collected through interview technique. Seven components i.e. Concept of menstruation and menstruation cycle, managing menstruation and products used during menstruation, Benefits of sanitary napkin, Availability of vending machine in school and colleges, Hygiene during menstruation and ways of disposal the sanitary napkin, Problems during menstruation and coping with discomfort and Nutrition during menstruation were selected for assess the knowledge of rural women about hygiene during menstruation. Results revealed that majority of the respondents, (54%) exhibited poor knowledge (less than 33.33%), 42 per cent exhibited average knowledge and only 2 per cent had good knowledge of all the components of hygiene during menstruation. It can be concluded that knowledge of the rural women about hygiene during menstruation were unsatisfactory. Women should be educated about the proper hygienic practices as well as to bring them out of traditional beliefs, misconceptions, and restrictions regarding menstruation so that they can prevent herself from many infections such as fungal or bacterial infections of the reproductive tract and the urinary tract.

Key words : *Knowledge, hygiene, rural women, menstruation.*

Introduction

In the era of scientific and technological advancements where changes have become a way of life, the female adolescent, enmeshed in fears and doubts, trying to assume physical and emotional maturity, invites more than a casual interest. Adolescence is that period of life during which maturity is attained. Adolescence is viewed as a time of rebellion, a time to fight for dreams. This is a period of transition from childhood to adulthood. During this period (12-16 years), girls attain puberty. With puberty come profound internal changes involving novel and more sensitized social reactions. This is also the stage which raises the status of the girl to that of a woman. Girls begin to have a growth spurt around the age of 10-13 years. The female typically begins breast development in her 10th year, experiences considerable genital growth in her 11th year and begins to menstruate from her 12thyear. This growth process continues for approximately 3 years during which all secondary sexual characteristics emerge. Sexual development due to the influence of hormones is the major change in adolescence. Sexual development occurs in three distinct stages-pre-pubescence, pubescence and post-pubescence.

During pre-pubescence, over all body growth increases, especially of the reproductive organs, the secondary sex characteristics begin to appear and as a part, menstruation begins in the girl. Menstruation is the first significant milestone in the reproductive history of a woman's life. It is a phenomenon unique to the females, and menarche is an important land mark in the process of growth and maturation. However the women and girls are lacking in right knowledge. They need to be educated about the facts of menstruation and its physiological implications. Also they should be educated about the significance of menstruation and development of secondary sexual characteristics, selection of a sanitary menstrual absorbent its proper disposal and the problems related to menstruation.

Materials and Methods

The study was conducted in Udaipur district of Rajasthan. There were 17 PanchayatSamitis in Udaipur district, out of which one i.e. Girwapanchayatsamiti, was selected randomly. From the list of villages of Girwa panchayat samiti one village i.e. Kharbdiya was selected randomly. For selection of sample, 50 rural women were selected randomly from the village. An interview schedule was prepared and personal interview technique was used by the researcher for the purpose of data collection. The collected data was processed, tabulated and analysed using frequency, percentage and mean percent score.

Results and Discussion

Knowledge is the most important component of behaviour and it plays a major role in the covert and overt behaviour of human beings. Once knowledge is gained, it helps in

developing favourable attitude to take certain action in accepting an innovation.

Table-1 : Distribution of respondents according to their knowledge.

Category	Knowledge	
	f	%
Good (66.66% - 100%)	2	4
Average (33.33% - 66.66%)	21	42
Poor (Less than 33.33%)	27	54

Table-2 : Component wise knowledge scores of the respondents.

S. No.	Components	Mean Percent Score
1.	Concept of menstruation and menstruation cycle	44.14
2.	Managing menstruation and products used during menstruation	80.32
3.	Benefits of sanitary napkin	27
4.	Availability of vending machine in school and colleges	2.0
5.	Hygiene during menstruation and ways of disposal the sanitary napkin	18.75
6.	Problems during menstruation and coping with discomfort	23
7.	Nutrition during menstruation	8.66

Table-1 indicates that majority of the respondents (54%) exhibited poor knowledge (less than 33.33%), 42 per cent exhibited average knowledge and only 4 per cent had good knowledge category in all the components of hygiene during menstruation. Maji (2016) reported that 45 per cent of respondents knew about menstrual cycle before their menarche. In most cases (60%) their first informants were their peer group followed by mothers. Most of the girls in the study were not aware of the cause and the source of the bleeding. A majority of them had knowledge about the use of sanitary pads but still now 34% of them use old cloths and use those cloths. The study was also supported by Borker et al. (2014), most of the women (76%) have a positive attitude towards menstrual hygiene. Main reason of not using sanitary napkins was economic reasons. However, 29 per cent of the women opined that they were not aware regarding the method of its disposal and another 29 per cent opined that they did not like it. Most of the women (68%) of the study population reuse their cloth during their periods and 43.7 per cent of the women used soap to clean the reused cloth during their period. Also 31 per cent of women were using Dettol for cleaning the cloth before re-use. Most of the women (76.5%) of the study population took bath twice per day during their periods and 99 per cent of women were taking bath at least once a day during the periods.

Table-2 reveals that all the respondents exhibited poor knowledge in most of the components of hygiene during menstruation. Majority of the respondents (80.32%) exhibited good knowledge in the component 'managing menstruation and products used during menstruation. Less than half of the respondents (44.14%) were aware about 'concept of menstruation and menstruation cycle', followed by 'benefits of sanitary napkin (27%), 'problems during menstruation and coping with discomfort (23%)' hygiene during menstruation and ways of disposal the sanitary napkin (18.75%). Majority of the respondents reported that they used cloth for the purpose of menstruation and dried under shade, mostly in rooms and they used soap for clean the groin area. More than half of the respondents had no knowledge about the nutrition during menstruation. The least initial knowledge was found in the components 'availability of vending machine in school and colleges' and 'nutrition during menstruation' with mean percent scores 2.0 and 8.66. None of the respondents had any previous knowledge regarding the process of menstruation and as too in which phase egg is released. According to Kansal et al. (2016), 90.78 per cent respondents had attained menarche at the time of interview and only one-third of the respondents (29.4%) were aware of menstruation before menarche. Only 31 per cent respondents were using sanitary pads during menstruation. Self-reported reproductive tract infection (RTI) was observed more in respondents not maintaining hygienic practices (6.6%) as compared to those maintaining hygiene (2.6%). According to Patel *et al.* (2016) majority of the respondents i.e. 86.70 per cent girls used sanitary napkins whereas 13.3 per cent girls were using clothes and reusing them. Most of the girls perceived that sanitary napkin was comfortable and caused adequate absorption but having disadvantage of an expensive and not being easily available at all places.

Santra (2017) found that only 32 women (20%) had idea before menarche regarding menstruation. Majority of the women used only sanitary pads and 30 per cent used only cloth pieces whereas 5 per cent used both pad and cloth piece. Prevalence of sanitary pad use was significantly higher among those aged below 25 years ($p<0.05$).

Conclusion

It can be concluded from the study that despite changes in trends and modernization over the years, we still fall behind in creating a satisfactory level of awareness of menstrual health and hygiene. In the study, menstrual

hygiene knowledge and practices were found be unsatisfactory among the rural women and various restrictions during menstruation were also in practice. It is recommended from the study that women should be educated about the importance of use of sanitary pads and the harms of using cloths. Awareness also needs to be created to abolish the unnecessary restrictions that are imposed on women to be followed during menstruation so that they can prevent herself from many infectionssuch as fungal or bacterial infections of the reproductive tract and the urinary tract.

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Perception of Migrants on Push and Pull Determinants of Rural Out Migration : A Study on Interstate Migration from Assam to Kerala

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Abstract

Migration is a process of movement of an individual from his place of birth to a new place of residence. Interstate migration is an outcome of social, economic and cultural diversity in India.The factors in the state of origin forms the basis for people to migrate to another state while certain factors in destination state also attract people to it. The increasing urbanization trends inthe past show that there is larger migration from rural to urban parts of India. Various push & pull factors are the reason for rural to urban migration of these interstate migrants, which arise due to regional disparities among the states in India. The study on reason for migration of youth from Assam was conducted in the year 2020 with 120 respondents. The respondents were rural youths of Assam migrated to Ernakulam, Kerala and worked in unorganized sector. The Snow ball technique was applied to select the respondents. The study revealed that 69.16 per cent of the respondents perceived push factors as the major determinant for migration and 88.30 per cent of the respondents perceived pull factors as the major determinant for migration.

Key words : *Interstate out migration, snow ball technique, reasons, push and pull factors.*

Introduction

Migration is a universal phenomenon. People explored all around the world for better economic condition and secure places. It is as old as human history. This movement of people from one .place to another temporarily, seasonally or permanently, associates with numerous push or pull factors of voluntary or involuntary reasons. Such movements lead to significant economic .and social transformation in the regions of source and destination of the migrants. The out-migration of people from Kerala to different parts of India and to the Gulf countries like Saudi Arabia, Dubai etc. and the role played by the remittance in the state economy and individual households is well known. This has created a huge gap in the unorganized sector in Kerala, leading to huge demand for certain categories of workers such as welders, drivers, helpers etc. The shortage of workforce in construction and other related sectors resulted in the, in-migration of workers from other states like Tamil Nadu, West Bengal, Orissa and Assam to Kerala. The migration from Assam started after the collapse of plywood factories in Assam. One of the main reason for migration was lack of adequate income or the lack of adequate non-agricultural jobs in rural areas, and higher expected income or better job opportunities in urban areas (Sridhar *et al,* 2010).The Present study was carried to find out reasons of migration as perceived by the respondents.

Materials and Methods

The state of Kerala comprises of 14 districts among those Ernakulam district was selected purposively for the present study. A multistage sampling design using the snow ball technique was followed in the present study. A total of 120 migrants from Ernakulam district were selected using snowball sampling for the study. Respondents were rural youth migrated from Assam to Kerala for livelihood. A pretested, structured questionnaire was prepared and interviewed every respondent personally for collecting the data. The collected data were coded, tabulated and analyzed in accordance with the objectives of the study by using appropriate statistical tools like Percentages, frequencies, standard deviation mean, class interval and Chi-square.

Results and Discussion

The findings have been discussed in the following heads :

Perception of migrants on determinants (push and pull determinants) of rural out migration : The perception of respondents on determinants of interstate out migration was described by two factors (i) Push factors and (ii) Pull factors.

Perception on push factors : Table-1 shows that majority (69.16%) of the respondents had a high level followed by medium (28.33%) and low (2.5%) level of perception on push factors of out migration.

The majority (69.16%) of the respondents had high level of perception on push factors of migration because they might be struggling to survive in their native place with the existing income and their livelihood became difficult. The mean value was also skewed towards high perception category side which indicated that the push

Table-1 : Distribution of respondents according to their overall perception on push factors of out migration.

Sl. No.	Category	Range	Frequency	Percentage	Mean	Standard deviation
1.	Low	14 - 23	3	2.5	34.15	4.38
2.	Medium	23 - 32	34	28.33		
3.	High	32 - 41	83	69.16		

Table-2 : Distribution of respondents according to their overall perception on pull factors of out migration.

Sl. No.	Category	Range	Frequency	Percentage	Mean	Standard deviation
1.	Low	12 - 20	2	1.66	30.8	3.06
2.	Medium	20 - 28	12	10.00		
3.	High	28 - 36	106	88.33		

Table-3 : Distribution of respondents according to their perception on various push factors of out migration.

Sl. No.	Push determinants	Agree*		Partially agree*		Disagree*		Mean Score	Rank
		f	%	f	%	f	%		
1.	Crop failure due to heavy rainfall and flood	73	60.83	32	26.66	15	12.50	2.48	VI
2.	Lack of employment opportunities in the village	83	69.16	30	25.00	7	5.83	2.63	III
3.	Frequent natural calamities force people to migrate	59	49.16	43	35.83	18	15.00	2.34	X
4.	Inability to meet basic needs with existing income	86	71.66	27	22.50	7	5.83	2.65	II
5.	Inability to meet educational expenses and medical expenses of family	54	45.00	47	39.16	19	15.83	2.29	XI
6.	The existing income of the family did not permit to clear off the bank loan	53	44.16	45	37.50	22	18.33	2.25	XII
7.	Decreased wage rates influence people to migrate to other places	93	77.50	21	17.50	6	5.00	2.72	I
8.	Peer group and relatives encourage them to migrate to other states	63	52.50	45	37.50	12	10.00	2.42	IX
9.	Low returns from agriculture causes migration of people to other states	70	58.33	42	35.00	8	6.66	2.51	V
10.	Farmers have no social status in the village	67	55.83	40	33.33	13	10.83	2.45	VIII
11.	No or less land holding owned by family	82	68.33	24	20.00	14	11.66	2.56	IV
12.	When a person faces family Conflict he would like to leave his family and to migrate to other place	45	37.50	47	39.16	28	23.33	2.14	XIV
13.	Social, caste and status related struggle in village causes migration	51	42.50	39	32.50	30	25.00	2.17	XIII
14.	Lack of proper government support to people force them to migrate	71	59.16	36	30.00	13	10.83	2.48	VII

factors were strongly forcing the respondents to move out of the village.

Results of migrants perception on various push determinants that are forcing them to move out of their villages were shown in Table 3. From the table, it was indicated that 77.5 per cent of the respondents perceived that decreased wage rate was the major push factor for out migration. This may be due to inability of the respondents to look after their family using the existing income. It has also been noticed that natural calamities like flood, erosion have made agriculture as non remunerative and drudgerous in the study area. Many people from the flood affected areas are migrating for finding better avenues and more profit by leaving agriculture.

The employment opportunities in the villages were very limited, irregular in nature and also they received less income. They engaged in a particular period of the year. This showed an increased dependence on wage-earning occupations and decrease in dependence on agricultural works. More than half (71.66%) of the respondents perceived that inability to meet basic needs with existing income was one of the major push factor for their interstate out migration. The livelihood expenses were increasing and they couldn't meet it with existing income, so they took the decision to migrate. These findings indicated that the migrants were more interested on regular wage earnings rather than seasonal earnings. The respondents also agreed that the other push factors like no or less land holding (68.33%), no proper government support (59.16%), no social status in the village for farmers (55.83%), due to encouragement of peer group and relatives (52.50%), inability to meet educational expenses and medical expenses of family with the existing income (45.00%), social, caste and status related struggle in the village (42.50%) and family conflicts (37.50%) as the main reason that forced the respondents for their interstate out migration. This is in conformity with the results of Singh *et al.* (2011) and Madhu and Uma (2014).

Perception on pull factors : Table-2 shows that, the majority (88.33%) of the respondents had a high level followed by medium (10%) and low (1.66%) level of perception on pull factors of out migration.

From the Table-3, it is clear that the majority of respondents had high level of perception on pull factors of

Table-4 : Distribution of respondents according to their perception on various pull factors of out migration.

Sl. No.	Pull determinants	Agree*		Partially agree*		Disagree*		Mean Score	Rank
		f	%	f	%	f	%		
1.	Improved railway and communication facilities	86	71.66	23	19.16	11	9.16	2.62	VI
2.	Diverse employment opportunities in Ernakulam	96	80.00	24	20.00	0	0	2.80	II
3.	High demand of labors in urban areas of Kerala	95	79.16	22	18.33	3	2.50	2.76	III
4.	Better earning opportunities in urban areas	99	82.50	13	10.83	8	6.66	2.75	IV
5.	Wages are higher comparatively	111	92.50	9	7.50	0	0	2.92	I
6.	Experience of already migrated persons	83	69.16	30	25.00	7	5.83	2.63	V
7.	Works are available throughout year	76	63.33	33	27.50	11	9.16	2.54	VII
8.	Works are not drudgeous comparatively	60	50.00	39	32.50	21	17.50	2.32	X
9.	Availability of unskilled works attract people	73	60.83	33	27.50	14	11.66	2.49	VIII
10.	Can earn maximum money within 6 months/1 year of stay	67	55.83	35	29.16	18	15.00	2.40	XI
11.	Availability of basic facilities in the work place attract them	55	45.83	38	31.66	27	22.50	2.23	XII
12.	Lack of mandatory permit limits attract people	52	43.33	51	42.50	17	14.16	2.29	XI

migration because they were mostly attracted by the pull factors related to employment and wages which is comparatively higher in Kerala. The availability of works throughout the year and improved transportation and communication facilities encouraged them to migrate. The presence of friends and relatives in the destination was also attracted them to migrate to Kerala, as it reduced the risk of searching for jobs and getting rented homes for staying.

From the Table-4, it is clear that the majority (92.5%) of the respondents perceived that higher wages were the main reason for their out migration. This may be because the minimum wages they get in Kerala is double the wages they get in Assam. Around 82.5 per cent of the respondent's perceived that better earning opportunities in urban areas for unskilled labors was one of the major pull factor for their out migration. The reason behind this may be they can earn a good money without any skills. About 80 per cent of the respondent's perceived that the diverse employment opportunities were one of the important pull factors. This is because Ernakulam is the commercial capital and they can easily find jobs in various sectors without much delay. About 71.66 per cent of the respondents perceived that improved railway and communication facilities were main reason for their out migration. There is direct trains and flights that connects Assam and Kerala. Earlier migrants used to travel in trains but now they started using flights. About 69.16 per cent of the respondents perceived that experience of already migrated persons attracted them to migrate to Kerala. This helped them for finding jobs easily and they don't need to search for places to stay. They were also attracted to the factors like availability of unskilled works (60.83%), can earn maximum money with 6 month/1 year for which they stay in Kerala (55.83%), less drudgerous work comparatively (50%), availability of basic facilities in the work place (45.83%) and lack of mandatory permits (43.33%). This is in conformity with the results of Sridhar *et al.* (2010), Patidar (2018) and Kumar (2016).

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Management of Powdery Mildew of Okra through Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) Chemical under Field Conditions

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Abstract

Powdery mildew of okra caused by *Erysiphecichoracearum* DC is one of the important diseases affecting the crop. A field trial was conducted at Agricultural Research Station, Nipani, during kharif/Rabi 2016-17 to 2017-18 to find out the effective fungicidal application for its management. The crop was sprayed with seven different fungicides along with check starting from the first appearance of the disease. Two sprays of Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) 0.23% (T2), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) 0.28% (T3), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) 0.32% (T4), Trifloxystrobin 50% WG 0.66% (T5), Tebuconazole 250 EC (Tebuconazole 25.9% w/w EC) 0.66% (T6), Sulphur 80% WP 2.93% (T7) and Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) 0.16% (T8) were taken up in the treated plots. Effect of each treatment on the disease incidence and yield was recorded. The disease index was significantly reduced in plots treated when compared to the untreated control. Analysis of the data for one season/year showed that okra powdery mildew can be significantly reduced by spraying 0.28% Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) @ 150+75 a. i. (g)/ha followed by 2.93% Sulphur 80% WP @ 2504 a. i. (g)/ha in both the year 2016 and 2017. Highest bhendi yield of 14.07 and 13.19 t/ha was harvested in the treatment spraying with 0.28% Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) @ 150+75 a. i. (g)/ha followed by 2.93% of Sulphur 80% WP @ 2504 a. i. (g)/ha 13.25 and 12.21 t/ha in both the year 2016 and 2017. There were no symptoms of phytotoxicity and other harmful effects on okra plants either on leaves or on stem after application of Nativo @ 175+87.5 a. i. (g)/ha and Nativo @ 350+175 a. i. (g)/ha used in this trial (by visual observation).

Key words *: Okra, powdery mildew, nativo and management*

Introduction

Okra (*Abelmoschus esculentus* L. Moench) generally known as lady finger, belongs to family Malvaceae. Origin of okra is Asian and African countries but now a day it is cultivated in various parts of the world like Florida, Albama, Georgia and Pakistan (Thompson and Kelley, 1937). A number of fungal diseases attack on okra crop but powdery mildew disease caused by *Erisiphaecichoracearum* is an emerging potential threat to okra crop which causes huge losses in yield up to 90 % (Ghanem, 2003) and continuously hammering economics of farmers. Researchers recommended different management strategies for this disease and concluded that use of resistant source is the principle one but due to non-availability resistant cultivars, use of chemical for quickcontrol of powdery mildew disease is highly desirable. That is why in present study Nativo (tebuconazole 50% + trifloxystrobin 25% WG) at different concentration are evaluated to search out most suitable and effective dosageof fungicide as compared to chemical check. Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a.i. 125+62.5(g), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)a. i. 150+75 (g), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a.i. 175+87.5 (g), Trifloxystrobin 50% WG a.i. 87.5 (g),Tebuconazole 250 EC (Tebuconazole 25.9% w/w EC) a.i. 175 (g), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a.i. 350+175(g), and Sulphur 80% WP a.i. 2504 (g) were tested against powdery mildew disease. Triadimefon and Tridemorph expressed most promising results (Upadhyay and Gupta, 1994; Shivanna *et al.,* 2006). Saxena and Saxena (2002) reported that penconozole, carbendazim and tridemorph expressed promising results against powdery mildew disease while Alam *et al.,* (2007) examined efficacy of eight fungicides against powdery mildew disease and reported that chemical Seozole 5EC not only reduced percent disease index (PDI) but also improve yield, pod height, pods per plant, length of pod, breadth of pods and seeds per plants. Abundant use of chemicals is neither economical nor beneficial for environment. Plant extracts which consist of anti-microbial compound are safe for environment. Anumber of plants posse's antifungal agents which were used by different researchers against powdery mildew disease of okra (Culter and Hill, 1994). Hot and cold water extracts of papaya leaves were effective in reducing the powdery mildew disease of okra (Kumar, 2010) but cold water extracts were more effective than hot water extracts as bioactive extracts were sensitive to heat. No doubt fungicides expressed prompt results in controlling plant diseases but continuous use of chemicals exhibited health

hazard effects as well as it resulted evolution of new races of pathogens.

Materials and Methods

A field trial was conducted during 2016 and 2017 at Agricultural Research Station, Nipani, Karnataka, India, to test the efficacy of Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) against Okra Powdery mildewat different a.i. Concentration. Okra crop variety Arka Anamika was raised during kharif seasons in a randomized block design with three replications. A spacing of 60 x 10 cm was adopted in plots of 3.6 X 7.0 m (25.2 sq. mt.) and eight treatments were imposed, namely, Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a. i. 125+62.5(g) (T2), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a.i. 150+75 (g) (T3), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)a. i. 175+87.5 (g) (T4), Trifloxystrobin 50% WG a.i. 87.5 (g) (T5), Tebuconazole 250 EC (Tebuconazole 25.9% w/w EC) a.i. 175 (g) (T6), Sulphur 80% WP a.i. 2504 (g) (T7), Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a. i. 350+175(g) (T8), and untreated control (T1). The fungicides were sprayed soon after the first appearance of the disease. The treatments were repeated two times at 15 days interval, and a total of four sprayings were taken up for each fungicide. Observations on the disease incidence were recorded 10 days after the last spray using thescale of 0-5 (Joi and Shinde, 1974) on randomly selected 10 plants of upper, middle and lower leaves. From total grades of 30 leaves, the percent disease index (PDI) was calculated. The yield ofgreen okra fruits pickings in each treatment was recorded. The data were statistically analyzed to evaluate the effect of different concentrations of Nativofungicide on the okra yield. The percent decrease in the disease and increase in the yield over the control were also calculated by using following formula :

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \quad 100$$

Results and Discussion

The disease appeared at 45 to 52 DAS during both the years on the test crop laid out. The results were presented in the table-1. During the1st year of study the okra powdery mildew disease severity was recorded in untreated control with a minimum of 56.00 PDI in 2016-17 toa maximum of 58.33 PDI in 2017-18 (Table-1). The mean PDI in differentially sprayed okra plots ranged from 28.00 in case of Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG) a.i. 150+75 (g) (T3) to 54.00 in case of Tebuconazole 250 EC (Tebuconazole 25.9% w/w EC) a.i. 175 (g) (T6) whilein untreated control (T1) it was 56.00 in 2016-17 and in case of 2017-18 27.00 in case of

Table-1 : Evaluation of different concentrations of Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) and other chemicals on okra Powdery Mildew in the year 2016 and 2017.

Sl. No.	Treatments	a.i. (g)	Dose (g or ml/ha)	Dose (%)	Mean PDI of Powdery Mildew 2016	Mean PDI of Powdery Mildew 2017	Mean	Yield (t/ha) 2016	Yield (t/ha) 2017	Mean
T_1	Unreated check	-	-	-	56.00 (48.43)	58.33 (49.84)	57.17 (49.14)	10.56	10.42	10.49
T_2	Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)	125+62.5	250	0.23	48.00 (43.83)	46.67 (43.04)	47.34 (43.44)	12.65	11.66	12.15
T_3	Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)	150+75	300	0.28	28.00 (31.93)	27.00 (31.29)	27.50 (31.61)	14.07	13.19	13.63
T_4	Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)	175+87.5	350	0.32	41.66 (40.18)	42.00 (40.37)	41.83 (40.28)	12.89	11.34	12.11
T_5	Trifloxystrobin 50% WG	87.5	700	0.66	50.66 (45.36)	50.33 (45.17)	50.50 (45.27)	12.97	11.19	12.08
T_6	Tebuconazole 250 EC (Tebuconazole 25.9% w/w EC)	175	700	0.66	54.00 (47.28)	53.67 (47.13)	53.84 (47.21)	12.62	11.90	12.26
T_7	Sulphur 80% WP	2504	3130	2.93	33.00 (35.04)	35.00 (36.14)	34.00 (35.59)	13.25	12.21	12.73
T_8	Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)*	350+175	175	0.16	41.00 (39.80)	40.67 (39.59)	40.84 (39.70)	12.60	10.97	11.785
				SEm	0.87	3.27	2.07	0.36	1.21	0.785
				CD (p=0.05)	2.64	9.41	6.03	1.08	3.48	2.28

Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG) a i. 150+75 (g) (T3) to 53.67 in case of Tebuconazole 250 EC (Tebuconazole 25.9% w/w EC)a. i. 175 (g) (T6) while in untreated control (T1) it was 58.33. Disease index was significantly reduced in plots treated when compared to the untreated control. Amongthe seven different concentrations of fungicides sprayed, lowest mean disease severity of 28.00 and 27.00 PDI was recorded with Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG) a.i. 150+75 (g) (T3). This was followed by Sulphur 80% WP a.i. 2504 (g) (T7) (33.00 and 35.00 PDI) and Triflxystrobin 50 % WG (T5) (41.00 and 40.67 PDI) in both the years respectively. During the two years of study, the okra green fruit yield was recorded in untreated control with a minimum of10.56 t/ha in 2016-17 to a minimum of 10.42 t/ha in 2017-18 (Table-1). The mean yield in differentially sprayed okra plots ranged from 12.60 to 10.97 t/ha in case of Trifloxystrobin 50% WG a.i. 87.5 (g) (T5) and 14.07 to 13.19 t/ha in case of Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG) a.i. 150+75 (g) (T3) while in untreated control (T1) it was 10.56 to 10.42 t/ha from both the years respectively. The fruit yield was significantly increased in plots treated whencompared to the untreated control. Highest yieldof 14.07 and 13.19 t/ha was obtained from plots treatedwith Nativo (Tebuconazole 50% +Trifloxystrobin 25% WG) a.i. 150+75 (g) (T3) followed by Sulphur 80% WP a.i. 2504 (g) (T7) (13.15 and 12.21 t/ha) and Trifloxystrobin 50% WG a.i. 87.5 (g) (T5) (12.97 and 11.19 t/ha). All the plots sprayed with different fungicides showed increase in the okra green fruit yield. All these treatments stood at par statistically than the unsprayed. In Bhendi crop, during the earlier studies tridemorph gave the most effective control with mean disease incidence of 1.8% i.e., 96.2 percent mean disease reduction followed by carbendazim and dinocap (Karathane) (both at3.3% i.e., 92.9 per cent mean disease reduction)and highest yield increase of 76.34 q/ha i.e., 28.8per cent mean green fruit yield increase with tridemorph and 24.8 with carbendazim (Ragupathy and Thamburaj 1997). Four sprays of penconazole (Topas) (0.05%) and cyproconazale 50 SL (San619 F)(0.02% and 0.03%) at 15 days interval were themost effective in reducing E. cichoracearum onokra and increasing crop yield in field plots in Tamil Nadu (Ragupathy *et al.,* 1998). Lowest disease incidence (43.34%) with greatest seed yield (8.08 q/ha) was recorded with 0.05% tridemorph during rabi season, however, highest cost benefit ratio of 1:20.44 was achieved with 0.2% wettable sulfur spray treatment (Singh *etal.,* 1998). Plots sprayed with 0.1% penconazole during rainy season recorded no incidence of powdery mildew as well as the highest mean fruit yield (4.81 t/ha), which was comparable to carbendazim (0.1%) (Naik and Nagaraju, 2000). Chlorothalonil was included in the trial because of its broad-spectrum nature as well as it was one of the effective fungicides tested against powdery mildew of ber (*Oidium*sp) (Das *et al.,*1994) and gave best control of urd bean powdery mildew (*E. polygoni*) (Raghuchander *et al.,* 2000). In the present studies, pooled data (Table-1) for one season/year plots sprayed with 0.28% Nativo (Tebuconazole 50% + Trifloxystrobin 25% WG)150+75 a.i (g) (T6) recorded the least disease incidence of 27.50 PDI and Highest yield of 13.63 t/ha. This was followed by Sulphur 80% WP 2.93% 2504 a.i (g) (T7) recorded 34.00 PDI and yield of 12.73 t/ha.

In the earlier reports okra powdery mildew was effectively controlled by 0.3% wet table sulfur (Sridhar and Poonam Sinha, 1989). Wettable sulfur provided maximum benefit followed by carbendazim against mango powdery mildew caused by *Oidiummangiferae* (Sinha andVarma, 2002). In terms of cost benefit ratio, wet table sulfur was recommended against powdery mildew of cucurbits (Bhatia and Thakur,1989). Similarly highest benefit cost ratio was obtained with wet table sulfur against *E. polygoni*on pea (Rana*et al.,* 1991). The efficacy ofwettable sulfur against pea powdery mildew was not significantly different from that of tridemorph and dinocap (Rajappan and Yesuraja, 2000). Inconclusion, Okra powdery mildew can beprofitably managed by spraying Nativo @ 150+75 a. i. (g)/ha fallowed by Sulphar @ 2504 a.i. (g)/ha.

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Economics, Correlation and Regression Study of Sesame Varieties under Different Sowing Dates

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Abstract

A Field experiment was conducted at the instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during Kharif 2017. The experiment was laid out in a split plot design with three replications. The four dates of sowing (10 July, 20 July and 30 July, and 09 August) were allocated in main plots and four sesame varieties (RT-125, RT- 46, RT-127 and V_4: RT-346) in sub plots. The results revealed that crop sown on 10 July recorded significantly higher gross and net returns, B:C ratio and total factor productivity as compared to 30 July and 09 August, but it was at par with 20 July. Higher seed and straw yield was observed by crop sown on 10 July as compared to 20, 30 July and 09 August. In case of varieties, variety RT- 125 recorded higher gross and net returns, B:C ratio and seed yield as compared to rest of tested varieties. The result of correlation coefficient revealed that seed yield was significantly and positively correlated with number of capsules/plant (r = 0.972), number of seeds/capsule (r = 0.930) test weight (0.850), nitrogen uptake (0.952) and phosphorus uptake (0.976). Further results revealed that every unit increase in number of capsules/plant, number of seeds/capsule, test weight, nitrogen uptake and phosphorus uptake, the seed yield increased by 49.50, 37.81, 3.06, 21.52 and 4.80 kg/ha, respectively.

Key words *: Sesame, sowing dates, varieties, TFP, correlation, regression.*

Introduction

Sesame (*Sesamum indicum* L.) is an oilseed crop generally cultivated on small holdings by poor-resource farmers in the tropics. Sesame is considered as a drought tolerant crop and is therefore mainly grown as dry land crop especially in Indian sub-continent where crop sowing time is dependent upon the availability of moisture, therefore sowing is delayed. Sesame yield is highly variable depending upon the growing environment, cultural practices and cultivars used. Yield decreases as a result of late sowing (late them optimum sowing date) have been reported in the literature and this reduction could be due to increased incidence of the sesame webworm (*Antigastra catalaunalis* Dup), changes in photoperiodism of sesame (Alamsarkar *et al.,* 2007). Rahman *et al.* (2012) reported that grain yield of cultivars were significantly influenced by sowing date and the interaction between sowing dates and cultivars were also highly significant.

Among the available higher production technology selection of appropriate sowing time according to specific location and region is imperative phenomena to fully exploit the genetic potentiality of a variety as it synchronizes the optimum environmental conditions such as temperature, light, humidity, rainfall etc. with the different growth phases of the crop and results in boosting production of sesame. It is fact that particular genotypes do not exhibit the same phenotypic characteristics in all environmental circumstances. The responses of qualities, yield attributes and yield potential as well of genotype varies for a specific or different date of sowing (Dinda *et al.,* 2015). Keeping in view the present study was carried out to determine the optimum sowing date and variety for higher productivity of sesame in the arid region.

Materials and Methods

The field experiment was conducted at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India (28° 01'N latitude and 73° 22'E longitude at an altitude of 235 meters above mean sea level) during *kharif* season of 2017. The soil of experimental field was loamy-sand, alkaline in reaction (pH 8.5) having 118 kg/ha available N (Alkaline permanganate method, low level of available phosphorus (15.1 kg/ha, Olsen's method and medium in available potassium (173.7 kg/ha, Flame photometric method in 0-15 cm soil depth at the start of the experiment. Seed rate of 3.0 kg ha^{-1} of sesame seed was used for experimentation. The experiment was laid out in a split plot design with three replications. The four dates of sowing (10 July, 20 July and 30 July, and 09 August) were allocated in main plots and four sesame varieties (RT-125, RT- 46, RT-127 and V_4: RT-346) in sub plots. The sowing

of sesame varieties on scheduled dates of sowing and maintained crop geometry 30 ×10 cm. the size of individual plot was kept 3.0 × 4.0 m. the rainfall received during growing period (July to November) was 168.3mm in 09 rainy days. The mean weekly minimum and maximum temperature during the crop season fluctuated from 15.4 to 47.1^{0}c with the average relative humidity from 16.7 to 85.9%. Experimental crop was raised as per recommended package of practices.

Gross return (GR) : The GR is the value of the total produce of a particular treatment as per existing marker ate. It was computed treatment wise on per hectare area basis. It gives an indicative of the true gain over every rupee of investment under a particular treatment.

Net return (NR) : The cost of cultivation for each treatment was subtracted from the gross returns worked out for the respective treatment to arrive at net returns for each treatment.

Net returns (₹/ha) = Gross return (₹/ha) - Cost of cultivation (₹/ha).

Benefit: cost ratio : Treatment wise benefit: cost ratio was calculated to ascertain economic viability of the treatment using the following formula :

$$\text{B:C ratio} = \frac{\text{Gross returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

Total factor productivity (TFP) : A broader gauge of productivity, total factor productivity is measured by combining the effects of all the resources used in the production of goods and services (Labour, capital, raw materials, energy etc.) and dividing it into the output.

$$\text{TFP} = \frac{\text{Seed yield (kg / ha)}}{\text{Total Cost of cultivation (₹/ha)}}$$

Correlation and regression coefficient : To assess the relationship, correlation and regression coefficients between seed yield of sesame (Y) and the independent variables (X) such as yield attributes and nutrient uptake were computed using the method given by Snedecor and Cochran (1968).

Statistical analysis : Experimental data recorded in various observations were statistically analysed with the help of Fisher's analysis of variance technique (Fisher, 1950).

Results and Discussion

Effect of sowing dates and varieties on economics : Significantly highest gross and net returns of 54210 and 35324 ha^{-1} and B:C ratio of 2.87 were obtained in the crop sown on 10 July followed by the crop sown on 20 July, 30 July and 09 August, respectively (Table 1). Crop sown on 10 and 20 July remained at par in gross and net returns and B:C ratio. It was due to the significantly higher seed and straw yield on 10 July sown crop than the crop sown on 20 July, 30 July and 09 August, which resulted in higher gross and net returns. Similar results have been reported earlier by Ramchandra, P.B., (2011) and Lakhran, (2015).

Varieties exhibited differences in their economics and the highest gross and net returns and B:C ratio were obtained in RT- 125 followed by RT- 127, RT- 46 and RT- 346, respectively (Table 1). The lead of RT- 125 was due to the highest seed yield production in comparison to other varieties. These findings are similar to that of Ramchandra, P. B., (2011), Chonder *et al.,* (2015) and Meena, (2015).

Total Factor Productivity : Data presented in Table-1 indicated that total factor productivity of sesame influence significantly by sowing dates and varieties. Crop sown on 10 July recorded significantly higher total factor productivity as compared to 30 July and 09 August, but it was at par with 20 July. Among sesame varieties, all sesame varieties found non-significant in total factor productivity.

Yield : Seed and straw yield of sesame influenced, significantly due to different sowing dates. Sowing on 10 July produced significantly higher seed yield (810 kg/ha) and straw yield (2444 kg/ha) as compared to sowing on 20 July, 30 July and 09 August. The higher seed produced in 10 July was mainly due to production of higher number of branches, capsules/plant and maximum number of seeds/capsule. Early sowing produced taller plants and more number of branches that resulted greater straw yields. This was again due to the production number of branches and increased vegetative growth of plant for favourable weather conditions. Suryavanshi *et al.* (1993) also reported that early sowing significantly increased straw yield.

Among varieties, highest seed yield (616 kg/ha) was produced by variety RT- 125 over RT-46, RT- 127 and RT- 346. High yield RT- 125 may be attributed to its higher biomass accumulation due higher number of branches and its proper partitioning as evident from equally higher harvest index and good yield attributes i.e. higher number of capsules/plant, higher number of seed/capsule. These findings are similar by Chonder *et al*., 2015. Significantly higher straw yield observed in variety RT- 346 followed by RT-46, RT- 127 and RT- 125. Similar results were found by Patra, 2001.

Correlation : Correlation coefficient were work out between yield and number of capsules/plant, number of seeds/ capsule, test weight, nitrogen and phosphorus

Table-1 : Effect of sowing dates on economics of sesame varieties.

Treatments	Gross return (/ha)	Net return (/ha)	B:C ratio	Total factor productivity (kg seed/ invested)	Seed yield (kg/ha)	Straw yield (kg/ha)
Sowing dates						
10 July	54210	35324	2.87	0.0429	810	2444
20 July	52308	33422	2.77	0.0413	779	2387
30 July	35083	16197	1.86	0.0275	519	1734
09 August	15009	-3877	0.79	0.0114	215	983
SEm±	-	663	0.04	0.0004	8	26
CD (P=0.05)	-	2293	0.12	0.0015	29	88
Varieties						
RT – 125	41289	22403	2.19	0.0326	616	1868
RT – 46	37389	18503	1.98	0.0293	554	1901
RT – 127	37664	18778	1.99	0.0294	555	1870
RT – 346	40270	21384	2.13	0.0316	597	1908
SEm±	-	340	0.02	0.0003	6	28
CD5%	-	993	0.05	NS	16	NS

Table-2 : Correlation coefficient and linear regressions equations showing relationship between independent variable (yield attributes and nutrient uptake) and dependent variable (seed yield).

Dependent variable (Y)	Independent variable (X)	Correlation coefficient (r)	Regression equations (Y= a+bx)
Seed yield	Capsules/plant	0.972**	Y= -1.956 + 49.50X1
	Seeds/capsule	0.930**	Y = -0.912 + 37.81X2
	Test weight	0.850**	Y= -0.054 + 3.06X3
	N uptake	0.952**	Y = -1.035 + 21.52X4
	P uptake	0.976**	Y = -0.227 + 4.80X5

** Significant at 1% level of significance

uptake. The data presented in table-2. The result of correlation coefficient revealed that seed yield was significantly and positively correlated with number of capsules/plant (r = 0.972), number of seeds/capsule (r = 0.930) test weight (0.850), nitrogen uptake (0.952) and phosphorus uptake (0.976). Similar finding was also reported by Meena, 2015.

Regression : The regression equations (Table 2) show that the every unit increase of number of capsules/plant, number of seeds/capsule, test weight, nitrogen uptake and phosphorus uptake the seed yield increased by 49.50, 37.81, 3.06, 21.52 and 4.80 kg/ha, respectively. Similar finding was also reported by Meena, 2015.

Conclusion

Based on one year experimentation in is concluded that the crop sown on 10 July overall better than other dates of sowing it was recorded significantly net return, B:C ratio and total factor productivity. The maximum net return and B:C ratio was recorded by variety RT- 125.

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Nutrient Use Efficiency as Influenced by Levels of FYM and Bio-Digester Liquid Manure under Aerobic Rice-Filed Bean Cropping Sequence

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Abstract

Field experiments were conducted for two years consecutively at Zonal Agricultural Research Station, Mandya to study the effect of farmyard manure and bio-digester liquid manure on the performance of aerobic rice – field bean cropping sequence. Soil was red sandy loam in texture, low in organic carbon (0.38 %) and available nitrogen (215.5 kg ha^{-1}), medium in available P_2O_5 (26.2 kg ha^{-1}) and K_2O (162.3 kg ha^{-1}). Higher agronomic efficiency in aerobic rice (19.8, 38.5 and 36.4 kg grain kg^{-1} N, P_2O_5 and K_2O applied, respectively) was found with recommended practice (FYM 10 t + 100:50:50 N:P_2O_5:K_2O kg ha^{-1}). It was followed by the application of FYM 12.5 t + BDLME to 125 kg N ha^{-1} and FYM 12.5 t + BDLME to 150 kg N ha^{-1}. While the superiority of recovery efficiency (54.4, 25.3 and 77.1 % for N, P_2O_5 and K_2O, respectively) was stamped by the recommended practice followed by FYM 12.5 t + BDLME to 125 kg N ha^{-1}. Similarly in field bean, higher agronomic efficiency (13.3, 11.4 and 17.5 kg grain kg^{-1} N, P_2O_5 and K_2O applied, respectively) was found with recommended practice (FYM 7.5 t + 25:50:25 N:P_2O_5:K_2O kg ha^{-1}) followed by the application of FYM 10 t + BDLME to 30 kg N ha^{-1}. While higher recovery efficiency (94.2, 14.9 and 97.8 % for N, P_2O_5 and K_2O, respectively) were with recommended practice followed by FYM 10 t + BDLME to 30 kg N ha^{-1}.

Key words *: Nutrient use efficiency, aerobic rice, field bean, FYM and BDLM*

Introduction

Nutrient use efficiency (NUE) is a critically important concept in the evaluation of crop production systems. It can be greatly impacted by fertilizer management as well as by soil- and plant-water management. The objective of nutrient use is to increase the overall performance of cropping systems by providing economically optimum nourishment to the crop while minimizing nutrient losses from the field. NUE addresses some but not all aspects of that performance. Therefore, system optimization goals necessarily include overall productivity as well as NUE. The most appropriate expression of NUE is determined by the question being asked and often by the spatial or temporal scale of interest for which reliable data are available.

Further, considering the increasing societal demand for food, fiber and fuel, intense global financial stress, and growing concerns over impacts on water and air quality, simultaneous improvement of productivity and resource use efficiency, including nutrient use efficiency (NUE), is an essential goal for agriculture. Best management practices (BMPs) can be defined as actions applied to resources which have been demonstrated through research to provide the best known combination of economic, social, and environmental performance, the three pillars of sustainability. They are the basic tools for improving NUE while sustainably meeting the demands of society. The uptake of nutrients is associated with the metabolic activities of plants and with the concentration and distribution of ions in the external medium. Generally, higher uptake of nitrogen, phosphorus and potassium is mainly depends on both economical and biological yield of crops.

Materials and Methods

Field experiments were conducted at Zonal Agricultural Research Station, Mandya of the University of Agricultural Sciences, Bangalore to study the "Effect of farmyard manure and bio-digester liquid manure on the performance of aerobic rice – field bean cropping sequence". The experimental site is situated between 11^0 30' to 13^0 05' North latitude and 76^0 05' to 77^0 45' East longitude and an altitude of 695 meters above mean sea level. Soil of the experimental site was red sandy loam in texture, low in organic carbon (0.38 %) and available nitrogen (215.5 kg ha^{-1}), medium in available P_2O_5 (26.2 kg ha^{-1}) and K_2O (162.3 kg ha^{-1}). The experimental design followed was RCBD.

Nutrient use efficiency : Agronomic efficiency (AE) of nitrogen, phosphorus and potassium was worked out for aerobic rice and field bean during both the years. The formula used to find out the efficiency is as follows.

$$\text{AE (kg grain kg}^{-1}\text{ nutrient applied)} = \frac{Yf - Yc}{Na}$$

Table 1 : Agronomic efficiency (kg grain kg^{-1} nutrient applied) of different nutrients as influenced by FYM and bio-digester liquid manure in aerobic rice.

Treatments	Nitrogen				P_2O_5				K_2O		
	2010	2011	Mean		2010	2011	Mean		2010	2011	Mean
T_1	11.0	12.9	11.9		25.0	30.2	27.6		21.3	24.9	23.1
T_2	9.4	11.1	10.3		21.6	26.5	24.1		18.7	21.8	20.3
T_3	11.3	12.8	12.1		26.4	31.1	28.8		22.8	25.6	24.2
T_4	10.0	11.4	10.7		23.7	28.0	25.9		20.4	23.0	21.7
T_5	12.2	14.6	13.4		27.0	33.4	30.2		23.1	27.6	25.3
T_6	10.5	12.5	11.5		23.5	29.4	26.4		20.3	24.2	22.3
T_7	10.9	12.8	11.9		25.0	30.5	27.8		21.6	25.0	23.3
T_8	10.3	12.3	11.3		23.9	29.6	26.8		20.6	24.3	22.5
T_9	11.7	14.3	13.0		25.2	32.2	28.7		21.6	26.6	24.1
T_{10}	10.4	12.5	11.5		22.8	28.9	25.8		19.8	23.8	21.8
T_{11}	13.1	16.1	14.6		29.3	37.8	33.6		25.4	31.1	28.2
T_{12}	11.9	14.6	13.2		27.1	34.7	30.9		23.4	28.5	26.0
T_{13}	18.6	21.0	19.8		35.6	41.5	38.5		33.9	38.9	36.4
T_{14}	-	-	-		-	-	-		-	-	-

T_1 : FYM 7.5 t + BDLME to 75 kg N ha^{-1}	T_6 : FYM 10 t + BDLME to 100 kg N ha^{-1}	T_{11} : FYM 12.5 t + BDLME to 125 kg N ha^{-1}
T_2 : FYM 7.5 t + BDLME to 100 kg N ha^{-1}	T_7 : FYM 10 t + BDLME to 125 kg N ha^{-1}	T_{12} : FYM 12.5 t + BDLME to 150 kg N ha^{-1}
T_3 : FYM 7.5 t + BDLME to 125 kg N ha^{-1}	T_8 : FYM 10 t + BDLME to 150 kg N ha^{-1}	T_{13} : FYM 10 t + 100:50:50 kg N:P_2O_5:K_2O ha^{-1}
T_4 : FYM 7.5 t + BDLME to 150 kg N ha^{-1}	T_9 : FYM 12.5 t + BDLME to 75 kg N ha^{-1}	T_{14} : Absolute control
T_5 : FYM 10 t + BDLME to 75 kg N ha^{-1}	T_{10} : FYM 12.5 t + BDLME to 100 kg N ha^{-1}	BDLME- Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure		

Table 2 : Recovery efficiency (% of nutrient taken up by a crop) of different nutrients as influenced by FYM and bio-digester liquid manure in aerobic rice.

Treatments	Nitrogen				P_2O_5				K_2O		
	2010	2011	Mean		2010	2011	Mean		2010	2011	Mean
T_1	30.2	36.9	33.6		11.0	15.0	13.0		48.2	59.9	54.1
T_2	26.6	32.4	29.5		10.4	14.4	12.4		42.3	52.7	47.5
T_3	31.0	36.3	33.7		13.0	17.6	15.3		48.4	58.5	53.4
T_4	28.6	33.0	30.8		12.0	17.1	14.5		44.2	52.6	48.4
T_5	32.4	39.7	36.0		11.9	16.7	14.3		49.1	60.6	54.8
T_6	28.5	34.6	31.5		11.1	15.3	13.2		43.2	55.1	49.1
T_7	31.0	36.3	33.7		14.8	20.3	17.5		48.1	59.0	53.5
T_8	28.6	34.2	31.4		13.8	18.6	16.2		46.1	55.3	50.7
T_9	32.9	38.9	35.9		12.4	17.4	14.9		47.2	59.3	53.3
T_{10}	29.5	34.4	31.9		11.0	15.9	13.4		43.3	53.3	48.3
T_{11}	35.5	41.9	38.7		17.5	24.3	20.9		53.4	63.7	58.6
T_{12}	32.6	38.4	35.5		16.8	22.8	19.8		48.9	58.1	53.5
T_{13}	50.7	58.1	54.4		22.0	28.5	25.3		69.8	84.4	77.1
T_{14}	-	-	-		-	-	-		-	-	-

T_1 : FYM 7.5 t + BDLME to 75 kg N ha^{-1}	T_6 : FYM 10 t + BDLME to 100 kg N ha^{-1}	T_{11} : FYM 12.5 t + BDLME to 125 kg N ha^{-1}
T_2 : FYM 7.5 t + BDLME to 100 kg N ha^{-1}	T_7 : FYM 10 t + BDLME to 125 kg N ha^{-1}	T_{12} : FYM 12.5 t + BDLME to 150 kg N ha^{-1}
T_3 : FYM 7.5 t + BDLME to 125 kg N ha^{-1}	T_8 : FYM 10 t + BDLME to 150 kg N ha^{-1}	T_{13} : FYM 10 t + 100:50:50 kg N:P_2O_5:K_2O ha^{-1}
T_4 : FYM 7.5 t + BDLME to 150 kg N ha^{-1}	T_9 : FYM 12.5 t + BDLME to 75 kg N ha^{-1}	T_{14} : Absolute control
T_5 : FYM 10 t + BDLME to 75 kg N ha^{-1}	T_{10} : FYM 12.5 t + BDLME to 100 kg N ha^{-1}	BDLME- Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure		

Where, AE = Agronomic efficiency

Yc = Grain yield in control plot (kg ha^{-1})

Yf = Grain yield in fertilized plot (kg ha^{-1})

Na = Amount of nutrient applied (kg ha^{-1})

Table 3 : Agronomic efficiency (ka grain kg^{-1} nutrient applied) of different nutrients as influenced by FYM and bio-digester liquid manure in field bean.

Treatments	Nitrogen				Phosphorus				Potassium		
	2010	2011	Mean		2010	2011	Mean		2010	2011	Mean
T_1	7.8	10.1	8.9		9.3	12.4	10.9		11.3	18.0	14.6
T_2	7.2	9.7	8.5		8.3	11.5	9.9		10.3	17.3	13.8
T_3	8.0	11.2	9.6		8.9	12.8	10.9		11.2	20.0	15.6
T_4	7.5	10.6	9.1		8.2	11.8	10.0		10.4	18.9	14.6
T_5	6.8	9.6	8.2		8.7	12.7	10.7		10.1	16.9	13.5
T_6	6.7	8.4	7.5		8.2	10.7	9.5		9.8	14.9	12.3
T_7	6.9	10.1	8.5		8.3	12.4	10.4		10.1	18.0	14.0
T_8	6.5	10.0	8.2		7.5	12.0	9.7		9.2	17.8	13.5
T_9	6.2	8.5	7.4		8.4	11.9	10.1		9.4	15.1	12.3
T_{10}	5.9	8.1	7.0		7.6	10.9	9.3		8.8	14.4	11.6
T_{11}	7.6	11.3	9.4		9.5	14.6	12.1		11.2	20.0	15.6
T_{12}	7.3	10.7	9.0		8.9	13.6	11.3		10.7	19.1	14.9
T_{13}	11.3	15.2	13.3		9.7	13.1	11.4		14.9	20.1	17.5
T_{14}	-	-	-		-	-	-		-	-	-

T_1 : FYM 7.5 t + BDLME to 20 kg N ha^{-1}	T_6 : FYM 10 t + BDLME to 25 kg N ha^{-1}	T_{11} : FYM 12.5 t + BDLME to 30 kg N ha^{-1}
T_2 : FYM 7.5 t + BDLME to 25 kg N ha^{-1}	T_7 : FYM 10 t + BDLME to 30 kg N ha^{-1}	T_{12} : FYM 12.5 t + BDLME to 25 kg N ha^{-1}
T_3 : FYM 7.5 t + BDLME to 30 kg N ha^{-1}	T_8 : FYM 10 t + BDLME to 35 kg N ha^{-1}	T_{13} : FYM 10 t + 100:50:50 kg N:P_2O_5:K_2O ha^{-1}
T_4 : FYM 7.5 t + BDLME to 35 kg N ha^{-1}	T_9 : FYM 12.5 t + BDLME to 20 kg N ha^{-1}	T_{14} : Absolute control
T_5 : FYM 10 t + BDLME to 20 kg N ha^{-1}	T_{10} : FYM 12.5 t + BDLME to 25 kg N ha^{-1}	BDLME- Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure		

Recovery efficiency (RE) of nitrogen, phosphorus and potassium was worked out for aerobic rice and field bean during both the years. The formula used to find out the efficiency is as follows.

$$\text{RE (\% of nutrient taken up by a crop)} = \frac{\text{NUf - NUc}}{\text{Na}} \quad 100$$

Where,

RE = Recovery efficiency

NUf = Amount of nutrients taken up by a crop in fertilized plot (kg ha^{-1})

NUc = Amount of nutrients taken up by a crop in control plot (kg ha^{-1})

Na = Amount of nutrient applied (kg ha^{-1})

Results and Discussion

Crasewell and Godwin (1984) viewed that physiological efficiency as the efficiency with which crops utilize photosynthates for grain production while, agronomic efficiency is the product of the physiological efficiency and the apparent recovery and thus reflects the overall efficiency with which applied nutrients are used.

In Aerobic rice, higher agronomic efficiency (19.8, 38.5 and 36.4 kg grain kg^{-1} N, P_2O_5 and K_2O applied, respectively) was found with recommended practice (FYM 10 t + 100:50:50 N:P_2O_5:K_2O kg ha^{-1}). It was followed by the application of FYM 12.5 t + BDLME to 125 kg N ha^{-1} (14.6, 33.6 and 28.2 kg grain kg^{-1} N, P_2O_5 and K_2O applied, respectively) and FYM 12.5 t + BDLME to 150 kg N ha^{-1} (13.2, 30.9 and 26.0) (Table 1). While the superiority of recovery efficiency (54.4, 25.3 and 77.1 % for N, P_2O_5 and K_2O, respectively) was stamped by the recommended practice (FYM 10 t + 100:50:50 N:P_2O_5 : K_2O kg ha^{-1}) followed by FYM 12.5 t + BDLME to 125 kg N ha^{-1} (38.7, 20.9 and 58.6) (Table-2).

In filed bean, higher agronomic efficiency (13.3, 11.4 and 17.5 kg grain kg^{-1} N, P_2O_5 and K_2O applied, respectively) was found with recommended practice (FYM 7.5 t + 25:50:25 N:P_2O_5:K_2O kg ha^{-1}) followed by the application of FYM 10 t + BDLME to 30 kg N ha^{-1} (9.4, 12.1 & 15.6) (Table 3). While higher recovery efficiency (94.2, 14.9 and 97.8 % for N, P_2O_5 and K_2O, respectively) were with recommended practice (FYM 7.5 t + 25:50:25 N:P_2O_5:K_2O kg ha^{-1}) followed by FYM 10 t + BDLME to 30 kg N ha^{-1} (77.3, 16.2 and 87.1%) (Table 4).

Higher nutrient use efficiencies in both the crops was due to production of higher grain yield and nutrient uptake. In the present study, combination of FYM and bio-digester liquid manure at high doses might have helped in meeting the rhythmatic demand of the crop. Organic sources leave lot of residues in soil as evidenced through high soil carbon, N, P and K content. Obviously, all these could have contributed for higher agronomic

Table 4 : Recovery efficiency (% of nutrient taken up by a crop) of different nutrients as influenced by FYM and bio-digester liquid manure in field bean.

Treatments	Nitrogen				Phosphorus				Potassium		
	2010	2011	Mean		2010	2011	Mean		2010	2011	Mean
T_1	59.1	83.0	71.0		11.0	16.7	13.9		52.1	61.5	56.8
T_2	56.0	79.5	67.7		10.2	15.3	12.8		50.9	62.6	56.8
T_3	65.0	91.7	78.4		11.9	17.1	14.5		66.4	87.5	77.0
T_4	61.6	86.6	74.1		11.0	15.7	13.4		62.6	83.7	73.2
T_5	53.8	78.4	66.1		11.0	17.0	14.0		54.0	68.0	61.0
T_6	52.6	71.7	62.1		10.4	15.2	12.8		52.5	66.4	59.4
T_7	57.2	81.9	69.6		11.2	16.3	13.8		61.5	80.2	70.8
T_8	53.8	78.9	66.4		10.3	15.1	12.7		58.0	75.6	66.8
T_9	50.2	70.7	60.5		10.9	16.3	13.6		54.4	66.2	60.3
T_{10}	47.1	66.7	56.9		9.9	14.7	12.3		49.9	62.4	56.2
T_{11}	64.6	90.0	77.3		13.6	18.8	16.2		76.8	97.3	87.1
T_{12}	62.6	85.7	74.1		12.8	17.4	15.1		73.9	93.1	83.5
T_{13}	93.5	94.9	94.2		13.2	16.7	14.9		96.7	98.8	97.8
T_{14}	-	-	-		-	-	-		-	-	-

T_1 : FYM 7.5 t + BDLME to 20 kg N ha^{-1}	T_6 : FYM 10 t + BDLME to 25 kg N ha^{-1}	T_{11} : FYM 12.5 t + BDLME to 30 kg N ha^{-1}
T_2 : FYM 7.5 t + BDLME to 25 kg N ha^{-1}	T_7 : FYM 10 t + BDLME to 30 kg N ha^{-1}	T_{12} : FYM 12.5 t + BDLME to 25 kg N ha^{-1}
T_3 : FYM 7.5 t + BDLME to 30 kg N ha^{-1}	T_8 : FYM 10 t + BDLME to 35 kg N ha^{-1}	T_{13} : FYM 10 t + 100:50:50 kg N:P_2O_5:K_2O ha^{-1}
T_4 : FYM 7.5 t + BDLME to 35 kg N ha^{-1}	T_9 : FYM 12.5 t + BDLME to 20 kg N ha^{-1}	T_{14} : Absolute control
T_5 : FYM 10 t + BDLME to 20 kg N ha^{-1}	T_{10} : FYM 12.5 t + BDLME to 25 kg N ha^{-1}	BDLME- Bio-Digester Liquid Manure Equivalent
FYM - Farmyard manure		

efficiency, recovery efficiency and physiological efficiency of nutrients. Purushottam Kumar and Puri (2001), Yogananda *et al*. (2010) and Anand (2003) also reported higher agronomic efficiency and recovery efficiency with organic manures application. Further, Prasad *et al.* (2000) found that legume – wheat sequence resulted in higher N use efficiency (32.3%), N uptake efficiency (95.5%), N utilization efficiency (34.9%), available N use efficiency (53%) and N available efficiency (90%) than rice - wheat system.

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Evalution of Front Line Demonstration Trials on Barley in Rewa District of Madhya Pradesh

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Abstract

The study was carried out during rabi seasons of 2018-19 in five village namely Rithi, Chhijwar, Madua, Khokam and Puraina village of Rewa districts of Madhya Pradesh to assess the impact of front line demonstrationconducted by conducted by KrishiVigyan Kendra, Rewa on yield and economics of barley production .The data were collected from 10 farmers. The findings of the study results revealed that improved technology recorded a mean yield of 3056 kg/ha which was 29 per cent higher than obtained by farmers practices (2140 kg/ha). The higher net returns (Rs. 23014/ha) and benefit: cost ratio of 2.10 was obtained with improved technologies in comparison to farmer's practices (Rs. 12697 and 1.70).

Key words : *Barley, front line demonstration.*

Introduction

Barley (*Hordeumvulgare*), an important cereal, is globally ranked next to maize, wheat and rice both in acreage and production FAO (2017). Traditionally, barley is a poor man's cereal in India and its cultivation requires low input with better adaptability todifferent stresses like drought, salinity and alkalinity, andmarginal lands Sendhil *et al.* (2018). Barely is the most nutritional crop in the world and is recommended for children during their growing stage. This is because, barley contains many essential elements that are rich sources for health and energy. The nutritional composition of barley, contains about 12.50 per cent water, 11.50 per cent of protein, 1.30 per cent fat and 69.6 per cent of carbohydrate, 3.9 per cent fibre and 1.2 per cent minerals Singh (2005). Low productivity of traditional varieties is acause of concern for farmers at large. There is aconsiderable scope for increasing the productivity of barley by using improved practices. There is a considerable scope for increasing the production of the crop Singh *et al* (2016).

Materials and Methods

The study was carried out by Krishi Vigyan Kendra, Rewa during 2018-19 at farmers' fields of four villages namely namely Rithi, Chhijwar, Madua, Khokam and Puraina village of Rewa districts of Madhya Pradesh. 4 ha area was covered under front line demonstration. Before selection of farmers for FLDs, a comprehensive list of all barley growers was prepared.Intensive trainings were imparted to the selected farmers regarding different aspects of barley cultivation. The differences between the demonstration package and existing farmers, practices are mentioned in (Table-1). In demonstration plots, use of quality's seed of improved variety JB 58, line sowing, seed treatment and timely weed control, as well as recommended dose of fertilizer (60 kg nitrogen + 40 kg phosphorus) were emphasized. All demonstrations were conducted under the supervision of KVK scientists. All the production and protection technology other than interventions were applied in similar manner in demonstrated as well as in farmers practices. The data on output were collected from FLD plots as well as grain yield; cost of cultivation, net returns with the benefit cost ration was worked out.

Results and Discussion

A comparison of productivity levels between demonstrated varieties and local check is shown in (Table-1). During the period under study, it was observed that in front line demonstration, the improved barley variety recorded the average higher seed yield (30.56 q/ha) as compared to local check (21.4 q/ha). The percentage increase in yieldover local check was 29%. The results clearly show the positive effects of FLD over the existing practices words enhancing the yield of barley in the study. Higher value of grain yield obtained under demonstration plots might be due to improved variety and recommended practices and better managements. Value Similar yield enhancement in different crops in front line demonstration has amply been documented by Jeengar *et al.* (2006), Hiremath *et al.* (2007) Dhaka *et al.* (2010) and Patel *et al.* (2013). From these results it is evident that the performance of improved variety as found better than the local check under same environment conditions. Farmers were motivated by results of agro technologies applied in the FLDs trials.

The cost of improved technologies was estimated by

Table-1 : Comparison between demonstration package and existing farmers practices of barley production.

S. No.	Interventions	Demonstration package (Improved practices)	Farmers practices
	Barley		
1.	Farming situation	Rainfed	Rainfed
2.	Variety	JB 58	Local
3.	Seed treatment	Seed treatment with mancozeb @ 2g/kg seed	Nil
4.	Time of sowing	1-20 November	15-30 December
5.	Method of sowing	Line sowing proper crop geometry	Broadcasting
6.	Seed rate	90-100 kg/ha	100-125 kg/ha
7.	Fertilizer dose	60 kgN and 40 kgP	Negligible
8.	Plant protection measures	Need based application	NIL
9.	Weed management	Pendimethaline 3 liter/ha as preplant incorporation following by One hand weeding	No weeding

Table-2 : Technical Impact of barley crop demonstrations during 2018-2019.

S. No.	Crop	Variety	Technology Demonstrated	Area (ha.)	No. of Demonstration	Yield of the crop (q/ha) under Demonstration	Variety and Yield of local Check (q/ha) Desi Jawa	Increase in yield (%)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Year (2018-2019)								
(i)	Barley	JB 58	Timely sown HYV	04	10	21.4	30.56	29

Table-3 : Economic Impact of barley crop.

Variety	Average Cost of Cultivation (Rs./ha)		Average Gross Return (Rs./ha)		Average Net Return (Profit) (Rs./ha)		Benefit-Cost Ratio
	Demonstration plot	Local Check plot	Demonstration plot	Local Check plot	Demonstration plot	Local Check plot	
	1	**2**	**3**	**4**	**5**	**6**	**8**
Year (2018-2019)							
JB 58	20992	18119	44006	30816	23014	12697	2.10

the yield economic calculations (Table-3). The improved practices in barley front line demonstration exhibited high value returns. Regards economic returns, the gross return of improved technologies was higher in FLD plots than farmers practices. The average gross returns of demonstrations was Rs. 44006 /ha as against local check (farmers practices) of Rs. 30816 /ha. The average net returns of demonstration were Rs. 23014 while in local check it was Rs. 12697. Cost benefit ratio was 2.10 in demonstration while in local practices it was 1.70. The results are in accordance with the findings of Hiremath et al. (2007), Hiremath and Nagaraju (2009), Rao *et al.* (2011) and Patel *et al.* (2013).

Conclusion

The findings of the study revealed that demonstration yield in high yielding barley varieties due to technology. By conducting front line demonstrations proven technologies, yield potential of barley can be increased toa great extent. This will substantially increase the income as well as the livelihoods of the farming community. Therefore, it is suggested that these factors may be taken for consideration to increase the scientific temperament of the farmers.

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Bio-Efficacy of Insecticides against Onion Thrips and their Effect on Natural Enemies and Bulb Yield

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Abstract

A field experiment was conducted at Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during Rabi 2019-20 and 2020-21 to study bio-efficacy of insecticides against onion thrips (*Thrips tabaci* L.) and their effect on natural enemies and onion bulb yield. Seven insecticides including were tested along with water spray treatment in RBD. Among insecticidal treatments the minimum mean thrips population i.e., 4.59 and 2.59 thrips/plant were recorded during Rabi 2019-20 and 2020-21 respectively. In plots treated with T_1- Lambda cyhalothrin 5% EC+ Fipronil 5% SC(17.5%ZC)@ 300 ml/ha recorded maximum mean coccinellid population (2.16 and 2.02 no./plant) and spider population (1.81and 1.13 no./plant) and were found promising regarding its safety to predators during 2019-20 and 2020-21, respectively. The highest yield of onion was recorded in the plot, treated with T_2- Lambda cyhalothrin 5% EC+ Fipronil 5% SC(17.5%ZC) @400 ml/ha (12.09 t/ha) followed by T_6 Fipronil 5% SC @ 1000 ml/ha (11.98 t/ha) indicating the significance of thrips management in rabi onion.

Key words : *Bio-efficacy, insecticides, onion, Trips tabaci*

Introduction

Onion (*Allium cepa* L.) belonging to family Liliaceae is one of the most popular bulb vegetables originated from Central Asia (Brewster, 1994). Thrips (*Thrips tabaci* L.) is a regular and potential pest of onion and cause considerable loss as high as 90% in quality and yield (Gupta *et al*., 1984).It is a cosmopolitan pest which is recorded on more than 300 species of host plants mainly cabbage, cotton, carnation, garlic, onion and cereals especially wheat (Nault and Hessney, 2010). Both nymphs and adults are the damaging stages which feed by rasping the leaves and other tissues of plants and suck the sap, as a result, it causes silver patches and streaks on leaves. (Straub and Emmett, 1992) Onion thrips feeds directly on leaves, causing blotches and as well as distort the bulbs and convert them into undersize causing yield loss >50% but can be even more problematic by transmitting viral disease like Iris yellow spot virus (IYSV) (Diaz-Montano *et al*., 2011). The chemical insecticides have been the primary tactics for thrips management, however, repeated applications often led to resistance in thrips, suppression of natural enemies and unsustainable management. Besides the increased cost and environmental pollution, it is difficult to control this pest with insecticides because of its small size and cryptic habits (Lewis, 1997).

Materials and Methods

The field experiment was conducted at Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during Rabi 2019-20 and 2020-21 to evaluate relative efficacy of insecticides against thrips infesting onion crop and their effect on natural enemies. Seven insecticides were evaluated for the bio-efficacy against *Thrips tabaci* L. Pretreatment observation were recorded a day prior to insecticides application while, post treatment observations were recorded after 1, 3, 5 and 10 days of spraying. All the insecticides were sprayed at 15 days interval between two sprays by using high volume knapsack sprayer. Thrips population was recorded on randomly selected five plants on each plot. The yield data of each treatment was recorded replication wise and subjected to statistical analysis to test the significance of mean yield in different treatments.

Results and Discussion

During Rabi, 2019-20,The mean thrips population on onion crop varied in various treatments from 4.59 to 9.55 (no./plant). The minimum mean thrips population were recorded in plots treated with Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC)@400 ml/ha (4.59 thrips/plant) followed by Fipronil 5% SC @ 750 ml/ha (6.10 thrips/ plant). The maximum mean population were recorded in plots treated with Lambdacyhalothrin 5% EC @ 400 ml/ha (9.55 thrips/plant).After first and second spray, percent reduction of thrips population was ranged from 60.45 to 80.99 per cent in various treatments. The overall maximum thrips population reduction was recorded in T_2- RIL-237/F1 17.5% ZC@400 ml/ha treated plot (80.99%), followed by T_5- Fipronil 5% SC @ 750 ml/ha.(74.74%) and

Table 1 : Bio-efficacy of insecticidesagainst onion thrips (*Thrips tabaci*) after first and second spray during Rabi, 2019-20.

Treatments	Pre-treatment observation	Post-treatment observation				Pre-treatment observation	Post-treatment observation				Mean	Percent reduction of insect population over control
		1 DAS	3 DAS	5 DAS	10 DAS		3 DAS	5 DAS	7 DAS	10 DAS		
Lambda cyhalothrin 5% EC + Fipronil 5% SC (17.5% ZC)	21.30 (4.67)	4.90 (2.32)	6.20 (2.59)	9.60 (3.18)	12.20 (3.56)	17.80 (4.28)	5.40 (2.43)	6.00 (2.55)	7.10 (2.76)	10.60 (3.33)	7.75	67.90
Lambda cyhalothrin 5% EC + Fipronil 5% SC (17.5%ZC)	22.20 (4.76)	2.60 (1.76)	3.00 (1.87)	5.40 (2.43)	10.20 (3.27)	15.90 (4.05)	1.30 (1.33)	1.90 (1.55)	4.00 (2.12)	8.30 (2.97)	4.59	80.99
Lambda cyhalothrin 5% EC	21.50 (4.69)	6.00 (2.55)	6.90 (2.72)	9.80 (3.21)	12.40 (3.59)	19.40 (4.46)	5.70 (2.49)	6.30 (2.61)	7.90 (2.89)	11.10 (3.41)	8.265	65.77
Lambda cyhalothrin 5% EC	21.60 (4.70)	7.30 (2.79)	8.50 (3.00)	11.10 (3.41)	13.00 (3.67)	18.80 (4.39)	6.60 (2.66)	7.70 (2.85)	9.50 (3.16)	12.80 (3.64)	9.55	60.45
Fipronil 5% SC	22.70 (4.82)	4.00 (2.12)	5.40 (2.43)	8.10 (2.93)	11.00 (3.39)	19.70 (4.48)	3.00 (1.87)	3.20 (1.92)	5.20 (2.39)	8.90 (3.07)	6.10	74.74
Fipronil 5% SC	22.00 (4.74)	6.80 (2.70)	8.30 (2.96)	10.60 (3.33)	14.00 (3.81)	16.70 (4.14)	5.90 (2.53)	7.10 (2.76)	8.90 (3.07)	12.00 (3.53)	9.21	61.86
Fipronil 80% WG	21.50 (4.69)	4.10 (2.14)	5.80 (2.51	8.30 (2.96)	11.40 (3.45)	16.00 (4.06)	4.10 (2.14)	4.80 (2.30)	7.50 (2.83)	11.00 (3.39)	7.125	70.49
Untreated Control	21.10 (4.58)	21.40 (4.68)	22.00 (4.74)	22.50 (4.80)	24.00 (4.95)	19.00 (4.42)	25.00 (5.11)	25.60 (5.11)	25.90 (5.13)	26.80 (5.21)	24.15	-
SE (m)±	0.19	0.05	0.06	0.06	0.07	0.12	0.07	0.06	0.08	0.11	-	-
CD at 5%	NS	0.15	0.18	0.19	0.22	NS	0.21	0.19	0.24	0.35	-	-

Note : Figure in parentheses are square root transform value, DAS-Days after Spraying.

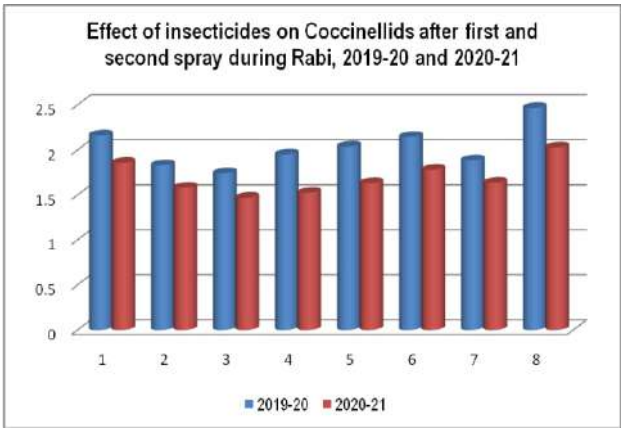
Table-2 : Bio-efficacy of insecticides against onion thrips (*Thrips tabaci*) after first and second spray during Rabi, 2020-21.

Treatments	Pre-treatment observation	Post-treatment observation				Pre-treatment observation	Post-treatment observation				Mean	Percent reduction of insect population over control
		1 DAS	3 DAS	5 DAS	10 DAS		3 DAS	5 DAS	7 DAS	10 DAS		
Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5% ZC)	16.63 (4.191)	2.60 (1.76)	3.60 (2.02)	5.90 (2.53)	9.00 (3.08)	14.62 (3.88)	3.80 (2.07)	4.10 (2.14)	5.60 (2.47)	8.50 (3.00)	5.39	77.81
Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC)	15.39 (4.048)	0.10 (0.77)	1.80 (1.52)	3.60 (2.02)	7.00 (2.74)	14.90 (3.92)	0.50 (0.99	0.90 (1.17)	3.90 (2.10)	5.90 (2.53)	2.96	87.81
Lambda cyhalothrin 5% EC	15.85 (4.102)	4.40 (2.21)	4.60 (2.26)	6.00 (2.54)	10.30 (3.29)	15.45 (3.98)	4.80 (2.30)	6.80 (2.70)	8.40 (2.98)	13.00 (3.67)	7.29	70.00
Lambda cyhalothrin 5% EC	14.92 (3.988)	5.00 (2.34)	5.70 (2.49)	7.80 (2.88)	10.80 (3.36)	13.65 (3.76)	6.10 (2.56)	7.30 (2.79)	9.80 (3.21)	12.30 (3.58)	8.10	66.66
Fipronil 5% SC	14.02 (3.854)	1.20 (1.30)	2.60 (1.76)	4.70 (2.28)	8.40 (2.98)	16.95 (4.17)	1.80 (1.51)	3.20 (1.92)	5.00 (2.33)	7.60 (2.85)	4.31	82.26
Fipronil 5% SC	16.47 (4.178)	3.80 (2.07)	4.00 (2.12)	6.10 (2.57)	9.60 (3.17)	16.87 (4.16)	5.00 (2.34)	5.70 (2.49)	7.60 (2.85)	10.50 (3.32)	6.54	73.08
Fipronil 80% WG	15.70 (4.085)	2.40 (1.70)	2.80 (1.82)	5.40 (2.43)	9.20 (3.11)	16.30 (4.06)	2.00 (1.58)	3.30 (1.95)	5.90 (2.53)	8.50 (3.00)	4.94	79.67
Untreated Control	16.14 (4.135)	27.80 (5.31)	28.10 (5.35)	27.60 (5.30)	28.30 (5.36)	14.52 (3.87)	19.90 (4.42)	20.10 (4.54)	21.00 (4.64)	21.60 (4.70)	24.30	-
SE (m)±	0.160	0.09	0.07	0.08	0.06	0.138	0.07	0.09	0.08	0.05	-	-
CD at 5%	NS	0.27	0.21	0.25	0.18	NS	0.22	0.27	0.24	0.15	-	-

Note : Figure in parentheses is square root transform value, DAS-Days after Spraying.

Table 3 : Total yield recorded during both the year.

S. No.	Treatment	Dose (g a.i./ ha)	Formulation (g or ml/ha)	Yield (t/ha)	Mean yield (t/ha)	% increase over control	
				1st year	2nd year		
1.	Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC)	15+37.5	300 ml	9.17	10.33	9.75	10.56
2.	Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC)	20+50	400 ml	11.90	12.28	12.09	27.82
3.	Lambda cyhalothrin 5% EC	15	300 ml	11.66	9.44	10.55	17.34
4.	Lambda cyhalothrin 5% EC	20	400 ml	9.66	9.50	9.58	8.98
5.	Fipronil 5% SC	37.5	750 ml	9.56	10.00	9.78	10.84
6.	Fipronil 5% SC	50	1000 ml	12.02	11.95	11.98	27.21
7.	Fipronil 80% WG	60	75g	10.69	11.57	11.13	21.65
8.	Control	-	-	8.55	8.90	8.72	-
	SE(m) +			0.145	0.155	-	-
	C.D.(5%)			NS	NS	-	-



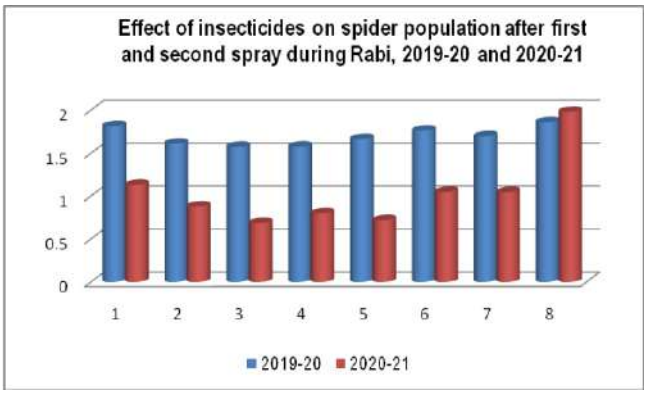


Fig.-1 : Effect of insecticides on the population of Natural Enemies of Onion Thrips.

lowest in T_4 - Lambdacyhalothrin 5% EC @400 ml/ha. and was recorded 60.45 per cent reduction in insect population.

During Rabi, 2020-21, the mean thrips population on onion crop varied in various treatments from 2.96 to 8.10 (thrips/plant). The minimum mean thrips population were recorded in plots treated with Lambda cyhalothrin 5% EC + Fipronil 5% SC (17.5%ZC)@400 ml/ha. (2.96 thrips/ plant) followed by T_5 Fipronil 5% SC @ 750 ml/ha. (4.31 thrips/plant). The maximum mean population were recorded in plots treated with Lambdacyhalothrin 5% EC @300 ml/ha (8.10 thrips/plant). During first and second spray, percent reduction of thrips population was ranged from 66.66 to 87.81 percent in various treatments. The overall maximum thrips population reduction was recorded in T_2- Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC)@400 ml/ha. treated plot (87.81%), followed by followed by T_5 Fipronil 5% SC @ 750 ml/ha (82.26%) and lowest in T_4 - Lambdacyhalothrin 5% EC @400 ml/ha. and was recorded 66.66 percent reduction in thrips population.

Simlarly, Din *et al*. 2016, revealed that maximum population reduction was observed in Imidacloprid + Fipronil 80WG (94.28%). Patil and Patil (2018) showed that fipronil was the most effective treatment in controlling thrips and in recording highest yield of onion bulbs and the data revealed that fipronil 0.005 percent excelled over all other treatments and was effective in controlling thrips population. Pathak et al.,2018 concluded that the basal application of Chlorantraniliprole 0.4% @ 10kg/ha and subsequently sequential sprays of Fipronil @ 0.1%, Carbosulfan @ 0.2%, Profenofos @ 0.1% and Spinosad @ 0.03% at 10 days interval is effective for managing of thrips.

Natural enemies : Field experiment data revealed that among the various treatments T_1- Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC) @ 300 ml/ha recorded maximum mean coccinellid population of 2.16 no./plant as against 2.466 no/plant in untreated plots during Rabi 2019-20 after 1st and 2nd spray. Similarly, during Rabi 2020-21 after 1st and 2nd second spray the maximum

mean coccinellid population recorded in plots treated with T_1- RIL-237/F1 17.5% ZC @ 300 ml/ha. (1.858) as against 2.028 (no./plant) in untreated plots. In both seasons, field experiment data revealed that among the various treatments T_1-Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5% ZC)@ 300 ml/ha. recorded maximum mean spider population (1.813 spider/plant) as against 1.86 in untreated plots,during Rabi 2019-20 after 1st and 2nd spray. Similarly, during Rabi 2020-21 after 1st and 2nd second spray also the maximum mean spider population recorded in plots treated with T_1- Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC) @ 300 ml/ha. (1.131) as against 1.98 (spider/plant) in untreated plots.

Yield : In both seasons, the highest yield of onion was recorded in the plot, treated with T_2-Lambda cyhalothrin 5% EC+ Fipronil 5% SC (17.5%ZC) @400 ml/ha (12.09 t/ha), which was followed by T_6 Fipronil 5% SC @ 1000 ml/ha (11.98 t/ha) while the lowest bulb yield of 9.58 t/ha was observed in plot treated with T_4- Lambdacyhalothrin 5% EC @400 ml/ha and the untreated control plot resulted least onion bulb yield (8.72 t/ha) in comparison to plots treated with different insecticides. Similarly, Hosamani *et al*. (2010) revealed that fipronil 80 WG @ 60 ha^{-1} was effective in reducing the thrips populations with increased onion yield. Wagh *et al.* (2016) also recorded the maximum bulb yield in fipronil treated plots followed by spinosad. The lowest mean thrips population (8.0 nymphs/plant) and the highest marketable yield (362 q/ha) were achieved by applying fipronil @ 1.5 ml/lt, as suggested by Pandey et al. (2013). Ullah *et al*., 2010; Gachu *et al*., 2012 were also reported that fipronil and imidachlorprid reduced the thrips damage severity and increased the onion bulb yield.

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Field Evaluation of *Metarhizium rileyi* (Deuteromycotina : Hypomycetes) as a Mycoinsecticide for Management of Lepidopteran Pests

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Abstract

Six native entomofungal strains of *Beauveria bassiana, Metarhizium anisopliae, M. rileyi, Paecilomyces fumaroseus* and *Lecanicillium lecanii* were evaluated against 2nd instar larvae of the maize fall armyworm (FAW*) Spodptera frugiperda* (J. E. Smith) and *Spodoptera litura* (Fabricius, 1755) (Lepidoptera: Noctuidae) in a laboratory bioassay. Among the six strains tested, *M. rileyi* UASRBC-Mr2 showed LC_{50} of 5.37 x 10^7spores/ml and UASRBC-Bb52 showed LC_{50} of 1.92 × 10^6 spores/ml. Field evaluation with these six promising strains were conducted against maize fall armyworm and *S. litura* during 2020 at UAS Raichur, Karnataka, India. Field trial results indicated that highest per cent reduction was recoded in *M. rileyi,* UASRBC-Mr2 (91.34 per cent) followed by *M. anisopliae* UASRBC-Ma2 (86.89 per cent) on 30 days after spraying and increase in yield were observed in the plots treated with these six entomofungal pathogen. Maximum yield recorded in *M. rileyi,* UASRBC-Mr2 (9256.67 Kg/ha) treated plot followed by *M. anisopliae* UASRBC-Ma2 (8986.67 Kg/ha) (F value = 323.22; P<0.0001). The results indicated that potential of *M. rileyi* UASRBC-Mr2 as biocontrol agent for management of the fall armyworm and *S. litura* in maize and cabbage cropping ecosystem.

Key words : *Spodoptera frugiperda, Beauveria bassiana, Metarhizium anisopliae, Metarhizium rileyi, maize, cabbage.*

Introduction

Insect pests are the main limiting factor for crop production in India and tropical Asia, amongst the insect pests belongs to Lepidoptera are the most common on a wide range of crops especially on maize and cabbage. There is hardly any cultivated plant not attacked by at least one lepidopteran pest. One of the major pests of cabbage includes tobacco caterpillar, *Spodoptera litura* (F.). The tobacco caterpillar is an economically important polyphagous pest in India and is considered as one of the major threats to the present-day intensive agriculture and changing cropping patterns worldwide, next only to *Helicoverpa armigera* (Hubner). *S. litura* is reported to feed on 150 species of plants (Rao *et al*, 1993) causing 26-100 per cent yield loss under field conditions (Dhir *et al*, 1992). The pest occurs in India, Pakistan, Bangladesh, Sri Lanka, South East Asia, China, Korea, Japan, Philippines, Indonesia, Australia, Pacific Islands, Hawaii and Fiji (Hill, 1993).

Similarly, Fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), is native to tropical and sub-tropical areas of the Americas (Sparks 1979). FAW has strong migration ability and in the past three years it has invaded 47 African countries, 18 Asian countries and now Australia where it seriously threatens crop production. FAW is polyphagous and two sympatric host-plant strains have been identified, the “corn-strain” (C-strain) feeding mostly on maize, cotton and sorghum and the “rice-strain” (R-strain) mostly associated with rice and various pasture grasses (Nagoshi and Meagher 2004). In the past few decades, FAW has developed multiple resistance and cross-resistance mechanisms against various kinds of insecticides and transgenic *Bacillus thuringiensis* (Bt) maize, due to the extensive use of the treatments to manage the pest. The synthesis of these biological characteristics has contributed to its spread and invasion, and increased its economic importance. The cost of controlling FAW is enormous: according to statistics from the Food and Agriculture Organization (FAO), Brazil alone spends US$600 million each year in attempts to control FAW. Due to its perniciousness and invasiveness, it was rated as one of the top ten out of 1187 arthropod pests by the Centre for Agriculture and Biosciences International (CABI) in the report “State of the World’s Plants” in 2017.

Entomopathogenic fungi usually cause insect mortality by nutritional deficiency, destruction of tissues and releasing of toxins and several mycotoxins are produced during pathogenesis which acts like poisons for the insects. After the death of the insects the fungus breaks open the integument and form aerial mycelium and sporulation on the cadavers. The internal tissue shows disintegration prior to the insect death (Ramanujam, 2014). The mycoinsecticides based on deuteromycetous fungi such as *Metarhizium anisopliae*; *Beauveria bassiana* (Kumar and Chowdhry 2004) and *Metarhizium rileyi* (Vimala Devi *et al* 2003) have been reported to be useful to control insect pests. M. rileyi, a

Table 1 : Dose mortality response of *S. frugiperda* to different entomopathogenic fungi.

Sl. No.	Isolates	n	LC_{50}	Lower limit	Upper limit	Slope ± SE	^{2} value	P value
1.	UASRBC-Mr 2	210	5.37×10^5	1.63×10^3	1.72×10^9	y = 2.25 ± 1.03	0.62	0.96
2.	UASRBC-Ma 2	210	1.92×10^6	1.45×10^6	1.70×10^{10}	y = 2.90 ± 0.92	0.58	0.90
3.	UASRBC-Bb 52	210	8.43×10^5	2.43×10^4	6.20×10^9	y = 3.84 ± 1.41	2.17	0.70
4.	UASRBC-Pfu2	210	6.75×10^7	1.97×10^3	1.08×10^9	y = 2.82 ± 1.26	0.57	0.97
5.	UASRBC-Ll22	210	1.96×10^5	7.42×10^4	1.57×10^8	y = 3.57 ± 1.27	0.86	0.93

Table 2 : Dose mortality response of *S. litura* to different entomopathogenic fungi.

Sl. No.	Isolates	n	LC_{50}	Lower limit	Upper limit	Slope ± SE	^{2} value	P value
1.	UASRBC-Mr 2	210	1.09×10^8	4.20×10^3	3.13×10^{12}	y = 2.29 ± 1.10	0.30	0.99
2.	UASRBC-Ma 2	210	6.10×10^6	4.77×10^3	2.61×10^{10}	y = 3.81 ± 0.89	2.70	0.60
3.	UASRBC-Bb 52	210	1.14×10^8	4.22×10^2	3.20×10^{11}	y = 2.24 ± 1.17	0.29	0.91
4.	UASRBC-Pfu2	210	1.00×10^8	4.00×10^4	3.00×10^{12}	y = 2.82 ± 1.26	0.27	0.89
5.	UASRBC-Ll22	210	1.92×10^7	3.92×10^5	9.60×10^{10}	y = 2.90 ± 0.91	0.58	0.97

potential insect infecting fungus, is a dimorphic hyphomycete that can cause epizootic death in various insects. The mycelium is septate, white, with flocculent overgrowth, sparse in culture to dense on insects (often completely covering the hosts), usually becoming green, or purple-gray to purple as sporulation proceeds. Its conidiogenous cells are short, with blunt apices. The host specificity of *N. rileyi* and its eco-friendly nature encourage its use in insect pest management. Its mode of infection and development have been reported for several insects hosts such as *Trichoplusia* sp., *H. armigera*, Plathypena scabra, Bombyx mori, etc. The conidia were produced on erect conidiophores much like in *Beauveria, Isaria* and *Metarhizium.* Both solid substrate and submerged liquid fermentation have been explored for mass production of this fungus.

For the management of *S. litura* and *S. frugiperda* in cabbage and maize, growers have been depending exclusively on application of various insecticides. As a result, many field populations of *S. litura* have developed multiple resistances and field control failure is often more frequent (Kranthi *et al,* 2002). Indiscriminate use of insecticides, multiple generations of insects per annum, year-round availability of host crops contributed to the insecticide resistance. Recently, resistance to some newer insecticides such as abamectin, spinosad and indoxacarb has also been documented. Utilization of this potential entomopathogenic fungus in the management of lepidopteran pests as one of the prime alternative to chemicals is more advantageous and also remunerative. Since the fungus is not only ecofriendly and cost effective but also highly persistent and self-perpetuating in nature. In addition, agriculture ecosystem which helps to develop the fungus because of its ideal microclimate, heavy rainfall area, high humidity and soil containing high organic matter helps to perpetuate the fungus itself in nature. So, management of lepidopteran insect pests by isolating virulent entomopathogenic fungi, *M. rileyi,* development of solid formulation and large scale evaluation is very much necessary. By considering all these points the study was under taken to find out its efficacy against *S. litura* and *S. frugiperda* in cabbage and maize ecosystem.

Materials and Methods

Isolation of entomopathogenic fungus (EPF) **:** Larval instars of *S. frugiperda* and *S. litura* infected with EPF were collected from the maize, cabbage and tomato field in the research farm of UAS Raichur, during October 2020 and the pathogen was isolated on Sabouraud's maltose yeast extract agar (SMYA) by standard protocol of Vimala *et al.* (2002). The dead larvae collected from the field were surface sterilized by immersing in 4% sodium hypochlorite solution for 1 min, followed by rinsing in 3 changes of sterile distilled water. The surface sterilized diseased specimens were cut in a sterile watch glass and a small portion of the infected tissue was transferred to a sterile culture plate containing Sabouraud's maltose agar media fortified with 2% yeast extract. The plates were incubated at 26±1°C for 8 days and the colonies formed were further purified by subculture on SMYA medium.

Pathogenicity test : Pathogenicity of the isolated fungus was carried out as per the method of Dutta *et al.* (2014) with slight modification. Laboratory reared 3rd instar larvae of *S. frugiperda* (N = 30 in 3 replications) were inoculated by spraying with conidial suspension of *M. rileyi* containing 2×10^8 spores/ml. The inoculated larvae were kept in plastic beakers covered with muslin cloth. Thoroughly washed maize leaf bits and Castor leaves were provided as food for *S. frugiperda* and *S. litura*

Table 3 : Bioefficacy of different entomopathogens against *S. frugiperda.*

Sl. No	Treatments	Pre count	Post count	Post count	Per cent reduction over control	Yield
			15 DAS	30 DAS		
1.	*M. rileyi* (UASRBC-Mr2)	26.67 (5.16)^{a}	5.00 (2.38)^{ab}	4.34 (2.3)^{b}	81.25^{a}	76500.00 (276.19)^{a}
2.	*M. anisopliae* (UASRBC-Ma2)	26.34 (5.13)^{a}	5.67 (2.23)^{a}	3.00 (1.71)^{a}	78.48^{ab}	48266.67 (219.54)^{c}
3.	*B. bassiana* (UASRBC-Bb52	27.67 (5.26)^{b}	6.34 (2.49)^{ab}	5.67 (2.07)^{a}	77.09^{c}	63266.67 (251.24)^{b}
4.	*P. fumaroseus* (UASRBC-Pfu2)	29.00 (5.34)^{c}	6.34 (2.51)^{b}	5.34 (2.35)^{b}	78.14^{ab}	65550.00 (255.86)^{ab}
5.	*L. lecanii* (UASRBC-LI 22)	28.34 (5.32)^{bc}	7.00 (2.64)^{c}	6.00 (2.44)^{c}	75.29^{d}	64900 (253.96)^{ab}
6.	Control	27.67 (5.26)^{b}	25.34 (5.03)^{d}	24.00 (4.89)^{d}	8.42^{e}	59833.33 (244.36)^{b}
F-value		1.21	84.58	150.58	-	6.49
P-value		NS	<0.0001	<0.0001	-	<0.0001

Figures in the parenthesis indicate $\sqrt{x}$+0.5 transformed values.

(a) (b) (c)

Plate 1 : Naturally *M. rileyi* mycosed fall army worm in Maize crop ecosystem (a) and observed the mycelia and spore characters (b and c).

(a) (b) (c)

Plate 2 : Isolation and bioassay *M. rileyi* against *S. frugiperda* and *S. litura*.

larvae. Similarly, 30 individuals of 3rd instar larvae were sprayed by sterile distilled water, which served as a control. The progress of larval infection and mortality by the fungus was monitored at 24-h interval.

Dose mortality studies

Fungal spore suspension : Each fungal isolate was grown on broken rice for laboratory bioassay. Spore suspension was prepared by taking 1 g of 15 days old conidiated rice in 9 ml of sterile distilled water containing 0.01% Tween 80. The suspension was filtrated through three layers of muslin cloth to get hyphal-free spore suspension, and the spore concentration was adjusted to various concentrations like (1×10^4, 1×10^5, 1×10^6, 1×10^7, and 1×10^8 spores/ml) using Neubauer' s improved hemocytometer.

Five promising different entomopathogenic fungi were subjected to dose mortality studies. Seven spore concentrations (1×10^4, 1×10^5, 1×10^6, 1×10^7, and 1×10^8 spores-1) were used to study LC_{50} and bioassays were carried out as described above. The dose to kill 50%

Table-4 : Bioefficacy of different entomopathogens against *S. litura* in cabbage.

Sl. No.	Treatments	Pre count	Post count 15 DAS	Post count 30 DAS	Per cent reduction over control	Yield/ha (ha)
1.	*M. rileyi* (UASRBC-Mr2)	27.00 (5.19)^{a}	4.00 (1.99)^{a}	2.34 (1.52)^{a}	91.34^{a}	9256.67 (96.21)a
2.	*M. anisopliae* (UASRBC-Ma2)	28.00 (5.29)^{a}	5.00 (2.23)^{b}	3.67 (1.91)^{b}	86.89^{b}	8986.67 (94.79)a
3.	*B. bassiana* (UASRBC-Bb52)	29.66 (5.45)^{c}	5.00 (2.19)^{b}	4.34 (2.08)^{bc}	85.37^{c}	8433.33 (91.83)b
4.	*P. fumaroseus* (UASRBC-Pfu2)	29.00 (5.38)^{b}	5.00 (2.20)^{b}	4.34 (2.06)^{bc}	85.03^{c}	7500.00 (86.59)c
5.	*L. lecanii* (UASRBC-Ll 22)	28.34 (5.32)^{ab}	5.67 (2.36)^{b}	5.00 (2.23)^{bc}	82.35^{d}	6563.33 (81.00)d
6.	Control	28.67 (5.35)^{b}	26.34 (5.13)^{c}	22.34 (4.72)c	22.08^{e}	23.33 (4.80)e
F-value		1.04	47.37	100.22	-	323.22
P-value		NS	<0.0001	<0.0001	-	<0.0001

Figures in the parenthesis indicate $\sqrt{x}$+0.5 transformed values.

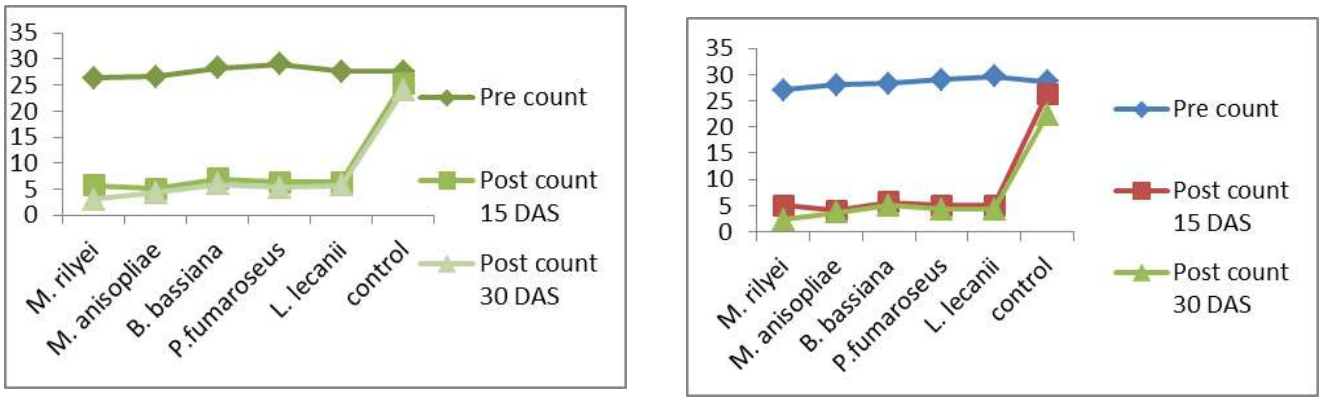

Fig.-1 : Bioefficacy of different entomopathogens against a) *S. frugiperda* in maize and b) *S. litura* in cabbage.

of the population (LC_{50}) was determined by probit analysis (Finney 1971). Statistical analysis was done using SPSS windows version 20.0.

Field evaluation : The field trials were carried out using 5 promising strains of *M. rileyi* UASRBC-Mr2, UASRBC-Mr3 and UASRBC-Mr4, UASRBC-Ma2, *B. bassiana* UASRBC-Bb52, UASRBC-Pf2 and UASRBC-Ll22 on maize FAW and Cabbage *S. litura* at UAS, Karnataka, India, during 2020 (November to February). The field trials were laid out in completely randomized block design with 8 treatments and three replications using maize hybrid variety (MRM-4062) and Cabbage (MAHY-118). The maize and cabbage were sown manually in the experimental plot with a plot size of 4 m × 5 m for each treatment and spacing of 60 cm × 30 cm were maintained and irrigated regularly. All the agronomic practices with recommended doses of fertilizers were followed to maintain good plant health till harvest of crop as per package of practice by UAS, Raichur, Karnataka, India, and harvesting was done manually. The talc formulations of these isolates were applied at the dose of 5g/l (1×10^{8} Cfu/g) during 30 days after sowing of maize and cabbage seeds in the experimental field when the pest incidence was at peak. Pre- and post-observations on number of plants infested with *S. frugiperda* and *S. litura* were recorded after 5 days of treatment. The plant infestation with *S. frugiperda* and *S. litura* were recorded based on the number of plants infested by *S. frugiperda* and *S. litura* out of 120 plants (15 plants per replication in each treatment, total 120 plants). The percent plant damage by *S. frugiperda* and *S. litura* was calculated. Yield was recorded at the time of crop harvest for each crop and treatment. The data was subjected to statistical analysis for drawing inferences using SPSS windows version 20.0. Significant level was set at 0.05 and the means were separated by Turkey test.

Results and Discussion

Six different entomopathogenic fungi were isolated (Plate 1a. 1b and 1c) using mycosed larvae collected naturally from maize and cabbage cropping ecosystem and confirmed as an entomopathogenic fungi by observing mycelia and spore character under phase contrast

microscope at Bio control laboratory, UAS, Raichur (plate 2a and 2b). The results of the dose mortality response of *S. frugiperda* to different entomopathogenic fungi with UASRBC-Mr2, UASRBC-Ma2, UASRBC-Bb 52, UASRBC-Pfu2 and UASRBC-Ll22 isolate are given in the (Table 1). The desired LC_{50} value for these isolate were found to be 5.37 x 10^7; 1.92 × 10^6; 8.43 × 10^5; 6.75 × 10^7 and 1.96 × 10^5conidia/ml, respectively with fiducial limit ranging from 1.63 × 10^3 to 1.72 × 10^9**;** 1.45 × 10^6 to 1.70 × 10^{10}**;** 2.43 × 10^4 to 6.20 × 10^9**;** 1.97 × 10^3 to 1.08 × 10^9 and 7.42 × 10^4 to 1.57 ×10^8**,** respectively**.** Similarly, the results of the dose mortality response of *S. litura* to different entomopathogenic fungi with UASRBC-Mr2, UASRBC-Ma2, UASRBC-Bb 52, UASRBC-Pfu2 and UASRBC-Ll22 isolate are given in the (Table 2). The desired LC_{50} value for these isolate were found to be 1.09 x 10^8; 6.10 × 10^6; 1.14 × 10^8; 1.00 × 10^8 and 1.92 × 10^7conidia/ml, respectively with fiducial limit ranging from 4.20 × 10^3 to 3.13 × 10^{12}**;** 4.77 × 10^3 to 2.61 × 10^{10}**;** 4.22 × 10^2 to 3.20 × 10^{11}**;** 4.00 × 10^4 to 3.00 × 10^{12} and 3.92 × 10^5 to 9.60 × 10^{10}**,** respectively**.**

Field bio efficacy of different entomopathogenic fungi with UASRBC-Mr2, UASRBC-Ma2, UASRBC-Bb 52, UASRBC-Pfu2 and UASRBC-Ll22 isolates against Maize fall armyworm *S. frugiperda* was presented in Table 3. Significant difference was observed in different bio control agents. Minimum number of larvae recorded in *M. rileyi* UASRBC-Mr2 (5.00 and 4.34) followed by *M. anisopliae* UASRBC-Ma2 (5.67 and 3.00) treated plot on 15 and 30 day after spraying, respectively. Maximum number of *S. frugiperda* recoded in Control (25.34 and 24.00) followed by *L. lecanii*, UASRBC-Ll22 (7.00 and 6.00) (F value = 84.58; P<0.0001 and F = 150.58; P<0.0001) on 15 and 30 day after spraying, respectively. Highest per cent reduction over control was recoded in *M. rileyi* (UASRBC-Mr2) (81.25 per cent) followed by *M. anisopliae* UASRBC-Ma2 (78.48 per cent) on 30 days after spraying. Maximum yield recorded in *M. rileyi* (UASRBC-Mr2) (76500.00 Kg) treated plot followed by *P. fumaroseus* (UASRBC-Pfu2) (65550.00 Kg) (F value = 6.49; P<0.0001) (Table 3) (Fig. 1a) (Plate 2c).

Field bio efficacy of different entomopathogenic fungi with UASRBC-Mr2, UASRBC-Ma2, UASRBC-Bb 52, UASRBC-Pfu2 and UASRBC-Ll22 isolates against *S. litura* was presented in Table 4. Significant difference was observed in different bio control agents. Higher number of larvae recorded in *M. rileyi* UASRBC-Mr2 (4.00 and 2.34) followed by *M. anisopliae* UASRBC-Ma2 (5.00 and 3.67) treated plot on 15 and 30 day after spraying, respectively. Lower number of *S. frugiperda* recoded in Control (26.34 and 22.34) followed by *L. lecanii*, UASRBC-Ll22 (5.67 and 5.00) (F value = 47.37; P<0.0001 and F = 100.22; P<0.0001) on 15 and 30 day after spraying, respectively. Highest per cent reduction over control was recoded in *M. rileyi,* UASRBC-Mr2 (91.34 per cent) followed by *M. anisopliae* UASRBC-Ma2 (86.89 per cent) on 30 days after spraying. Maximum yield recorded in *M. rileyi,* UASRBC-Mr2 (9256.67 Kg) treated plot followed by *M. anisopliae* UASRBC-Ma2 (8986.67 Kg) (F value = 323.22; P<0.0001) (Table 4) (Fig 1b). Present study is in line with Anand and Tiwary (2009) reported the larvae were found susceptible to all isolates in a dose dependent manner. Three promising isolates against larvae, *viz*. *M. anisopliae, F. lateritium and L. muscarium* (ARSEF 7037) resulted in average percent mortalities of 88, 89 and 77%, respectively at 10^8 conidia/mL.

Similarly, Montecalvo and Navasero (2021) cross infection of this entomopathogenic fungus to *S. frugiperda* was confirmed with a fungal infection that was initiated at 1–2 d post-treatment depending on the age of the larvae. Larval mortality significantly increased at 4–5 d post-treatment. Up to 100% larval mortality was recorded at 7 d post-treatment. Early larval instars (1st–3rd) were more susceptible than late larval instars (4th–6th). Higher conidial concentrations caused a higher and faster rate of larval mortality than lower conidial concentrations. The inflicted mycoses due to *M. rileyi* resulted in a slightly lower lethal dose (LD_{50}) (1.44 x 10^5 to 9.36 x 10^8 conidia mL–1) and shorter mean time to death (4.51–8.89 d). Mummification of the cadaver confirmed fungal infection with white fungal growth that later changed to green during sporulation.

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Role of Agricultural Libraries and Information Center in the Digital Era : A Study

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Abstract

Most of the Agricultural universities and Information centers are complete the library automation. But some universities and information center are not complete the digitization and automation, Discus in this paper the role of agriculture libraries on digital era with the help of the KOHA software. KOHA is library management software, many e-resources are used in agricultural i.e. CeRA, Krishikosh, Agricat, e-granth project and digitization e-learning. The ICAR provide funding for the strengthening and development of agriculture libraries. Agriculture libraries provided information to users in agricultural sector in digital Era. Role of the libraries are change and convert in digital library or virtual library, therefore the most important role of agricultural libraries in digital era.

Introduction

Agriculture has been a part of human life for many thousands of years. The need life for agriculture library and information centre is probably almost as old. In colonial America, the earliest agricultural information comes from Europe. But the American Revolution domestic agricultural publications and Agriculture libraries existed. The year of 1929 has proven a landmark for agricultural development in India. Imperial Council of Agricultural Research was established on 16 July 1929 asregistered society's registration Act, in1860 pursuance of the report of the Royal Commission on Agriculture. ICAR head quarters at New Delhi Agricultural Universities Research and Development was encouraged by efforts of various committees and communication.

The Indian economy is depending on the agricultural. Agriculture is the back bone of India. Many people livelihood depends on agricultural product, agro industries and Agri. Bigness management. Agriculture libraries and Information centers are places where various types of knowledge and information. It is the most important role ofgood information center in any agricultural Universities and institute. Libraries provide agricultural information to people in agriculture sector. The role of libraries in digital era, change and convert to digital and virtual library.So the reading materials, research materials and extension materials and information recourses available in digital form. Agriculture libraries and information centers support very fast determination of knowledge from at a source.

Objectives

To know the role of Agricultural libraries and information centers in the digital era.

To the study of strengthening and development of agricultural library support by ICAR Delhi.

To know the major role of library professionals in agricultural libraries to smoothly work in the digital environment.

Agricultural Libraries in India : Universityagricultural libraries and information centerhave played a major role in the agricultural education. It isprovide information to teacher, students, livestock's, farmers, agricultural business, agricultural organization and research workers, etc. ICAR is a biggest network for researches and extension in agriculture and allied disciplines. ICAR Library was established in 1929. ICAR Library considered as mothers of agriculture libraries in India. ICAR Umbrella Approximate two hundred libraries are working four deemed university libraries as national libraries. Three central university libraries, 64 State Agricultural, Veterinary and Horticulture University libraries, 65 central institute libraries, 13 Project Directorate libraries, 14 National Research Centre libraries. Agriculturallibrary is smoothly working in different places of our country. Approximate two hundred college libraries in the field of agriculture, Horticulture, agriculture engineering, veterinary and animal husbandry fisheries are providing library services are also in country.

Agricultural Libraries Providing Information Services: Agriculture libraries and Information center are playing a very important role in research and development of agricultural field. Agricultural libraries provided much different kind of services to users.

Documents services : Agriculture Libraries and Information centre provided the Photocopy services, indexing services, Abstracting services, Bibliography services, Translation services through email Print services, Selective Dissemination Information Services (SDI) and Current Awareness Services (CAS).

E–Services : Libraries and information center subscribed resources e-Book R- Resources e-journal online journal database Access.

KOHA Software : Agricultural libraries and information centers (ALIC) are provide many services, i.e. Loan privilege, e-recourses and e-services with the help of modern communication technology. University libraries automation has been done through KOHA. Koha is the library management open source software.

Role of Agriculture Libraries and information center in Digital Era : Agriculture Libraries and information center are playing important role in Agriculture education, research and extension field. In digital era of agriculture libraries and information centers are known as e-library. The main role of University agriculture library and information center into increase uses of agricultural recourses in teaching and research services improve the quality of agriculture education, research and extension services. Library provided CAS(Current Awareness Services) and SDI(Selective Dissemination of Information) services in hard and soft copy form. Era the printed library catalogued is converted in to online public access catalogue (OPAC) form now two days concept of union catalogue is coming.

Most of the library use union catalogue. Union catalogue is a combined library catalogue. Library data are digitalized and the uploaded on the websites. In digital study materials reading recourses, are arrange in electronic version soft copy form.

Agriculture libraries allow latest information technology tools i.e. Computer, Hardware, Software, internet and Wi-Fi facilities for creating digital environment. Libraries and information center provides and sharing various E-resources by the community of userssuch as online Journals through CeRA, e-books and electronic databases software. E-libraries should accessible in every where i.e. classroom, lab, as well as in central library facilities.

Role of ICAR for Development of Agriculture Library and Information Center :

Indian Council of Agriculture Research (ICAR) is an autonomous body. ICAR providing support for agricultural education, research and extension activities in India. Indian council of Agriculture Research (ICAR) contributed a lot toward strengthening and modernization of agriculture libraries, by Information technology tools, Agriculture education for strengthening and development of agriculture libraries.

ICAR had sanctioned network project, Library Information system project under national Agriculture Technology Project. In this regards National Agriculture Innovation Project (NAIP) are also launched for development of this sector.

ICAR development Consortium for-Recourses in Agriculture in (CeRA),ICAR development e-Granth for Agricultural community under NAIP.

Main object of the consortia is to develop the existing research and development information resources in libraries. ICAR efforts are given below :

e-Granth : e-Granth is a sub project of National Agriculture Innovation Project (NAIP) of Indian council of Agricultural Research. The aims of project provide digital access to library resources of Agricultural University research center and Information center. Which include online public Access catalogue (OPAC), Institutional repository, periodicals, Old journal.Accessible over internet under NARS. KOHA Software is the common software for this purpose.

CeRA : ICAR Launched Consortium of E- resources in Agriculture under MAIP. The main objective of the consortia is to bring together several libraries in group to develop the existing research and development information resources bass of ICAR institute of universities etc.

AgriCat : Agricate is a union catalogue of the agriculture libraries of ICAR Institute and State Agriculture Universities. It has been developed as a group catalogue of 12 partner libraries. These are combined together and make accessible to NARS libraries. http://www.egranth.ac.in/Agricat.html. It is a software platform built on 'Software a ready to use, intern atonal standards based platform for sharing library holding through an union catalogue (Agricats).

Krishikosh : Development of Digital Library and Information Management under NARES (National Agriculture Research and education System). Krishikosh is a digital repository which captures, preserves, archives and provide many kind policy based access to the intell electoral output of India NARES. (http://krishikosh.egranth.ac.in)

Impact of Ag. Libraries on Digital Era :

Agriculture libraries inform the quality of education, extension, research and development in digital era.

Agriculture libraries increase the users of agriculture information research.

Agriculture libraries and Information centers provided the database services to Researchers, Scientist, Students and Farmers.

Libraries provided the technical information facilities.

Advantage of Agriculture Libraries in Digital Era : Agriculture subject is the multi disciplinary subject. It is belong to many discipline i.e. Science, Horticulture, Soil Science, Agriculture Biotechnology, Agronomy, Animal Science and others. The following benefits in the agriculture libraries professional in digital Era.

Access of Union Catalogue

Inter library lone facilities.

Consortium of Agriculture Research (CeRA) uses.

Acquisition of library.

Save the time of staff and users in library.

Professional Communications among group in agriculture libraries.

Develop the infrastructure in the Agriculture library and Information center.

Need of Agricultural Libraries in Digital Era :

Agricultural Libraries and information center helpful in the agriculture education, research and extension activities. So the need of Agricultural libraries in Digital environment.

Libraries using automation software programming language should be independent platform.

Agricultural University provided regular awareness and training program me time to time for library staff.

Agricultural Libraries should preference to organize user awareness, orientation program me lecture to agricultural users and farmer.

Agriculture Library should provide al online services i.e. CAS, Database services Indexing etc.

Need to develop web based collection, website, and online public access catalogue (OPAC) facility.

Agricultural Libraries should provide web base services, e-mail, internet browsing, wifi and new arrivals services.

All agricultural libraries should connected with CeRA.

Agricultural Libraries should support for e-repository, Krishikosh.

Need of Library Professionals in Digital Era : In this time libraries working environment changed. Therefore the library professional is properly changed according to user's need. The following qualities are required in the library staff.

Good Communication and enthusiast.

Professional qualification.

Working confidence.

Hard working, Punctually, Sharp memory

Knowledge of latest course material, researcher and latest development.

Knowledge of online public Access catalogue, and Union catalogue.

Knowledge of Computer, Photocopy machine, and different kind of software.

Knowledge of Agriculture resources, Database, Consortium, Institutions Repository, Networks, DELNET, INFLIBNET and document delivery services.

Challenges of Agriculture Libraries in Digital Era : Many Challenge in this Areas.

Main challenge is Security and Privacy.

Intellectual Property rights (IPR).

Low speed of Internet to using e-resources.

Internet connectivity Problem in Rural areas.

Training on ICT required for knowledge management time to time.

Funding not properly available for e-resources.

Properly supply of electricity in the library and Information center for the Networking purpose.

Barrier in Agricultural Libraries :

Main Power Problem : Most of the Agriculture Libraries depend on officer Incharge whose are non professional staff. Only six or seven Agricultural University has appointed librarian out of seventy one agricultural universitiesin India. So no any progress in agricultural library services. No taking interest for improvingStatus of library professional.

Some Agricultural Universities not provide UGC status for agricultural library staff. There for library staff not taking proper interest in this sector.

State Governments is not interested in the filling vacant and backlog post of Agricultural Libraries. Many post are Vacating the Agriculture Libraries.

Most of the agricultural university provides UGC scale but some agricultural universities are not provide proper UGC scale in agricultural libraries therefore library staff not taking proper interest for improving library services.

Conclusions

The role of agricultural libraries and libraries professionals has a good. Now a day's agriculture library is use modern technology. But sum agricultural library is now being utilized to satisfy the information needs of the users and provided digital and networking facility. Most of the peoples depended on agricultural. Now a day's every section of societies wants to be educated and move

forward to update itself. Agricultural library to provided relevant information services i.e., documents services, Internet browsing services, e-services, and OPAC in right form to right person in right time. Agriculture Libraries also have strength to educate and train to researchers, farmers, extension workers, agri-business, students and other agricultural information seekers on how to search and use the required information in right form and quick time. Keeping in views of barriers and challenge in agricultural libraries i.e., Main power salary of library staff, Vacant, post, technically knowledge, copy right, Intellectual property right (IPR) and anti plagiarism. It is conclude that the agricultural libraries and information center can play a vital role in disseminating current, accurate, relevant and up to date information on agricultural to all users.

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Economics of Onion Production in Jaipur District of Rajasthan

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Abstract

The Onion is the major vegetable crop of Rajasthan. The study was conducted in Jaipur district of Rajasthan, where onion is an important crop. A sample of 75 onion growers, based on land holding size were selected *viz.,* small, semi-medium, medium and large size. The average area, production and productivity of Jaipurdistrict in the last 30 years (1981 to 2010) were observed 2118.2hectares, 11857.0tons and 58.8q /ha, respectively. In Jaipur district area, production and productivity of onion in the overall period (1981-2010) have increased by 2.99, 4.14 and 1.11per cent per annum. Production of onion in the Jaipur district increased at a compound growth rate of 4.14% per annum, which was contributed both by increase in area (2.99%) as well as increase in productivity (1.11%) but the contribution of area was more than that of productivity.The average bulb yield of onion was obtained by the small, semi-medium, medium and large farmers was 306.4, 312.6, 329.9 and 355.2 q/ ha, respectively. Total onion bulb yield was produced by the all 75 respondents (onion growers) was 16314.87q from the 48.07 ha area. On an average, total cost (cost C_2) incurred in cultivation of onion was Rs. 52513.1 per hectare. The total cost incurred in cultivation of onion was highest on small farms (Rs.57437.3/ha) followed by semi-medium farms (Rs.52809/ ha), large farms (Rs.50466.4/ha) and least on medium farms (Rs.49223.1/ha). The operational cost in cultivation of onion was highest on small sized farms and lowest on large sized farms. The overhead cost in cultivation of onion was highest on large sized farms followed by small, semi-medium and medium sized farms.The cost of production per quintal of onion was highest on small and lowest on large sized farms. The study concluded that the large size group of farms obtained the largest amount of profit similarly, as observed in the present study. The results further revealed that the income measures *viz.,* gross return, return over operating cost, net return, family labour income and farm business income recorded highest on large sized farms followed by medium, semi-medium and small sized farms in the Jaipur district.

Keywords : *Onion, production, costs, returns.*

Introduction

The onion (*Allium cepa* L.) is one of the most important vegetable crops grown in the entire world. Globally onions are grown in an area of 4.45 million hactare with a production of 85.94 million tonnes of an average productivity of 19.30 t/ha. In India production of onion has increased from 40.4 lakh tonnes (1994-95) to 215.63 lakh tonnes (2016-17), India ranks first by area (12.71 lakh hectare) in onion and second in production (215.63 lakh tonnes) next to China, but productivity is 16.1 tonnes hectare which is low as compared to Netherland, USA, China and the other countries. During 2016-17 India exported 34.93 lakh tonnes of onion (Anonymous, 2017). The reason for low productivity may be due to majority of Indian varieties are short day type which yields low per unit area, whereas long day types onion yields are high per unit area since prevailing of long crop duration, which are not suited for major onion growing areas of India except hilly regions where long day falls (Manjunathagowda *et.al.,* 2015). The major onion producing states in the country are Maharashtra, Karnataka, Gujarat, Bihar, Madhya Pradesh, Andhra Pradesh, Rajasthan, Haryana, Uttar Pradesh and Tamil Nadu. These states together account about 87.93 per cent of the total area and 89.91 per cent of the total production of onion in the country (Anonymous, 2010). Onion in the country is planted in three season's viz., *kharif*, *late kharif* and *rabi* with 20, 20 and 60% proportion, respectively.

The growing demand for onions induced by rising income and changing consumption patterns coupled with declining farm incomes due to rising costs and stagnating food grain productivity has necessitated diversification towards high-value crops in recent times in Jaipur district of Rajasthan. Apart from income enhancement, this high-value crop has potential to generate additional employment opportunities in farming due to their labour-intensive character (Weinberger and Lumpkin, 2006). Thus, to improve income, provide gainful employment and save natural resources from further degradation, diversification from grain crops to high-value crops like onion vegetable has emerged as an important strategy for agricultural growth (Sekhon and Kaur, 2004). The fluctuations in production of onion adversely affect the employment and income distribution and hamper the economic growth of the state. The overtime increase in the cost of production and prices of onion have affected the profitability of onion producers. Hence, there is

needed to study the input use, cost structure and profitability of onion on different size group of farms. There are only few prominent studies were under taken, which have covered the cost of production, marketing and constraints aspects and analyses various factors affecting its profitability to the producer and intermediaries in the sale of onion is available (Dangat *et al.* 1989; Mishra *et al.* 1995; Shyamas under and Achoth 1996; Mohapatra 1999; Shah 1999; Verma *et al.* 2004).

Objectives of the study : The present investigation was under taken with the following objectives :

To work out the growth rate in area, production and productivity of onion.

To study the economics of production of onion on the farms of different size-groups.

Materials and Methods

The study was conducted in Jaipur district of Rajasthan, where onion is an important crop. A sample of 10 villages was selected in the three tehsils having highest cultivated area of onion in Jaipur district. Further, a sample of 75 farmers was taken from the selected onion producing villages. The onion producing farmers were then categorized as small (0-2 ha) semi-medium (2-4 ha), medium (4-10 ha) and large size (>10.0 ha), based on land holding size of the farmers in each selected district. The farmers to be selected from each village were distributed among these four categories in proportion to the number of farmers in each category. The number of selected onion producing farmers was in 16 in small, 28 in semi-medium, 19 in medium and 12 in large category. The study utilized both secondary and primary data, to fulfill the objectives of the present study. To study the growth rate in area, production and productivity, of Jaipur district, time series data on area, production and productivity of onion were collected for the period from 1981 to 2010 from the Statistical Cell, Commissionerate of Agriculture Rajasthan, Jaipur. The primary data regarding cost of cultivation, fixed assets, yield returns of production was collected from the sample farmers through personal interview with the help of pre-tested and structured schedules.

Analytical frame work : Tabular analytical technique with help of percentages, averages and ratio were used to analyze and compute costs, returns, prices, sales etc. of producer-seller as well as different market functionaries. Analysis of primary and secondary data for estimation of trends of growth in area, production and productivity was estimated by the standard statistical analytical procedures as per the objectives of the present study. Cost of cultivation was computed by the standard statistical analytical procedures as per suggested by Acharya, 1997.

(a) Trends of growth in area, production and productivity : To study the trends of growth in area, production and productivity of onion crop in Jaipur district compound growth rate were worked out for 30 years data by using the formula :

$$X_t = a\, b^t$$

$$\text{Log } X_t = \text{Log } a + t \text{ Log } b$$

Where;

X_t = Area/production/productivity of onion crop in year "t"

t = Time element which takes the value 1, 2, 3, ———, n

a & b = Constant

(b) Compound growth rate :

Compound growth rate (r) = (b – 1) x 100

Where;

r = growth rate in percentage

Student 't' test was used to test the significance of the calculated compound growth rates by using the formula :

$$T = \frac{r}{\text{S.E. (r)}}$$

d.f. = N-2

(c) Cost of cultivation : In order to assess the profitability and economic viability in onion cultivation, various components of costs were estimated. The details of these cost concepts are given as follows :

Cost A_1	It is the actual paid cost by the farmers, cost of inputs such as value of hired human labour + value of owned bullock labour + value of hired bullock labour + value of owned machine labour + value of hired machine labour + value of owned seed + value of purchased seed + value of owned farm yard manure + value of purchased farm yard manure + value of fertilizers + value of plant protection chemicals + irrigation charges + land revenue + interest on working capital + depreciation + miscellaneous expenses
Cost A_2	Cost A_1 + Rent paid for the leased-in land
Cost B_1	Cost A_1 + interest on value of owned fixed capital assets (excluding land)
Cost B_2	Cost B_1 + Rental value of owned land
Cost C_1	Cost B_1 + imputed value of family labour
Cost C_2	Cost B_2 + imputed value of family labour

(i) Operational cost (OC) : It is variable cost, which varies with the level of production. It is expressed as :

O.C. = Cost A_1 – Land revenue – Depreciation + Family labour charges.

(ii) Over Head Cost (OHC) : It is fixed cost, which is incurred irrespective of the volume of production. It is expressed as :

Table 1 : Area, Production and Productivity of Onion in Jaipur District.

Period	Jaipur			
	1981-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2009-10	Per cent increased in 2001-10 over 1981-90
Area (ha)	1301.1	2131.4	2622.1	101.53
Production (tones)	5641.7	15221.2	14708.1	160.70
Productivity (q/ha)	43.4	71.4	56.1	29.26
Average of the last 30 years	2118.2	11857.0	58.8	

Source : Rajasthan Agricultural Statistics at a Glance 2010, Commissionrate of Agriculture, Rajasthan, Jaipur.

Table-2 : Triennium average ending (TE) of area, production and productivity of onion in Rajasthan.

	TE 1989-90	TE 1999-00	TE 2009-10	Percentage Change
Area (ha)	1385.7	2413.3	1845.0	33.1
Production (tones)	6733.7	16059.7	8891.3	32.0
Productivity (q/ha)	111.2	78.8	119.6	7.6

Source : Rajasthan Agricultural Statistics at a Glance 2010, published by Commissionrate of Agriculture, Rajasthan, Jaipur.

$$OHC = \text{Cost } C_2 - OC$$

(iii) Cost of production (per quintal) : Cost of production of onion was worked out using the formula :

$$\text{Cost of production (per quintal)} = \frac{\text{Cost of cultivation - Value of by - product}}{\text{Quantity of main product}}$$

Results and Discussion

Area, production and productivity of onion inJaipurdistrict : The Table-1 depicts that the area under onion crop in Jaipur district was 1301.1 hectares in 1981-90, which increased to 2131.4 hectares in 1991-2000 and further to 2622.1 hectares in 2001-10. Overall area under onion crop increased by 101.53 per cent over 1981-1990. The maximum rate of increase (160.70 per cent) was recorded in production while, minimum increase (29.26 per cent) was recorded in productivity of onion. It is clear from the Table1 that the average area, production and productivity of Jaipur district in the last three decades were 2118.2 hectares, 11857.0 tons and 58.8 q/ha, respectively.

Triennium average ending (TE) ofarea, production and productivity of onion : The change in area under onion cultivation in Jaipur district was 33.1 per cent, while productivity of onion has decreased by 4.1 per cent during TE 2009-10 over TE 1989-90. Thus, increase in production of onion in the district was recorded at merely 32.0 per cent from 6733.7 tones during TE 1989-90 to 8891.3 tones during TE 2009-10. Though, the area and production of onion has increased during TE 1999-2000 (Table 2). The district accounted for about 10.0 per cent share in area under onion cultivation in the state during TE 1989-90, which declined to 4.6 per cent during TE 2009-10. Jaipur district produced about 11.9 per cent of total onion production in the state during TE1999-2000; however, it reduced from 2.5 per cent share during TE 2009-10. Decreases in both area and production in Jaipur district were observed due to acute shortage of ground water for irrigation owing to erratic rainfall during the period of observations.

Annual compound growth rates in area, production and productivity of onion : It is evident from the**T**able 3 that the compound growth rate of area, production and productivity of onion in the Jaipur district during the period-I worked out at 1.04, 1.67 and 0.62 per cent per annum, respectively. During the period-II, the production of onion increased at the compound growth rate of 5.79 per cent per annum inspite of negative growth in productivity of the crop (-0.49 per cent per annum). The positive growth in area (6.31%) has not only compensated the negative growth of productivity but also helped in increasing the production of the crop. During the period-III, compound growth rate of the area (-7.94%), production (-12.43) and productivity (-4.88%) of Jaipur district were recorded negative / decreased. It is further evident from the table that in the overall period (1981-2010), production of onion in the Jaipur district increased at a compound growth rate of 4.14% per annum, which was contributed both by increase in area (2.99%) as well as increase in productivity (1.11%) but the contribution of area was more than that of productivity. Similarly Waghmare and Babar (1986), Pandita and Midmore (1994), Singh and Choudhary (1997), Kallo and Singh (2000) , Malik *et al.* (2004) in their studies they also observed increasing trends in area, production and productivity of onion in various parts of the country including vegetables.

Total Costs and its Components in Production of Onion in Jaipur District : This study of onion was based on 21.33, 37.34, 25.33 and 16.00 percent of small,

Table 3 : Annual compound growth rate in area, production and productivity of onion in Jaipur.

District	Period	Area (%)	Production (%)	Productivity (%)
Jaipur	1980-81 to 1989-90	1.04	1.67	0.62
	1990-91 to 1999-00	6.31	5.79	-0.49
	2000-01 to 2009-10	-7.94	-12.43	-4.88
	1980-81 to 2009-10	2.99	4.14	1.11

Table-4 : Land holding and onion cultivation by sample farmers.

District	Category	Sample farmers	Total holding (ha)	Area under onion crop (ha)	Onion area as % of total Holding	Bulb yield of onion (q/ha)
Jaipur	Small	16 (21.3)	1.38 (5.4)	0.069	5.0	345.1
	Semi-medium	28 (37.3)	2.96 (20.3)	0.21	7.1	329.9
	Medium	19 (25.3)	7.88 (36.7)	0.95	12.1	312.6
	Large	12 (16.1)	12.76 (37.5)	1.92	15.0	306.4
	Overall	75 (100)	5.44	0.64	11.8	312.49

*Figures in parenthesis are percentages of sample farmers/total holding.

Table-5 : Analysis of Cost of Cultivation of Onion on the Farms of Different Sizes in Jaipur District of Rajasthan.

(Rs./ha)

S. No.	Particulars	Size Group				
		Small	Semi-medium	Medium	Large	Overall
A.	**Operational Cost**					
1.	Machine Labour	2567.4 (4.5)	2942.3 (5.6)	2967.2 (6.0)	2786.5 (5.5)	2843.7 (5.4)
2.	Seed and Nursery raising cost	8097.7 (14.1)	7387.4 (14.0)	5292.6 (10.8)	5537.3 (11.0)	6712.2 (12.8)
3.	Manure	3581.9 (6.2)	3040.5 (5.8)	3114.8 (6.3)	3155.8 (6.3)	3193.3 (6.1)
4.	Fertilizers	3905.9 (6.8)	3859.4 (7.3)	3629.1 (7.4)	3458.7 (6.9)	3746.9 (7.1)
5.	PP Chemicals	1264.7 (2.2)	1127.8 (2.1)	1217.2 (2.5)	1168.6 (2.3)	1186.2 (2.3)
6.	Irrigation Charges	2060.7 (3.6)	1692.4 (3.2)	1647.6 (3.3)	1597.8 (3.2)	1744.5 (3.3)
7.	Interest on working capital	667.0 (1.2)	673.5 (1.3)	661.5 (1.3)	678.5 (1.3)	669.9 (1.3)
8.	Human Labour	21270.4 (37.0)	18612.3 (35.2)	18347.2 (37.3)	17427.6 (34.5)	18922.7 (36.0)
	Total Operational Cost	43415.7 (75.6)	39335.6 (74.5)	36877.2 (74.9)	35810.8 (71.0)	39019.26 (74.3)
B.	**Overhead cost**					
1.	Interest on fixed capital	604.9 (1.1)	492.4 (0.9)	579.3 (1.2)	674.7 (1.3)	567.6 (1.1)
2.	Depreciation on farm implements and machinery	445.3 (0.8)	352.7 (0.7)	434.8 (0.9)	514.6 (1.0)	419.2 (0.8)
3.	Rental value of owned land	12962.4 (22.6)	12612.3 (23.9)	11315.8 (23.0)	13445.3 (26.6)	12491.8 (23.8)
4.	Land revenue	9.0 (0.02)	16.0 (0.03)	16.0 (0.03)	21.0 (0.04)	15.3 (0.03)
	Total overhead cost	14021.6 (24.4)	13473.4 (25.5)	12345.9 (25.1)	14655.6 (29.0)	13493.9 (25.7)
	Total cost	57437.3	52809.0	49223.1	50466.4	52513.1

Note : Figures within the parenthesis for different components of operational cost and overhead cost are the percentages to the total cost.

semi-medium, medium and large size sampled farmers, respectively in Jaipur district. The average size of holding of the sampled respondents small, semi-medium, medium and large was 1.38 ha, 2.90 ha, 7.88 ha, and 12.76 ha, respectively. The sample farmers small, semi-medium, medium and large were found to grow onion over an area

Table-6 : Economics of Onion Production on the Farms of Different Sizes in Jaipur District of Rajasthan.

(Rs./ha)

S. No.	Particulars	Size Group				
		Small	Semi-medium	Medium	Large	Overall
1.	Operational Cost Return	43415.7 (75.6)	39335.6 (74.5)	36877.2 (74.9)	35810.8 (71.0)	39019.3 (74.3)
2.	Overhead Cost Return	14021.6 (24.4)	13473.4 (25.5)	12345.9 (25.1)	14655.6 (29.0)	13493.9 (25.7)
3.	Cost A1	27800.2 (48.4)	27984.1 (53.0)	27571.0 (56.0)	28354.1 (56.2)	27899.4 (53.1)
4.	Cost A2	27800.2 (48.4)	27984.1 (53.0)	27571.0 (56.0)	28354.1 (56.2)	27899.4 (53.1)
5.	Cost B1	28405.1 (49.5)	28476.5 (53.9)	28150.3 (57.2)	29028.8 (57.5)	28467.0 (54.2)
6.	Cost B2	41367.5 (72.0)	41088.8 (77.8)	39466.1 (80.2)	42474.1 (84.2)	40958.8 (78.0)
7.	Cost C1	44474.9 (77.4)	40196.7 (76.1)	37907.3 (77.0)	37021.1 (73.4)	40021.3 (76.2)
8.	Cost C2	57437.3 (100.0)	52809.0 (100.0)	49223.1 (100.0)	50466.4 (100.0)	52513.1 (100.0)
	Cost of Production (Rs./q)	187.5	168.9	149.2	142.1	162.8
	Returns					
1.	Gross Returns	136348.0	139107.0	146805.5	158064.0	143501.8
2.	Return over Operating Cost	92932.3	99771.4	109928.3	122253.2	104482.6
3.	Net Income	78910.7	86298.0	97582.4	107597.6	90988.7
4.	Family Labour Income	94980.5	98018.2	107339.4	115589.9	102543.0
5.	Farm Business Income	108547.8	111122.9	119234.5	129709.9	115602.4
6.	Returns Per Rupee of Expenditure	2.37	2.63	2.98	3.13	2.73

Note : Figures within the parenthesis for different cost groups are the percentages to the total cost.

of 5.00, 7.09, 12.06 and 15.05 per cent, respectively in the total average size of the holding available with them. The average bulb yield of onion was obtained by the small, semi-medium, medium and large farmers was 306.4, 312.6, 329.9 and 355.2 q/ ha, respectively. Total onion bulb yield was produced by the all 75 respondents (onion growers) was 16314.87q from the 48.07 ha area (Table 4).

The total cost incurred and their components in the cultivation of onion on sample farms in Jaipur district are presented in Table 5. On an average, total cost (cost C_2) incurred in cultivation of onion was Rs. 52513.1 per hectare. The total cost incurred in cultivation of onion was highest on small farms (Rs.57437.3/ha) followed by semi-medium farms (Rs.52809/ ha), large farms (Rs. 50466.4/ha) and least on medium farms (Rs.49223.1/ha). The total cost of cultivation consists of operational cost and overhead costs.

Operational costs : The operational cost incurred in cultivation of onion was higher than the overhead cost on all size groups of farms. The operational cost in absolute terms was lowest on large sized farms and highest on small sized farms in the study area. The operational cost incurred in cultivation of onion was Rs. 39019.26 (74.3 per cent) per hectare on the overall basis. It was varied for different size groups of farms and recorded Rs. 43415.7 (75.6 per cent), Rs. 39335.6 (74.5 per cent), Rs.36877.2 (74.9 per cent) and Rs. 35810.8 (71.0 per cent) per hectare of total cost per hectare on small, semi-medium, medium and large sized farms, respectively. Thus, the operational cost in cultivation of onion was highest on small sized farms and lowest on large sized farms (Table-5).

Human labour was the major component of the operational cost on sample farms as it was alone accounted for 36.0 per cent (Rs.18922.7/ha) of the total cost. Similar results were also reported by the Bijarnia (1998) in a study of an economic analysis of onion cultivation in Jaipur district of Rajasthan found that human labour as an important component, which contributed maximum per cent share in the total operational cost of onion cultivation in Jaipur district. The cost on manures, machine labour, fertilizers, plant protection chemicals, seed and nursery raising cost, and irrigation charges together accounted for 37.0 per cent of the total cost.

Medium and large sized farms incurred more on cost for manure (6.3 per cent) compared to other size groups. Vermi-compost/poultry manures being costlier manure is used by the medium and large sized farmers, whereas small and medium sized farmers used FYM only. Further, in general, machine labour cost increased, in absolute

value as well as in terms of per cent of the total cost, with the increase in size small to medium size of holding (4.5 – 6.0 per cent). Seed and nursery raising cost was highest on small and semi–medium sized farms and lowest on medium sized farms.

Overhead costs : On an average, the total overhead cost in cultivation of onion was Rs. 13493.9 (25.7 per cent) per hectare. On different size groups, it was Rs. 14021.6 (24.4 per cent) per ha on small; Rs. 13473.4 (25.5 per cent) on semi-medium; Rs. 12345.9 (25.1 per cent) on medium and Rs. 14655.6 (29.0 per cent) per hectare on large sized farms. The overhead cost in cultivation of onion was highest on large sized farms followed by small, semi-medium and medium sized farms. Rental value of owned land was the main item in the overhead cost as it accounted for 23.8 per cent of the total costs. The items viz., interest on fixed capital and depreciation together accounted for 1.9 per cent of the total cost of cultivation. Land revenue was accounted for negligible share to the total cost of cultivation (Table 5).

Cost Groups and Returns from Cultivation of Onion in Jaipur District

Cost groups : The various cost groups and returns from the cultivation of onion by sampled farmers in Jaipur district are presented in Table-6.

Cost groups : The overall cost A_1 andcost A_2, cost B_1, cost B_2 and cost C_1 were Rs. 27899.4 per ha (53.1 per cent); Rs. 28467.0 (54.2 per cent); Rs. 40958.8 (78.0 per cent) and Rs. 40021.3 (76.2 per cent) per hectare, respectively on different sized sampled farms. The Cost A_2 was same as cost A_1 on all size groups of farms because none of the sampled farmers leased any land for cultivation of onion in the study area. The overall cost of production of onion was Rs. 162.8 per quintal. It was Rs. 187.5, Rs. 168.9, Rs. 149.2 and Rs. 142.1 on small, semi-medium, medium and large sized farms, respectively. The cost of production per quintal of onion was highest on small and lowest on large sized farms (Table 6).

Returns : The overall average gross income received by farmers from cultivation of onion was Rs. 143501.8 per hectare. Large farmers received highest gross income (Rs 158064.0/ha) followed by medium (Rs. 146805.5/ha) farmers, semi-medium (Rs. 139107.0/ha) and least by small farmers (Rs. 136348.0/ha). The average return over operating costs, net income, family labour income and farm business income per hectare of onion cultivation were Rs. 104482.6, Rs. 90988.7, Rs. 102543.0 and Rs. 115602.4, respectively on sample farms (Table-6). The return per rupee of expenditure from onion cultivation was Rs. 2.37 on small, Rs. 2.63 on semi-medium, Rs.2.98 on medium and Rs. 3.13 on large sized farms with an overall of Rs. 2.73.Jat (1992) in his study of economic analysis of onion cultivation in Jaipur district of Rajasthan reported that the large size group of farms obtained the largest amount of profit similarly, as observed in the present study.

Table-6 further depicts that the income measures *viz.,* gross return, return over operating cost, net return, family labour income and farm business income recorded highest on large sized farms followed by medium, semi-medium and small sized farms in the Jaipur district.

Conclusions

The results indicate that in Jaipur district area, production and productivity of onion in the overall period (1981-2010) have increased by 2.99, 4.14 and 1.11 per cent per annum. Production of onion in the Jaipur district increased at a compound growth rate of 4.14% per annum, which was contributed both by increase in area (2.99%) as well as increase in productivity (1.11%) but the contribution of area was more than that of productivity. It could be concluded that on an average, total cost (cost C_2) incurred in cultivation of onion was Rs. 52513.1 per hectare. The total cost incurred in cultivation of onion was highest on small farms (Rs.57437.3/ha) followed by semi-medium farms (Rs.52809/ ha), large farms (Rs.50466.4/ha) and least on medium farms (Rs.49223.1/ha). The operational cost in cultivation of onion was highest on small sized farms and lowest on large sized farms. The overhead cost in cultivation of onion was highest on large sized farms followed by small, semi-medium and medium sized farms. The cost of production per quintal of onion was highest on small and lowest on large sized farms. The study concluded that the the large size group of farms obtained the largest amount of profit similarly, as observed in the present study. The results further revealed that the income measures *viz.,* gross return, return over operating cost, net return, family labour income and farm business income recorded highest on large sized farms followed by medium, semi-medium and small sized farms in the Jaipur district. Since increase in production of onion is must for meeting domestic requirement and for increasing income of farmers so, it is necessary to identify the thrust areas of development and prioritize the same for effective achievement of the goal at a faster rate.

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Economic Analysis of Farming Systems in Satara District of Maharashtra

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Abstract

The present study was based on primary data were collected from 108 farmers by personal interview method with the help of specially design schedule from Satara district of Maharashtra during the agricultural year 2018-2019.In study area three major farming systems were evaluated viz; 1) Crops only 2)Crop + Livestock 3) Crop + Livestock + Horticulture. Resource use pattern in proposed farming system are in varied proportion. Farmers applied their resources in very cogent and excessive manner. Limit the resources use in farming system, farmers go through a very sustainable way of agriculture. In C+L+H farming system, farmers used more resources as compared to other two farming system. Next table indicate the how farmers use resources in their farming system.In C+L+H farming system per hectare as well per farm profit was high as compared to Crops only and C+L farming system. Similarly, the per hectare and per farm profit in C + L farming system was higher than Crops only farming system. Per hectare and per farm income of C + L + H farming system over C + L and C + L over Crops only farming system was more. To sum up, it can be noted that as farmer shifts from Crop only to C + L and C + L to C + L + H farming system, the income, expenditure and profit goes on increases. It indicates that the C + L + H farming system was economically most viable in Satara district as compared to other farming systems. Since, C+L+H Farming system is profitable farmers should be motivated to undertake horticultural crops and livestock with cash crops for enhancing their income and employment on farms.

Key words : *Profitability, farming systems, JEL Classification, Maharashtra.*

Introduction

Traditional farming system used by farmers in India were based on centuries of experiences characterized by mixed farming involving crop production with one or more enterprises like dairy, poultry, sericulture, piggery, sheep, goat, fisheries, bee-keeping *etc*. Their main aims were to achieve stability of production, provide subsistence for the family and guard against weather aberration and other environmental stresses.

In the recent years, farming system approach gave scientific touch to the existing practices and found ways and means to make it sustainable in changing global scenario. “Farming system” is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of the farm household, while preserving the resource base for future generation and maintaining a high environmental quality. Thus, farming system is the result of interaction among several interdependent components.

Land being the most limited and scarce resource, particularly on small and marginal farms, the scope to increase farm income and employment through crop production alone is too bright. Therefore, one has to look for alternatives in order to get assured increase in the employment of the weaker sections. In this regard integrated farming system is the answer in which dairy, sericulture, poultry, sheep and goat rearing, mushroom cultivation and other allied activities are regarded as important components.

The farming systems is a whole farm approach, where in farm is studied in holistically. The farm situation changes with very little spatial change, therefore the location specific farming system should be identified, studied and the profitable farming system which are perfectly suited to a particulars location need to be suggested, because crop or any other enterprise cannot sustain the farmer in long run. The farming system approach provides a solution for sustainability of farm in long run. In view of this, study was carried out in Satara district of Maharashtra state.

Materials and Methods

The present study was based on primary data were collected from 108 farmers by personal interview method with the help of specially design schedule from Satara district of Maharashtra during the agricultural year 2018-2019. Two tahsils *viz*; Satara and Wai were purposively selected. Three villages from each tahsils were selected randomly purposively and 18 farmers from each village were selected randomly.

The farmers selected from each village were further classified into crop only, crop with livestock and crop with livestock and horticulture farming system. The data was

Table-1 : Resource use pattern (2018-19). **(Rs/ha)**

Sr. No.	Particulars	C		C + L		C + L + H		Overall	
		q.	Rs / ha	q.	Rs / ha	q.	Rs/ ha	q.	Rs / ha
1.	Hired labour (Man-days)	23.62 (0.4)	5850.35 (4.6)	20.82 (0.4)	5205.09 (2.5)	31.52 (0.6)	7903.97 (3.6)	25.32 (0.5)	5795.97 (3.5)
2.	Family labour (Man-days)	37.41 (0.5)	9353.209 (7.4)	32.96 (0.5)	8241.71 (4.0)	47.69 (0.7)	11957.32 (5.4)	39.35 (0.6)	10772.60 (6.5)
3.	Total labour (Man-days)	61.03 (0.6)	15203.55 (12.17)	53.78 (0.6)	13446.80 (6.5)	79.21 (0.8)	19861.29 (9.0)	64.67 (0.7)	16568.57 (10.2)
4.	Tractor (Hrs.)	42.01 (0.5)	29408.16 (23.5)	35.94 (0.59)	25160.05 (12.32)	38.74 (0.69)	31500 (14.3)	38.89 (0.6)	18468.76 (11.2)
5.	Seed (Kg.)	3750.28 (75.49)	34522.21 (27.63)	3972.84 (79.06)	31307.20 (15.33)	3361.5 (66.8)	31070.57 (14.15)	3694.87 (73.79)	17531.66 (10.6)
6.	Manure (Qt.)	11.96 (0.2)	2725.24 (2.1)	10.96 (0.2)	2476.72 (1.2)	12.59 (0.2)	2928.57 (1.3)	11.83 (0.2)	1637.80 (0.9)
7.	Fertilizers (Kg.) N	482.03 (9.7)		417.73 (8.3)		550.46 (10.49)		483.40 (9.6)	
	P	298.19 (6.0)	41785.31 (33.45)	258.84 (5.1)	35742.06 (17.50)	492.11 (9.7)	60446.35 (27.5)	349.71 (6.98)	31660.65 (19.28)
	K	322.03 (6.4)		274.44 (5.4)		494.40 (9.8)		363.62 (7.2)	
8.	Plant protection	-	1269.49 (1.03)	-	1116.32 (0.5)	-	1458.75 (0.6)	-	591.93 (0.3)
9.	Livestock maintenance	-	-	-	94922.06 (46.49)	-	72257 (32.91)	-	61139.87 (37.2)
10.	Total	4967.53 (100)	124913.96 (100)	5024.53 (100)	204171.21 (100)	5029.01 (100)	219522.53 (100)	5006.99 (100)	164167.75 (100)

(Figure in the parentheses are percentage to the respective total)

analysed in the tabular form with the help of means and averages.

Results and Discussion

Per hectare resource use pattern : The average per hectare expenditure made on input utilization is given in Table-1.The average per hectare cash expenditure was Rs 164167.75 at the overall . The major portion in the total expenditure was livestock maintenance, which shared 37.2 per cent, followed by fertilizers (19.58%), tractor (11.2%), seed (10.6%), labour charges (10.2%), manure (0.9%) and plant protection charges (0.3%).

While the average per hectare cash expenditure in Crops only farming system was Rs 124913. Fertilizers constituted major portion of the total expenditure, which shared 33.45 per cent, followed by seed (27.63%), tractor (23.5%), labour charges (12.17%) and plant protection charges (1.03%).

The average per hectare cash expenditure in C + L farming system was Rs 204171.21 Livestock maintenance constituted major portion of total expenditure, which shared 46.49 per cent, followed by fertilizers (17.50%), seed (15.33%), tractor (12.32%), labour charges (6.5%), manure (1.2%) and plant protection charges (0.5%).

The average per hectare cash expenditure in C + L + H was Rs 219522.53 The major portion of total expenditure was livestock maintenance, which shared 32.19 per cent, followed by fertilizers (27.5%), tractor (14.3%), seed (14.15%), labour charges (9.0%), manure (1.3%) and plant protection charges (0.6%).

Resource use pattern in proposed farming system are in varied proportion. Farmers applied their resources in very cogent and excessive manner. Limit the resources use in farming system, farmers go through a very sustainable way of agriculture. In C+L+H farming system, farmers used more resources as compared to other two farming system. Next table indicate the how farmers use resources in their farming system.

These findings are confirmed with the results of *Rana et al*. (2010), *Srivastava et al.* (2010), and *Patil* (2018).

Profitability of different Farming Systems : Profitability of farming systems is important to examine the best farming system in the study area. The information on profitability of different farming system is presented in Table-2.

It can be seen from the Table 2 that,Per farm total income was maximum in C + L + H farming system (Rs.

Table-2 : Profitability of farms (2018-19).

Sr. No.	Particulars	Unit	Farming systems			
			C	C + L	C + L + H	Overall
1.	Income (Rs)	Per / ha	373652.67	507994.29	642937.84	508194.93
		Per / farm	657392.19	977071.34	1634345.9	1089603.14
2.	Expenditure (Rs)	Per / ha	174571.79	275029.56	307005.84	252202.39
		Per / farm	305500.64	572978.28	901796.01	593424.97
3.	Profit (Rs)	Per / ha	199080.88	232964.73	335932	255992.53
		Per / farm	351891.55	404093.06	732549.83	496178.15

1664345.9) followed by C+L farming system (Rs. 977071.34) and Crops only farming system (Rs. 657392.19), which indicated higher returns in farming system in which livestock and horticultural crop were undertaken. The per hectare income (Rs. 642937.84) were maximum in C+L+H farming system followed by C+L farming system (Rs. 507994.24) and Crops only farming system (Rs. 373652.67). The study revealed that, the among all the three farming systems, C+L+H farming system was found to be highly profitable farming system than Crops only and C + L farming systems.

To sum up, it can be noted that as farmer shifts from Crop only to C+L and C+L to C+L+H farming system, the income, expenditure and profit goes on increases. It indicates that the C+L+H farming system was economically most viable in Satara district as compared to other farming systems.

These findings i.e. crop+livestock+horticulture farming system is profitable than remaining proposed farming systems, confirmed with the results of Dorge (2010), Raghav and Srivastava (2015), Singh and Burak (2016).

Conclusions

Resource use pattern in proposed farming system are in varied proportion. Farmers applied their resources in very cogent and excessive manner. Limit the resources use in farming system, farmers go through a very sustainable way of agriculture. In C+L+H farming system, farmers used more resources as compared to other two farming system. Next table indicate the how farmers use resources in their farming system. To sum up, it can be noted that as farmer shifts from Crop only to C+L and C+L to C+L+H farming system, the income, expenditure and profit goes on increases. It indicates that the C+L+H farming system was economically most viable in Satara district as compared to other farming systems. Since, C+L+H Farming system is profitable farmers should be motivated to undertake horticultural crops and livestock with cash crops for enhancing their income and employment on farms.

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Correlation Analysis and Frequency Distribution Among Seed Traits in a Population of $F_{2:3}$ Progenies of Safflower (*Carthamus tinctorius* L.)

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Abstract

Present study was conducted to estimate relationships among seed traits in in $F_{2:3}$ population in safflower using simple correlations. Correlations between a range of seed attributes (physical, physiological, and biochemical) were investigated and compared in this study for breeding high oil yeild in safflower. Simple correlation analysis in $F_{2:3}$ progenies showed that seed size was positively correlated with test weight (r=0.632***) and negatively correlated with hull type (r=-0.288**) and seed oil content (r=-0.276**). Test weight showed positive correlation with seed length (r=0.492**), seed breadth (r=0.502**), seed thickness (r=0.547**) and length breadth thickness product (r=0.632**). Striped hull type showed positive association with seed oil content (r=0.301**) and negative association with seed breadth (r=-0.332**), seed thickness (r=-0.341**), length breadth ratio (r=-0.324**) and length breadth thickness product (r=-0.288**). Hull content showed negative correlation with seed oil content (r=-0.385**). Seed oil content showed positive correlation with hull type (r=0.301**) and negative association with seed length (r=-0.229**), seed thickness (r=-0.263**), length breadth thickness product (r=-0.276**) and hull content (r=-0.385**). The results indicated some trait correlations such as seed size *versus* seed weight and hull content versus oil content occurred irrespective of the genetic backgrounds (diverse germplasm collection or segregating population produced from two diverse germplasm accessions) and size of the population.

Key words : *Safflower populations and correlation.*

Introduction

The safflower (*Carthamus tinctorius* L.) is an ancient Indian oilseed crop. Its seeds, flowers and foliage are economically valuable since they are used to produce cooking oil, natural colouring and animal feed, respectively. Carthamin, a natural dye produced from the brightly coloured flowers, is used to colour foods, clothing and cosmetics. Safflower foliage, seeds and seed meal after the extraction of oil are used as animal feeds (5). India is the second largest producer of safflower seeds in the world. India accounts for >30% (0.28 million ha) of area and >20 per cent (0.19 million tonnes) of global production (3). Maharashtra, Karnataka, Telangana and Andhra Pradesh are the major safflower growing states in India. Seed yield (~650 Kg/ha) and oil content (~30%) in the popular cultivars remain low, which are major concerns for increasing the profitability of safflower cultivation in India. Increase of seed yield and oil content in the cultivar would eventually lead to increase in oil yield, which would make safflower a commercially competitive crop for the farmers. High oil yield potential of cultivars can be realized when seed yield *per se* combines positively with seed morphological and biochemical traits. Therefore, genetic basis and the relationships of seed traits correlation is very essential to identify a combination of traits to be used for selection in breeding programmes.

One of the major interests of this research was to test the hypothesis that trait correlations observed in germplasm might perhaps be 'incidental' if the germplasm set had skewed representation of genotypes for the concerned traits, such correlations may need to be validated in populations consisting of individuals sharing common pedigree Keeping this view, main objective of this study to observe seed traits correlation using the $F_{2:3}$ segregating population produced from two contrasting parents are compared and discussed with the results from safflower germplasm.

Materials and Methods

Plant material : In this study, a set of 184 $F_{2:3}$ genotypes produced from the cross: A-1 x EC-755675-1, which was developed and maintained at the ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad was used. The seed traits are evaluated at seed quality testing laboratory of Department of Seed Science and Technology, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. Measurement of oil content was carried out at IIOR-ICAR, Rajendranagar, Hyderabad.

Seed trait measurements : Seed length (SL), seed width (SW) and seed thickness (ST) were measured for 10 randomly selected seeds with digital Grain Vernier meter.

Table-1 : Correlation analysis among seed traits in $F_{2:3}$ population in safflower**.**

	SL	SB	ST	LBR	LBT	TW	HT	HC
SB	0.261**							
ST	0.453**	0.680**						
LBR	0.475**	-0.678**	-0.259**					
LBT	0.673**	0.832**	0.880**	-0.241**				
TW	0.492**	0.502**	0.547**	-0.103	0.632**			
HT	0.053	-0.333**	-0.333**	0.324**	-0.288**	-0.1497		
HC	0.178**	0.059	0.0921	0.072	0.135	0.0132	-0.057	
OC	-0.229**	-0.148	-0.263**	-0.0659	-0.276**	0.120	0.301**	-0.385**

Critical values of correlation coefficients at 1% and 5% level of significance are 0.219 and 0.1665, respectively for n=184.SL- Seed Length, SB- Seed Breadth, ST- Seed Thickness, LBR-Length Breadth Ratio, LBT- Length Breadth Thickness Product, HT – Hull Type, HC-Hull Content, TW-Test Weight, OC-Seed oil content.

The measurements were repeated three times and the average value was expressed in milli meters. Seed size was also defined as the ratio between length and breadth (LBR), the product of maximum seed length and maximum seed width (LBP) (1). Randomly selected 100 seeds each with three replicates were weighed on a top pan balance with an accuracy of 0.001g and expressed in grams. The average value of three replicates was taken as test weight and expressed in grams. Hull content (HC) (%) was calculated as the ratio of the seed hull to the total seed using a random sample of 100 seeds as per the seed soaking procedure (9). Hull type (HT)-normal (0) or striped (1) was recorded as per safflower descriptors. All measurements were repeated three times.The oil content (%) was measured on whole seeds (~ 20 g of sample) using nuclear magnetic resonance (NMR) spectroscopy as described by (14).

Data analysis : Data were analyzed as per Completely Randomized Design. Least square means and range were obtained. Frequency distribution graphs of traits were drawn by the software, MYSTAT V.12 (https://systatsoftware.com). Simple correlation analysis based on Pearson correlation coefficients (*r*) was performed using 'Data Analysis' option implemented in MS Excel.

Results and Discussion

A frequency distribution provides a summarized grouping of data divided into mutually exclusive classes and the number of concurrences in a class. It is applied to indicate the nature of genetic variation (qualitative or quantitative) for traits in a population. When discrete phenotypic classes are found for a trait in the population, it is an indication of qualitative nature of variation and if the phenotypic data could not be grouped into discrete classes, it is an indication of quantitative nature of variation. The distribution of phenotypic values of seed morphological traits such as seed length, seed breadth, seed thickness, length breadth thickness product, test weight, hull content and seed oil content (Fig.1) clearly the indicate quantitative nature of genetic variation showing continuous distribution across progenies. Quantitative nature of distribution for the traits namely seed length, seed breadth, seed thickness, length/breadth ratio, length breadth thickness product, hull content, test weight and oil content in safflower germplasm reported (11). In this study, quantitative variation for those traits has been established in a segregating population produced from contrasting parents, which suggested that those are genetically complex traits and may be controlled by many genes and influenced by the environment. (15) reported that variation for oil content in safflower was quantitative, which resulted from complex inheritance involving many genes. Genetic basis of oil content in safflower has not yet been elucidated. Experience in other oilseed crops suggests that the seed oil content is genetically complex and involves many quantitative trait loci (2).

Simple correlations among five seed traits in a population of 184 $F_{2:3}$ progenies along with parents (A-1 and EC-755673-1) are presented in Table-1. Seed length showed strong positive correlation with seed breadth (*r*=0.261**), seed thickness (*r*=0.453**), length breadth ratio (*r*=0.475**), length breadth thickness product (*r*=0.673**) and test weight (*r*=0.492**). It showed weak positive association with hull content (*r*=0.178*) and strong negative association with seed oil content (*r*=-0.229**). The results indicated that seed length may not influence hull type but would positively influence seed size and seed weight and negatively the seed oil content. The results of this study are in consistent with the observations of (11) except for oil content. Surprisingly, negative correlation between seed length and oil content emerged from this study of $F_{2:3}$ segregating population, which did not show correlation in germplasm collection. (12) found no discernible relationship between seed length and oil content in safflower varieties. One possible reason that correlation between seed length and oil content did not appear in germplasm collection because of small sample size. A large sample size (184 lines) used in this study would have contributed for detecting negative

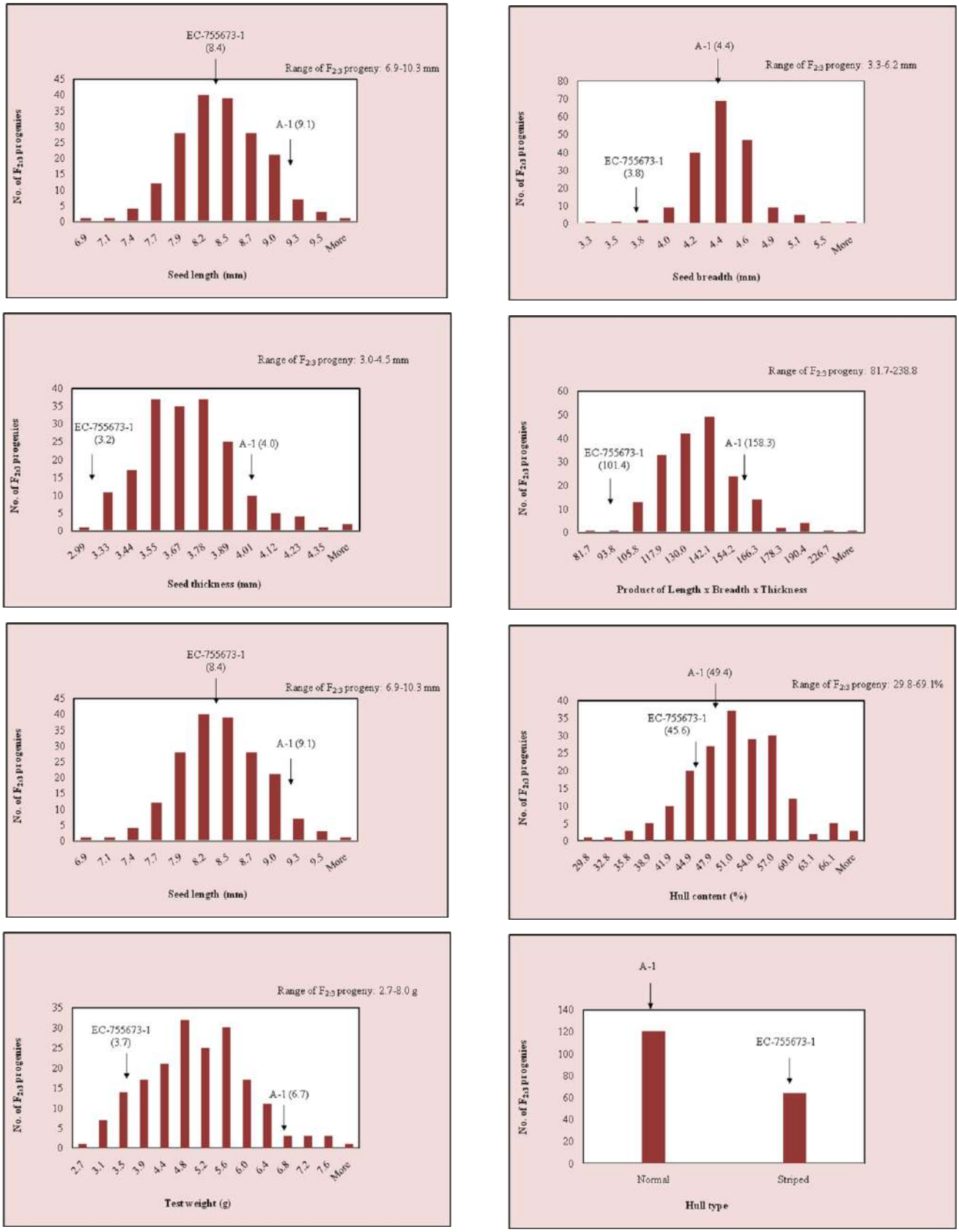

Fig-1 : Frequency distribution of : (A) Seed Length, (B) Seed Breadth, (C) Seed Thickness, (D) Product of Length x Breadth x Thickness, (E) Test Weight, (F) Hull Content, (G) Seed oil content (H) Hull type in $F_{2:3}$ population of safflower.

correlation between seed length and oil content. Results of (13) in a collection of 2000 jatropha germplasm accessions support this negative relationship between seed length and oil content.

Seed breadth exhibited strong positive association with seed length (r=0.261**), seed thickness (r=0.680**), length breadth thickness product (r=0.832**) and test weight (r=0.502**). It had strong negative association with length breadth ratio (r=-0.678**) and hull type (r=-0.333**). It was not correlated with hull content and oil content. It's negative correlation with hull type is interesting, which suggest that striped hull seeds possess less breadth. Similar to the results of seed length, positive correlation of seed breadth with seed size and weight remained the same in both germplasm collection (11) and in the current study of segregating population. Negative correlation of seed breadth with hull type emerged and with oil content disappeared in segregating population when compared with the results from germplasm collection. (12) reported negative correlation of seed width with oil content in jatropha. Seed thickness showed strong positive association with seed length (r=0.453**), seed breadth (r=0.680**), length breadth thickness product (r=0.880**) and test weight (r=0.547**) as expected. It showed negative association with length breadth ratio (r=-0.259**), hull type (r=-0.333**) and seed oil content (r=-0.263**). It was not correlated with hull content. These correlations were consistent with the findings of (11) in safflower germplasm collection. Length breadth ratio showed strong positive association with seed length (r=0.475**) and hull type (r=0.324**) while it showed strong negative association with seed breadth (r=-0.678**), seed thickness (r=-0.259**) and length breadth thickness product (r=-0.241**). The results clearly indicated that length breadth ratio may not influence hull content and seed oil content. The results were in consistent with the findings of (11). Length breadth thickness product showed strong positive correlation with seed length (r=0.673**), seed breadth (r=0.832**), seed thickness (r=0.880**) and test weight (r=0.632***). It showed negative correlation with length breadth ratio (r=-0.241**), hull type (r=-0.288**) and seed oil content (r=0.276**).

Among seed size related parameters, suggested that the length breadth thickness product is more informative, therefore, it was used for final analysis on seed size. Overall, correlation of seed size remained positive with seed weight and negative with seed oil content in two different genetic backgrounds (situations) namely germplasm collection as well as segregating population ($F_{2:3}$) derived from two contrasting genotypes. Interestingly, hull content (%) was not correlated with seed size in both the situations, which provides hope that seed size can be altered without affecting hull content and *vice versa*. However, a new correlation (negative) of seed size with hull type (striped) appeared in the segregating population which were not actually correlated in germplasm collection. This observation suggests that striped hull seeds were small sized, which may have implications for developing genotypes high seed yield potential. When large seeds are important for high seed yield, the striped hull type and the traits associated with it might inversely affect the seed yield. (9) also reported negative association of seed size with oil content (r=-0.51**) in safflower through indirect effect of hull content. (10) reported inverse relationship (r= -0·9635**) of seed size with oil percentage in castor, which was attributed to the increase in proportion of hull in large seeds.

Seed weight (100-seed weight) had positive relationship with seed length (r=0.492**), seed breadth (r=0.502**) seed thickness (r=0.547**) and length breadth thickness product (r=0.632**). These results concurred with the (11). However, in the present study, no correlation of seed weight with hull content and seed oil content was observed, which were in contrast with the findings of (11)in safflower germplasm collection. No correlation of seed weight with hull content and seed oil content in the segregating population suggest that those traits are independent of each other and could be amenable for manipulation without inversely affecting each other.

Striped hull type showed positive association with seed oil content (r=0.301**) and length breadth ratio (r=0.324**). It had negative association with seed breadth (r=-0.333**), seed thickness (r=-0.333**), and length breadth thickness product (r=-0.288**), which suggest that striped hull type is negatively associated with seed size. It was not correlated with test weight and hull content. It indicate that hull content may not be influenced by hull type. Historically, safflower breeders have used striped hull type for developing high oil varieties (6), which is clearly supported by the positive correlation found between these traits in this study as well germplasm (11). It might be interesting to know if striped hull type reduces the hull proportion. If not, striped hull would probably contribute for high oil content through other traits independent of hull content, which require further investigation.

Hull content showed negative correlation with seed oil content (r=-0.385**). Notably, it did not strongly correlate with seed size and weight. Negative correlation of hull content with seed oil content remained the same in a segregating population used in this study and germplasm collection (9 and 11). However, found that hull content was positively correlated with test weight and negatively correlated with striped hull type but the current study did not find them correlated. No correlation of hull

content with seed size and weight indicates that hull content does not influence seed size and weight and these traits may possibly under different genetic control. It is generally expected that increase in hull content would lead to increase in seed size and weight, which would result in high seed yield. If no correlation of hull content with seed size and weight is established, it would desirable for breeding purpose. Given the situation that hull content, seed size and weight negatively affects the oil content, no correlation among them offers hope to manipulate them independent of each other. It means that hull content can be reduced without reduction in seed size and weight, which would help to increase seed yield and oil content simultaneously and high oil yield can be achieved. The research so far has clearly established that reduction of hull proportion is the most efficient way to increase oil content in the safflower cultivars.

Seed oil content showed positive correlation with hull type (r=0.301**) while it showed negative association with seed length (r=-0.229**), seed thickness (r=-0.263**), length breadth thickness product (r=-0.276**) and hull content (r=-0.385**). Notably, oil content was not correlated with test weight. The positive relationship of hull type (striped hull) has been exploited inbreeding of commercial high oil safflower varieties (6 and 9) and (11) also observed clear negative association of seed size and hull content with oil content in safflower, which is further confirmed in this study. Surprisingly, test weight was not correlated with oil content in segregating population while both showed strong negative correlation in germplasm.

Conclusions

Positive correlation of seed size and seed weight, negative correlation of seed size with oil content, negative correlation of hull content with oil content, positive correlation of striped hull with oil content. No correlation of seed size with hull content were observed. From the results, it was noted that some of the trait correlations such as seed size versus seed weight and hull content versus oil content were consistently observed in the segregating population as well as in the germplasm collection as reported in the literature suggesting that those correlations could be 'universal and not incidental', which occur irrespective of the genetic backgrounds, size of the population and environments. Trait correlations provide the basis for trait selection to achieve desirable results in breeding programmes. Reliability of trait correlation results are critical considering the resource intensive nature of trait selection work in breeding programmes. In most cases, trait correlations are context dependent, which are influenced by the number and type of plant materials used and the traits considered for study. Therefore, it would be worthwhile to validate the trait correlations in different genetic backgrounds such as different sets of germplasm accessions, segregating populations produced either by two contrasting parents or by multiple parents, keeping the genotype x environment interaction in mind.

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Assessment of Spatial Variability in Physico-Chemical Properties of Soil in Chambal Division of Madhya Pradesh, India

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Abstract

Information regarding spatial variability and distribution of soil properties is critical for farmers attempting to increase nutrients use efficiency (NUE) and crop productivity. Application of fertilizers on the basis of soil characteristics maps associated with fertilizers recommendation may aid to curtail fertilizers input without surrendering the crop yield. The present study was focused on assessing the variability in physico-chemical properties of soils in Chambal division of Madhya Pradesh using geo-statistical approaches. For this, total 90 GPS based surface (0-15 cm) soil samples were collected from three districts *(Bhind, Morena and Sheopur*) of Chambal division after crop harvest, during *rabi* season 2019-20. The data obtained from laboratory analysis were statistically and geo-statistically interpreted. The results revealed that pH, EC, OC and $CaCO_3$ of soil samples collected varied from 5.80 to 8.65, 0.12 to 0.89 dSm^{-1}, 1.50 to 10.20 g kg^{-1} and 1.0 to 65 g kg^{-1} soil, respectively. Whereas, available N, P, K and S in soils ranged from 71.25 to 348 kg ha^{-1}, 7.14 to 92.12 kg ha^{-1}, 60 to 620 kg ha^{-1} and 0 to 72 mg kg^{-1}, respectively. The results obtained in the present study clearly showed a large variability in physico-chemical properties of soil across the Chambal division. This information could aid in decision making for application of plant nutrients and selection of cropping sequence for higher monetary returns to the farmers.

Key words : *Geo-statistical approach, NUE, soil characteristics, soil quality, productivity.*

Introduction

Understanding of spatial variability and distribution of soil properties is critical for farmers attempting to increase nutrients use efficiency and productivity. Application of fertilizers on the basis of soil characteristics associated with fertilizers recommendation may aid in minimizing the fertilizers input without any yield loss. Geo-statistics is a useful tool extensively used for analyzing spatial variability, interpolating between point observations and ascertaining the interpolated values with specified error using a minimum number of observations (Long *et al.,* 2014 and Cambule *et al.,* 2014). The information about spatial variability in physical, chemical and biochemical properties as well as microbiological activities of soil had great importance in the selection of crops and cropping system and also extent the ideas about prevailing management practices (Weindorf and Zhu, 2010; Cao *et al.,* 2011 and Liu *et al.,* 2013). Spatial variability in pH, EC, organic matter and available NPK has been studied by various researchers under contrasting soil and its management systems to refine and implement the site-specific management (Franzen *et al.,* 2002 and Li *et al.,* 2011).

The soil is one of the key components of the sustainable agricultural production system and its quality is governed by physico-chemical characteristics and nutrient supplying capacity which ultimately reflected through crop productivity. Soil quality was defined as the capacity of specific kind of soil to function, within the ecosystem and land use boundaries, to sustain productivity, maintain environmental quality and promote plant growth as well as human health (Andrews *et al.,* 2001). Soils are inherently heterogeneous in nature because many factors contribute to their formation and the complex interactions of these factors (Maniyunda *et al.,* 2013). It is well established that a change in land use, long-term cultivation and mineral fertilization can cause significant variations in soil properties (Jha and Mohapatra, 2012). The nature and characteristics of soils are mainly dependent on geological formations, topography, and climate of the region in which the soil occurs. Dokuchaev who considered the soils to be as independent natural body each with a unique morphology resulting from the unique combination of climate, living matter, parent materials, relief and age of landform.

Materials and Methods

Description of study area : Chambal division is a part of Chambal valley of Madhya Pradesh which covers these three districts areSheopur, Morena and Bhind. The area of chambal division is spread over 16054 square kmbetween 25°15'N to 26°48'N latitude and 76°31'E to79°15'E longitude of 160 m above mean sea level. The topography extends from west to east direction with medium slope gradient of 0 to 6 per cent.

Soil sampling and their processing : GPS based ninety surface soil samples were collected from different location across the Chambal division. Approx 1.0 kg of representative composite soil sample was collected and kept into properly labeled sample bags. Soil samples were brought to the laboratory and air dried, crushed with wooden pestle and mortar, sieved through 2 mm stainless steel sieve and used for determination of various soil physico-chemical characteristics.Location map of study area show in fig.-1.

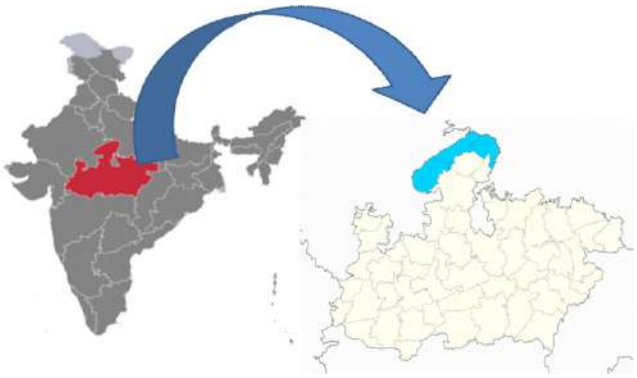

Fig.-1 : Location map of study area.

Physico-chemical properties : The soil pH was measured in 1: 2.5 ratio of soil: water using the pH meter and supernatant of same was used for electrical conductivity determination with the help of conductivity meter (Jackson, 1973). Organic carbon (OC) in soil was determined using the method as described by Walkley and Black (1934). The calcium carbonate in the soil was carried out using a rapid back titration method as described by Jackson (1973). Available nitrogen (N) was determined as per the method is given by Subbiah and Asija (1956). Available phosphorus (P) was determined by 0.5 M sodium bicarbonate procedure as described by Olsen *et al.* (1954) and then read on Spectrophotometer. Available potassium (K) was extracted with 1 N NH_4OAc and then measured by Flame Photometer (Jackson, 1973). The available sulphur (S) was extracted by 0.15 per cent $CaCl_2$ solution and the concentration of sulphur was determined by the turbidimetric method using Spectro-photometer (Chesnin and Yien, 1951).

The nutrient index (NI) values for available nutrients present in the soils was calculated utilizing the formula suggested by Parker et al. (1951) and classified this index as low (<1.67), medium (1.67 to 2.33) and high (>2.33).

$$NI= [(NL \times 1) + (NM \times 2) + (NH \times 3)]/NT,$$

Where NL, NM, and NH are the number of soil samples falling in low, medium and high categories for nutrient status and are given weight age of 1, 2 and 3, respectively. NT is the total number of soil samples.

Results and Discussion

Physico-chemical properties and nutrients content in soils of Chambal division : Data pertaining to physico-chemical properties and fertility status of soil in *Chambal division*are accessible (table-1). Results pertaining to physico-chemical properties of soils of Chambal division showed that the soil pH of Chambal division as whole, varied from 5.80 to 8.65 with mean value of 7.68 and under different districts variation in soil pH ranged from 5.80 to 8.65 with mean values varied from 6.69-7.71. Variation in soil pH under different districts and division as whole might be due to variations in parent material of soil, management practices and land uses. Similar variations in soil pH under different regions were also reported by Raghuvanshi *et al.* (1992), Singh *et al.* (2014), Baishya and Sharma (2017) and Yadav *et al.* (2018).

However, electrical conductivity of soils across different districts of Chambal division ranged from 0.12 to 0.89 dS m^{-1}at 25°C with average of 0.36dS m^{-1} which was in normal range (< 1 dSm^{-1} at 25°C). The low electrical conductivity in soil under study area might be due to high rainfall received and deep water table. Similar results for different soils were also reported by Tomar (1968), Dilliwar *et al.* (2014) and Singh *et al.* (2017).

Whereas, organic carbon in soils of different districts of Chambal division was varied from 1.50 to 10.20 g kg^{-1} with mean values ranged from 4.04 to 6.07 g kg^{-1}, while for Chambal division as whole OC varied from 1.50 to 10.20 g kg^{-1} with average value of 4.72 g kg^{-1}. Variation in organic carbon content in soil samples was may be due to variation in land use pattern, addition of organic matter in soil. Mandal *et al.* (2011) also found that crop species and cropping systems may play an important role for variations in soil organic carbon. Findings of Singh *et al.* (2014) and Yadav *et al.* (2018) also support the findings of present study.

Calcium carbonate content in soils of different districts ranged from 1.0 to 65 g kg^{-1} with average values varied from 9.77 to 29.17 g kg^{-1}. Results also indicated that lowest and the highest values of $CaCO_3$ in soil were obtained in Morena and Bhind districts, respectively might be due to calcareous parent materials and lower leaching process. Similar results were reported by Dilliwar *et al.* (2014) Singh *et al.* (2014) and Yadav *et al.* (2018).

Fertility status in soils of Chambal division : Data presented in (table-1) indicates thatresults also revealed that deficiency of N, P, K and S in soils of Chambal division as whole was found to the extent of 83.41, 4.88, 5.85 and 39.09 per cent in soil samples, and 16.59, 69.76, 4.39 and 22.73 per cent soil samples were found medium, respectively. Whereas, 0, 25.37, 89.76 and 38.18 per cent

Table-1 : Descriptive statistics of physico-chemical properties and fertility status of soils of Chambal Division of Madhya Pradesh.

Parameters	Min	Max	Mean	SD	CV	PSD	PSM	PSH	NI
pH	5.80	8.65	7.68	0.50	6.52				
EC (dS m^{-1})	0.12	0.89	0.36	0.15	40.39				
OC (gk g^{-1})	1.50	10.20	4.72	1.60	33.99				
$CaCO_3$ (g kg^{1})	1.00	65.00	13.52	9.46	69.97				
N (kg ha^{-1})	71.25	348.00	202.26	51.41	25.42	83.41	16.59	0.00	1.17
P (kg ha^{-1})	7.14	92.12	20.01	12.00	59.97	4.88	69.76	25.37	2.20
K (kg ha^{-1})	60.00	620.00	390.13	103.63	26.56	5.85	4.39	89.76	2.84
S (mg kg^{-1})	0.00	72.00	16.36	13.42	81.99	39.09	22.73	38.18	1.99

soil samples were analyzed high in P, K and S status, respectively. Nutrient index (NI) was found to be 1.17, 2.20, 2.84 and 1.99for N, P, K and S, respectively. The categories of the soil fertility status were made with respect to N, P, K and S as medium high medium and low. The nutrient index and fertility variabilityin show (figure-2,3). Kumar *et al.* (2014), Ravikumar and Somashekar (2014), Singh *et al.* (2017), Yadav *et al.* (2018) also reported similar findings.

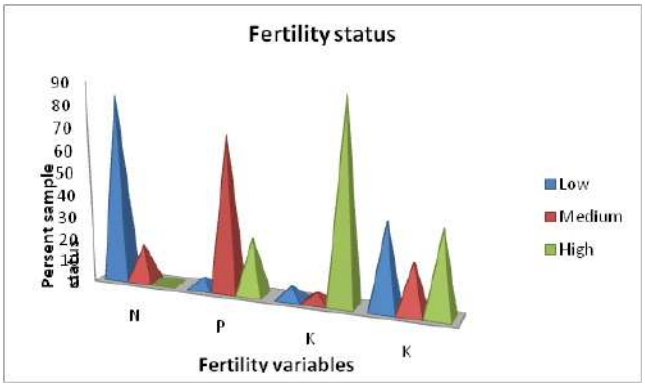

Fig.-2 : Fertility status of soils of Chambal Region of Madhya Pradesh.

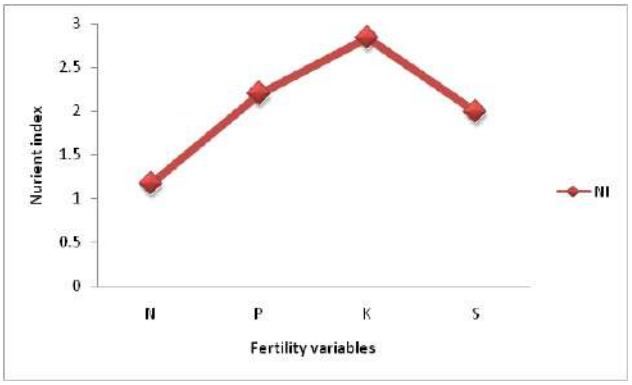

Fig.-3 : Index of nutrient availability in soils of Chambal division.

Physico-chemical properties of soils in different district of Chambal division : Data pertaining to variation in physico-chemical properties of soil in Bhind, Morena and Sheopurdistrict of Chambal division are presented (table-2). Data showed that in Bhind district, pH, EC, OC and $CaCO_3$ of soil samples varied from 6.98 to 8.14, 0.14 to 0.82dS m^{-1}, 2.40 to 10.20 g kg^{-1} and 15 to 65 g kg^{-1} with mean value of7.69, 0.48dS m^{-1}, 4.64 g kg^{-1}, and 29.17 g kg^{-1} respectively. Data also showed that thevalues of pH, EC, OC and $CaCO_3$ of the soil samples were varied from 6.90 to 8.20, 0.12 to 0.76dS m^{-1}, 1.50 to 8.60 g kg^{-1} and 1.00 to 23.50 g kg^{-1} with mean value of 7.71, 0.34dS m^{-1}, 4.04 g kg^{-1}, and 9.77 g kg^{-1}respectively inMorena district. Further, it was found that in Sheopur district of Chambal division the values of pH, EC, OC and $CaCO_3$ of the soil samples varied from 5.80 to 8.00, 0.12 to 0.49dS m^{-1}, 2.20 to 10.00 g kg^{-1} and 12 to 24 g kg^{-1} with mean value of 6.69, 0.28dS m^{-1}, 6.07 g kg^{-1}, and 18.30 g kg^{-1} respectively.

The macronutrients (NPK and S) status in Bhind, Morena and Sheopur districts of Chambal division are presented (table-3, 4). Available nitrogen content in soils of Bhind, Morena and Sheopur districts were ranged from146 to 348, 71.25 to 228.40 and 97 to 325 kg ha^{-1} with the mean values of 257.73, 172.32 and 237.07 kg ha^{-1}. It was also found that variability in available N content in soils of Bhind, Morena and Sheopur districts was 19.87, 22.44 and 26.67per. About 40 and 60, 100 and 0 and40 and 60 soil samples were rated to be low and medium, respectively indicating nutrient index value of 1.60, 1.0 and 1.60 in soils of Bhind, Morena and Sheopur districts.

Available phosphorus content in the soils of Bhind, Morena and Sheopur districts were ranged from 10.50 to 31.65, 7.14 to 28.70 and 8.0 to 58.0 kg ha^{-1} with a mean of 23.26, 15.72 and 21.67 kg ha^{-1}, respectively. It was also found that variability in available P in soils of Bhind, Morena and Sheopur districts were 25.90, 25.99 and 70.21 per cent. About 0, 33.33 and 66.67; 8.75, 77.50 and 2.05;13.33, 60 and 26.67 per cent samples drawn from Bhind, Morena and Sheopur districts were observed low, medium and high, respectively. Soil samples were observed to be indicating medium and high nutrient index value of 2.67, 2.05 and 2.13 of Bhind, Morena and Sheopur districts.Available potassium content in soils of

Table-2 : Status of physico-chemical properties of soils of different district of Chambal division.

District		pH	EC (d Sm^{-1})	OC (g kg^{-1})	$CaCO_3$ (g kg^{-1})
Morena	Min	6.90	0.12	1.50	1.00
	Max	8.20	0.76	8.60	23.50
	Mean	7.71	0.34	4.04	9.77
	SD	0.28	0.14	1.32	4.89
	CV	3.64	41.25	32.61	50.02
Bhind	Min	6.98	0.14	2.40	15.00
	Max	8.14	0.82	10.20	65.00
	Mean	7.69	0.48	4.64	29.17
	SD	0.35	0.23	2.16	13.78
	CV	4.60	48.78	46.58	47.24
Sheopur	Min	5.80	0.12	2.20	12.00
	Max	8.00	0.49	10.00	24.00
	Mean	6.69	0.28	6.07	18.30
	SD	0.70	0.13	2.47	3.00
	CV	10.52	44.99	40.72	16.42

Table-3 : Status of macro-nutrients in soils of different districts of Chambal division.

District		N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (mg kg^{-1})
Morena	Min	71.25	7.14	303.60	1.00
	Max	228.40	28.70	620.00	52.00
	Mean	172.32	15.72	444.05	13.60
	SD	38.67	4.09	74.21	11.70
	CV	22.44	25.99	16.71	85.99
Behind	Min	146.00	10.50	300.00	16.23
	Max	348.00	31.65	579.10	56.20
	Mean	257.73	23.26	393.87	25.85
	SD	51.20	6.02	75.58	10.54
	CV	19.87	25.90	19.19	40.79
Sheopur	Min	97.00	8.00	60.00	0.00
	Max	325.00	58.00	457.00	72.00
	Mean	237.07	21.67	269.53	21.60
	SD	62.75	15.21	116.65	18.68
	CV	26.47	70.21	43.28	86.47

Table-4 : Fertility status and nutrient index of macronutrients in soils of different district in Chambal division.

District	Status	N	P	K	S
Morena	PSD	100.00	8.75	0.00	48.75
	PSM	0.00	77.50	0.00	21.25
	PSH	0.00	13.75	100.00	30.00
	NI	1.00	2.05	3.00	1.81
Bhind	PSD	40.00	0.00	0.00	0.00
	PSM	60.00	33.33	0.00	33.33
	PSH	0.00	66.67	100.00	66.67
	NI	1.60	2.67	3.00	2.67
Sheopur	PSD	40.00	13.33	20.00	26.67
	PSM	60.00	60.00	33.33	20.00
	PSH	0.00	26.67	46.67	53.33
	NI	1.60	2.13	2.27	2.27

Bhind, Morena and Sheopur districts was ranged from 300 to 579.10, 303.60 to 620 and 60 to 457 kg ha^{-1} with a mean of 393.87, 444.05 and 269.53 kg ha^{-1}, respectively. It was also found that variability in available K in the soils of Bhind, Morena and Sheopur districts was 19.19, 16.71 and 43.28 per cent. About 100 per cent soil samples of Bhind and Morena district were found to beindicating high nutrient index value 3 the soil. However inSheopur the nutrient index value of 2.27; and 20, 33.33 and 46.67 percent samples was low, medium and high, respectively. Available sulphur content in soils of Bhind, Morena and Sheopur districts were ranged from 16.23 to 56.20, 1.0 to 52 and 0 to 72 mg kg^{-1} with a mean of 25.85, 13.60 and 21.60 mg kg^{-1}, respectively. It was also found that variability in available S in soil of Bhind, Morena and Sheopur districts were 40.79, 85.99 and 86.47 per cent. About 0, 33.33 and 66.67; 48.75, 21.25 and 30; and 26.67, 20 and 53.33 per cent samples drawn from Bhind, Morena and Sheopur districts were observed low, medium and high, respectively. Soil samples were observed to be low, medium and high indicating nutrient index value of 2.67, 1.81 and 2.27 of Bhind, Morena and Sheopur districts.

Conclusions

Based on the findings of present investigation it can be concluded thatthaSoils of Chambal division were found neutral to slightly acidic to alkaline in reaction, safe in lectrical conductivity, low to medium in organic carbon, non-calcareous in nature, extent of N deficiency in soils samples were to the extent of 83.41 per cent and extent of K excess in soils samples were to the extent of 89.76 per cent.

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Performance of High Yielding Varieties of Sesame during Early Kharif in Nellore District of Andhra Pradesh

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Abstract

In the context of optimizing sowing time and varieties for realizing higher productivity notably for sesame, an experiment with varying sowing times and varieties was conducted at Agricultural Research station, Nellore, A.P, India. The experimental findings revealed that crop sown on May II F.N recordedsignificantly highest seed yield (961 kg/ha.) followed by June sowings. Among the four varieties tested, YLM 66 (Sarada) registered significantly the highest seed yield (856 kg/ha), net returns and B: C ratio, due to significant improvement in yield components.

Keywords : *Sesame, sowing time, variety, seed yield.*

Introduction

Sesame (*Sesamum indicum* L.) is the oldest indigenous oilseed crop, with longest history of cultivation in India.Its oil contains an oxidant called sesmol which imparts longer shelf life. Sesame is also rich in phosphorous, iron, magnesium, manganese, zinc, and vitamin B1 (Anilakumar *et al.,* 2010). It is grown primarily in west Godavari, Srikakulam, Vizianagaram, Visakhapatnam, Prakasam, Kadapa and Chittoor districts of A.P. (Directorate of Economics & Statistics, International Journal of Current Microbiology and Applied Sciences (2020). In Andhra Pradesh, it is cultivated in Early *Kharif*,*kharif* and summer seasons with low inputs, and less care and management. As per recent estimate, it is grown in 51,660 ha land in the state with annual production of 17,640 tons and productivity of 323.43 kg/ha (Agriculture statistics, Ministry of Agriculture, Govt. of India, 2020-21). The main reasons for low productivity of sesame are its rainfed cultivation in marginal and sub marginal lands under poor management and input starved conditions. However, improved varieties and agro production technologies capable of increasing the productivity levels of sesame are now developed for different agro ecological situations in the country. The low yield of sesame varieties under delayed sown conditions leads to discourage growers resulting to less total area under sesame cultivation. Although genetic potentiality of varieties is important for improved yield and quality of sesame, but sowing time influences the growth and production to a great extent. Sharma (2005) reported 69 and 39% variation in seed yield of sesame due to differences in temperature and variety, respectively. Thus, present-day research on Sesame should emphasize on optimization of sowing time along with selection of suitable varieties for desirable production in a particular region.

Materials and Methods

A field experiment was conducted at Agricultural Research Station, Nellore, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India (14°27' N latitude, 79°59' E longitude and 20 m above mean sea level) to study the performance of sesame varieties under varied sowing times during Early kharif season of 2020. The experiment was laid out in a split-plot design, which consisted of 3 sowing times i.e., D_1: May II F.N, D_2: June I F.N, D_3: July II F.N, and four varieties of sesame as sub plots i.e. V_1: Madhavi, V_2: YLM 11, V_3: YLM 17 and V_4: YLM 66 and replicated thrice. The soil was well drained, sandy clay loam, with 8.1 pH, low in organic carbon (0.51%), Low available N (203 kg/ha), Medium in available P_2O_5 (41 kg/ha) and Medium in available K_2O (286 kg/ha). Seeds of sesame varieties were sown in furrows at 30 cmx15cm spacing in 4.5 m × 3.8 m plots and thinning was done at 15 days after sowing (DAS) to maintain optimum population. A uniform fertilizer does of 40:20:20 kg/ha of N: P_2O_5: K_2O including N in 2 splits was applied to all the experimental units. Sesame as an Earlykharif crop was grown under ID situation. The growth attributes like, plant height, yield components and seed yield were recorded. The data were analysed through SPSS statistics

Results and Discussion

Effect of time of sowing on yield attributes and yield of sesame : Significantly highest plant height (152 cm) was recorded when sesame was sown during May II F.N followed by June sowings. There was no significant difference in no. of branches produced plant^{-1} when sowing was done from May II F.N to June II F.N. Significantly highest no.of capsules plant^{-1}(84.2), No. of seeds capsules^{-1}(62) were recorded with May II F.N

Table-1 : Growth, yield components, Seed yield and Economics of Sesame as influenced by time of sowing and varieties during Early Kharif (2020).

Treatments	Pl. ht (cm)	No. of branches /plant	No. of capsule/ plant	No.of seeds/ capsule	1000 seed wt. (g)	Seed yield Kg/ha	Gross returns Rs/ha	Net returns Rs/ha	B:C ratio
Time of sowing									
May II F. N	152[a]	7.7	84.2[a]	62[a]	2.4	961[a]	86,490	56,490	2.88
June I F. N	143[b]	7.8	72.9[b]	58[b]	2.4	758[b]	68,220	38,220	2.27
June II F. N	142[b]	7.4	60.6[c]	52[c]	2.2	561[c]	50,490	20,490	1.68
Sig.	*	NS	**	**	NS	**			
P value	0.030	0.52	0.000	0.002	0.231	0.000			
Varieties									
Madhavi	140[c]	7.8[ab]	70.0	55[ab]	2.1c	808[ab]	72,720	42,720	2.42
YLM 11	144[b]	7.2[b]	67.9	48[b]	2.2b	650[c]	58,500	28,500	1.95
YLM 17	145[b]	8.6[a]	69.6	49[b]	3.1a	724[bc]	65,160	35,160	2.17
YLM 66	153[a]	6.8[c]	75.9	58[a]	2.3b	856[a]	77,040	47,040	2.57
Sig.	*	*	NS	*	*	**			
P value	0.044	0.026	0.237	0.035	0.021	0.008			
Interaction									
Sig	NS	NS	NS	NS	NS	NS			
P value	0.678	0.081	0.185	0.215	0.831	0.072			

sowing. Significantly the highest seed yield of 961 kg/ha was recorded when sesame was sown during May II F.N sowing followed by June I F.N (758 kg/ha) and June II F.N (561 kg/ha). The lowest seed yield was obtained with June II F.N sowing. No significant difference was found in 1000 seed weight. May II F.N sowing recorded highest gross returns (Rs 86, 490/- ha^{-1}), net returns (Rs 56,490/- ha^{-1}) and B: C ratio of 2.88 followed by June I and June II F.N sowings. Muhammad Aftab *et al.,* 2020 also reported similar findings

Yield attributes and yield of sesame as influenced by varieties : Among the four varieties tested, significantly highest plant height (153 cm) was recorded with YLM 66 (Sarada) followed by YLM 17, 11 and the lowest plant height was recorded with Madhavivariety. Highest number of branches $plant^{-1}$ was recorded with YLM 17 and Madhavi which were in turn on par with each other. Significantly highest no. of seeds $capsule^{-1}$ (58) were observed in YLM 66 and Madhavi (55) which were in turn on par with each other. Highest test weight was observed in YLM17 followed by YLM 66 and YLM 11. Significantly highest seed yield was observed with YLM 66 (856 kg/ha) and Madhavi (808 kg/ha) which were in turn on par with each other. Highest gross returns (Rs. 77, 040/- ha^{-1}), net returns (Rs47, 040/- ha^{-1}), and Benefit cost ratio (2.57) was recorded with YLM 66 (Sarada) followed by Madhavi, YLM 17 and YLM 11. The lowest grossreturns, net returns and B: C ratio was recorded with YLM11. Similar results were obtained by Govardhan Rao and Venkata Ramana (2017) and Sabitha (2020).

Conclusions

Thus it could be concluded that sesame can be sown during May II fortnight for getting highest seed yield, net returns and benefit cost ratio while YLM 66 (Sarada) is preferred as suitable variety for sowing during Early Kharif season in Nellore district of A.P., India.

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To Analyze Compound Growth Rate of Area, Production and Productivity of Maize in the Northern Hills of Chhattisgarh

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Abstract

A multi-stage design was adopted for the ultimate selection of maize grower. Chhattisgarh state consisted of three agro climatic sub-zones *i.e.* Chhattisgarh plains, Northern hills and Bastar plateau. From these sub-zones Northern hills are subjected as the major tribal populated area of the Chhattisgarh state. Therefore Northern hills will be selected for the study. Northern hills consist 5 districts. Two district from Northern hills *i.e.*Surajpur district and another one Balrampur district were selected purposively for the study. The time series cross sectional secondary data from 2009-10 to 2018-19 was used to examine the growth in area, production and productivity of maize of Chhattisgarh state as a whole and sampled districts of study area *i.e.,* Balrampur and Surajpur. The results showed that growth in production of maize of the state was significant and found to be 6.57 per cent growth in production which attributed with significant increase in area and yield of maize by 1.97 & 4.51 per cent. The sampled districts Balrampur and Surajpur have been noticed significant growth in production of maize, which was found to be 11.77 and 7.37 per cent, respectively. The attributing factors in production of maize were significant increase in area and yield of maize in Balrampur district. However, yield of maize was more attributing factor for significant growth in production of maize in Surajpur district. In context of area of Surajpur was found positively non significant. Therefore, it is being notice that awareness programmes for adoption of new technology in cultivation of maize have found significant impact in cultivation of maize in both districts.

Key words : *Significant, non-significant, area, production and productivity.*

Introduction

Maize (*Zea mays* L.) is an exciting and leading crop contributing significantly to world agriculture and more importantly to world's food basket of roughly 2000 million metric tons the wider adaptability and high yield potential of maize and its utility as food, feed and forage crop signifies the importance of maize. Among maize growing countries India ranks 4th in area and 7th in production, representing around 4% of world maize area and 2% of total production. During 2018-19 in India, the maize area has reached to 9.2 million ha (DACNET, 2020). During 1950-51 India used to produce 1.73 million MT maize, which has increased to 28.98 million MT by 2019-20, recording more than 16 times increase in production. The average productivity during the period has increased by 5.42 times from 547 kg/ha to 2965 kg/ha, while area increased nearly by three times. In Chhattisgarh maize occupies 118047 hectare land with the productivity of 2568 Kg/ha in2018-19. It is a kharif season crop in Chhattisgarh and second most important crop next to paddy in terms of both area and production. The maize area of the State has increased from 93.4 thousand ha in 2000-01 to 118.04 thousand ha in 2018-19, while the production has gone up from 125.7 thousand tons to 303.14 thousand tons. There is 2.03 times increase in productivity in the state. The yearly growth rate of maize area, production and productivity of the State since 2000-01 indicated that there is a steady increase over the years.

Materials and Methods

Method of enquiry and data collection : The secondary data was collected from various published sources and various government agencies and offices including the Directorate of Statistics and Agriculture official websites etc.

Compound Growth Rate : The compound growth rates in area production and productivity of maize will be worked out the following formula will be used for this purpose.

$Y = $ ^{t}

$\text{Log } Y = \log A + t \log B$

Where,

Y = Collection

= constant

= regression coefficient

t = time in year

Compound Growth Rate (%) = (Antilog B-1) 100

Table-1 : Compound growth rate of area, production and productivity of maize by sampled district and Chhattisgarh state.

S. No.	Particular	Compound growth rate		
		Area	Production	Productivity
1.	Chhattisgarh	1.97*	6.57**	4.51**
2.	Balrampur	3.26**	11.77**	8.20**
3.	Surajpur	0.32(NS)	7.37**	7.03**

Note : *Significant 5% level probability of 't' distribution
**Significant 1% level probability of 't' distribution

Table-2 : Area, production and productivity of maize in Chhattisgarh State.

S.No.	Year	Area	Production	Productivity
1.	2009-10	102700	185600	1807
2.	2010-11	104000	172000	1653
3.	2011-12	107200	207500	1935
4.	2012-13	111100	229100	2062
5.	2013-14	123430	254134	2058
6.	2014-15	125074	235014	1878
7.	2015-16	126356	237676	1881
8.	2016-17	120547	309324	2566
9.	2017-18	119617	306937	2565
10.	2018-19	118047	303145	2568

Table-3 : Area, production and productivity of maize in Surajpur District.

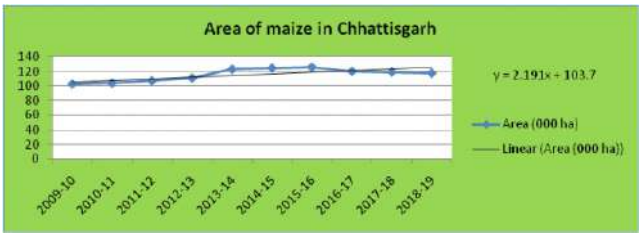
S.No.	Year	Area	Production	Productivity
1.	2009-10	9558	10896	1140
2.	2010-11	9837	17313	1760
3.	2011-12	10266	14321	1394
4.	2012-13	10391	18147	1746
5.	2013-14	11661	22187	1902
6.	2014-15	10489	18783	1790
7.	2015-16	10405	20778	1996
8.	2016-17	10696	20255	1893
9.	2017-18	10229	24200	2365
10.	2018-19	9723	24855	2556

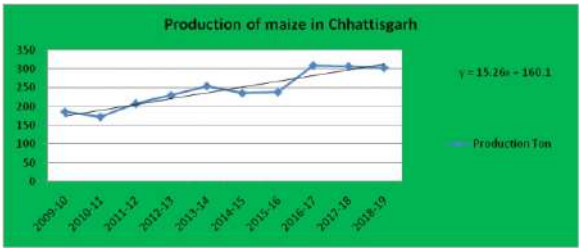
Table-4 : Area, production and productivity of maize in Balrampur District.

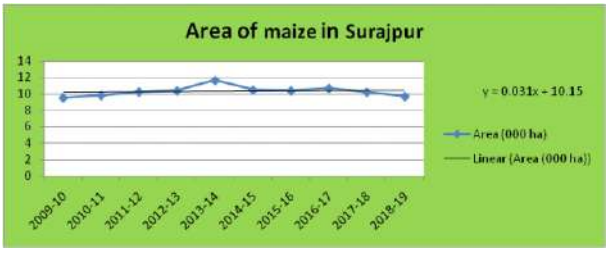
S.No.	Year	Area	Production	Productivity
1.	2009-10	16992	22004	1295
2.	2010-11	17847	31499	1765
3.	2011-12	18265	25481	1395
4.	2012-13	19649	40033	2037
5.	2013-14	19661	39902	2029
6.	2014-15	19750	35369	1790
7.	2015-16	21701	37253	1716
8.	2016-17	21577	62671	2904
9.	2017-18	21589	61553	2851
10.	2018-19	23271	63312	2720

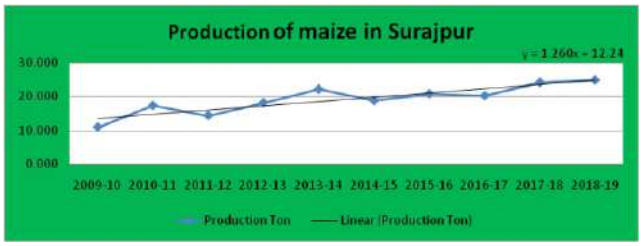
Results and Discussion

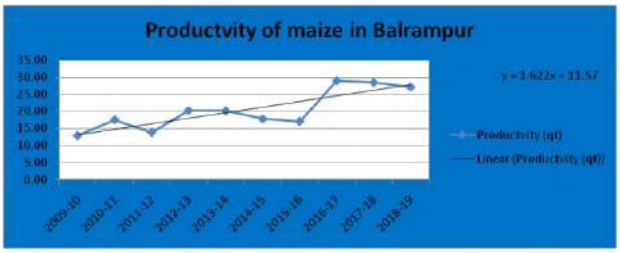
The time series cross sectional data from 2009-10 to 2018-19 was used to examine the growth in area, production and productivity of maize of Chhattisgarh state and sampled districts of study *i.e.,* Balrampur and Surajpur, which is shown in table-1. The results showed that growth in production of maize of the state was significant and found to be 6.57 per cent growth which attributed with significant increase in area of maize by 1.97 per cent. However, growth in yield of maize of the state has seen by 4.51 per cent. Therefore, it is being suggested that awareness programme for adoption of new technology in cultivation of maize should be introduced by extension personnel. The sampled districts Balrampur and Surajpur have been noticed significant growth in production of maize, which was found to be 11.77 and 7.37 per cent, respectively. In context to the area Surajpur district was found positively non-significant. The attributing factors in production of maize were significant increase in both districts.

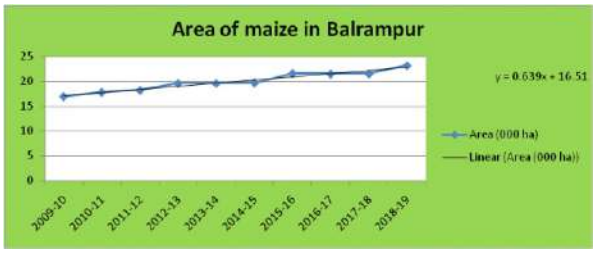


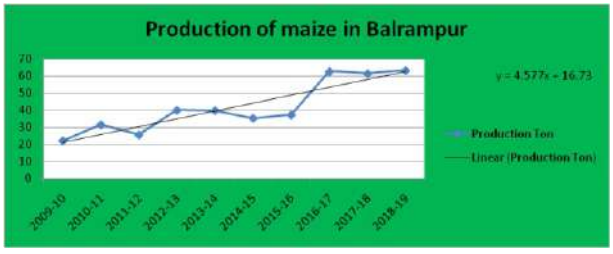












Conclusions

The results showed that growth in production of maize of the state was significant and found to be 6.57 per cent growth which attributed with significant increase in area of maize by 1.97 per cent. However, growth in yield of maize of the state has seen by 4.51 per cent. Therefore, it is being suggested that awareness programme for adoption of new technology in cultivation of maize should be introduced by extension personnel. The sampled districts Balrampur and Surajpur have been noticed positively significant growth in production of maize, which was found to be 11.77 and 7.37 per cent, respectively. In context to the area Surajpur district was found positively non-significant.

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Trait Linkages Among Turmeric (*Curcuma longa* L.) Genotypes for Yield and its Attributing Characters

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Abstract

Turmeric (*Curcuma longa* L.) is one among the important spice and also condiment crops grown in India since times immemorial.It's considered a logo of well being and widely utilized in ceremonies and non secular functions. it's an erect, herbaceous perennialbelonging to the Zingiberaceae and native to South East Asia. The experiment was administered with nineteen turmeric (*Curcuma longa* L.) genotypes to review the correlation and path coefficients analysis among the various characters at phenotypic andgenotypic levels revealed that yield per plot was having significantly positive association number of primary, secondary rhizomes,fresh weight of rhizome per plant, dry weight of rhizome per plant, while significantly negative correlations with dry recovery. Byindicating the above parameters the clonal selection should be made supported of those traits to bring the specified improvement inyield of turmeric. the trail coefficient analysis at genotypic level revealed that the amount of secondary rhizomes per plant features ahigh positive direct effect on yield per plot followed by dry weight of rhizome per plant and curcumin content, While, the highnegative direct effect of plant height was observed on yield per plot, indicating that selection should be made supported thesecharacters for improvement in turmeric.

Key words : *Trait linkages, correlation, path analysis, turmeric genotypes.*

Introduction

Turmeric (*Curcuma longa* L.) is one among the important spice and also condiment crops grown in India since times immemorial. It's considered a logo of well being and widely utilized in ceremonies and non secular functions. It's an erect, herbaceous perennial belonging to the Zingiberaceae and native to South East Asia. Turmeric of commerce is that the dried underground rhizome, valued for its deep yellow colour and pungent aromatic flavour thanks to the presence of colouring matter ''Curcumin'' and a essential oil ''termerole''. Traditionally it's utilized in Indian system of drugs as a stomachic, carminative, blood purifier, vermicide and antiseptic. The wound healing property of turmeric is documented to Indians since long. It's also a crucial condiment which finds a singular place in culinary arts and as a colouring agent in textile, food, confectionary, cosmetics and drug industries within the preparation of anticancer medicines. Turmeric is either grown as a pure crop or inter/mixed crop in coconut, betel nut and occasional plantations. In India, it's being cultivated in additional than 20 states in a neighborhood of 2.37 lakh ha with an annual production of 11.63 MT and earning 1241.89 crores by exporting 1.16 MT to other countries. In India, it's mainly grown in Telangana, Andhra Pradesh, Odisha, West Bengal, Tamil Nadu, Assam, Maharashtra, Karnataka, Bihar and Kerala. Among these, Telangana occupies 50,000 ha of the entire area and2.55 MT of total production of the country. The national productivity of crop is 5 tonnes per hectare. (NHB, 2017-18).

The yield of the economic component may be a very complex character and it's the results of the interaction of several factors inherent both in plant and therefore the environment during which the plant is grown. Therefore, variability exists within each component trait must be exploited selectively to understand the utmost gain in rhizome yield. Correlation and path coefficient analyses together provides a clear cut picture of interrelationships and relative contribution of independent characters on variable which enables to a plant breeder to use suitable selection procedures for crop improvement. this investigation was, therefore, conducted to seek out the main yield contributing traits in turmeric.

Materials and Methods

The experiment was conducted at Horticulture Research Station, Chinthapalli, Andhra Pradesh. The situation falls underAgro-climaticzone of High Altitude and Tribal Zone with average annual rainfall from South-Westmonsoon of quite 1300 mm,maximum temperature range 17 to 35 ºC, minimum temperature range from 5 to 24ºC and is found at an altitude of 933 m MSL.The geographical situation is 170.13' N latitude and 840.33' E longitudes. The experiment was laid call at Randomised BlockDesign with 19 treatments and three replications. The planting was

Table-1 : Estimates of phenotypic (P) and genotypic (G) correlation coefficients among yield and its components in turmeric.

Character		PH	NTP	NLP	LA	NMR	NPR	NSR	FWR	DWR	DR	CC	YPP
PH	P	1.000	-0.128	0.007	0.767**	-0.278*	0.335*	0.500**	0.093	0.441**	0.585**	0.222	-0.002
	G	1.000	-0.205	-0.049	0.805**	-0.365**	0.492**	0.545**	0.086	0.480**	0.649**	0.266*	-0.047
NTP	P		1.000	0.346**	0.016	0.207	-0.066	0.277*	0.110	-0.012	-0.403**	0.447**	-0.203
	G		1.000	0.604**	0.030	0.473**	0.179	0.309*	0.196	-0.056	-0.564**	0.655**	0.383
NLP	P			1.000	0.294*	0.220	0.108	0.121	-0.031	-0.190	-0.225	0.387**	0.159
	G			1.000	0.397**	0.196	0.310*	0.239	-0.076	-0.343**	-0.385**	0.599**	0.023
LA	P				1.000	-0.162	0.147	0.276*	-0.189	0.051	0.498**	0.551**	-0.146
	G				1.000	-0.242	0.229	0.291*	-0.194	0.055	0.533**	0.572**	-0.206
NMR	P					1.000	-0.143	-0.067	0.228	0.020	-0.290	0.068	0.133
	G					1.000	-0.183	-0.071	0.311*	0.153	-0.344**	0.085	0.163
NPR	P						1.000	0.643**	0.593**	0.597**	-0.046	-0.063	0.564**
	G						1.000	0.934**	0.787**	0.829**	-0.117	0.058	0.810**
NSR	P							1.000	0.674**	0.697**	-0.137	0.082	0.566**
	G							1.000	0.713**	0.756**	-0.172	0.099	0.802**
FWR	P								1.000	0.799**	-0.418**	-0.217	0.763**
	G								1.000	0.848**	-0.454**	-0.243	0.999
DWR	P									1.000	0.100	-0.216	0.567**
	G									1.000	0.061	-0.244	0.726
DR	P										1.000	0.101	-0.460**
	G										1.000	0.115	-0.631
CC	P											1.000	-0.125
	G											1.000	-0.157
YPP	P												1.000
	G												1.000

*-Significant at 5% level of significance **-Significant at 1% level of significance.

done on raised beds spaced row to row 30 cm with plant to plantdistance of 25 cm and therefore the net plot size was 3 x 1 m^2. The soil of the experimental field was alluvial and it had beenendowed with good drainage. Recommended package of practices and plant protection measures were followed to boost a healthycrop. VamshiKrishna*et al.* (2019). The observations were recorded for growth and yield parameters viz., plant height (cm), numberof tillers and leaves per plant, leaf area per plant (cm^2), number of mother, primary and secondary rhizomes per plant, fresh anddry weight of rhizome per plant (g), yield per plot (kg) dry recovery (%) and curcumin content (%). Genotypic and phenotypiccorrelation coefficients were estimated consistent with the formulae given by Johnson et al. (1955). The importance of thephenotypic and genotypic correlation coefficients was tested as given by Snedecor and Cochran (1967). Path coefficient analysis assuggested by Dewey and Lu (1959) was wont to partition the genotypic correlation coefficients of rhizome yield into direct andindirect effects.

Results and Discussion

Within the present study, the correlation coefficients among the various characters at phenotypic and genotypic levels revealed thatyield per plot had a significantly positive association with the amount of primary rhizomes, number of secondary rhizomes, freshweight of rhizome per plant, dry weight of rhizome per plant Table1. Plant height showed a big and positive association with leafarea, number of secondary rhizomes, dry weight of rhizome per plant, dry recovery. These results were also confirmed by thefindings of Lakshmi *et al.* (2017) for dry recovery. The amount of tillers showed a big and positive association with the amount ofmother rhizomes, curcumin content and therefore the number of mother rhizomes and number of tillers showed significant negativegenotypic correlation with dry recovery. The leaf area showed a big and

Table-2 : Estimates of genotypic direct and indirect effects of different traits on yield of turmeric.

Character	PH	NTP	NLP	LA	NMR	NPR	NSR	FWR	DWR	DR	CC
PH	-0.661	0.136	0.032	-0.533	0.241	-0.325	-0.360	-0.057	-0.318	-0.429	-0.176
NTP	0.124	-0.605	-0.366	-0.018	-0.286	-0.108	-0.187	-0.118	0.034	0.341	-0.396
NLP	-0.008	0.107	0.177	0.070	0.034	0.055	0.042	-0.013	-0.061	-0.068	0.106
LA	0.087	0.003	0.043	0.108	-0.026	0.024	0.031	-0.021	0.006	0.058	0.062
NMR	0.066	-0.086	-0.035	0.044	-0.182	0.033	0.013	-0.056	-0.028	0.062	-0.015
NPR	-0.063	-0.023	-0.040	-0.029	0.023	-0.129	-0.121	-0.102	-0.107	0.015	0.007
NSR	0.469	0.266	0.205	0.251	-0.061	0.804	0.860	0.614	0.651	-0.148	0.085
FWR	0.018	0.041	-0.016	-0.041	0.065	0.165	0.150	0.210	0.178	-0.095	-0.051
DWR	0.269	-0.031	-0.192	0.030	0.086	0.464	0.424	0.475	0.560	0.034	-0.136
DR	-0.108	0.094	0.064	-0.089	0.057	0.019	0.028	0.075	-0.010	-0.166	-0.019
CC	0.087	0.215	0.196	0.187	0.028	-0.019	0.032	-0.079	-0.080	0.037	0.328

*residual effect : 1.

PH = Plant height	NMR = Number of mother rhizomes	DWR = Dry weight of rhizome
NTP = Number of tillers per plant	NPR = Number of primary rhizomes	DR = Dry recovery
NLP = Number of leaves per plant	NSR = Number of secondary rhizomes	CC = Curcumin content
LA = Leaf area	FWR = Fresh weight of rhizome	YPP = Yield per plot

positive association with dry recovery and curcumin content these results were also confirmed by the findings of Roy *et al.* (2011) and Sivakumar *et al.* (2020) for dry recovery. Theamount of primary and secondary rhizomes showed a big and positive association with the fresh weight of rhizome per plant, dryweight of rhizome per plant and yield per plot these results were also confirmed by the findings of Yadav *et al.* (2006). Freshweight of rhizome had a positive and significant association with the amount of mother rhizomes, number of primary rhizomes,Number of secondary rhizomes, dry weight of rhizome per plant and yield per plot while a big and indirect correlation was observedwith dry recovery. The dry weight of rhizome per plant had a positive and significant linkage with plant height, number of primaryrhizomes, number of secondary rhizomes and fresh weight of rhizome per plant. These results were also confirmed by the findingsof Velmurugan *et al.* (2008). Dry recovery had a positive and significant association with plant height, leaf area. These results werealso confirmed by the findings Kuldeep (2012). The Curcumin content had a positive and significant association with tillers perplant, number of leaves per plant, and leaf area. Similar results were reported by several workers Viz., Velmurugan *et al.* (2008), Roy *et al.* (2011), and Kallur *et al.* (2017).

The trait coefficient analysis provides an efficient means of checking out the direct and indirect effect of association and permits acritical examination of specific forces acting to supply given correlation and measure the relative importance of every factor. Thedirect and indirect effects of various characters on yield at the genotypic level are presented in Table-2. Lenka and Mishra (1973) have suggested scales for path coefficients with values 0.00 to 0.09 as negligible, 0.10 to 0.19 low, 0.20 to0.29 moderate, and 0.30 to 0.99 high and quite 1.00 as very high path coefficients. Accordingly, during this study, the amount ofsecondary rhizomes per plant had a high positive direct effect on yield per plot followed by dry weight of rhizomes per plant,curcumin content. Whereas fresh weight of rhizomes per plant had a moderate positive direct effect on yield per plot and leaf areahad a coffee positive direct effect on yield per plot while, plant height had a high negative direct effect on yield per plot followedby the amount of tillers per plant, whereas the amount of mother rhizomes had a coffee negative direct effect on yield per plotfollowed by number of primary rhizomes. These findings showed that selection should be made on the idea of fresh weight ofrhizome and dry weight of rhizome per plant which had the very best positive direct effect taking other traits into consideration while making improvement in turmeric yield. Earlier workers like Tomar *et al.* (2005), Yadav *et al.* (2006) and

Kallur *et al.* (2017) had also reported similar effects of component traits on yield.

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Eco-Friendly Fabric Production through Coloured Fibres of Significant Cotton

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Abstract

The textile industry produces and uses of dyes, pigments and dye precursors, valued almost all of which is manufactured synthetically. Natural dyes are produced from plant tissue. Fibrous materials, especially cellulosic types used for textile products or other industrial purposes. Apart from economic considerations, the usefulness of a fibre for commercial purposes is determined by such properties as length, strength, pliability, elasticity, abrasion resistance, absorbency, and various surface properties. Therefore, naturally coloured cotton (NCC) should be produced in different forms of colours other than the yellowish off-white-type-based commercial cotton fibres. Brown and green shades were found be the typical colour of coloured cotton fibres. The natural colour is due to the plants inherent (non-modified) genetic properties. But now need different colour fibres can be produce from cotton through genetic modification.

Key words : *Strength of fineness, short fibre content and natural fibre colour, cotton spp.*

Introduction

Cotton belongs to *Gossypium genus*, which includes five species with 52-chromosome (2n=4x=52) that arose some 1-2 million years ago (4-6) through allotetraploidization between the extinct representatives of A and D cotton genomes. Cotton a leading natural fibre, is a major cash crop in the world which is grown commercially in more than 50 countries. China, India, USA, Pakistan and Uzbekistan are the five major cotton growing countries, with China holding the highest productivity (1265 kg/ha)[1], where climatic conditions suit the natural growth requirements of cotton, including periods of hot and dry weather, and where adequate moisture is available, often obtained through irrigation. The cotton species recognized in the world are about 50, of which 4 are cultivated. Two of these (*Gossypiumar boreum* and *G. herbaceum*) are diploids, and two (*G. hirsutum* and *G. barbadense*) are tetraploids. More than 80% of the world's cotton area is covered by tetraploids. However, diploid cottons are cultivated in Asia and the Middle East. India is the only country where all the cultivated species and some of their hybrid combinations are commercially grown. The diversity of cotton cultivars and cotton agro climatic zones in India is larger when compared to other major cotton growing countries in the world. Cotton is the most important natural fibre and it constitutes around 50% of the textile and clothing materials (Proto *et. al.* 2000). Due to its excellent natural hygienic and comfort-related properties, cotton is traditionally applied in clothing and other textiles used close to the human skin. In cotton research we can also observe intensive efforts aimed at the improvement of the competitiveness of cotton in the world textile market. First of all research work is carried out in order to improve the quality of cotton varieties as well as to increase the economical effectiveness of cotton production. Determination of quality value of cotton fibre is a complex problem and it has enormous importance in trade and manufacturing. Cotton merchants can demand for higher price commensurate with the fibre quality (Jung *et al* 2007, Majumdar *et al* 2010.). Seeds are removed from the cotton boll (fibre plus seed cases) in the ginning process. Extracted fibres contain a very high proportion of cellulose (95%) and there is less than 10% weight loss in the fibre extraction process. After drying, the cylindrical fibres collapse into flat, twisted and kinked ribbons which can interlock when spun to form yarn which is the basis of cotton textiles. On the other hand, yarn and fabric manufactures always crave for better fibre quality as the quality of spun yarn is largely (upto 80%) influenced by the

fibre characteristics by Klein et al 1995. The overall quality of cotton fibre depends on properties like strength, length, length uniformity, fineness (micronaire), short fibre content and colour. The level of influence of various cotton fibre properties (decision criteria) on yarn quality is diverse and it changes with the yarn manufacturing technology (Kelly *et al* 2013.).

Ideal cotton (*Gossypium* spp.) fibres are said to be as white as snow, as strong as steel, as fine as silk and as long as wool. The fibre quality of a specific cotton genotype is a composite of fibre shape and maturity properties that depend on complex interactions among the genetics and physiology of the plants producing the fibres and the growth environment prevailing during the cotton production season. Fibre shape properties, particularly length and diameter, are largely dependent on genetic makeup of the plant. Fibre maturity properties, which are dependent on deposition of in the fibre cell wall, are more sensitive to changes in the growth environment. The effects of the growth environment on the genetic potential of a genotype modulate both shape and maturity properties to varying degrees. Anatomically, a cotton fibre is a seed hair, a single hyper elongated cell arising from the protodermal cells of the outer integument layer of the seed coat. Like all living plant cells, developing cotton fibres respond individually to fluctuations in the macro- and micro environments. Thus, the fibres on a single seed constitute continua of fibre length, shape, cell-wall thickness, and physical maturity (Bradow *et al* 1997, Bradow *et al* 1996b.). Environmental variations within the plant canopy, among the individual plants, and within and among fields ensure that the fibre population in each boll, indeed on each seed, encompasses a broad range of fibre properties and that every bale of cotton contains a highly variable proportion of fibres. Successful processing of cotton lint depends on appropriate management during and after harvest of those highly variable fibre properties that have been shown to affect finished-product quality and manufacturing efficiency (Bradow *et al* 1996b.). If fibre-blending strategies and subsequent spinning and dyeing processes are to be optimized for specific end-uses and profitability, production managers in textile mills need accurate and effective descriptive and predictive quantitative measures of both the means and the ranges of these highly variable fibre properties (Moore *et al* 1996.). The naturally wide variations in fibre quality, in combination with differences in end-use requirements, result in significant variability in the value of the cotton lint to the processor. Therefore, a system of premiums and discounts has been established to denote a specified base quality. In general, cotton fibre value increases as the bulk averaged fibres increase in whiteness (+Rd), length, strength, and micronaire; and discounts are made for both low mike (micronaire less than 3.5) and highmike (micronaire more than 4.9). Ideal fibre-quality specifications favoured by processors traditionally have been summarized “as white as snow, as long as wool, as strong as steel, as fine as silk, and as cheap as hell”. But the textile industry produces and uses of dyes, pigments and dye precursors, valued almost all of which is manufactured synthetically. Natural dyes are produced from plant tissue and fungal species (Natural). In fibrous materials, especially cellulosic types such as cotton, wood, grains, and straw, only a small number can be used for textile products or other industrial purposes. Apart from economic considerations, the usefulness of a fibre for commercial purposes is determined by such properties as length, strength, pliability, elasticity, abrasion resistance, absorbency, and various surface properties (natural fiber). The natural colour is due to the plants inherent (non-modified) genetic properties. University of California and Bureau Veritas testing have shown that it compares favourably to white cotton fabrics in a study evaluating abrasion, resistance, dimensional stability and pilling resistance. Naturally coloured cotton (NCC) was produced in different forms of colours other than the yellowish off-white-type-based commercial cotton fibres. A brown and green shade was found the typical colour of coloured cotton fibers (Natural fibre colour.).

Types of lint colour : Cotton occurs naturally in four colors : white, brown, green and blue. White coloured cotton ranges from creamy to shinning white. Brown occurs in various shades from light Brown to dark Brown and mahogany. Green occurs in shades from light green to green, but only very light blue is available. Coloured lint usually has poor quality: the fibre is weak, it has higher micronaire and it is shorter in length (Chaudhary *et al* 2003). The lint colour of cotton under commercial cultivation is often white. Some of the genotypes in germplasm collection of USA and Russian Republics are reported to have coloured lint with shades of pink, red, blue, green and also black. Ms. Sally Fox of Vresers Ltd. claimed to have developed multi-coloured lint, i.e. development of more than one colour on the same lint strand. However, genotypes with multi coloured lint have not yet been made available to the researches nor produced on large scale. The two commonly occurring lint colours, i.e. brown and green are briefly discussed below: Brown colour- Among the coloured cottons, brown is the most common colour. The brown colour is found in different shades which ranges from light brown to intense mahogany red. Depending on the intensity of colour, it is named as light brown, khaki/camel colour, brown, dark brown / chocolate colour, dirty grey, tan and red. Brown colour is found in all the four cultivated as well as many of the wild species. Brown colour is more stable than green colour. On continuous exposure to sunlight, brown colour also fades but gradually at a very slow rate. In India, brown

linted varieties of G. arboreum, namely, Cocanada-1, Cocanada-2 and red Northerns were under commercial cultivation during first half of the 20th century (cicr.org.in.). Green Colour-Green is the second important commonly occurring lint colour in cotton. Green colour is less common than brown and occurs mainly in two shades i.e. light green and green. Green colour is more prone to fading, fades faster than the brown colour. Prolonged exposure to sunlight during boll opening leads to rapid fading of green colour and the colour turns to white, off-white or brownish. Portion of lint which is not directly exposed to sunlight retains its original lint colour. Green colour is mostly observed in G. hirsutum and probably varieties possessing green lint have not yet been released for commercial cultivation.

Sources of lint colour : There are two important sources (i) germplasm collections and (ii) wild species of coloured lint in cotton. These are briefly discussed below : Germplasm collection-Genetic resources are most vital for improvement of any crop. In India, about 40 coloured genotypes of upland cotton (*G. hirsutum*), mostly of various shades of brown and green colour are available in the National Gene Bank of Cotton maintained at the Central Institute for Cotton Research, Nagpur. These genetic stocks are indigenous collections as well as exotic accessions from USA, erstwhile USSR, Israel, Peru, Mexico, Egypt etc. In Asiatic diploid cottons (*G. arboreum* and *G. herbaceum*) about 10 germplasm lines possessing mostly light brown lint colour are also available. Most of the coloured linted germplasm lines have been evaluated for their economic attributes as well as fibre characteristics.

Fibre strength : Improvement in textile processing, particularly advances in spinning technology, have led to increased prominence on breeding cotton for both improved yield and improved fibre properties (Meredith *et al* 1972, Patil *et al* 1995.). Studies of gene action suggest that, within upland cotton genotypes there is little non-additive gene action in fibre length, strength, and fineness (Meredith *et al* 1972). that is, genes determine those fibre properties. Season-related shifts in cotton plant metabolism and fibre properties take the form of higher levels of fibre maturation in upland and pima bolls from July flowers, compared with the maturity levels of fibres in bolls from August flowers on the same plants (Sassenrath-Cole et al 1996, Bradow *et al* 1996, Bradow *et al* 1997.). Examined fibre length in relation to seed location in the locule and found that seeds near the apical or basal end of the boll produced the shortest fibres (Porter *et al* 1936.). Genotype canopy characteristics, such as solar tracking and leaf shape, and macro and micro-environmental factors interact to modulate canopy light distribution, which, in turn, alters photosynthetic activity within the canopy and the crop (Wells *et al* 1986, Sassenrath-Cole *et al* 1996.). The inherent breaking strength of individual cotton fibres is considered to be the most important factor in determining the strength of the yarn spun from those fibres (Munro *et al* 1987, Patil *et al* 1995, Moore, J.F.,1996). Recent developments in high speed yarn spinning technology, specifically opened rotor spinning systems, have shifted the fibre quality requirements of the textile industry toward higher-strength fibres that can compensate for the decrease in yarn strength associated with open-end rotor spinning techniques (Patil *et al* 1995.). Compared with conventional ring spinning, open-end rotor-spun yarn production capacity is five times greater and, consequently, more economical. Rotor-spun yarn is more even than the ring-spun, but is 15 to 20% weaker than ring-spun yarn of the same thickness. Thus, mills using open-end rotor and friction spinning have given improved fibre strength (together with fibre fineness) highest priority. Length and length uniformity, followed by fibre strength and fineness, remain the most important fibre properties in determining ring-spun yarn strength (Moore *et al* 1996, Patil *et a*l 1995). Fibre strength, that is, the force required to break a fibre, varies along the length of the fibre, as does fibre fineness measured as perimeter, diameter, or cross section (Hsieh *et al* 1995). In the textile literature, fibre strength is reported as breaking tenacity or grams of breaking load per tex, where tex is the fibre linear density in grams per kilometre (Taylor *et al* 1994). Early studies showed fibre strength to be significantly and positively correlated with maximum or mean growth temperature, maximum minus minimum growth temperature, and potential insolation (Hanson *et al* 1956). Increased strength was correlated with a decrease in precipitation. Minimum temperature did not affect fibre strength. All environmental variables were interrelated, and a close general association between fibre strength and environment was interpreted as indicating that fibre strength is more responsive to the growth environment than are fibre length and fineness. Square removal did not affect either fibre elongation (Pettigrew *et al* 1992) or fibre strength (Pettigrew *et al* 1992, Terry *et al* 1992). Shading, leaf pruning, and partial fruit removal decreased fibre strength (Pettigrew, W.T., 1987). Selective square removal had no effect on fibre strength in bolls at the first, second, or third position on a fruiting branch (Heitholt, J.J., 1995). Fibre strength was slightly greater in bolls from the first 4 to 6 weak of flowering, compared with fibres from bolls produced by flowers opening during the last 2 weak of the flowering period (Jones *et al.* 1997).

Fibre length and short-fibre content : Even on a single seed, fibre lengths vary significantly because the longer fibres occur at the chalazal (cup shaped, lower) end of the

seed and the shorter fibres are found at the micropylar (pointed) end. Variations in fibre length attributable to genotype and fibre location on the seed are modulated by factors in the micro- and macro- environment (Bradow *et al.,* 1997). Environmental changes occurring around the time off loral anthesis may limit fibre initiation or retard the onset of fibre elongation. Suboptimal environmental conditions during the fibre elongation phase may decrease the rate of elongation or shorten the elongation period so that the genotypic potential for fibre length is not fully realized (Hearn, A.B., 1976).

Measurement of fibre length : Fibre lengths on individual seeds can be determined while the fibres are still attached to the seed (Munro *et al* 1987,, Gipson, J.R. and Joham, H.E.,1969), by hand stapling or by photoelectric measurement after ginning (Munro et al 1987, Behery, H.M.,1993). The four upland staple classes are: short (<21 mm), medium (22–25 mm), medium-long (26–28 mm) and long (29–34 mm) (Pellow *et al* 1996). Pima (*Gossypium barbadense* L.) staple length is classed as long (29–34mm) and extra-long (>34 mm). Additionally, short fibre content is defined as the percentage of fibre less than 12.7mm. Cotton buyers and processors used the term staple length long before development of quantitative methods for measuring fibre properties. The resulting length-weight distribution is used in calculating various fibre length properties, including the mean fibre length and upper quartile length by weight, which is the fibre length exceeded by 25% of the fibre lengths by weight in the test specimen. Fibre length is directly related to yarn fineness, strength, and spinning efficiency (Moore *et al* 1996). Consequently, rapid, reproducible instrumental methods for fibre-length measurement have been developed. Both length and length uniformity can be measured with the Fibro graph (ASTM, 1994, D1447-89). In Fibro graph testing, fibres are randomly caught on combs, and the beard formed by the captured fibres is scanned photo electrically from base to tip 30 (Behery, 1993). The amount of light passing through the beard is a measure of the number of fibres that extend various distances from the combs. Data are recorded as span length (the distance spanned by a specific percentage of fibres in the test beard). Span lengths are usually reported as 2.5 and 50%. The 2.5% span length is the basis for machine settings at various stages during fibre processing. The uniformity ratio is the ratio between the two span lengths expressed as a percentage of the longer length. The Fibro graph provides a relatively fast method for reproducibility in measuring the length and length uniformity of fibre samples. Fibro graph test data are used in research studies, in qualitative surveys such as those checking commercial staple length classifications, and in assembling cotton bales into uniform lots.

Fibre length is primarily a genetic trait, but short-fibre content is dependent upon genotype, growing conditions, and harvesting, ginning, and processing methods. Further, little is known about the levels or sources of pre-harvest short-fibre content (Behery, H.M.,1993, Bradow, et al 1999). Based on length measurements of hand-ginned fibres from three genotypes, fibres attached to cotton seeds before harvest are said to account for 11.5% of the total short-fibre content in the bale (Fransen, T.J.F. and Verschraege, L., 1985, Alverson, J., 1997). However, the sesame literature sources show that total short-fibre content in mechanically ginned lint ranged from 6.1 to 9% (Fransen, T.J.F. and Verschraege, L., 1985). More recently, the average short-fibre content (by weight) of fibre finger-ginned from normal (full-weight). Deltapine 51 seeds were reported to be 6.2% (Davidonis, et al 1996). Because these Deltapine 51bolls were hand-harvested, post-harvest methods like spindle-picking, stripper-harvesting, mechanical ginning, or lint cleaning were not factors contributing to the higher short-fibre content percentages in the more recent reports (Davidonis, *et al* 1996, Rogers, C.D.,1997).

Fibre length and relation with Abiotic factors

1. Fibre Length and Temperature : Maximum cotton fibre lengths were reached when night temperatures were around 19 to 20°C, depending on the genotype (Gipson, J.R. and Joham, H.E.,1968, Gipson, J.R. and Ray, L.L., 1970). Early-stage fibre elongation was highly temperature dependent; late fibre elongation was temperature independent (Gipson, J.R. and Joham, H.E.,1969, Xie et al 1993). Fibre length (upper-half mean length) was negatively correlated with the difference between maximum and minimum temperature (Hanson *et al* 1956). Field experiments on the Texas High Plains showed that a night temperature of 15°C, compared with a night temperature of 25°C, caused a 4 to 5 days delay in fibre elongation (Gipson, J.R. and Ray, L.L.,1970). Although the observed effects of cool night temperatures were not categorized as delays in fibre initiation or in fibre elongation, field studies in India showed that fibres grown at 15 °C took 3 to 5 days longer to reach 2 mm in length than did control fibres grown at 24 °C (Thaker et al 1989)

2. Fibre length and water : Cotton water relationships and irrigation traditionally have been studied with respect to yield (Hearn, A.B.,1994, Radin et al 1992). Fibre length was not affected unless the water deficit was great enough to lower the yield to 700 kg ha$1(Grimes, D.W. and Yamada, H., 1982). Fibre elongation was inhibited when the midday water potential was –2.5 to –2.8 mPa. Occurrence of moisture deficits during the early flowering period did not alter fibre length. However, when drought occurred later in the flowering period, fibre length was

decreased (Marani, A. and Amirav, A., 1971-Lee, J.A.,1984). Commercial cotton genotypes are considered to be day-length neutral with respect to both flowering and fruiting (Johnson *et al* 1997). However, incorporation of day-length data in upland and pima fibre-quality models, based on accumulated heat units, increased the coefficients of determination for the length predictors from 30 to 54% for the upland model and from 44 to 57% for the pima model (Johnson *et al* 1997) Studies of the mineral nutrition of cotton and the related soil chemistry usually have emphasized increased yield and fruiting efficiency (Joham, H.E., 1986- Radin, J.W. and Mauney, J.R.,1986). More recently, the effects of nutrient stress on boll shedding have been examined (Jackson, B.S. and Gerik, T.J.,1982-Heitholt, J.J.,1994). Also, several mineral nutrition studies have been extended to include fibre quality (Cassman *et al* 1990-Pettigrew, W.T.,1996). These studies investigated the effects of either K or N on fibre properties, including span length.

3. Fibre maturity : Fibre properties reported by USDA-AMS classing offices for use by the textile industry, fibre maturity is probably the least well-defined and most misunderstood. The term, fibre maturity, used in cotton marketing and processing is not an estimate of the time elapsed between floral anthesis and fibre harvest (Lord, E. and Heap, S.A.,1988). However, such chronological maturity can be a useful concept in studies that follow fibre development and maturation with time (Ramey, H.H., 1982). On the physiological and physical basis, fibre maturity is generally accepted to be the degree (amount) of fibre cell-wall thickening relative to the diameter or fineness of the fibre (Perkins et al 1984). Classically, a mature fibre is a fibre in which two times the cell wall thickness equals or exceeds the diameter of the fibre cell lumen, the space enclosed by the fibre cell walls (Ramey, H.H.,1982). However, this simple definition of fibre maturity is complicated by the fact that the cross section of a cotton fibre is never a perfect circle; the fibre diameter is primarily a genetic characteristic (Lord, E. and Heap, S.A.,1988, Ramey, H.H.,1982, Matic-Leigh, R. and Cauthen, D.A.,1994). Further, both the fibre diameter and the cell-wall thickness vary significantly along the length of the fibre. Thus, attempting to differentiate, on the basis of wall thickness, between naturally thin-walled or genetically fine fibres and truly immature fibres with thin walls greatly complicates maturity comparisons among and within genotypes. For example, the mean fibre diameters of upland genotypes range from 21 to 29 m, and the diameters of genetically finer pima fibres range from 17 to 20m (Ramey, H.H.,1982). On a locule-average basis and across fruiting sites within single crop, Pee Dee 3 upland cotton fibre diameters ranged from 1.2 to 18.7m within a crop mean of 2.1 to 12.4m (Bradow and Bauer, unpublished mean diameter-by-number distribution obtained using the AFIS-A2 Length and Diameter module). Within a single fibre sample examined by image analysis, cell-wall thickness ranged from 3.4 to 4.9m when lumen diameters ranged from 2.4 to 5.2m (Matic-Leigh, R. and Cauthen, D.A.,1994). Based on the cited definition of a mature fibre having a cell-wall thickness two times the lumen diameter, assuming that 90% of the 40 fibres in that sample were mature.

4. Estimating fibre fineness : Fibre fineness has long been recognized as an important factor in yarn strength and uniformity, properties that depend largely on the average number of fibres in the yarn cross section. Spinning larger numbers of finer fibres together results in stronger, more uniform yarns than if they had been made up of fewer, thicker fibres (Ramey, H.H.,1982). However, direct determinations of biological fineness in terms of fibre or lumen diameter and cell-wall thickness are precluded by the high costs in time and labour, the noncircular cross sections of dry cotton fibres, and the high degree of variation in fibre fineness (Ramey, H.H.,1982). Advances in image analysis have improved determinations of fibre biological fineness and maturity (Matic-Leigh, R. and Cauthen, D.A.,1994), but fibre image analyses remain too slow and limited with respect to sample size for inclusion in the HVI-based cotton-classing process. Originally, the textile industry adopted gravimetric fibre fineness or linear density as an indicator of the fibre-spinning properties that dependon fibre fineness and maturity combined (Ramey, H.H.,1982). This gravimetric fineness testing method was discontinued in 1989, but the textile linear density unit of texpersists. Texis measured as grams per kilometer of fibre or yarn, and fibre fineness is usually expressed as millitex or micrograms per meter (Ramey, H.H.,1982). Earlier, direct measurements of fibre fineness (either biological or gravimetric) subsequently were replaced by indirect fineness measurements based on the resistance of a bundle of fibres to airflow. The first indirect test method approved by ASTM for measurement of fibre maturity, linear density, and maturity index was the causticaire method. In that test, the resistance of a plug of cotton to airflow was measured before and after a cell-wall swelling treatment with an 18% (4.5 M) solution of NaOH (ASTM, 1991, D 2480-82). The ratio between the rate of airflow through an untreated and then treated fibre plug was taken as indication of the degree of fibre wall development. The airflow reading for the treated sample was squared and corrected for maturity to serve as an indirect estimate of linear density. Causticaire method results were found to be highly variable among laboratories, and the method never was recommended for acceptance testing before it was discontinued in 1992.

5. Micronaire, an indirect estimate of fibre fineness and maturity : Micronaire is the most commonly used instrumental fibre-quality test (Lord, E. and Heap, S.A.,1988). Micronaire is an indirect measure of the air-permeability of a test specimen of known mass enclosed in a container of fixed dimensions. Initially, air-permeability of the sample was thought to depend on fibre linear density, and the empirically derived curvilinear micronaire scale was set in gravimetric fineness units of fibre weight per inch (Lord, E. and Heap, S.A.,1988- Ramey, H.H.,1982). However, basic fluid-flow theory states that air permeability is inversely dependent on the square of the fibre surface area, and linear density units were subsequently dropped from the micronaire scale. Now micronaire (also, mike or mic.) is treated as a dimensionless fibre property quantified against an empirically derived scale and standardized for each annual crop. Under standardized testing and calibration conditions, the micronaire test method, which has been incorporated into the HVI systems (ASTM,1994, D 4604-86, D 4605-86), is considered satisfactory for acceptance testing if users of the test results consider micronaire readings as estimates of both fibre fineness and maturity. The micronaire testing the HVI system is relatively insensitive to sample preparation and to small variations in relative humidity and temperature during testing. Standardized preconditioning is, therefore, required at the USDA-AMS classing offices. For micronaire determinations by the HVI system, the minimum sample size is currently 10 g (ASTM, 1994, D 4604-86, D 4605-86), but use of 50-gram samples is advised as a means of improving random sampling and decreasing sampling bias. In the USA, the acceptable, However, lower micronaire fibres stretch, tangle, and break more easily and do not impart the greater yarn strength and uniformity expected of genetically finer, but still mature, fibres.

6. The fibre fineness/maturity complex : Various methodologies and instruments have been used to separate the causes and effects of cotton fibre fineness and maturity. In addition to the previously discussed microscopic and image-analysis assays of fibre biological fineness and estimates of fibre linear density, near-infrared transmission spectroscopy (NITS) has been used to describe a linear relationship between fibre fineness and the amount of light scattered (Montalvo et al 1989). The distribution of cotton fibre fineness as diameter by number also can be determined rapidly and can be reproducible by the AFIS-A2 Length and Diameter (L&D) module (Bragg, C.K. and Wessinger, J.D.,1993, Yankey, J.M. and Jones, P.C.,1993). The AFIS-A2 Fineness and Maturity (F&M)module uses scattered light to measure single-fibre cross-sectional areas (Williams, G.F. and Yankey, J.M.,1996) .Algorithms have been developed for calculating the fine-fibre fraction (percent of fibres for which the cross-sectional area by number is less than 60m to 260m, perimeter, and micronaire, micron AFIS, from fibre data collected by the AFIS-A2 F&M module. Newer AFIS models combine the L&D and the F&M modules as the length and maturity (L&M) module that generates fineness data in millitex (Williams, G.F. and Yankey, J.M.,1996). Near-infrared reflectance spectroscopy (NIRS) has also been used in examinations of fibre cross-sectional area, that is, fineness (Montalvo, J.G. Jr.,1991a- Montalvo, J.G. Jr.,1991c).

7. Fibre colour : Raw fibre stock colour measurements are used in controlling the colour of manufactured grey, bleached, or dyed yarns and fabrics (Nickerson, D. and Newton, F.E.,1958-Xu *et al* 1998b). Of the three components of cotton grade, fibre colour is most directly linked to growth environment. Colour measurements also are correlated with overall fibre quality so that bright (reflective, high Rd), creamy-white fibres are more mature and of higher quality than the dull, grey or yellowish fibres associated with field weathering and generally lower fibre quality (Perkins et al 1984). Although upland cotton fibres are naturally white to creamy-white, pre-harvest exposure to weathering and microbial action can cause fibres to darken and to lose brightness (Perkins et al 1984, Allen et al 1995). Premature termination of fibre maturation by applications of growth regulators, frost, or drought characteristically increases the saturation of the yellow (+b) fibre-colour component. Other conditions, including insect damage and foreign matter contamination, also modify fibre color (Xu, B., Fang, C. and Watson, M.D.,1998a, Xu *et al* 1998b). The ultimate acceptance test for fibre colour, as well as for finished yarns and fabrics, is the human eye. Therefore, instrumental colour measurements must be correlated closely with visual judgment.

8. Fibre quality and yield : Like all agricultural commodities, the value of cotton lint respond to fluctuations in the supply and demand forces of the marketplace (Moore, J.F.,1996). In addition, pressure toward specific improvements in cotton fibre quality - for example, the higher fibre strength needed for today's high speed spinning - has been intensified as a result of technological advances in textile production and imposition of increasingly stringent quality standards for finished cotton products. Changes in fibre-quality requirements and increases in economic competition on the domestic and international levels have resulted in fibre quality becoming a value determinant equal to fibre yield (Ethridge *et al* 1996- Hudson *et al* 1996.). Indeed, it is the quality, not the quantity, of fibres ginned from the cotton seeds that decides the end use and economic value of a

cotton crop and, consequently, determines the profit returned to both the producers and processors. Wide differences in cotton fibre quality and shifts in demand for particular fibre properties, based on end-use processing requirements, have resulted in the creation of a price schedule, specific to each crop year, that includes premiums and discounts for grade, staple length, micronaire, and strength (Deussen *et al* 1995, Ethridge *et al* 1996). This price schedule is made possible by the development of rapid, quantitative methods for measuring those fibre properties considered most important for successful textile production (Chewning, C.H.,1995, Frye *et al* 1995). With the wide availability of fibre-quality data from HVI, predictive models for ginning, bale mix selection, and fibre-processing success could be developed for textile mills (Chewning, C.H., 1995). Price-analysis systems based on HVI fibre quality data also became feasible (Ethridge et al 1996, Deussen et al 1995). Quantitation, predictive modelling and statistical analyses of what had been subjective and qualitative fibre properties are now both practical and common in textile processing and marketing. Field-production and breeding researchers, for various reasons, have failed to take full advantage of the fibre-quality quantitation methods developed for the textile industry. Most field and genetic improvement studies still focus on yield improvement while devoting little attention to fibre quality beyond obtaining bulk fibre length, strength, and micronaire averages for each treatment (May, O.L. and Green, C.C., 1994-Porter *et al* 1996). Indeed, cotton crop simulation and mapping models of the effects of growth environment on cotton have been limited almost entirely to yield prediction and cultural-input management (Boone et al 1995, Wanjura *et al* 1996). Along the cotton production-processing timeline from field to finished fabric, most field-production studies and the resulting quantitative fibre-quality databases terminate at the gin, that is to say, at the bale level. The fibre-processing studies usually begin with the selection of bales from the mill warehouse (Chewning, C.H., 1995). Although the designs of field studies always include collection and analyses of environmental (weather) data, fibre processing studies begin to consider growth-environment factors only after some significant fibre-processing defect cannot be attributed to post-harvest events and handling. Few integrated studies have attempted to follow fibre production and utilization from floral anthesis, or better, planting to finished yarn or fabric (Pellow *et al* 1996). Plant physiological studies and textile-processing models suggest that bulk fibre-property averages at the bale, module, or crop level do not describe fibre quality with sufficient precision for use in a vertical integration of cotton production and processing. More importantly, bulk fibre-property means do not adequately and quantitatively describe the variation in the fibre populations or plant metabolic responses to environmental factors during the growing season. Such pooled or averaged descriptors cannot accurately predict how the highly variable fibre populations might perform during processing. Meaningful descriptors of the effects of environment on cotton fibre quality await high resolution examinations of the variabilities, induced and natural, in fibre-quality averages. Only then can the genetic and environmental sources of fibre quality variability be quantified, predicted, and modulated to produce the high-quality cotton lint demanded by today's textile industry and, ultimately, the consumer. Increased understanding of the physiological responses to the environment that interactively determine cotton fibre quality is essential. Only with such knowledge can real progress be made toward producing high yields of cotton fibres that are white as snow, as strong as steel, as fine as silk, and as uniform as genotypic responses to the environment will allow.

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Cotton Productivity as Influenced by Nutrition Management for Targeted Yield

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Abstract

The field experiment on cotton productivity and leaf reddening as influenced by nutrition management for targeted yield was conducted during growing seasons of 2014-15 and 2015-16 at College of Agriculture Farm, Raichur, Karnataka on medium deep black soil under irrigation. Three yield targets (3, 4 and 5 t kapas yield ha^{-1}) based site specific nutrient management (SSNM) alongwith four leaf reddening management (LRM) treatments (S_1 - Vermicompost @ 2.5 t ha^{-1} in seed line, S_2 - S_1 + $MgSO_4$ 10 kg ha^{-1} in seed line, S_3 - S_1 + $MgSO_4$ 25 kg ha^{-1} in seed line, and S_4 - $MgSO_4$ 25 kg ha^{-1} in seed line + foliar nutrition of 1% $MgSO_4$ +19:19:19 + 1% KNO_3 trice during flowering, boll development and boll bursting stages) besides recommended control were tested using RCBD. SSNM for 5 t ha^{-1} yield target and supplementary nutrition of $MgSO_4$ both to soil and to foliage and foliar application of major nutrients (19:19:19 and KNO_3) (S_4) recorded significantly higher plant height (64, 140, 146 and 158 cm, respectively), monopodials (1.90, 3.0, 3.0, 3.0, respectively) andsympodials (10.3, 25.9, 27.5 and 32.3, respectively) per plant, nodes on main stem (16.4, 29.9, 31.8 and 37.8, respectively), leaf area (27.8, 98.0, 131.8 and 99.0 dm^2 plant^{-1}, respectively) and leaf area index (0.51, 1.82, 2.4 and 1.83, respectively) per plant, and dry matter accumulation in leaves (63.4, 137.2 and 153.2 g plant^{-1}), stem (76.3, 146.6 and161.3, respectively) and reproductive parts (130.7, 146.3 and 161.0, respectively) at 45, 90 and 135 DAS and at final picking. Consequently, the treatment also recorded significantly higher seed cotton yield (5349 kg ha^{-1}), harvest index (0.43 on pooled basis) and benefit cost ratio (5.32 to 5.33)amongst all targets and LRM approaches. While recommended control fared poorly (2836 kg ha^{-1}, 0.37 and 4.14, kapas yield, harvest index and B:C ratio, respectively).

Key words : *Bt cotton, SSNM and RDF, growth and yield components, kapas yield, B:C*

Introduction

Cotton (*Gossypium* spp.), rightly appropriated as 'the king of fibers' and 'the white gold', enjoys a pre-eminent position amongst cash crops in the world and in India as well. In the country, the crop is cultivated in 10.50 m ha with a production of 35.10 million bales of seed cotton (2016-2017), and the country is very close in production to China ranking first in the world. Average productivity of cotton in India, however, is low (568 kg lint ha^{-1}) when compared to the world average (725 kg lint ha^{-1}) (CAB, 2016) or the leading producers namely, Australia (1781 kg ha^{-1}), China (1719 kg ha^{-1}), Brazil (1522 kg ha^{-1}), the USA (974 kg ha^{-1}) and Pakistan (699 kg ha^{-1}). Particularly, the fall in productivity in potential areas is raising concern. There is great discontent in some quarters about cultivars as some varieties are becoming vulnerable to boll worm (mostly due to spurious seed/F2 seed) and/or to many physiological disorders namely leaf reddening and therebyyielding below par (Venkateshwaralu, 2002) besides poor quality fibre as reported in Maharashtra and Gujarat (Hebbar and Mayee, 2011). The principle cause of reddening is probably nitrogen and magnesium deficiencies triggered by lower nutrient availability and /or crop uptake determined by inclement climate and/or poor soil. Supply of nitrogen alongwith phosphorus and potassium or potassium nitrate and/or magnesium to the leaf at these stages to reduce the formation of anthocyanin and achieve potential yields is critical (Sathyanarayanrao, *et al.*, 2014; Honnali and Chittapur, 2017 and Basavenneppa *et al.*, 2015), and more so when higher targets are set. Hence, an attempt is made in the present investigation to realize set yield targets through adequate nutrition (N, P, K and Mg) to soil and through leaf fortification during growth.

Materials and Methods

Experiment was carried out at Agricultural College Farm, University of Agricultural Sciences, Raichur, Karnataka during growing seasons of 2014-15 and 2015-16 under irrigation. The experiment consisted of three main plot treatments (SSNM based nutrition for 3, 4 and 5 t ha^{-1} seed cotton -M_{1-3}) and four sub plot treatments (nutrient supplementation to manage leaf reddening malady (LRM): S_1 - Vermicompost @ 2.5 t ha^{-1} in seed line, S_2 - S_1 + $MgSO_4$ 10 kg ha^{-1} in seed line, S_3 - S_1 + $MgSO_4$ 25 kg ha^{-1} in seed line and S_4 - $MgSO_4$ 25 kg ha^{-1} in seed line + foliar nutrition of 1% $MgSO_4$ +19:19:19 + 1% KNO_3 thriceduringflowering, boll development and boll bursting

Table-1 : Soil test value, ratings, nutrient requirement to achieve the target and adjusted nutrients.

Yield Targets	Soil test value ($N:P_2O_5:K_2O$ kg ha^{-1})		Nutrient requirement ($N:P_2O_5:K_2O$ kg ha^{-1})	Final applied ($N:P_2O_5:K_2O$ kg ha^{-1})
	2014-15	2015-16		
3 t ha^{-1}	168:72:184	198:74:208	192:84:114	240 : 63 :114
4 t ha^{-1}	168:72:184	198:74:208	256:112:152	316 :84 :152
5 t ha^{-1}	168:72:184	198:74:208	320:140:190	400 : 105 : 190

Table-2 : Plant height (cm), monopodials and sympodials per plant of cotton at various stages as influenced by SSNM based yield targets and nutrition for leaf reddening management.

Treat-ments	Plant height				Monopodials				Sympodials			
	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking
M_1S_1	52^{e}	110^{g}	116^{h}	132^{i}	1.23^{f}	2.0^{g}	2.0^{g}	2.0^{g}	7.7^{e}	16.6^{f}	19.0^{f}	21.1^{g}
M_1S_2	53^{ed}	117^{f}	119^{hg}	135^{ih}	1.23^{f}	2.03^{g}	2.03^{g}	2.03^{g}	8.3^{de}	18.1^{e}	20.5^{fe}	22.3^{fg}
M_1S_3	54^{ced}	121^{fe}	122^{fg}	138^{igh}	1.43^{e}	2.23^{fe}	2.23^{fe}	2.23^{fe}	8.6^{b-e}	18.7^{e}	20.7^{fe}	23.7^{fe}
M_1S_4	54^{ced}	122^{de}	126^{fe}	141^{fgh}	1.50^{ed}	2.37^{de}	2.37^{de}	2.37^{de}	8.7^{b-e}	19.1^{e}	21.9^{de}	25.2^{de}
M_2S_1	53^{ed}	126^{cde}	130^{de}	145^{feg}	1.63^{bcd}	2.17^{gf}	2.17^{gf}	2.17^{gf}	8.4^{dec}	20.9^{d}	21.8^{be}	23.9^{fe}
M_2S_2	54^{ced}	127^{cd}	132^{dc}	147^{fed}	1.50^{ed}	2.40^{dce}	2.40^{dce}	2.40^{dce}	8.9^{bdc}	22.8^{c}	23.4^{dc}	25.3^{de}
M_2S_3	56^{cbd}	127^{cd}	134^{dc}	149^{edc}	1.70^{bc}	2.57^{c}	2.57^{c}	2.57^{c}	9.2^{a-d}	23.9^{dc}	24.9^{dc}	26.3^{dc}
M_2S_4	57^{cb}	131^{cb}	136^{c}	153^{bcd}	1.57^{ecd}	2.33^{fe}	2.33^{fe}	2.33^{fe}	9.1^{bdc}	25.6^{a}	26.0^{ba}	28.2^{bc}
M_3S_1	55^{b-e}	133^{b}	136^{c}	151^{b-e}	1.70^{bc}	2.53^{dc}	2.53^{dc}	2.53^{dc}	9.1^{bdc}	21.5^{d}	23.2^{dc}	26.8^{dc}
M_3S_2	56^{cbd}	134^{b}	141^{b}	155^{bac}	1.63^{bed}	2.80^{b}	2.80^{b}	2.80^{b}	9.5^{bac}	23.2^{c}	24.9^{bc}	27.6^{dc}
rM_3S_3	58^{b}	139^{a}	143^{ba}	158^{ab}	1.90^{a}	3.0^{a}	3.0^{a}	3.0^{a}	9.8^{ba}	24.7^{ba}	26.2^{ba}	30.1^{ba}
M_3S_4	64^{a}	141^{a}	146^{a}	161^{a}	1.77^{ba}	3.0^{a}	2.0^{g}	2.0^{g}	10.3^{a}	25.9^{a}	27.5^{a}	32.3
S.Em±	0.8	0.9	5.0	1.7	0.1	0.1	0.1	0.1	0.2	0.3	0.17	0.9
Control	42	109	111	126	1.30	1.90	1.90	1.90	6.4	14.6	16.8	18.5
S.Em±	2.2	3.2	4.9	3.3	0.1	0.1	0.1	0.1	0.3	0.7	0.6	1.0
C.D. 0.05	4.6	9.2	14.2	9.4	0.2	0.30	0.30	0.30	0.9	1.9	1.7	2.7

*means with same letters do not differ significantly under DMRT
Note: DAS - Days after sowing, SSNM- Site Specific Nutrient Management

Main treatments : Yield Target (M)
M_1-SSNM for targeted yield of 3 tha^{-1}
M_2-SSNM for targeted yield of 4 tha^{-1}
M_3-SSNM for targeted yield of 5 tha^{-1}
Control-RDF with recommended practice

Sub treatments : Leaf reddening management (S)
S_1-Vermicompost @ 2.5 tha^{-1} in seed line
S_2-S_1+$MgSO_4$ 10 $kgha^{-1}$ in seed line
S_3-S_1+$MgSO_4$ 25 $kgha^{-1}$ in seed line
S_4- $MgSO_4$ 25 kg ha^{-1} in seed line + foliar nutrition of 1%$MgSO_4$ +19:19:19 + 1% KNO_3 (thrice each)

stages) along with recommended fertilizer practice (RDF) as outside control for comparison (3 x 4 + 1). For the yield targets fertilizers were applied based on the soil test and crop requirement as per SSNM (IPNI). In control the recommended doses of fertilizers were applied (150 N, 75 P_2O_5 and 75 K kg ha^{-1}).

The pooled data on growth and yield obtained from the experiment at different growth stages were subjected to statistical analysis (Gomez and Gomez, 1984) at P = 0.05. and means were compared using Duncan's Multiple Range Test (DMRT) using SPSS 16.0 version. Third order interactions were presented and discussed in the article.

Results and Discussion

SSNM for yield target of 5 t ha^{-1} and supplementary nutrition of $MgSO_4$ both to soil and to foliage and foliar application of major nutrients (19:19:19 and KNO_3) (M_3S_4) resulted in taller plants at all the stages (64, 140, 146 and 158 at 45, 90 and 135 DAS and at final picking, respectively on pooled basis), and M_1S_1 with 3 t ha^{-1} target and vermicompost alone to soil had lower plant height amongst all (52, 110, 116, and 132 at 45, 90 and 135 DAS and at final picking, respectively on pooled basis), however still it fared better than recommended control (42, 109, 111 and 126 at 45, 90 and 135 DAS and at final picking, respectively on pooled basis). Former treatment (M_3S_4) also resulted in numerically more number of monopodials (1.77, 3.0, 3.0 and 3.0 respectively, at 45, 90 and 135 DAS and at final picking, respectively on pooled basis), while, 3 t ha^{-1} yield target in combination with application of vermicompost alone (M_1S_1) recorded lower number of monopodials(1.23, 2.0, 2.0 and 2.0 at 45, 90 and 135 DAS and at final picking, respectively) per plant

Table-3 : Nodes on main stem, leaf area per plant and leaf area index of cotton at various stages as influenced by SSNM based yield targets and nutrition for leaf reddening management.

Treat-ments	Nodes on main stem				Lea area per plant				Leaf area index			
	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking
M_1S_1	11.9^{e}	20.4^{g}	22.3^{f}	24.8^{f}	18.9^{f}	88.6^{de}	109.6^{g}	78.8^{e}	0.35^{f}	1.64^{de}	2.03^{d}	1.46^{c}
M_1S_2	12.5^{de}	21.5^{fg}	23.1^{fe}	25.5^{f}	20.0^{ef}	85.1^{e}	111.2^{g}	80.4^{de}	0.37^{ef}	1.58^{e}	2.06^{dc}	1.49^{c}
M_1S_3	13.7^{b-e}	22.3^{fe}	24.5^{dc}	26.6^{fe}	21.1^{efd}	91.7^{bdc}	116.5^{fe}	82.2^{cde}	0.39^{efd}	1.70^{bdc}	2.16^{bdc}	1.52^{cb}
M_1S_4	14.6^{a-d}	23.6^{e}	25.4^{de}	28.0^{e}	20.8^{efd}	93.2a^{-d}	117.9^{be}	83.6^{cd}	0.38^{efd}	1.73^{a-d}	2.18^{bdc}	1.55^{cb}
M_2S_1	12.9^{dec}	25.3^{d}	25.0^{de}	26.5^{fe}	21.8^{ecd}	90.4^{dec}	112.1^{gf}	81.1^{de}	0.40^{ecd}	1.67d^{ec}	2.08^{dc}	1.50^{c}
M_2S_2	13.9^{b-e}	26.9^{de}	26.1^{dc}	27.0^{fe}	23.2^{bcd}	91.8^{bdc}	117.5^{e}	82.6^{cde}	0.43^{bdc}	1.70b^{dc}	2.18^{bdc}	1.53^{cb}
M_2S_3	14.4^{a-d}	27.7^{bc}	27.1^{dc}	28.6^{de}	23.9^{bc}	93.9^{a-d}	121.6^{dce}	84.2^{cd}	0.44^{bc}	1.74^{a-d}	2.25^{a-d}	1.56^{cb}
M_2S_4	15.5^{ba}	29.7^{a}	28.2^{bc}	30.5^{dc}	23.9^{bc}	94.9^{ba}c	125.1^{bc}	85.8^{cb}	0.44^{bc}	1.76^{bac}	2.32^{ba}	1.59^{cb}
M_3S_1	13.5^{b-e}	26.1^{dc}	27.0^{dc}	30.8^{dc}	25.4^{ba}	93.8^{a-d}	119.9^{de}	88.8^{b}	0.47^{ba}	1.74^{a-d}	2.22^{a-d}	1.64^{b}
M_3S_2	15.1^{bac}	27.6^{bc}	28.3^{dc}	32.1^{c}	26.8^{a}	95.6^{bac}	122.7^{de}	95.9^{a}	0.50^{a}	1.77^{bac}	2.27^{bac}	1.78^{a}
M_3S_3	15.6^{ba}	28.8^{ba}	29.7^{ba}	34.4^{b}	27.6^{a}	96.8^{ba}	128.0^{ba}	96.9^{a}	0.51^{a}	1.79^{ba}	2.37^{ba}	1.79^{a}
M_3S_4	16.4^{a}	29.9^{a}	31.8^{a}	37.8^{a}	27.8^{a}	98.0^{a}	131.8^{a}	99.0^{a}	0.51^{a}	1.82^{a}	2.4^{a}	1.83^{a}
S.Em±	0.22	0.5	0.2	1.0	0.4	1.4	1.9	1.0	0.01	0.03	0.04	0.02
Control	9.5	17.9	19.9	21.0	16.4	71.0	85.2	54.0	0.30	1.32	1.58	1.0
S.Em±	0.6	0.8	0.8	0.5	1.3	3.2	3.3	3.4	0.03	0.04	0.05	0.05
C.D. 0.05	1.8	2.4	2.4	1.4	4.6	9.2	9.5	9.9	0.09	0.13	0.16	0.15

*means with same letters do not differ significantly under DMRT
Note: DAS-Days after sowing, SSNM-Site Specific Nutrient Management
Main treatments : Yield Target (M) Sub treatments: Leaf reddening management (S)
M_1-SSNM for targeted yield of 3 tha^{-1} **S_1**-Vermicompost @ 2.5 tha^{-1} in seed line
M_2-SSNM for targeted yield of 4 tha^{-1} **S_2**-S_1+$MgSO_4$ 10 kgha^{-1} in seed line
M_3-SSNM for targeted yield of 5 tha^{-1} **S_3**-S_1+$MgSO_4$ 25 kgha^{-1} in seed line
Control-RDF with recommended practice **S_4**-$MgSO_4$ 25 kg ha^{-1} in seed line + foliar nutrition of 1% $MgSO_4$ +19:19:19 + 1% KNO_3 (thrice each)

but was better than recommended control. Sympodials per plant also differed significantly, and higher count occurred with M_3S_4 (10.3, 25.9, 27.5 and 32.3 at 45, 90 and 135 DAS and at final picking respectively on pooled basis) and it was on par with yield target 5 t ha^{-1} + vermicompost and 25 kg ha^{-1} $MgSO_4$.(M_3S_3)while, with 3 t ha^{-1} yield target in combination with application of vermicompost alone (M_1S_1) recorded lower number of sympodials (7.7, 16.6, 19.0 and 21.1 at 45, 90 and 135 DAS and at final picking respectively on pooled basis) per plant but was still superior to control.

Further, nutrition through SSNM and LRM had significant interaction effect wherein node count was higher with SSNM for 5 t ha^{-1} yield target and application of $MgSO_4$ @ 25 kg ha^{-1} along with foliar nutrition of 1% each of $MgSO_4$, 19:19:19 and KNO_3 (M_3S_4); the differences widened as thecrop growth advanced (16.4, 29.9, 31.8 and 37.8 plant^{-1}, respectively at 45, 90 and 135 DAS and at final picking), while yield target of 3 t ha^{-1} in combination with application of vermicompost (M_1S_1) recorded lower number of nodes (11.9, 20.4, 22.3 and 24.8 plant^{-1} respectively at 45, 90 and 135 DAS and at final picking) amongst all which again was superior to recommended practice. Again M_3S_4 produced higher leaf area throughout (27.8, 98.0, 131.8 and 99.0 dm^2 plant^{-1}at 45, 90 and135 DAS and at final picking, respectively), while the lower leaf area among two factor combinations was observed with lower target of 3 t ha^{-1} and application of vermicompost (M_1S_1) (18.9, 88.6, 109.6 and 78.8 dm^2 plant^{-1}at 45, 90 and135 DAS and at final picking, respectively). Consequently, SSNM with 5 t ha^{-1} yield target and supplementary nutrition of $MgSO_4$ @ 25 kg ha^{-1} to soil alongwith 1% each of $MgSO_4$, 19:19:19 and KNO_3 periodically (M_3S_4) resulted in higher LAI (0.51, 1.82, 2.4 and 1.83 at 45, 90 and 135 DAS and at final picking, respectively) throughout. Amongst all, 3 t ha^{-1} yield target in combination with application of vermicompost (M_1S_1) recorded fairly lower indices at all the stages (0.35, 1.64, 2.03 and 1.46 at 45, 90 and 135 DAS and at final picking, respectively).Recommended practice recorded lower LA and LAI.

The improved growth attributed to improved photosynthesis with ultimate influence on dry matter (DM)which varied significantly. SSNM for 5 t ha^{-1} yield target and supplementary nutrition with application of $MgSO_4$ @ 25 kg ha^{-1}along with foliar nutrition of 1% each of $MgSO_4$, 19:19:19 and KNO_3 periodically (M_3S_4) resulted in higher DM in leaves (63.4, 137.2 and 153.2 g plant^{-1} at 90, 135 DAS and at final picking, respectively) among all

Table-4 : Dry matter accumulation in leaves, stem and reproductive parts (g plant^{-1}) of cotton at various stages as influenced by SSNM based yield targets and nutrition for leaf reddening management.

Treat-ments	Leaves			Stem			Reproductive parts		
	90 DAS	135 DAS	At final picking	90 DAS	135 DAS	At final picking	90 DAS	135 DAS	At final picking
M_1S_1	50.8^{d}	93.1^{h}	94.8^{g}	64.0^{f}	108.3^{g}	114.0^{g}	109.3^{f}	118.1^{h}	125.0^{h}
M_1S_2	52.4^{cd}	94.6^{h}	100.6^{g}	65.3^{fe}	110.0^{gf}	115.6^{fg}	112.7^{ef}	123.7^{g}	131.6^{fg}
M_1S_3	53.9^{cd}	105.3^{gf}	110.8^{f}	67.3^{fed}	119.0^{ed}	120.0^{fe}	116.8^{ecd}	127.4^{fg}	133.6^{fg}
M_1S_4	56.9^{bc}	110.2^{ef}	115.2^{ef}	70.4^{bdc}	122.9^{d}	124.5^{e}	119.6^{cd}	132.2^{fdc}	140.4^{ced}
M_2S_1	53.2^{cd}	100.0^{gh}	108.4^{f}	66.6^{fed}	114.9^{ef}	121.1^{fe}	116.4^{ed}	124.3^{g}	128.5^{hg}
M_2S_2	55.6^{bcd}	107.7^{f}	114.7^{ef}	67.8^{c-f}	123.0^{d}	131.2^{d}	119.4^{cd}	130.8^{fdc}	138.1^{fcd}
M_2S_3	57.2^{bc}	116.5^{ed}	121.1^{ecb}	70.0^{b-c}	129.8^{c}	140.4^{c}	122.3^{bcd}	135.8^{cd}	143.5^{ced}
M_2S_4	59.4^{ba}	122.0^{cd}	138.1^{b}	72.4^{bae}	139.6^{b}	150.9^{b}	126.3^{ba}	138.3^{cb}	146.0^{cb}
M_3S_1	55.9^{bc}	120.8^{cd}	122.3^{d}	69.1^{b-e}	120.5^{ed}	130.5^{d}	119.1^{cd}	129.5^{fe}	137.3^{fe}
M_3S_2	57.4^{bc}	124.7^{cb}	131.1^{c}	70.8^{bdc}	130.7^{c}	141.4^{c}	122.9^{bc}	134.3^{cde}	144.5^{cbd}
M_3S_3	59.8^{ba}	129.9^{b}	140.4^{b}	74.0^{ba}	139.5^{b}	150.0^{b}	127.2^{ba}	140.9^{b}	150.^{4b}
M_3S_4	63.4^{a}	137.2^{a}	153.2^{a}	76.3^{a}	146.6^{a}	161.3^{a}	130.7^{a}	146.3^{a}	161.9^{a}
S.Em±	0.5	1.6	1.3	0.9	1.7	0.9	0.5	0.7	2.2
Control	41.4	75.9	81.1	49.9	85.0	89.0	81.9	87.8	93.5
S.Em±	3.2	3.4	3.1	3.2	3.2	3.2	2.9	3.1	4.8
C.D. 0.05	9.3	9.9	9.2	9.4	9.3	9.4	8.5	9.3	14.0

*means with same letters do not differ significantly under DMRT
Note : DAS-Days after sowing, SSNM-Site Specific Nutrient Management
Main treatments : Yield Target (M) Sub treatments: Leaf reddening management (S)
M_1-SSNM for targeted yield of 3 tha^{-1} **S_1**-Vermicompost @ 2.5 tha^{-1}in seed line
M_2-SSNM for targeted yield of 4 tha^{-1} **S_2**-S_1+$MgSO_4$ 10 kgha^{-1} in seed line
M_3-SSNM for targeted yield of 5 tha^{-1} **S_3**-S_1+$MgSO_4$ 25 kgha^{-1} in seed line
Control-RDF with recommended practice **S_4**- $MgSO_4$ 25 kg ha^{-1} in seed line + foliar nutrition of 1%$MgSO_4$ +19:19:19 + 1% KNO_3 (thrice each)

treatment combinations, while lower DM was observed with 3 t ha^{-1} yield target and vermicompost application (M_1S_1) (50.8, 93.1 and 94.8, g plant^{-1}respectively at 90 and 135 DAS and at final picking). Similar was the trend in DM accumulation in stem (M_3S_4-76.3, 146.6 and161.3 and M_1S_1- 64.0, 108.3 and 114.0 plant^{-1}at 90 and 135 DAS and at final picking, respectively) and reproductive parts (M_3S_4- 130.7, 146.3 and 161.0 and M_1S_1- 109.3, 118.1 and 125.0plant^{-1} at 90 and 135 DAS and at final picking, respectively) (Table 3-5). Recommended fertilization practice recorded lower values of DM in every plant part at all the stages than SSNM based nutrition coupled with LRM.

This significant increase in all the growth parameters with adequate fertilization for higher yields in combination with foliar spray of major nutrients for LR were responsible for higher assimilates production and their translocation ultimately to sink; the bolls and seed cotton yield/kapas. SSNM for yield target of 5 t ha^{-1} and supplementary nutrition of $MgSO_4$ both to soil and to foliage and foliar fortification (M_3S_4) resulted significantly higher seed cotton yield (5349 kg ha^{-1}), while M_1S_1 with 3 t ha^{-1} target and vermicompost alone to soil registered lower seed cotton yield amongst all (3401 kg ha^{-1}). Whereas yield with the recommended control (2836 kg ha^{-1}) was lower than SSNM + LRM combination which was lower by 53 percent over M_3S_4 and by 11.9 percent over M_1S_1. Similar findings reported by Radlika *et al*. (2009), Parminder Kaur *et al*. (2010), Biradar (2011) and Hosmani *et al*. (2013) who also reported improved growth parameters and consequently cotton yield with adequate nutrition through soil in addition to foliar spray of liquid soluble fertilizers over recommended practice.

Further,dry matter production and enhanced leaf area with M_3S_4 due to need based nutrition for the set target (400:105:190 kg NPK ha^{-1}) enabled higher photosynthesis and further sustenance of greenness for prolonged period because of supply of soluble form of nutrients particularly N and Mg during critical stages of crop growth which coincided with limiting climatic factors such as lower temperature and drier weather which occurred during latter part of reproductive stage. Further, during this period efficient translocation to developing bolls was facilitated due to foliar nutrition potassium (19:19:19 and KNO_3). N and Mg enabled extended greenness of leaf and thereby enabled extended utilization of radiant energy into chemical energy which ultimately helped to obtain higher seed cotton yield (Honnalli and Chittapur 2013; and Basavanneppa *et al*., 2011).

Table-5 : Seed cotton yield (kg ha^{-1}), harvest index and BC ratio of cotton influenced by SSNM based yield targets and nutrition for leaf reddening management.

Treatment	Seed yield	Harvest index	BC ratio
M_1S_1	3401^{i}	0.36^{fe}	4.31^{d}
M_1S_2	3452^{hi}	0.36^{fg}	4.32^{d}
M_1S_3	3509^{hg}	0.35^{g}	4.31^{d}
M_1S_4	3568^{g}	0.35^{g}	4.33^{d}
M_2S_1	4407^{f}	0.41^{b}	4.97^{b}
M_2S_2	4487^{e}	0.39^{cd}	4.99^{b}
M_2S_3	4517^{ed}	0.40^{d}	4.96^{cb}
M_2S_4	4568^{d}	0.39^{e}	4.96^{b}
M_3S_1	5148^{c}	0.43^{a}	5.32^{a}
M_3S_2	5212^{cb}	0.41^{b}	5.33^{a}
M_3S_3	5275^{b}	0.40^{cb}	5.32^{a}
M_3S_4	5349^{a}	0.38^{d}	5.32^{a}
S.Em±	86.9	0.007	0.04
Control	2836	0.37	4.14
S.Em±	162.6	0.01	0.03
C.D. 0.05	474.5	0.02	0.10

*means with same letters do not differ significantly under DMRT
Note: SSNM- Site Specific Nutrient Management
*means with same letters do not differ significantly under DMRT
Note: DAS - Days after sowing, SSNM-Site Specific Nutrient Management

Main treatments: Yield Target (M)
M$_1$-SSNM for targeted yield of 3 tha^{-1}
M$_2$-SSNM for targeted yield of 4 tha^{-1}
M$_3$-SSNM for targeted yield of 5 tha^{-1}
Control-RDF with recommended practice

Sub treatments: Leaf reddening management (S)
S$_1$-Vermicompost @ 2.5 tha^{-1} in seed line
S$_2$-S$_1$+$MgSO_4$ 10 kgha^{-1} in seed line
S$_3$-S$_1$+$MgSO_4$ 25 kgha^{-1} in seed line
S$_4$-$MgSO_4$ 25 kg ha^{-1} in seed line + foliar nutrition of 1%$MgSO_4$ +19:19:19 + 1% KNO_3 (thrice each)

SSNM basically takes care of plant requirement for a set yield target taking in to account soil supply and fertilizer contribution which is the major difference over blanket recommendation. Beside major nutrition, here cotton was supplied with 25 kg ha^{-1} $MgSO_4$ and foliar supplementation through 1 per cent spray of $MgSO_4$, 19:19:19 and KNO_3 thrice. Latter being LRM package, helped to alleviate leaf reddening and its consequent negative impact on yield. (0.23, 0.37, 0.68 and 1.10 at 90, 105, 120 and 135 DAS on pooled basis). Foliar application of KNO_3 which is a source of both N and K, is highly beneficial in increasing the seed cotton yield (Brar*et al*., 2009). Soil and foliar application of $MgSO_4$ also increased seed cotton yield because of magnesium which is an integral part of chlorophyll, which increased chlorophyll content and its stability and thereby photosynthesis and seed cotton yield. The results are in conformity with the findings of Brar *et al*. (2008) and Hosmath (2011). Further, potassium deserves special attention in cotton nutrition because of its high uptake rates and relative inefficiency of potash uptake mechanism compared to many other crops (Adams, 1985). Probably, SSNM based nutrition could able to take care of this issue and hence any benefits that accrued due to LRM were marginal in the present investigation.

Harvest index due to the interaction effect of SSNM and nutrient supplementation for leaf reddening also varied significantly but followed different trend. Lower yield target of 3 t ha^{-1} coupled with 25 kg ha^{-1} $MgSO_4$ alongwith foliar nutrition of 1% each of $MgSO_4$, 19:19:19 and KNO_3 (M_1S_4) had significantly lower HI (0.35) on pooled basis while 5 t ha^{-1} yield target coupled with application of vermicompost alone (M_3S_1) had consistently higher HI (0.43 on pooled basis) among all. Recommended control was comparable with crop nutrition for 3 t ha^{-1} yield target irrespective of LRM practices. Again combinations of SSNM based yield targets and nutrient supplementation for leaf reddening influenced benefit cost ratio during both the years and on pooled basis as well. Overall, SSNM for yield target of 5 t ha^{-1} irrespective of the LRM practice resulted in higher B:C ratio among all (5.32 to 5.33), while lower yield target of 3 t ha^{-1} irrespective of LRM practices recorded lower benefit cost ratio (4.86-4.88 on pooled basis) which, however was superior to blanket recommendation (4.14).

Thus, from the study it could be concluded that SSNM based nutrition for 5 t ha^{-1} yield target and soil application of $MgSO_4$ @ 25 kg ha^{-1}and foliar spray of 1% each of $MgSO_4$, 19:19:19 and KNO_3 thrice at flower initiation, boll development and boll bursting and sowing could be advantageously followed in TBP irrigation command.

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Interaction Effect of Genotypes and Time of Sowing on Crop Productivity and Leaf ReddenIng in Bt Cotton

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Abstract

Field experiments wereconducted at College of Agriculture Farm, Raichur, Indiaduring 2014-15 and 2015-16 to study the interaction between cultivars (Bindas, Bunny-Bt, ATM and Brent) and planting time(II fortnight of June, and I and II First fortnights of July and August)on the performance of the *Bt* cotton. Significantly highernumber of monopodials (1.9, 2.8, 2.8 and 2.86, respectively), sympodials (12.5, 24.4, 28.5 and 31.9, respectively), maximum number of nodes on main stem (13.8, 30.6, 32.9 and 35.3, respectively), leaf area per plant (20.6, 95.1, 112.2 and 78.1dm^2 plant^{-1}, respectively), leaf area index (0.38, 1.76, 2.08 and 1.45, respectively) at 45, 90 and 135 DAS and at final picking), higher DM in leaves, stem and reproductive parts (49.9, 84.7 and 87.3, 75.0, 112.2 and 123.5, and 106.7, 121.6 and 128.1 g plant^{-1}at 90 and 135 DAS and at final picking, respectively), seed cotton yield (4173 kg ha^{-1}), harvest index (0.40),and benefit: cost ratio (5.22) were registered with early sowing during June II fortnight particularlywith cv. Bindas compared to delayed sowings with same or different cultivars.

Key words : *Bt cotton, growth and yield attributes, B:C ratio*

Introduction

Cotton (*Gossypium* spp.) is the nature's most precious gift to the mankind, contributed by the genus *Gossypium* to clothe the people all over the world. Four out of the 50 recognized *Gossypium* species viz., *G. arboreum*, *G. herbaceum, G. hirsutum* and *G. barbadense*arecultivated for natural fibrein the world, and India is the only country in the world where all the four species and some of their intra-species derivatives are commercially grown. Today over hundreds of *Bt* cultivars are cultivated and the production has increased from a meager 2.79 million bales (170 kg lint bale^{-1}) in 1947-48 to an all time record of 35.10 million bales during 2016-17 (CAB, 2016). However, there is a great discontent in different quarters with the cultivars as some varieties are becoming vulnerable to boll worm mostly due to spurious seed/F_2 seed and/or to many physiological disorders and, hence, yield is below par (Venkateshwaralu, 2002) besides poor quality fibre as reported in Maharashtra and Gujarat (Hebbar and Mayee, 2011). Apart from cultivars, leaf reddening malady is the major handicap in achieving potential crop yields, particularly in *hirsutums* in majority of the locations in spite of following best production practices. Leaf reddening could reduce the seed cotton yield to the extent of 30-60 per cent depending on variety and reddening intensity (Pagare, 2011) and time of occurrence. The red colour becomes apparent when the green chlorophyll decomposes with the approaching winter (Anon., 2007) and, therefore, early planting or use of cultivars suitable for late planting to escape hardships of winter assumes significance. Intense light and low temperatures of winter favour the development of anthocyanin pigments. In this context, the present investigation on interaction effect of genotypes and time of sowing on crop productivity and leaf reddening in cotton was planned and executed during the growingseasons of 2014 and 2015 under irrigation.

Materials and Methods

Investigations were carried out at Agricultural College Farm, University of Agricultural Sciences, Raichur, Karnataka, Indiafalling in TungaBhadra irrigation command under deep black soil under irrigation. The experiment was laid out using Split plot design consisting of five sowing dates (D_1- Second fortnight of June, D_2- First fortnight of July, D_3- Second fortnight of July,D_4- First fortnight of August, and D_5- Second fortnight of August)as main plots and four cotton cultivars (G_1- Bindas, G_2- Bunny-Bt, G_3- ATM and G_4- Dr. Brent) as sub plot treatments. The recommended dose of fertilizers 150: 75:75 kg ha^{-1}N, P_2O_5 and K_2O were applied during both the years. Observations on growth and development periodically and seed cotton yield were taken up and the data were subjected to statistical analysis (Gomez and Gomez, 1984), and the means were compared using Duncan's Multiple Range Test (DMRT) using SPSS 16.0 version at P = 0.05.

Table-1 : Plant height (cm), monopodials per plant and sympodials per plant of cotton at various stages as influenced by time of planting and genotypes.

Treat -ments	Plant height				Monopodials				Sympodials			
	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking
Plant time												
D_1	60[a]	139[a]	146[a]	153[a]	1.7[a]	2.5[a]	2.5[a]	2.5[a]	10.6[a]	22.5[a]	26.5[a]	28.7[a]
D_2	57[b]	109[b]	123[b]	133[bc]	1.5[b]	0.8[b]	0.8[b]	0.8[b]	7.9[b]	19.4[b]	23.0[b]	24.9[b]
D_3	54[c]	99[c]	114[c]	120[cb]	0.6[c]	1.6[c]	1.6[c]	1.6[c]	4.5[c]	15.7[c]	20.1[c]	20.8[c]
D_4	40[d]	86[d]	109[c]	114[c]	0.7[d]	1.3[d]	1.3[d]	1.3[d]	2.6[d]	10.8[d]	15.6[d]	19.3[c]
D_5	28[e]	86[d]	96[d]	100[dc]	0.4[e]	1.2[e]	1.2[e]	1.2[e]	1.9[e]	9.3[d]	12.6[e]	12.8[d]
S.Em	**0.8**	**2.6**	**2.4**	4.**8**	0.01	0.02	0.02	0.02	0.11	0.32	0.49	0.67
Genotypes												
G_1	49[b]	103[b]	114[b]	121[b]	1.2[a]	1.8[a]	1.8[a]	1.8[a]	6.7[a]	17.2[a]	20.9[a]	23.4[a]
G_2	45[c]	97[b]	105[c]	112[d]	0.9[c]	1.6[b]	1.6[b]	1.6[b]	5.0[c]	14.5[b]	17.8[b]	19.6[c]
G_3	53[a]	113[a]	135[a]	144[a]	1.0[b]	1.6[b]	1.6[b]	1.6[b]	5.7[b]	16.3[a]	20.5[a]	21.8[b]
G_4	45[c]	101[b]	115[b]	119[c]	0.8[c]	1.6[b]	1.6[b]	1.6[b]	4.9[c]	14.6[b]	18.9[b]	19.9[c]
S.Em	0.8	1.7	1.9	2.9	0.01	0.03	0.03	0.03	0.11	0.22	0.48	0.65
D x G												
D_1G_1	62[ba]	133[cb]	140[cb]	143[c]	1.9[a]	2.8[a]	2.8[a]	2.8[a]	12.5[a]	24.4[a]	28.5[a]	31.9[a]
D_1G_2	56[bce]	123[c]	130[cd]	136[c]	1.7[b]	2.4[c]	2.4[c]	2.4[c]	9.8[cb]	21.9[da]	24.2[dc]	25.7[cd]
D_1G_3	65[a]	160[a]	177[a]	191[a]	1.9[a]	2.2[d]	2.2[d]	2.2[d]	10.3[b]	23.6[a]	26.9[ba]	29.5[b]
D_1G_4	57[dce]	135[b]	137[cb]	141[c]	1.5[c]	2.6[b]	2.6[b]	2.6[b]	10.0[b]	22.5[ba]	25.6[bc]	27.8[cb]
D_2G_1	58[dc]	111[d]	119[edf]	136[c]	1.9[a]	2.0[e]	2.0[e]	2.0[e]	9.8[cb]	20.8[bc]	24.8[dc]	26.7[cd]
D_2G_2	55[de]	98[ef]	106[hgf]	117[ef]	1.3[b]	1.8[f]	1.8[f]	1.8[f]	7.0[d]	17.8[dc]	21.9[de]	24.5[ed]
D_2G_3	62[b]	126[c]	149[b]	155[b]	1.5[c]	1.8[f]	1.8[f]	1.8[f]	8.6[c]	20.8[bc]	24.7[dc]	25.2[ed]
D_2G_4	54[fe]	103[ed]	118[edf]	122[ed]	1.3[d]	1.6[g]	1.6[g]	1.6[g]	6.8[d]	18.2[dc]	21.8[e]	24.8[ed]
D_3G_1	55[de]	96[efg]	111[egh]	114[gf]	0.9[e]	1.8[f]	1.8[f]	1.8[f]	5.6[ed]	16.8[dc]	20.9[fe]	22.9[ef]
D_3G_2	52[f]	95[e-h]	105[hgf]	110[gh]	0.3[h]	1.6[g]	1.6[g]	1.6[g]	3.8[gfh]	14.3[ef]	17.9[hg]	18.8[ghi]
D_3G_3	59[c]	107[d]	129[ed]	137[c]	0.7[f]	1.6[g]	1.6[g]	1.6[g]	4.6[ef]	16.5[de]	20.9[fe]	20.9[gf]
D_3G_4	52[f]	97[efg]	117[edf]	119[gf]	0.5[g]	1.4[h]	1.4[h]	1.4[h]	4.1[gf]	15.2[fe]	19.0[fg]	20.1[gh]
D_4G_1	40[h]	87[hfg]	106[hgf]	112[gih]	0.9[e]	1.4[h]	1.4[h]	1.4[h]	2.7[gih]	12.8[fg]	16.7[hji]	21.6[gf]
D_4G_2	37[h]	86[hfg]	100[hg]	107[ji]	0.7[f]	1.2[i]	1.2[i]	1.2[i]	1.7[i]	10.0[hgi]	14.0[kjl]	17.9[hi]
D_4G_3	45[g]	90[gh]	121[ed]	126[d]	0.7[f]	1.4[h]	1.4[h]	1.4[h]	2.8[gih]	11.0[hg]	16.1[hji]	19.8[ghi]
D_4G_4	39[h]	80[h]	106[hgf]	110[ih]	0.7[f]	1.2[i]	1.2[i]	1.2[i]	2.6[ih]	9.5[hi]	14.7[kji]	17.4[i]
D_5G_1	29[j]	87[i]	96[hi]	98[ji]	0.5[g]	1.2[i]	1.2[i]	1.2[i]	1.9[i]	11.8[hg]	13.0[kml]	13.8[j]
D_5G_2	26[k]	84[hfg]	85[i]	90[j]	0.5[g]	1.2[i]	1.2[i]	1.2[i]	2.0[i]	7.6i	10.9m	11.6[k]
D_5G_3	34[i]	84h[g]	107[hgf]	111[gfh]	0.5[g]	1.2[i]	1.2[i]	1.2[i]	1.8[i]	9.6[hi]	13.0[kml]	13.5[kj]
D_5G_4	35[k]	87[hfg]	96[hi]	100[j]	0.3[h]	1.2[i]	1.2[i]	1.2[i]	1.7[i]	9.3[hi]	12.1[ml]	10.9[k]
S.Em	1.7	4.3	4.4	6.4	0.03	0.06	0.06	0.06	0.24	0.54	1.04	1.42

*Means with same letters do not differ significantly under DMRT

Note : DAS – Days of sowing

Main plot treatments : Time of planting (D)

D_1 : Second fortnight of June
D_2 : First fortnight of July
D_3 : Second fortnight of July
D_4 : First fortnight of August
D_5 : Second fortnight of August

Sub plot treatments: Genotypes (G)

G_1 : Bindas
G_2 : Bunny-*Bt*
G_3 : ATM
G_4 : Dr. Brent

Table-2 : Nodes on main stem, leaf area per plant and leaf area index of cotton at various stages as influenced by time of planting and genotypes.

Treat-ments	Nodes on main stem				Leaf area per plant				Leaf area index			
	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking	45 DAS	90 DAS	135 DAS	At final picking
Plant time												
D_1	12.5^{a}	26.5^{a}	31.0^{a}	33.0^{a}	19.9^{a}	91.4^{a}	109.7^{a}	76.6^{a}	0.37^{a}	1.69^{a}	2.03^{a}	1.42^{a}
D_2	10.4^{b}	23.2^{b}	26.2^{b}	29.4^{b}	17.7^{b}	79.3^{b}	96.3^{b}	65.7^{b}	0.33^{b}	1.47^{b}	1.78^{b}	1.22^{b}
D_3	7.3^{c}	19.5^{c}	21.5^{c}	26.2^{c}	13.1^{c}	73.8^{c}	87.5^{c}	56.7^{c}	0.24^{c}	1.37^{c}	1.62^{c}	1.05^{c}
D_4	6.1^{d}	14.5^{d}	18.4^{d}	21.0^{d}	10.2^{d}	68.0^{d}	76.8^{d}	45.9^{d}	0.19^{d}	1.26^{d}	1.42^{d}	0.85^{d}
D_5	4.6^{e}	12.0^{e}	13.6^{e}	16.5^{e}	8.2^{e}	56.4^{e}	64.1^{e}	32.3^{e}	0.15^{e}	1.04^{e}	1.19^{e}	0.60^{e}
S.Em±	0.29	0.31	0.44	0.39	0.1	0.9	0.6	1.3	0.01	0.03	0.02	0.01
Genotypes												
G_1	8.5^{a}	21.2^{a}	24.9^{a}	26.2^{a}	14.5^{a}	76.1^{a}	89.1^{a}	58.3^{a}	0.27^{a}	1.41^{a}	1.65^{a}	1.08^{a}
G_2	7.9^{b}	17.5^{c}	21.0^{c}	24.3^{c}	13.3^{b}	72.1^{ba}	85.8^{ba}	54.0^{b}	0.25^{a}	1.34^{b}	1.59^{b}	1.00^{b}
G_3	8.1^{b}	19.9^{b}	22.5^{b}	25.6^{b}	13.9^{b}	74.2^{b}	87.2^{b}	55.9^{b}	0.26^{a}	1.37^{ba}	1.61^{ba}	1.03^{b}
G_4	8.2^{b}	18.1^{c}	21.1^{c}	24.7^{cb}	13.5^{b}	72.6^{b}	85.6^{b}	53.7^{b}	0.25^{a}	1.34^{b}	1.58^{b}	1.00^{b}
S.Em±	0.20	0.24	0.29	0.39	0.1	0.6	0.2	1.2	0.01	0.03	0.004	0.01
D x G												
D_1G_1	13.8^{a}	30.6^{a}	32.9^{a}	35.3^{a}	20.6^{a}	95.1^{a}	112.2^{a}	78.1^{a}	0.38^{a}	1.76^{a}	2.08^{a}	1.45^{a}
D_1G_2	10.7^{cd}	24.2^{dc}	29.2^{b}	31.5^{bc}	19.8^{a}	89.3^{a}	110.4^{a}	75.6^{a}	0.37^{a}	1.65^{a}	2.05^{a}	1.40^{a}
D_1G_3	11.9^{b}	27.4^{b}	31.9^{a}	33.5^{da}	19.9^{a}	91.5^{a}	109.6^{a}	77.4^{a}	0.37^{a}	1.69^{a}	2.03^{a}	1.43^{a}
D_1G_4	13.4^{a}	24.6^{c}	29.1^{b}	32.8^{bc}	19.2^{a}	89.8^{a}	106.8^{a}	75.4^{a}	0.36^{a}	1.66^{a}	1.98^{a}	1.40^{a}
D_2G_1	11.2^{cb}	24.2^{dc}	27.6^{cb}	30.0^{de}	17.9^{ab}	81.4^{b}	98.4^{b}	69.4^{b}	0.33^{ab}	1.51^{bc}	1.82^{b}	1.29^{b}
D_2G_2	9.2^{e}	22.2^{de}	25.0^{de}	28.3^{fe}	17.5^{ab}	77.6^{bcd}	94.7^{b}	64.0^{cd}	0.32^{ab}	1.44^{bcd}	1.75^{b}	1.19^{cd}
D_2G_3	10.6^{cd}	23.3^{dce}	26.4^{cd}	28.5^{e}	17.8^{ab}	80.0^{bc}	96.8^{b}	66.1^{cb}	0.33^{ab}	1.48^{b}	1.79^{b}	1.22^{cb}
D_2G_4	10.1^{ed}	22.1^{fe}	25.6^{cde}	28.9^{e}	17.6^{ab}	78.3^{bcd}	95.5^{b}	63.4^{cb}	0.33^{ab}	1.45^{bc}	1.77^{b}	1.17^{cd}
D_3G_1	7.6^{f}	21.0^{gf}	23.4^{fe}	28.0^{fe}	14.9^{cd}	75.7^{b-e}	88.8^{c}	60.1^{de}	0.28^{bc}	1.40^{b-e}	1.64^{c}	1.11^{bc}
D_3G_2	7.1^{gf}	18.6^{hi}	20.2^{gh}	26.8^{h}	11.9^{c-f}	71.8^{d-g}	85.8^{cd}	55.0^{e}	0.22^{c-f}	1.33^{d-g}	1.59^{cv}	1.02^{f}
D_3G_3	6.0^{ih}	19.4^{gh}	21.8^{gf}	26.9^{fg}	13.5^{dc}	74.8^{c-f}	88.9^{c}	56.6^{e}	0.25^{dc}	1.38^{b-f}	1.65^{c}	1.05^{ef}
D_3G_4	6.9^{gfh}	18.9^{ghi}	20.5^{gh}	25.3^{hg}	12.2^{cde}	72.8^{d-g}	86.7^{c}	55.1^{e}	0.23^{cde}	1.35^{c-g}	1.61^{c}	1.02^{f}
D_4G_1	4.9^{jk}	18.0^{ji}	20.6^{ih}	22.1^{i}	10.7^{def}	69.6^{efg}	80.8^{dc}	48.8^{f}	0.20^{d-g}	1.29^{efg}	1.50^{de}	0.90^{g}
D_4G_2	6.6^{gh}	13.4^{k}	19.0^{i}	20.9^{i}	9.5^{def}	66.5^{g}	74.7^{f}	44.6^{f}	0.18^{d-g}	1.23^{g}	1.38^{f}	0.83^{g}
D_4G_3	6.2^{ih}	15.9^{j}	19.0^{ih}	21.2^{i}	10.2^{def}	68.4^{fg}	76.5^{ef}	46.3^{f}	0.19^{d-g}	1.27^{fg}	1.42^{ef}	0.86^{g}
D_4G_4	5.6^{ij}	13.4^{k}	17.6^{i}	19.8^{i}	10.5^{def}	67.3^{g}	75.3^{f}	44.0^{f}	0.19^{d-g}	1.25^{g}	1.39^{ef}	0.81^{g}
D_5G_1	4.6^{jk}	13.5^{k}	14.7^{j}	16.9^{j}	8.7^{ef}	58.7^{h}	65.3^{g}	35.0^{g}	0.16^{efg}	1.09^{h}	1.21^{g}	0.65^{h}
D_5G_2	4.7^{jk}	10.6^{l}	12.8^{j}	16.1^{j}	7.9^{f}	55.4^{h}	63.2^{g}	30.7^{g}	0.15^{g}	1.03^{h}	1.17^{g}	0.57^{h}
D_5G_3	4.2^{k}	13.3^{k}	13.8^{j}	16.7^{j}	8.2^{ef}	56.5^{h}	64.2^{g}	32.9^{g}	$0.15e^{fg}$	1.05^{h}	1.19^{g}	0.61^{h}
D_5G_4	4.3^{k}	11.7^{l}	13.1^{j}	16.0^{j}	8.0^{f}	54.9^{h}	63.6^{g}	30.8^{g}	0.15^{fg}	1.02^{h}	1.18^{g}	0.57^{h}
S.Em±	0.48	0.59	2.36	1.45	0.2	1.5	0.59	2.6	0.01	0.01	0.01	0.01

*Means with same letters do not differ significantly under DMRT

Note : DAS – Days of sowing

Main plot treatments : Time of planting (D)

D_1 : Second fortnight of June
D_2 : First fortnight of July
D_3 : Second fortnight of July
D_4 : First fortnight of August
D_5 : Second fortnight of August

Sub plot treatments : Genotypes (G)

G_1 : Bindas
G_2 : Bunny-*Bt*
G_3 : ATM
G_4 : Dr. Brent

Table-3 : Dry matter accumulation in leaves, stem and reproductive parts (g plant^{-1}) of cotton at various stages as influenced by time of planting and genotypes.

Treat -ments	DMP in leaves			DMP in stem			DMP in reproductive parts		
	90 DAS	135 DAS	At final picking	90 DAS	135 DAS	At final picking	90 DAS	135 DAS	At final picking
Plant time									
D_1	46.4^{a}	79.3^{a}	83.6^{a}	72.9^{a}	111.0^{a}	118.8^{a}	102.5^{a}	116.2^{a}	123.5^{a}
D_2	40.6^{b}	71.2^{b}	76.7^{b}	67.5^{b}	95.2^{b}	104.5^{b}	89.6^{b}	108.6^{b}	116.3^{b}
D_3	38.0^{c}	60.7^{c}	68.8^{c}	59.4^{c}	84.5^{c}	92.2^{c}	81.3^{c}	98.2^{c}	107.8^{c}
D_4	35.3^{d}	51.4^{d}	57.8^{d}	52.9^{d}	72.6^{d}	80.4^{d}	75.4^{d}	83.5^{d}	94.3^{d}
D_5	27.9^{e}	43.4^{e}	50.3^{e}	44.7^{e}	58.9^{e}	65.9^{e}	59.3^{e}	75.1^{e}	82.8^{e}
S.Em±	0.3	0.6	0.8	0.8	1.0	0.9	0.7	1.0	0.7
Genotypes									
G_1	39.7^{a}	66.7^{a}	70.9^{a}	62.3^{a}	86.8^{a}	95.4^{a}	85.9^{a}	99.5^{a}	108.6^{a}
G_2	36.9^{c}	57.0^{d}	64.7^{b}	57.0^{c}	82.0^{c}	89.9^{c}	79.9^{b}	93.5^{c}	102.4^{b}
G_3	37.7^{b}	62.5^{b}	68.4^{a}	60.3^{ba}	85.6^{ba}	93.3^{ba}	80.8^{b}	97.8^{ba}	105.4^{ba}
G_4	36.3^{d}	58.7^{c}	65.7^{b}	58.2^{bc}	83.2^{bc}	90.9^{bc}	79.8^{b}	94.6^{bc}	103.4^{b}
S.Em±	0.2	0.6	0.2	0.3	0.2	0.2	0.2	0.6	0.7
D x G									
D_1G_1	49.9^{a}	84.7^{a}	87.3^{a}	75.0^{a}	112.2^{a}	123.5^{a}	106.7^{a}	121.6^{a}	128.1^{a}
D_1G_2	45.1^{b}	74.0^{dc}	80.3^{b-e}	71.3^{bac}	109.0^{a}	116.5^{b}	99.1^{b}	113.1^{bc}	121.6^{bac}
D_1G_3	46.7^{ba}	82.8^{ba}	85.3^{ba}	73.5^{ba}	112.9^{a}	118.9^{ba}	103.9^{ba}	116.2^{ba}	124.4^{ba}
D_1G_4	43.8^{bc}	75.7^{bdc}	81.3^{bdc}	72.0^{ba}	109.8^{a}	116.2^{b}	100.2^{b}	114.0^{bac}	120.0^{a-d}
D_2G_1	43.4^{bc}	77.3^{bac}	80.9^{bac}	70.3^{a-d}	96.8^{b}	106.0^{c}	93.6^{c}	111.4^{bc}	123.2^{ba}
D_2G_2	40.1^{dc}	68.0^{ed}	73.7^{d-g}	65.2^{fde}	94.1^{b}	103.3^{c}	86.8^{de}	106.0^{edc}	112.3^{fde}
D_2G_3	39.9^{dc}	70.4^{edc}	77.1^{edc}	68.1^{bdc}	95.2^{b}	105.3^{c}	90.6^{dc}	110.7^{bc}	116.0^{b-e}
D_2G_4	38.9^{de}	69.0^{edc}	75.1^{c-f}	66.3^{dec}	94.7^{b}	103.6^{c}	87.5^{de}	106.5^{dc}	113.6^{c-f}
D_3G_1	39.6^{def}	65.7^{edf}	71.2^{efg}	62.1^{feg}	85.8^{c}	94.1^{d}	84.4^{fe}	99.7^{edf}	111.8^{fde}
D_3G_2	37.4^{def}	58.0^{hgf}	67.0^{ihg}	56.9^{ihg}	82.6^{c}	90.1^{ed}	81.6^{fg}	96.4^{f}	104.9^{fg}
D_3G_3	38.1^{def}	61.5^{efg}	69.2^{fhg}	60.3^{fhg}	85.3^{c}	93.2^{d}	78.5^{hg}	98.6^{edf}	106.6^{f}
D_3G_4	37.1^{def}	57.7^{hgf}	67.6^{ihg}	58.3^{hg}	84.3^{c}	91.4^{d}	80.6^{fg}	98.1^{ef}	107.8^{fe}
D_4G_1	36.1^{def}	56.6^{hgf}	61.7^{ih}	55.2^{ih}	75.4^{d}	84.3^{ef}	78.9^{hg}	87.4^{g}	98.3^{hg}
D_4G_2	35.2^{ef}	48.4^{kl}	54.4^{k}	49.5^{kj}	69.1^{ed}	78.1^{f}	75.2^{hi}	81.1^{hg}	92.3^{hi}
D_4G_3	35.5^{ef}	51.8^{hgi}	59.8^{ij}	55.3^{ih}	74.9^{d}	80.3^{f}	73.0^{i}	84.1^{hg}	94.1^{hi}
D_4G_4	34.3^{f}	48.7^{hji}	55.4^{kj}	51.7^{ij}	71.0^{d}	79.0^{f}	74.6^{hi}	81.3^{hg}	92.6^{hi}
D_5G_1	29.6^{g}	48.9^{hji}	53.5^{k}	49.2^{kj}	63.9^{ef}	69.1^{g}	65.7^{j}	77.4^{hij}	81.4^{j}
D_5G_2	26.7^{g}	36.5^{l}	48.1^{k}	42.3^{l}	55.4^{g}	61.4^{h}	56.9^{k}	71.0^{j}	80.9^{j}
D_5G_3	28.3^{g}	45.8^{jl}	50.4^{k}	44.3^{kl}	59.6^{gf}	68.7^{g}	58.2^{k}	79.1^{hi}	85.8^{ji}
D_5G_4	27.2^{g}	42.3^{kj}	49.1^{k}	42.9^{l}	56.5^{g}	64.2^{hg}	56.4^{k}	73.0^{ij}	83.1^{j}
S.Em±	0.5	1.2	0.9	1.0	1.1	0.9	0.8	1.5	1.6

***Means with same letters do not differ significantly under DMRT**

Note : DAS–Days of sowing

Main plot treatments: Time of sowing (D)

D_1 : Second fortnight of June

D_2 : First fortnight of July

D_3 : Second fortnight of July

D_4 : First fortnight of August

D_5 : Second fortnight of August

Sub plot treatments: Genotypes (G)

G_1 : Bindas

G_2 : Bunny-*Bt*

G_3 : ATM

G_4 : Dr. Brent

Table-4 : Seed cotton yield (kg ha^{-1}), harvest index and B:C ratio of cotton as influenced by time of planting and genotypes.

Treatments	Yield (kg ha^{-1})	Bolls per plant	Harvest index	B:C ratio
Plant time				
D_1	3837^{a}	61.7^{a}	0.39^{a}	4.89^{a}
D_2	3392^{b}	49.8^{b}	0.38^{a}	4.58^{b}
D_3	2711^{c}	46.6^{c}	0.35^{b}	3.74^{c}
D_4	2015^{d}	45.4^{c}	0.32^{c}	2.84^{d}
D_5	982^{e}	38.9^{d}	0.21^{d}	1.46^{e}
S.Em±	71	0.7	0.01	0.08
Genotypes				
G_1	2873^{a}	50.0^{a}	0.35^{a}	3.84^{a}
G_2	228^{0}d	46.2^{c}	0.31^{c}	3.14^{d}
G_3	2673^{c}	48.4^{b}	0.34^{b}	3.61^{b}
G_4	2517^{b}	48.0^{cb}	0.33^{b}	3.43^{c}
S.Em±	43	0.5	0.005	0.05
D x G				
D_1G_1	4173^{a}	62.8^{a}	0.40^{a}	5.22^{a}
D_1G_2	3692^{cb}	62.6^{a}	0.39^{a}	4.75^{d}
D_1G_3	3784^{b}	60.7^{a}	0.38^{a}	4.84^{b}
D_1G_4	3695^{cb}	60.3^{a}	0.39^{a}	4.75$_{d}$
D_2G_1	3595^{c}	50.0^{cb}	0.39^{a}	4.80^{c}
D_2G_2	3335^{d}	50.1^{cbd}	0.38^{a}	4.52^{e}
D_2G_3	3364^{d}	47.3^{ccd}	0.38^{ba}	4.55$_{e}$
D_2G_4	3276^{d}	49.8^{cb}	0.38^{ba}	4.46^{e}
D_3G_1	3113^{e}	50.6^{b}	0.38^{ba}	4.21^{gf}
D_3G_2	1810^{h}	38.7^{gf}	0.27^{e}	2.66^{j}
D_3G_3	3205^{ed}	49.6^{ced}	0.39^{a}	4.32$_{f}$
D_3G_4	2718^{f}	48.1^{ed}	0.35^{b}	3.77$_{h}$
D_4G_1	2202^{g}	45.6^{ed}	0.33$_{c}$	3.08^{i}
D_4G_2	1728^{h}	42.1^{f}	0.29$_{d}$	2.49^{j}
D_4G_3	2073^{g}	45.0^{e}	0.33^{c}	2.92^{ji}
D_4G_4	2058^{g}	45.6^{e}	0.33^{c}	2.89$_{ji}$
D_5G1	1286i	39.6gh	0.25e	1.88k
D_5G2	856j	37.7i	0.20f	1.29m
D_5G3	946j	37.5ih	0.20f	1.42l
D_5G4	841j	35.5j	0.19f	1.27m
S.Em±	113	1.2	0.01	0.13

*Means with same letters do not differ significantly under DMRT

Main plot treatments: Time of planting (D)
D_1: Second fortnight of June
D_2: First fortnight of July
D_3: Second fortnight of July
D_4: First fortnight of August
D_5: Second fortnight of August

Sub plot treatments: Genotypes (G)
G_1: Bindas
G_2: Bunny-Bt
G_3: ATM
G_4: Dr. Brent

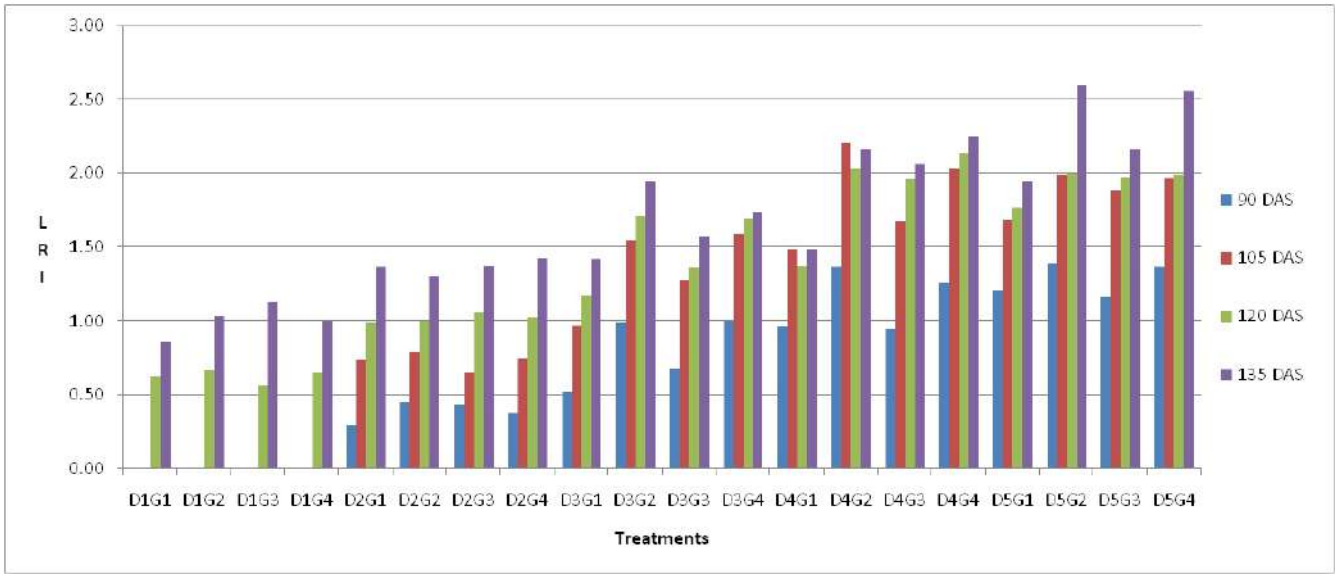

Fig.-1: Leaf reddening cotton as influenced time of planting and genotypes

Main plot treatments: Time of planting (D)
D_1 : Second fortnight of June
D_2 : First fortnight of July
D_3 : Second fortnight of July
D_4 : First fortnight of August
D_5 : Second fortnight of August

Sub plot treatments: Genotypes (G)
G_1 : Bindas
G_2 : Bunny-Bt
G_3 : ATM
G_4 : Dr. Brent

Results and Discussion

Across genotypes early sowing during II fortnight of June performed better and progressive delay in planting resulted in linear decrease in growth and yield attributes, while among cultivars averaged across planting time, cv. Bindas fared better followed by ATM (Table 1-4). Among the treatment combinations plant height in all the cultivars sown during II fortnight of June fared similarly and cv. Bindas (D_1G_1) recorded numerically higher values. ATM sown during II fortnight of June ($D1G_3$) recorded the tallest plants (65, 160, 177 and 191 cm at 45, 90 and 135 DAS and at final picking) among all followed by the same cultivar sown during I fortnight July (D_2G_3) (62, 126, 149 and 155 cm respectively, at 45, 90 and 135 DAS and at final picking) and II fortnight of July (D_3G_3); other cultivars sown during II fortnight of June were comparable with the latter treatment; last sown crop particularly Bunny Bt (D_5G_2) recorded lower plant height (26, 84, 85 and 90cm, respectively at 45, 90 and 135 DAS and at final picking) among all and cvs. Bindas and Dr Brent sown during same period were on par. Monopodials count also differed significantly due to interaction effects, initially the differences were more but with time the differences decreased and cv. Bindas sown during I fortnight of June (D_1G_1) recorded more number of monopodials (1.9, 2.8, 2.8 and 2.8 6 at 45, 90 and 135 DAS and at last picking respectively) and last sown crop irrespective of cultivars used recorded lower counts among all. Combination of cotton sowing time and genotypes also resulted in significant differences in sympodial count wherein the maximum number of sympodial branches (12.5, 24.4, 28.5 and 31.9 at 45, 90 and 135 DAS and at last picking respectively) was recorded with cv. Bindas sown during II fortnight of June (D_1G_1) followed by cv. ATM sown simultaneously (D_1G_3) (10.3, 23.6, 26.9 and 29.5 at 45, 90 and 135 DAS and at final picking, respectively), while last sown crop irrespective of cultivars except cv. Bindas recorded lower sympodial count among all.

Cotton cultivars sown during II fortnight of June in combination with cv. Bindas (D1G1) had the maximum number of nodes (13.8, 30.6, 32.9 and 35.3 at 45, 90 and 135 DAS and at final picking, respectively) among all followed by cv. ATM sown during simultaneously (D_1G_3) while sowing during I and II fortnights of August resulted in lower number of nodes irrespective of cultivars used. Among the treatment combinations, all the cultivars sown during II fortnight of June fared at par with regard to leaf area per plant, in all cv. Bindas (D_1G_1) recorded numerically higher values al all the stages (20.6, 95.1, 112.2 and 78.1 dm^2 $plant^{-1}$at 45, 90 and 135 DAS and at last picking, respectively), with delay in sowing the leaf area decreased and similar trend remained thoughout. Cv. Bindas fared better among cultivars during July but with sowings in August differences narrowed and cultivars

were at par and comparable. Among all irrespective of cultivars used, lower leaf area was recorded with last sowing (D_5G_{1-4}). In case of leaf area index initiallyat 45 DAS, the differences were narrow which widened with delay in sowing. Of all at all stages, II fortnight of June sown crop recorded higher indices, while last sown crop had lower indices; others fared in between. Cv. Bindas sown during II fortnight of June (D_1G_1) had higher indices (0.38, 1.76, 2.08 and 1.45 at 45, 90 and 135 DAS and at final picking, respectively) whereas cv. Dr. Brent sown last (D_5G_4) had lower indices (0.15, 1.02, 1.18 and 0.57 at 45, 90 and 135 DAS and at final picking, respectively) among all.

Dry matter production and its distributionin different plant parts also differed significantly. Among the treatment combinations, cv. Bindas sown during II fortnight of June (D_1G_1) recorded significantly higher DM in leaves (49.9, 84.7 and 87.3 g plant^{-1}at 90 and 135 DAS and at final picking, respectively), other cultivars sown simultaneously were at par and were next in order, while similar trend prevailed at other dates but the cultivars closed-in in their differences recording the lowest DM in leaves with last sowing. Overall, II fortnight of June with cv. Bindas (D_1G_1) resulted in higher DM in stem (75.0, 112.2 and 123.5 g plant^{-1}at 90 and 135 DAS and at final picking, respectively) followed by cv. ATM (D_1G_3) sown simultaneously; similar trend prevailed at other dates of sowing while lower DM in stem among all was observed with last sown crop particularly with cvs. Bunny *Bt* and Dr Brent (D_5G_2 and D_5G_4). Among the treatment combinations, cv. Bindas sown during II fortnight of June (D_1G_1) recorded higher DM in reproductive parts (106.7, 121.6 and 128.1 g plant^{-1}at 90 and 135 DAS and at final picking, respectively) and cv. ATM sown simultaneously (D_1G_3) and cv. Bindas sown during I fortnight of July (D_2G_1) were at par. At others dates, cultivars were mostly comparable when sown simultaneously while, significantly lower DM in reproductive parts (56.9, 71.0 and 80.9 g plant^{-1}at 90, 135 DAS and at last picking, respectively) was observed with last sowing during II fortnight of August with Bunny-*Bt* (D_5G_2).

Amongst the interactions no reddening was observed up to 105 DAS with first sowing in any of the cultivars and thereafter mild reddening occurred and the cultivars were at par. From second sowing onwards LRI increased and cultivars also revealed variations with higher LRI with Bunny *Bt* followed by Dr Brent which during last planting during II fortnight of August had 1.55, 1.99, 2.00 and 2.60 and 1.67, 1.97, 1.99 and 2.56 respectively at 90, 105, 120 1nd 135 DAS, respectively while cvs. Bindas and ATM had relatively lower indices.Similar results were obtained with the findings of Chimmad 1989 and Hosmath 2009.

Total number of bolls among treatment combinations ranged from 35.5 to a maximum of 62.8 spreading across sowing dates and cultivars; being higher with early sowing and dropped considerably with delay in sowing. Cv. Bindas sown during II fortnight of June (D_1G_1) had the maximum (62.8 on pooled basis) boll count and cultivars sown simultaneously fared on par. D_2G_1, D_2G_2 and D_3G_1 were at far and were next in the order while last sown crop (II fortnight of August) had lesser number of bolls wherein again cv. Bindas fared better while others (D_5G_{2-4}) were at far (35.5 to 37.7 on pooled basis) and had lower count of bolls among all with cv. Dr Brent (D_5G_4).

Seed cotton yield ranged from 841 to 4173 kg ha^{-1} due different treatment combinations and revealed significant differences. Average of last sown crop was less than one-quarter of first sown crop. Overall, II fortnight of June with cv. Bindas (D_1G_1) resulted in maximum seed cotton yield (4173 kg ha^{-1}); cv. ATM sown simultaneously (D_1G_3) was next best (3784 kg ha^{-1}), while other cultivars (G_2 and G_4) were at par. Cv. Bindas sown during I fortnight of July (D_2G_1) was also on par with the latter cultivars. Whereas, significantly lower seed cotton yield (841, 856 and 946 kg ha^{-1}, respectively) was observed with the second fortnight of August with cvs. Dr Brent, Bunny *Bt* and ATM (D_5G_{2-4}). Cv. Bindas was superior to others even during last sowing (D_5G_1) (1286 kg ha^{-1}).Among the treatment combinations, irrespective of cultivars first sowing during II fortnight of June (D_1G_{1-4}) recorded significantly higher final picking indices; cv. Bindas topping all (0.40 on pooled basis), second sowing during I fortnight of July (D_2G_{1-4}) and D_3G_1 had comparable values, then on the values decreased appreciably with considerably low values with last sowing during II fortnight of August (0.19, 0.20 and 0.20, respectively with cvs. Dr Brent, ATM and Bunny *Bt* on pooled basis), while crop sown during I fortnight of August fared a lot better.

First sowing during II fortnight of June using cultivar Bindas (D_1G_{1-4}) recorded significantly higher benefit cost ratio (5.22 on pooled basis), followed by cv. ATM sown simultaneously and Bunny *Bt* and Dr Brent were comparable with each other. Bindas sown during I fortnight of July also fared better than $D_1G_{2\&4}$. Thereafter, benefit cost ratio decreased with considerably low values with the last sowing during II fortnight of August, wherein cvs. Dr. Brent (D_5G_4) (1.27) and Bunny-*Bt*(1.29each) were on par and had lower B:C ratio.Overall, cv, Bindas sown during II fortnight June (D_1G_1) resulted in maximum seed cotton yield (4173 kg ha^{-1}) followed by cv. ATM sown simultaneously and cv. Bindas sown during I fortnight of July (D_2G_1 - 3695 kg ha^{-1}) was at par. Significantly lower seed cotton yield was recorded with last sowing during II fortnight of August wherein (D_5) ATM, Bunny *Bt* and Dr. Brent fared at par. Similarly in Pakistan Kalid Usman *et al*.

(2016) reported higher yield with cv. CRR when sown early during April 19th. Sukbir Singh (2010) from Punjab, India observed superior performance of cv. RCH-134 with still earlier planting on April 20th sowing among the 4 cultivars and 5 dates of sowing studied.

Thus, delayed planting would lead to yield reduction which could not compensated by any other production practices (Pyati, 2016). Lower lint yield with late sowing could be probably due to shortened fruiting period and delayed maturity compared to early sowing (Bangee *et al*., 2004 and Bauer *et al*., 2000). In case of late sowing flowering initiates late in the season when temperature is low that probably affected radiation use efficiency which might have limited crop growth, while early sowing provided favourable temperature and water supply contributing towards boll development and boll filling that probably resulted in higher yield (Yates *et al*., 2010a). Elayan *et al.* (2015) opined that delayed planting pushes cotton plant for an early flowering and maturity.

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Socio-Economic Profile of Multivoltine (Pure Mysore) Sericulture Farmers in Kunigal and Magadi Taluk Seed Area of Karnataka, India

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Abstract

In India, sericulture is one of the most important agro and forest based cottage industry, earning a foreign exchange of Rs. 400 corers / annum and providing gainful employment to over six million people (Anon, 2019).Sericulture is an eco-friendly agro-based labour intensive and commercially attractive economic activity, falling under cottage and small-scale sector. The cost and return structure in sericulture plays an important role in its adoption, success and dissemination. Indian sericulture shifted from crossbreed to bivoltine hybrid sericulture; aiming at higher production and productivity.In spite of that also Cross breed production contributing >60 per cent of the raw silk production during 2019-20. The present study was an ex-post facto research conducted in puremysore silk worm seed areas of Kunigaland Magaditaluk of Karnataka. The results indicated that more than half percentage (54.44 %) of the multivoltinesilkworm rearing farmers belong to middle age (31 to 50 years), as high as 14.44 farmers studied up to PUC level of education (11th to 12thStd)and 52.22 percent of the silk worm rearing family belogs to medium family size and 43.33 oercent having medium experience in sericulture. Further, 53.33.00 per cent of the silkworm rearing farmers reared meduum seed crops (5-8), 64.44 per cent medium Dfls per crop (100-200 dfls /crop) and dfls brushing per year (500 to 900 per year). Among all the respondents 61.11 per cent documented with medium cocoon yield (300 to 700 kg/year) with benefit cost ration of Rs.1.5 to 3.0.

Key words : *Cocoon yield, education, multivoltine, Sericulture, age and silkworm.*

Introduction

Silkworm seed is the sheet anchor of sericulture industry. During the early twentieth century, the industry was unorganized and mainly pure races were exploited for commercial silk production. Unlike other agriculture commodities wherein traditionally the producer can keep a part of his produce as seed material, in sericulture industry the commercial silkworm rearer has to procure fresh eggs every rearing . Hence, the quality of the fresh silkworm seed assumes importance in the production of ultimate end product the silk. The ruling hybrid in Karnataka is a cross breed of Pure Mysore and a bivoltine accounting for more than 90 % production.

Pure Mysore, Mysore, local, MSC (Mysore Seed Cocoon) are some of the synonyms of the famous polyvoltine silkworm race of Karnataka. It has a glorious history of more than two centuries. It has been the foundation for sericulture development not only in Karnataka but also in the other Southern States. At present, more than 90% of the raw silk produced in South India is by Pure Mysore x bivoltine cross-breed combination.Realizing the importance of Pure Mysore local race (PM) the erstwhile sericulture proponents have carved out an exclusive geographical location comprising Kunigal, Magadi and Hebburhobli of Tumkurtaluk as Pure Mysore Seed Area.India has the unique distinction of being the only country in the world to produce all four commercial silks *viz*., Mulberry (*Bombyxmori* L.), Tasar (*Antheraeamylitta* Durry), Eri (*Samiacynthiaricini* Boisduval) and Muga (*Antheraeaassamensis* West wood) (Anon., 1982). Among the four types of silks mulberry contributes more than the others in raw silk production.In mulberry sericulture cross breed contribute more than 60 per cent raw silk production as compare bivoltine sericulture. In the Cross breed seed production pure Mysore rolled as a female component with bivoltine male for CB production.Mysore seed female cocoons are retained for crossbreeding with bivoltine males to produce commercial layings. Such commercial layings are supplied to rearers for producing commercial cocoons which are marketed in markets, outside the seed area for reeling. Thus, the demand for Mysore seed cocoons has a direct relationship with the silk production in the State.

Karnataka state is one of the importantsilkworm cocoon producing state in thecountry.With are under mulberry 98,135 hectares and with a contribution of the state tocountry's silkworm cocoon production was66,833 MT during 2019-20 (Anil *et al* 2019). Silk, a highly priced agricultural commodity, accounts for about 0.2% of the total world production of textile fiber. Since sericulture stands next to agriculture for rural employment in India, it

Table-1 : Socio-Economic characteristics of Multivoltine Silkworm Rearing Farmers in Kunigal and magadi Taluk Seed Area of Karnataka.

Sl. No	Categories	Respondents	
		Trained n1=90	
		Frequency	Percentage
1.1	**Age**		
a	Young (up to 30 years)	32	35.55
b	Middle (31 to 50 years)	49	54.44
c	Old (>50 years)	09	10.00
1.2	**Education**		
a	Illiterate	19	21.11
b	Primary (1^{st} to 4^{th} std)	21	23.33
c	Middle (5^{th} to 7^{th} std)	15	16.66
d	High School (8^{th} to 10^{th} std)	20	22.22
e	PUC (11^{th} to 12^{th})	13	14.44
f	Graduate and above (>12^{th} std)	02	2.22
1.3	**Family size**		
a	Small (up to 4 members)	30	33.33
b	Medium (5 to 8 members)	47	52.22
c	Large (> 8 members)	13	14.44
1.4	**Experience in sericulture**		
a	Very Low (<1 years)	14	15.55
b	Low (1-3 years)	09	10.00
c	Medium (4-8 years)	39	43.33
d	High (>8 years)	28	31.11

becomes a matter of concern to examine the sericulture production trend over the years and reasons for slow growth. Sericulture is an important agro industry in Indian economy.Economics is an important criterion to evaluate, acceptance and wider adoption of any technology which is economically sound and that can be accepted by the sericulture farming community. Among different indicators of economic efficiency in sericulture, benefit cost have greater impact on the practical utility and acceptance of the production technology by the farmers.

The knowledge and adoption on maintenance of garden for the successful seed crop are influenced by various socio-economic factors like age, education, economic condition of the farmers etc. Hence, this study has conducted to know the social and economic status of the Multivoltine Agreed Seed Rearers (ASRs) and other farmers throughthe questionnaire developed.

Research Methodology

The present study was an “Ex-post facto” research data on the Scio-Economic condition of the sericulture farmers collected through questionnaire developed. This Ex-post facto research undertaken during 2019-20 in Kadasinganahalli, Nittur, Hebbur, Rajgere , Kempanahalli, Santhemavattur, Magadi, HuliyurDurga, NAG Palya, Taredakuppe Nagenahalli villages of Kunigal and Magaditaluks of Multivoltine seed area of Karnataka. All

Table-2 : Rearing Details and average yield of Multivoltine Silkworm Farmers in Kunigaland Magadiseed area of Karnataka.

Sl. No.	Categories	Respondents	
		Trained n1=90	
		Frequency	Percentage
2.1	**Number of crops per year**		
a	Low (up to 5)	30	33.33
b	Medium (5-8)	48	53.33
c	High (>8)	12	13.33
2.2	**Average Dfls/crop**		
a	low (<100 dfls/crop)	25	27.77
b	Medium (100 - 200 dfls/crop)	58	64.44
c	High (>200 dfls/crop)	07	7.77
2.3	**Average Dfls brushing per year**		
a	Low (<500year)	23	25.55
b	Medium (500 to 900/year)	58	64.44
c	High (>900 kg/year)	09	10.00
2.4	**Average cocoon yield (kg) per year**		
a	Low (200 to 250 kg/year)	26	28.88
b	Medium (300 to 700 kg/year)	58	61.11
c	High (>700 kg/year)	09	10.00

the above villages playing a vital role in the multivoltine sericulture with Pure Mysore Silk Worm from last 25 years. From all the villages silkworm rearing farmers were selected randomly to arrive overall sample size of 90 silk worm rearing farmer. A pre-tested and standardized interview schedule was used to collect the data from the respondents by personal interview method. The data collected from respondents was tabulated and analyzed by using appropriate statistical tools such as frequency, percentage, mean score and rank. Statistical packages viz., Microsoft excel was used for analysis.

Results and Discussion

Common belief is that the productivity of a farmer increases with age, reaches some midage peak, and then decreases with further age. An increase and then decrease in efficiency as a farmer ages has implications for the survival of beginning farmers, for successful succession planning, and even for the competitiveness of the nation’s farmers with farmers of other countries. The result of the study on the age of the farmer indicated in Table 1 reviled that more than half percentage (54.44 %) of the pure mysore silkworm rearing farmers belong to middle age (31 to 50 years) and remaining 35.55 and 17.78 per cent farmers belongs to the young up to 30 years) and old>50 years), respectively. The findings are in line with Hadimani *et al*. (2017).

Education is important to the improvement of sericulture productivity; education opens the mind of the farmer to knowledge, better methods of farming. As such, education improves the allocative efficiency via the

Table-3 : Benefit cost ratio of Multivoltine Silkworm Farmers in Kunigal and Magadi seed area of Karnataka.

Sl. No.	Categories	Respondents Trainedn1=90	
		Frequency	Percentage
1.	B:C ratio		
a	Low (<1.5 Rs)	4	4.44
b	Medium (1.5 to 3.0 Rs)	65	72.22
c	High (>3.0 Rs)	21	23.33

Table-4 : Survey questionnaire for collecting the information on socio-economic condition of the Pure Mysore Sericulture Farmers at Kunigal&MagadiTaluk Seed Area of Karnataka during 2019-20.

Name of the farmer and address :	
Village/Taluk/District :	
Land holding :	
Area of mulberry cultivation :	
1. Social condition of farmer :	
(a) Age	:
(b) Education	:
(c) Family size	:
(d) Experience in sericulture	:
2. Silkworm Rearing Details	
(a) Number of crops per year	:
(b) Average dfls per crop	:
(c) Average dfls brushing per year	:
(d) Average cocoon yield per year	:
3. Economy of the farmer	
(a) Benefit Cost Ratio	:

greater propensity to select inputs of higher mulberry and cocoon productivity also education improves decision-making skills of farmers. In the study it was found that 23.33 per cent silkworm rearing farmers educatedupt fourth standared. 22.22 per cent appeared between 8th to 10th standard and 21.11 per cent farmer's completely illiterate and practicing sericulture. The graduate and above level of education was up to 2.22 per cent. Hence education is prime important social factor of the farmer in adoption technologies and new ides of advanced sericulture. The results of the present study are in line with the results of Priyadarshani and Vijaya Kumari (2013).

Family size and relationships within the farmers family have important implications on production decisions, such as the choice of crops, the organization of family labour and its allocation to different tasks, management of farm land and other assets, and questions of inheritance. Family and small farms are vital to our economy and well-being as a nation. Not only do they support the competitiveness and sustainability of rural and farm economies, they serve to: Protect and enhance natural resources and the environment. Provide a nursery for the development of new enterprises and marketing. From the Table-3 it was documented that high family size i.e 52.22 per cent of respondents belongs to medium family size(5 to 8 members) followed by 33.33 and 14.44 per cent respondents had small (up to 4 members) and large family size (> 8 members).The findings of the present study are in line with Tamboli (2012).Farmer experience is useful in early stages of adoption of a given technology when farmers are still testing its potential benefits, which later determine its retention or disadoption over time. Thus, gradual advances in technology development and experience of the farmer isessential for sustainable adoption of sericulturial technologies**.** The experience in sericulture from the data revieled that indicated that majority of the silkworm rearing farmers (43.33 %) belonged to medium experience category of between 4 to 8 years followed by high experience category of more that eight years (31.11 %).In the present study 15.55 per cent farmers are very low in sericulture. The above findings are in line with those of Hadimani *et al*. (2017)

Selection of the rearing house, number of dfls according to the size of the house , average number of crops depending up on the mulberry garden and other rearing techniques are ver very important to get higher cocoon yield. In the present study rearing details of pure mysore sericulture farmers exhibited in the table 2. In the study with respect to number of crops per year indicated that majority of farmers (53.33 %) belonged to medium category of upto5 to 8 crops followed by low category up to5crops (33.33 %) remaining farmer falls on the high category of number of crops grown per year (13.33 %) (Table-2). Average dfls/crop: It was observed from Table 2 that as high as 64.44.22 per cent of the farmers belonged to medium category of 100 to 200 dfls/crop brushing followed by low category of less than 100 dfls/crop (27.77 %) and highcategory more than 200 dfls/crop (7.77%). The findings are in line with Hadimani *et al*. (2017). Further in case of average dfls brushing per year study indivated that highest (64.44%) sericulture farmers brushing the dflsbetween 500 to 900 per year depending on the rearing house mulberry garden. At the mean time 28.88 per cent of the farmere rearing averge less than 500 dfls per year whereas 10 percent of farmers brushing more than 700 dfls per year**.**The results of the study also showed the wide range of difference in the farmer getting the average cocoon yield. In the study it is noticed that 61.00 per cent of the silkworm rearing farmers belongs to medium cocoon yield category 300 to 700 kg/year) followed by low category between 200 to 250 kg/year (28.88 %) and 10 per cent of the farmer recorded highest average cocoon yield per year (10.00 %). The findings are in line with Hadimani *et al*. (2017).

Economics is an important criterion to evaluate, acceptance and wider adoption of any technology which is economically sound and that can be accepted by the

sericulture farming community. The adoption of new technology is not a simple and one-time process but a number of social, economic, institutional, psychological, physical and biological factors influence the process to a considerable extent (Singh and Yadav, 1989). In the present study 72.22 per cent of the farmer noticed with average B:C ration of Rs. 1.5 to 3.0 per cent whereas (4.44 % & 23.33 %) sericulture farmers documented with low and high benefit cost ratio (less than Rs. 1.5 and more than Rs. 3.0 respectively).

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Biochemical Alterations in Healthy and Diseased Leaves of Barley Cultivars against *Drechslera graminea* (Rabenh. Ex Schlecht) Shoemaker

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Abstract

In present years the stripe disease caused by *Drechslera graminea* has been reported as serious problem in major growing region of northern Rajasthan as well as in northern state of India. The disease is seed borne in nature and pathogen survives on pericarp or hull of seed. In this investigation, the biochemical such as Total phenol, Peroxidase, IAA oxidase and Total sugar were examined in leaves of RD-2660, RD-2624 and RD-2035 cultivars of barley. The studies were performed in three stages viz. 30, 45 and 60 days of disease progression and observed substantial variation in biochemical modification. The effect of biochemical constituents were showed that the function of total phenol was increased in diseased leaves as opposed to healthy leaves of all cultivars at different intervals. Similarly the activity of IAA oxidase and peroxidase have gradually increased in diseased leaf as opposed to healthy leaf of all cultivar at different intervals. Whereas, the highest occurrence of total sugar content was observed in health leaf of all cultivars at 60 days after sowing as opposed to diseased leaf tissues.

Key words : *Drechslera graminea, IAA oxidase, peroxidase, total phenol.*

Introduction

The ancestral cereal grain crop barley (*Hordeum vulgare* L.) is used as a food grain in the malting process and has nutritional value for humans and livestock (Baik and Ullrich, 2008). It is a major Rabi crop in India, and it is grown in Punjab, Rajasthan, Madhya Pradesh, Haryana, Uttar Pradesh, and Bihar. The total area under cultivation of barley in India is around 6.7 lakh hectares, with a production of 1.75 million tonnes in 2016-2017 (www.agricoop. gov.in). It comprises 2.8 lakh hectares in Rajasthan and produced 9.0 lakh tonnes in 2016-17 (www.agriculture.rajasthhan.gov.in). Barley is a hardier crop as compare to wheat, and it is built to react admirably well to reduced inputs and grow easily in saline soils (S. Kumar and S.S. Karwasra, 2019). Barley is considered as a functional food and used in many bakery products and recipes. In India, malt products such as “Sattu” and “Missi roti” have long been used (Verma *et al.,* 2011).Barley crop subjected by several diseases such as leaf rust, stripe rust, loose smut, covered smut, net blotch, leaf blight and stripe disease etc. which cause significant losses to crop yield.Among the fungal disease the stripe disease caused by *Drechslera graminea* (Telomorph-*Pyrenophora graminea*) is most devastating barley disease in the world (Benbelkacem *et al.,* 2000).In India, the disease was first time reported by Butler in 1918. Yaduman *et al.* (2013) reported that the barley leaf stripe disease caused by *Drechslera graminea*is a major disease causing losses as high as 70 to 72% under epiphytotic conditions. Mathur and Bhatnagar (1991) reported up to 31.9 per cent loss occurred due to barley stripe. Singh and Siddiqui (1986) estimated that 22 per cent fewer grains were harvested from diseased ears than in healthy ears and moreover germination was reduced. Now days the incidence of this disease is progressively increase in all barley growing reason of northern Rajasthan as well as in northern state of India.

The nature of pathogen is seed born and the mycelium exists on the peri-carp or seed hull. The diseased plant emerges only from infected seeds and the mycelium systematically grow inside the plant tissues. Initial symptoms are appeared on leaf after 30-35 days of sowing. White to yellow stripes are formed on leaf sheath as well as on the basal portion of the leaf blade and gradually extend to the full length of leaf and become necrotic. The fungus produces clusters of conidia on infected leaves which are carried by the wind to developing seed on the ear of healthy plants with in the crop and in neighbouring crops. In inflorescence seeds are become susceptible to infection from anthesis to soft dough stage (Teviotdale and Hall, 1976). Some of the spores germinate and infect the developing seed, there is potential for infection to multiply significantly from one season to next season (S. Kumar and S.S. Karwasra, 2019).

I did not find any comprehensive prior report about biochemical changes in barley plants caused by the *Drechslera graminea*. Therefore, study was conducted on the quantitative estimations of total phenol, peroxidase, IAA oxidase and total sugar activities in diseased and healthy leaf of resistant and susceptible barley cultivars.

Materials and Methods

Isolates and planting material : The six isolates (DG-01, DG-02, DG-03, DG-04, DG-05 and DG-06) were isolated from diseased leaf samples that were collected from six districts of Rajasthan. The virulence of all isolates were tested on different barley cultivars. On the basis of virulence the DG-03 caused more symptoms and mortality as compared to other isolates whereas three cultivar, namely RD-2660, RD-2624 and RD-2035 were showing resistance, moderate resistance and susceptible reaction. Therefore, the DG-03 isolate and all three cultivars were used to know the biochemical alteration in diseased and healthy leaves. The twenty five seeds of each cultivar for each pot were inoculated by plunging in active mycelial suspension of DG-03 isolate for 8 hours before sowing.

Estimation of total phenols : On different intervals (30, 45 and 60 days) the quantity of phenolic compounds in the infected and healthy leaves was determined by using the folin ciocalteau reagent method of Bray and Thorpe (1954). 4ml of 4 percent Na_2CO_3 solution was added in the 0.2 ml pre-prepared chlorophyll solution, then 0.2 ml of Folin-Ciocalu reagent was applied and shaken for 3 minutes on a vortex mixer to monitor the colour of the solution. Absorption was measured after 30 minutes at 750 nm and total phenolic content was measured as mg/g fresh weight of barley leaves.

Estimation of peroxidase activity : Peroxidase activity has been calculated with small modifications using the procedure defined by Shannon *et al.* in 1966. Two gram fresh leaf sample was ground in a previously chilled mortar in 10 ml ice-cold 0.1 phosphate buffer at pH 6.0. The homogeneous was separated by means of a two-layered muslin, and then centrifuged at 16,000 rpm for 20 minutes. The supernatant was used as an enzyme source. The reaction mixture (0.05 M sodium phosphate buffer (pH 5.5), 2% H_2O_2, and 0.05 M guaiacol) was mixed with 0.1 ml enzyme extract. The solution's absorbance was recorded at 470 nm after every 20-second.

Total sugar analysis : The sugar content in the samples was determined by using Du Bois *et al.,* 1956. Five mg of the sample were with 1M H_2SO_4 combined was a mixture sufficient for total sugar. A blank used to make sure that no undigested carbohydrates or interferences were detected. The mixture was boiled at 90?C for one hour in water bath. The boiled samples were placed in a centrifuge and rotated for 10 minutes at 5,500 rpm. One ml of the supernatant was added to a simmering tube. Added 0.5 ml phenol in mixture of H_2SO_4 (2.5 ml) and 1 ml supernatant and left for 30 min. to cool (yellow orange colour). The cooled mixture was carefully into acid resistant tubes and absorbance was recorded using the UV at 630nm.

IAA oxidase : IAA oxidase activity of diseased and healthy leaf was projected according to the method of Mahadevan and Sridhar (1986). Infected samples were taken from 30, 45, 60 days old plants of each cultivar and cut into small uniform pieces. The uniform small pieces were homogenized in 10 ml phosphate buffer (pH 6.4) in a chilled pestle mortar. The crushed samples were filtered through muslin cloth and centrifuged at 12,000 rpm and the supernatant was used for enzyme assay. Reaction mixture contained 1 mM 2, 4-dinitrophenol, 0.25 ml (0.5mM manganese chloride), 0.75 ml of a mixture of 1mM IAA, 3.0 mL of 0.1M phosphate buffer (pH 6.0) and 1 ml of enzyme extract. The mixture was shaken and kept 1 hour for incubation at 32?C. After one hr. 5ml of assay mixture was pipette out at different time intervals and added 1 ml 0.5 Mm $FeCl_3$ which initiated reaction.The pink colour developed and visual density of each reaction mixture was then recorded at 530 nm in a spectrophotometer.

Statistical analysis : The data from each experiment were evaluated individually and subjected to XL-STAT 2013 for analysis of variance (ANOVA) and the least significant difference ($P < 0.05$). Tukey's HSD test was used to determine the significance of the means, and the results given are the mean of five replicates±standard error (SE).The error bars in the figures represent SED.

Results and Discussion

Phenolic substances may enhance the mechanical strength of host cell walls by facilitating the production of lignin and suberin, which are involved in the development of physical barriers that prevent pathogen transmission (Ngadze *et al.* 2012; Singh *et al.* 2014). In present study, the amount of total phenols was significantly higher ina diseased leaf of RD-2660 while, minimum total phenol content (8.81 mg/g) recorded in a diseased leaf of RD-2035 at 60 days after sowing. However, a considerable increase in the total phenol content was recorded in all cultivars at all stages (30, 45 and 60 days). The maximum increase of total phenol content in a diseased leaf of RD-2660 shows genetic dominance in terms of secretion of defence-related bio-chemicals (Figure-1). Yao *et al.* (1995) shown that changing the amount of phenolic substances in plants may alter disease susceptibility. In this study, the amount of total phenols was found minimum in healthy leafs of RD 2035 followed by RD2624 and RD 2660. Similarly, Meena *et al*., (2015) and Gogoi *et al.,* (2001) reported that the total phenol content was higher in diseased tissue of resistant cultivar as compared to the susceptible cultivars. Phenols as the biochemical basis for the resistance of wheat to karnal bunt disease and accumulate in resistant varieties after the pathogenic attack, whereas susceptible varieties did not accumulate significantly higher phenolics. Kulbat

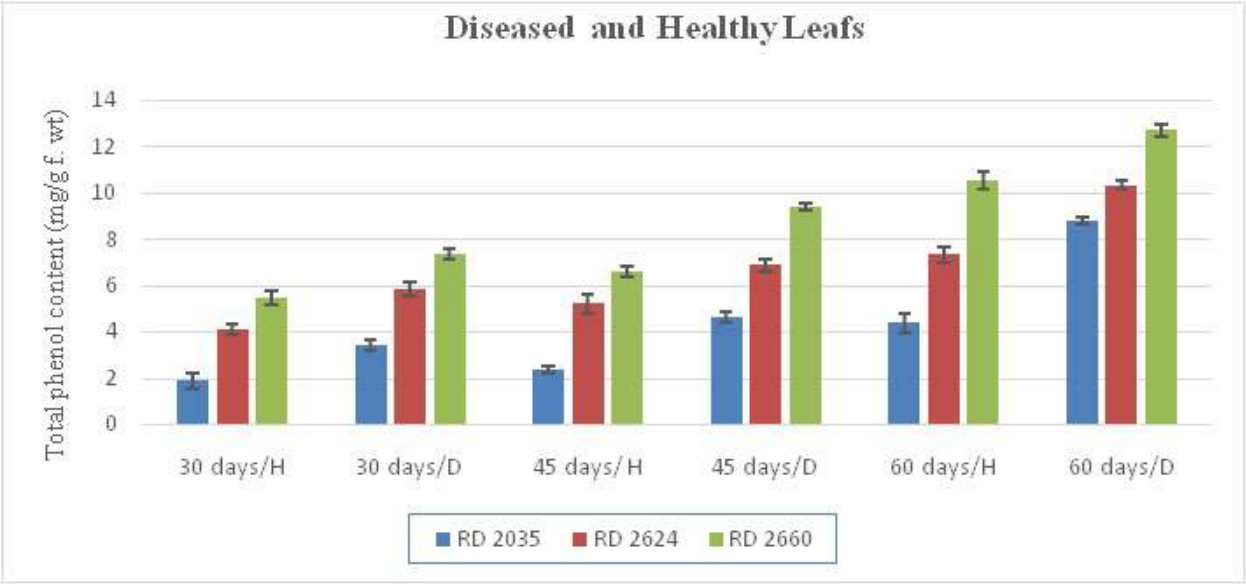

Table-1 : Change in total phenol content in a healthy and diseased leaf of different cultivars of barley at different days.

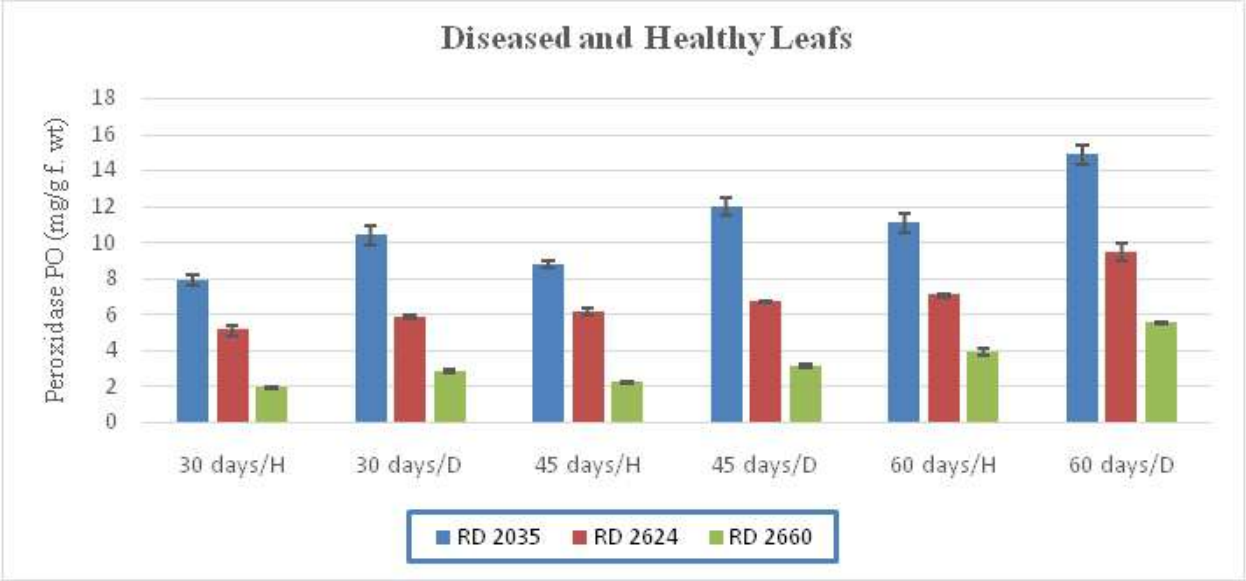

Table-2 : Change in Peroxidase (PO)enzyme in healthy and diseased leaf of different cultivars of barley at different days.

(2016) reported the phenolic compound is mainly synthesized from amino acid phenylalanine which is converted into cinnamic acid. The cinnamic acid and its derivatives have been described as phenylpropanoids and it is enhanced in plants under stress conditions. Phenylpropanoid pathway may also lead to the formation of non-polymer derivatives like salicylic acid, which is the most important signalling molecule, involved in systemic acquired resistance (SAR) and inhibited the growth of fungus. POX is among the earliest enzymes that react to plant infections and provide early protection (Sulman *et al.* 2001). In plants, POXs play a role in lignification, suberification, polymerization of hydroxy-proline-rich glycoproteins, cell wall extension, wound repair, and resistance to disease (Hammond-Kosack and Jones 1996; Yoshida *et al.* 2003; Maksimov *et al.* 2014).The result of peroxidase (POX) activity revealed that peroxidase activity were gradually increasing in an infected and healthy leaf of barley at all intervals. The peroxidase activity was significantly highest recorded in diseased leaves as compared to healthy leaves in RD2035 followed by RD2624 and RD 2660 in all crop stages. While minimum accumulation of these defence enzymes was observed in a healthy leaf of RD-2660 at 60 days after sowing followed by RD 2624 and RD 2035, respectively (Figure 2). Several studies on these defence enzymes were carried out by many workers and reported that the level of peroxidase activity increases both in

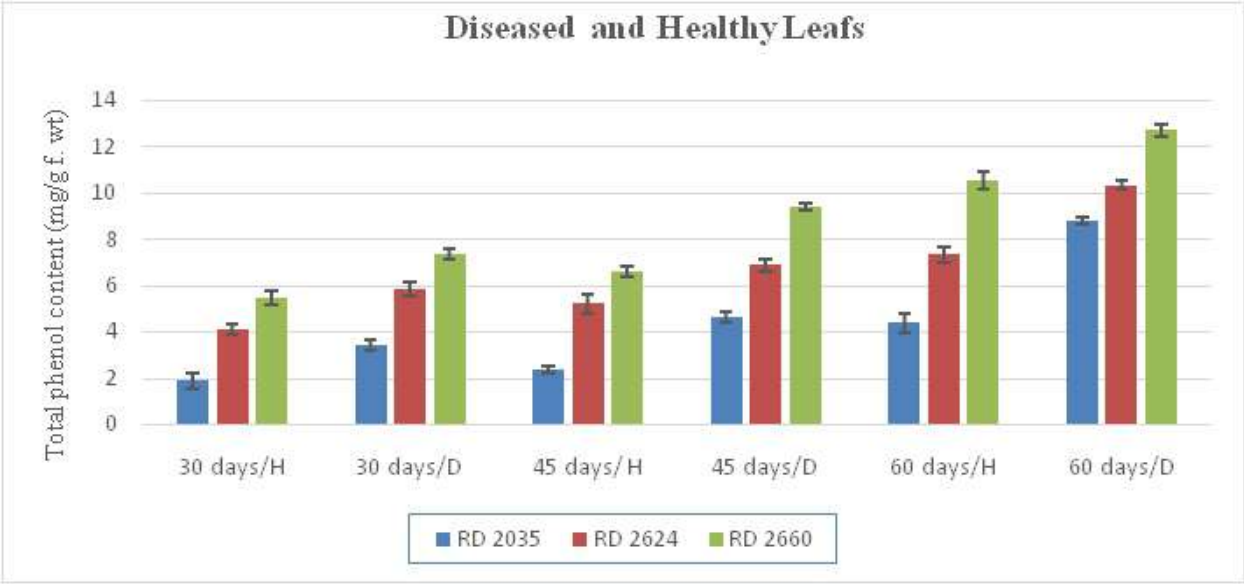

Table-1 : Change in total phenol content in a healthy and diseased leaf of different cultivars of barley at different

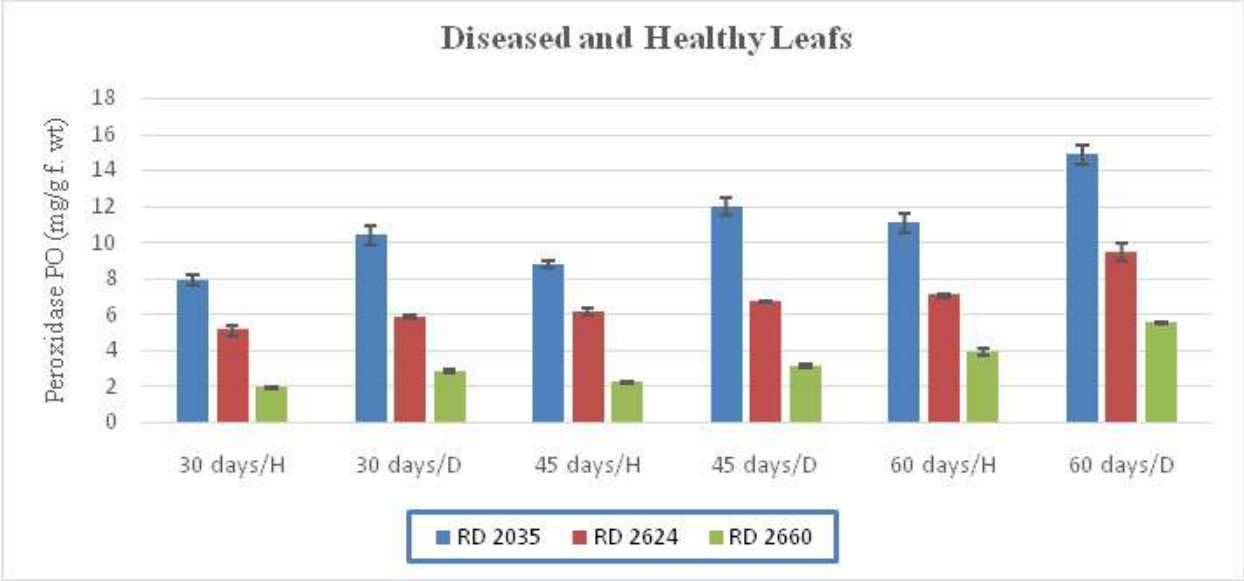

Table-2 : Change in Peroxidase (PO)enzyme in healthy and diseased leaf of different cultivars of barley at different days. *H-Healthy, **D-Diseased,Values are means of 5 replicates, bars indicate significant differences between genotypes for each treatment at P = 0.05.

healthy and diseased plants as the disease progressed with crop age. However, the difference in enzyme activity of disease and healthy plant reduced as the crop moves towards physiological maturity (Anjum, *et al*., 2012). Joshi (2004), Plazek *et al.,* (2009) and Meena *et al.,* (2015) reportedthe activity of peroxidase increased with the increase in disease intensity in defence mechanism against *Alternaria* blight in cluster bean and in barley leaves due to *Bipolaris Sorokiniana* and *Drechslera graminea*. Kuc and Preisig, (1984) reported that the peroxidase activity in resistance response has been related to lignifications, which has an important role in the reduction and blockage of nutrient diffusion from neighbouring host cells. The IAA-oxidase activity was significantly maximum recorded in diseased leaves of RD-2660 followed by RD-2624 and RD 2660 at 60 days after sowing (Figure-3).These finding are supported by some of the earlier studies, which showed that specific activities of Peroxidase and IAA oxidase increased as the severity of infection due to *Drechslera graminea* and it was highest in heavily infected among categories of naturally infected seeds as well as in healthy, naturally infected and artificially inoculated seedlings of barley, throughout from 10 to 30 days (Trivedi and Singh, 2014). Singh, *et al*., (2011) found the higher activity of IAA-oxidase in infected leaves and inflorescence as compared to healthy leaves

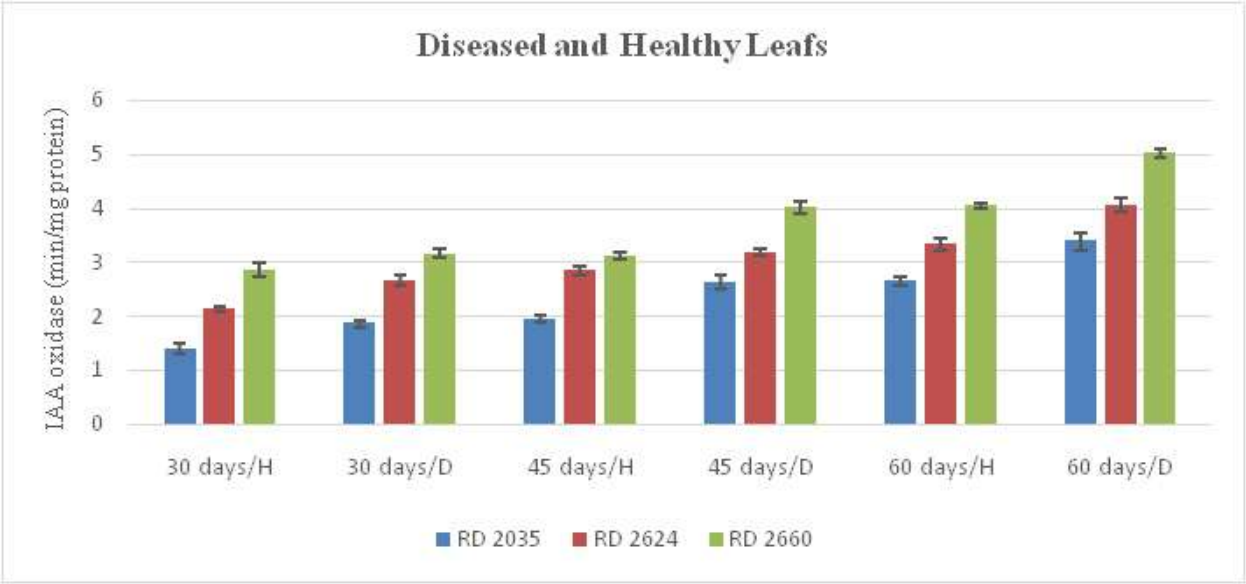

Table-3 : Change in IAA oxidaseenzyme in healthy and diseased leaf of different cultivars of barley at different days.

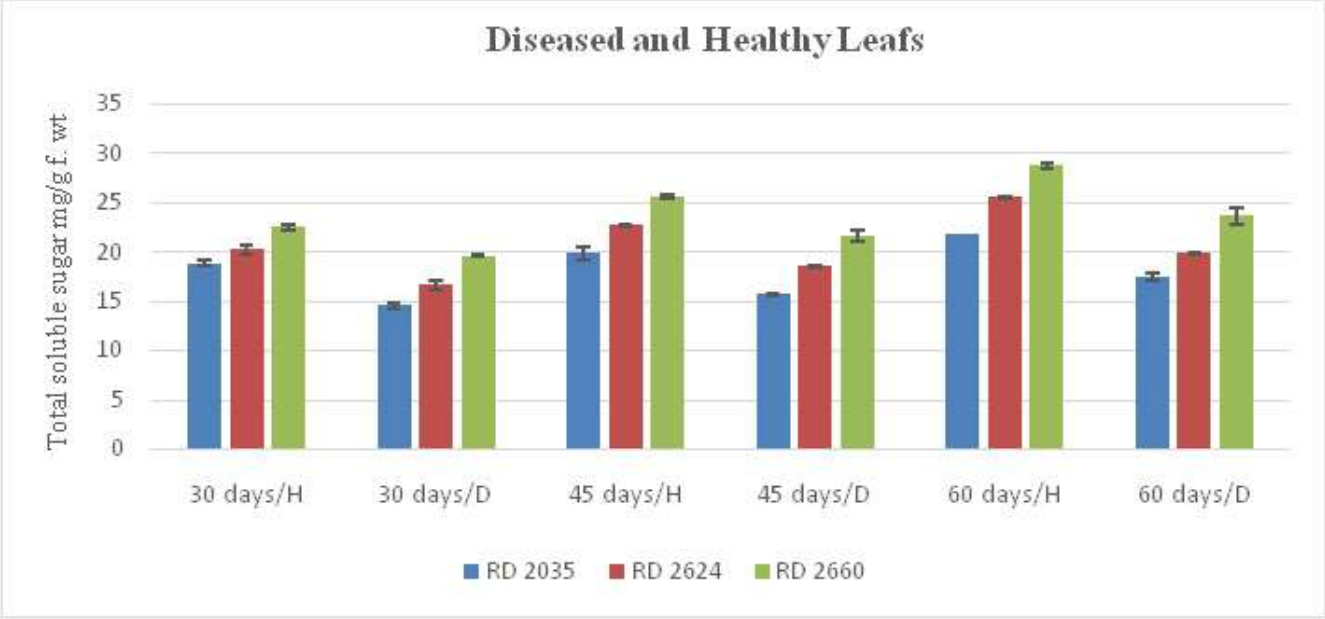

Table-4 : Change in total soluble sugar in healthy and diseased leaf of different cultivars of barley.
*H-Healthy, **D-Diseased,Values are means of 5 replicates, bars indicate significant differences between genotypes for each treatment at P = 0.05.

and inflorescence of *Brassica napus*.During initial stage of infection the activity of IAA-oxidase was less in diseased and healthy tissues of *Brassica napus*. Similarly, the activity of IAA-oxidase was observed lower in leaves of all cultivars at 30 days after sowing (Figure 3).The total soluble sugar was significantly decreasedin diseased leaf of cultivar RD-2035 comparison to diseased leaf of of cultivar RD-2660 while maximum total sugar content was recorded in healthy leaf tissues of all cultivar (RD-2660, RD-2624 and RD-2035) at 60 days after sowing, respectively (Fig.-4). Meena, *et al.,* (2015) also observed a reduction in the contents of total sugars and non-reducing sugars in diseased leaves of all five barley varieties irrespective of susceptibility towards *D. graminea*. The total sugar content reduced in diseased tissues indicate that the total sugar content utilized by host plant due to the increased respiration during infection. The host tissues required more energy during high rate of respiration and the energy produced by the reduction of total sugar (Khare *et al*., 2011).

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Effect of Foliar Spray of Bio Regulator, Bio-Formulations and Nutrients on Vigor and Survival of Mango Grafts

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Abstract

An experiment was conducted at at naturally ventilated Polyhouse College of Horticulture, Mudigere during 2016-17 to know the effect of foliar spray of bio regulator, bio-formulations and nutrients on vigor and survival of mango grafts. All the treatments promoted highest graft parameters when compared with control. There was highly significant effect of foliar sprya on mango grafts. The Panchagavya-3 per cent and GA_3 at 500 ppm concentration was registered significantly highest graft success, survivable and graft percentage (100 per cent). During 30 to 120 DAG, the highest graft height was recorded in urea 1 per cent, panchaguaya-3 per cent and GA_3 at 500 ppm. On the 30th day after grafting, significantly higher graft index was recorded in the graft, sprayed with GA_3 at 500 ppm (3490.39 cm), while significantly lowest graft index was recorded in control (1506.36 cm). Similar trend was followed even at 30, 60, 90 and 120 DAG also.

Key words : *Panchagavya, GA_3, amrit pani, graft success, graft survivability.*

Introduction

Mango is most popular among the tropical fruits of the world and is rightly described as 'king of fruits' owing to its delicious taste, captivating flavour and attractive aroma. Now days, mango is commercially propagated by softwood grafting with varied degree of success. The use of ancient bioformulations such as Panchagavya, Amrit pani, Pandrapur slurry cow urine and vermiwash probably work on the principles of introduction of number of saprophytes, growth promoting and bio-control microorganisms along with their metabolites rich in growth regulators, hormones, vitamins, enzymes, *etc.*, that might aid in the nutrient release and transport of nutrients to the plant organics and chemicals spraying, which has highly beneficial effects on grafts. Application of foliar spray of different chemicals and organics is known to improve the graft survival percentage and minimize the mortality rate. And also increase the growth of the grafts and encourage early vigor of the grafts. This necessitates raising the seedlings/ rootstocks organically and inorganically (from the nursery itself) to ensure higher graft-take, better growth, particularly more stem girth development which is required for early grafting which would be able to meet ever increasing demand for elite planting materials. The growth regulators play important role in the success of graft union (Maiti and Biswas 1980) reported that optimal concentration of IAA and GA_3 sprayed on above graft union improved the graft-take and increased the callus formation with old rootstock. The differences for graft union success may be due to variations in their genetic makeup influencing histological and physiological changes for the scion shoots (Maiti and Biswas, 1980). Spraying with optimal concentration of urea and vermiwash improved the vegetative parameters of grafts. In the present study, an attempt was made using Panchagavya and Amrit pani along with cow urine to find out and compare their effects on mango grafts. In the light of these few scanty references an experiment was taken up in the present investigation to study and enhance the graft parameters by sprayed with different foliar treatments like organics and chemicals.

Materials and Methods

The study was carried out in fruit science experimental field, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga during 2016-2017 in Karnataka. The experiment was laid out in a Complete Randomized Block Design (CRD) with 13 treatments were replicated thrice. The treatments are Urea-1per cent, Urea-2 per cent, cow urine-3 per cent, Cow urine-5 per cent, Panchagavya-3 per cent, Panhagavya-5 per cent, Amritpani-3 per cent, Amritpani-5 per cent, GA_3 at. 500-ppm, GA_3-1000-ppm, Vermiwash 1:1, Vermiwash 1:2 Control (no spraying). Propagation source: One season old shoots of pencil thickness, free from pest and disease were selected for the preparation of scions. Defoliation operation was done, ten days prior to grafting and these scions were separated on the day of grafting. These scions were dipped in 0.1 per cent bavistin solution at the time of grafting to prevent fungal disease. New sprouts (side shoots) arising from the rootstocks were removed regularly. Research duration was one year. The foliar spray was done on one-month-old graft

Table-1: Effect of foliar spray of bio-regulator and bio-formulation on graft success, graft survivability sprout height and graft diameter of mango *cv.* Mallika.

Treatments	Graft success (%) after three months	Survivability (%) after six months	Sprout height (cm)				Graft diameter (mm)			
			30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG
T_1 – Urea (1%)	93.15	92.76	3.38	5.19	6.93	8.23	8.95	9.26	9.38	9.93
T_2 – Urea (2%)	9611	94.05	3.03	5.00	5.99	7.51	8.93	8.94	9.20	9.67
T_3 – Cow urine (3%)	90.31	92.26	2.34	4.48	4.60	6.43	8.62	8.72	8.78	9.08
T_4 – Cow urine (5%)	86.14	96.07	2.32	4.15	5.29	6.85	8.29	8.79	9.08	9.01
T_5 – Panchagavya (3%)	91.97	94.58	3.20	5.19	6.71	7.93	9.06	9.16	9.27	9.90
T_6 – Panchagavya (5%)	100.00	100.00	2.99	4.74	5.08	7.16	9.05	9.17	9.24	9.93
IT_7 – Amrit pani (3%)	96.80	93.06	2.78	4.59	5.33	6.70	8.81	8.96	9.09	9.61
T_8 – Amrit pani (5%)	80.48	75.23	2.37	4.18	6.22	7.31	8.69	8.78	9.10	9.63
T_9 – GA_3 at 500 ppm	100.00	100.00	3.20	5.19	6.38	7.38	8.94	9.18	9.39	9.82
T_{10} – GA_3 at 1000 ppm	96.85	96.37	3.08	5.10	6.15	7.09	8.94	9.01	9.31	9.73
T_{11} – Vermiwash 1:1 ratio	86.28	95.86	2.53	4.30	5.19	6.19	8.45	8.64	9.13	9.08
T_{12} – Vermiwash 1:2 ratio	80.46	93.04	2.70	3.26	4.92	6.74	8.12	8.73	9.03	9.13
T_{13} – Control	63.38	83.74	2.22	2.96	4.06	5.41	7.65	8.04	8.35	8.76
S.Em±	0.72	0.30	0.17	0.24	0.37	0.15	0.24	0.17	0.12	0.20
C.D. at 5%	2.10	0.87	0.50	0.71	1.07	0.44	0.71	0.50	0.34	0.58

and sprays were given up at an interval of 15 days intervals. The observations were recorded three months after grafting (MAG) for graft success, six (MAG) for graft survival and monthly interval for sprout height, number of sprouts, graft diameter and number of leaves. Per cent success of grafting is observed in those grafts in which the scion had sprouted and remained alive without shrivelling at the time of observations (after three months of grafting) were noted and percentage of graft success was worked out. The graft survivable was computed using the formulas as bellow.

$$\text{Survival (\%)} = \frac{\text{Number of grafts remained alive at the end of the experiment}}{\text{Number of successful grafts}} \quad 100$$

Results and Discussion

All the treatments significantly gave good results over control. Among these spraying with Panchaguaya-5 per cent and GA_3 at 500 ppm concentration was registered significantly highest graft success of 100 per cent after three months followed by GA_3 at 1000 ppm, (96.85 %), Amrit pani-3 per cent (96.80 %) urea-1 per cent (96.11 %), urea-2 per cent (93.15 %), Panchaguaya-3 percent (91.97 %), cow urine-3 per cent (90.31 %), vemiwash 1:1 ratio (86.28 %), cow urine-5 percent (86.14 %) and vemiwash 1:2 ratio (80.46%), However these organics were statistically on par with each other. Significantly lowest graft success was recorded in control with (63.38 per cent).

Panchaguaya-5 per cent and GA_3 at 500 ppm registered significantly with highest per cent graft survival i.e.100 per cent, followed by with GA_3 at 1000 ppm, (96.37 %), cow urine-5 per cent (96.07 %), vemiwash 1:1 ratio urea-2 per cent (94.05 %), Amrit pani-3 per cent 93.06 per cent, vemiwash 1:2 ratio (93.04 %), urea-1 percent (92.76 %), cow urine-3 percent (92.26 %) and control (83.74 per cent) success, these organic solvents were statistically on par with each other. Significantly lowest graft success was recorded in Amrit pani-5 per cent (75.23 %). The survival percentage with vermiwash 1:1 ratio found maximum (94.03%) next to Panchagavya and GA_3.

Among the treatments urea 1 per cent recorded maximum sprout height (3.38 to 8.23 cm) at 30 to 120 DAG, followed by Panchagavya 3 per cent and GA_3 500 ppm. The minimum sprout height was recoded in control (2.22 to5.49 cm) at 30 to 120 DAG. The graft height relatively attributed to sprout height. Panchagavya 3 percent (9.06 mm) produced maximum graft diameter followed by panchagavya 5 percent (9.05 mm) and urea 1 per cent (8.95 mm). While minimum graft diameter was found in control (7.65 mm) .

The maximum number of sprouts was observed in GA_3 500 ppm was (2.95, 3.18, 3.34 and 3.51 sprouts at 30, 60, 90 and 120 DAG) followed by Amrita pani 5 percent and urea 1 per cent, while minimum sprouts were recorded in control (1.19,1.66,1.75 and 1.85 respectively). Number of leaves per scion was observed significant at all the stages. The treatment Amrit pani 5 % produced maximum number of leaves at all the stages of graft growth, with range of (14.33 to 21.96), followed by GA_3 500 ppm and urea 1 % noticed while, minimum number of

Table-2 : Effect of foliar spray of bio-formulations and bio-regulators on number of sprouts and leaves on grafts of mango *cv.* Mallika.

Treatments	Number of sprouts				Number of leaves			
	30DAG	60DAG	90DAG	120DAG	30DAG	60DAG	90DAG	120DAG
T_1 – Urea (1%)	2.30	2.63	3.02	3.09	13.45	13.45	13.45	13.45
T_2 – Urea (2%)	2.18	2.39	2.68	2.70	12.82	12.82	12.82	12.82
T_3 – Cow urine (3%)	2.33	2.15	2.56	2.51	11.79	11.79	11.79	11.79
T_4 – Cow urine (5%)	1.52	1.80	2.18	2.54	11.85	11.85	11.85	11.85
T_5 – Panchagavya (3%)	2.29	2.75	2.57	2.86	11.56	11.56	11.56	11.56
T_6 – Panchagavya (5%)	1.78	2.35	2.75	2.61	11.05	11.05	11.05	11.05
T_7 – Amrit pani (3%)	2.34	2.84	2.77	2.93	13.55	13.55	13.55	13.55
T_8 – Amrit pani (5%)	2.78	3.01	3.18	3.31	14.33	14.33	14.33	14.33
T_9 – GA_3 at 500 ppm	2.95	3.18	3.49	3.51	12.36	12.36	12.36	12.36
T_{10} – GA_3 at 1000 ppm	2.14	2.44	2.57	2.74	13.93	13.93	13.93	13.93
T_{11} – Vermiwash 1:1 ratio	2.10	2.23	2.40	2.03	9.39	9.39	9.39	9.39
T_{12} – Vermiwash 1:2 ratio	1.19	1.75	1.66	1.85	10.31	10.31	10.31	10.31
T_{13} – Control	1.03	1.52	1.64	1.67	8.26	8.26	8.26	8.26
S.Em±	0.22	0.19	0.23	0.21	1.03	1.03	1.03	1.03
C.D. at 5%	0.63	0.55	0.67	0.61	3.00	3.00	3.00	3.00

DAG = Days after grafting

leaves were produced in control with range (8.26 to 9.62 respectively).

Out of thirteen foliar treatments, there existed varied response on graft success and graft-take. It can be cleared that more efficient absorption of various nutrient elements and production of growth hormones and uptake of nutrients lead to higher graft and survival percentage. The graft parameters i.e., sprout height, graft diameter, number of sprouts and numbers of leaves were significantly highest with the foliar spraying at fifteen days interval. The organics and chemicals effects leads to production of secondary metabolites of graft buds which leads to maximum graft parameters were observed. The most effective foliar treatments are Panchagavya 3 per cent, GA_3 500 ppm and urea 1 and 2 per cent.

This effect may due to vermiwash, which contains phosphates, sulphates and chlorides of potassium, sodium and magnesium. Sulphur and iron are other organic acids and ammonia/urea is also found in small quantities. All these salts being in soluble form, they can diffuse into the plants system through the stomata openings. Vermiwash at lower concentration (1:1) was most effective in inducing the vegetative growth and graft parameters. (Similarly growth effects were observed in Anthurium by (Karuna *et al. 19*99). Urea sprayed with at both concentrations had a higher graft survival percentage but initial stage scorching effect was observed. This experiment indicates urea 1 % is optimum for spraying on grafts. (Singh 1975) observed similar results, (Rajput*et. al.,* 1976), (Singh, 1973) in mango. Highest bud success percentage was observed in treatment foliar spray with panchagavya at 5 per cent (98.00 per cent), during 120 days after bud initiation, highest bud survival percentage and bud percentage was recorded in treatment foliar spray with panchagavya at 5 per cent concentration (99.00 and 100 per cent) was sprayed. (Santhosh 2015). This may be due to highest metabolites produced in bud union and treatment effects. Probably this effect is due to production of secondary metabolites and more number of sprouts leads to highest number of leaves. The maximum bud sprout diameter was observed in treatment foliar spray with GA_3 at 100 ppm concentration (4.30 mm), whereas lowest bud sprout diameter was recorded in with control (3.10 mm). Maximum number of bud sprouts was observed in treatment foliar spray with citrus special at 0.2 per cent concentration (1.27). And highest budling height was observed in treatment foliar spray with GA_3 at 100 ppm concentration (42.64 cm) (Santhosh, 2015).

GA_3 had a direct effect on stem elongation by inducing cell wall loosening, by increasing the solute concentration by increasing cell wall extensibility, stimulating the wall synthesis, reducing the rigidity of cell wall by increasing cell division leading to more graft growth. Panchagavya is a blend of five products, obtained from cow, also produced positive effects on living organisms in the present investigation. Panchagavya works on with cosmic energy and with a production of certain plant growth stimulants, *viz*., hormones, and enzymes with enormous increase in beneficial micro organisms (Natarajan, 2002). The work carried out on microbiological parameters of Amrit pani, vermiwash and

Panchagavya during the present investigation revealed that they contain a lot of saprophytic bacteria, actinomycetes, yeasts, nitrogen fixers, 'P' solubilisers, PGPRs (plant growth promoting rhizobacteria) or plant health promoting rhizobacteria (PHPR)) and bio control agents, leading to microbial biotechnology and their amplified effects on soil fertility and plant growth. Further, Amrit pani, which is a blend of three products acts as a good plant tonic and vermiwash, which contains exudates of body fluids of earth worms (*Eudrilus eugeniae*).

The organics and chemicals effects leads to production of secondary metabolites of graft buds which leads to maximum graft parameters were observed. The most effective foliar treatments are Panchagavya 3 per cent, GA_3 500 ppm and urea 1 and 2 per cent. It was interesting to notice that both chemicals and organics had proved to be better than the control in their effects on grafts growth and subsequent grafts survival. It has observed that congenial climatic factors like optimum temperature (23-33°C and humidity 63.8 -87%) plays vital role in present investigation. The influence of weather parameters like humidity and temperature on graft survival and grafting has been observed by Patel and Amin (1976). In their experiment they found that temperature range of 23.15 and 25.87^{0}C was the most favourable. Same results were found in present investigation also. Foliar spray of organics and chemicals wit congenial climate could be at used for grafts, they had good effect on survivable with less mortality and growth of grafts. Similar results were reported in mango (Sontosh, 2004, Bassanagowda, 2005, in mango and Devachandra, 2006 in Jamun), (Singh, N.P. and Srivastava 1982) in mango.

Conclusions

Significant results were observed for foliar spraying of organics and chemicals. The Panchagavya-3 per cent and GA_3 at 500 ppm was recorded significantly highest graft success, survivable (100 per cent), graft diameter and graft index. Urea (1%), Amritpani (5%) recorded maximum sprout height, number of sprouts and number of leaves. Foliar spray of organics and chemicals with congenial climate could be at used for grafts, they had good effect on survivable with less mortality and growth of grafts.

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Growth in Area, Production and Productivity of Rice in Agro-Climatic Zone of Chhattisgarh

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Abstract

A study was examine to the present status of rice production in different agro-climatic zone and Chhattisgarh state as a whole by analyzing the relative percentage change in area, production and productivity of rice during the period of 2002-03 to 2017-18. The study concluded that the relative change for area, production and productivity of rice was positive in the study area except Northern hills of Chhattisgarh.Overall it could be concluded that the significant growth in production of rice was due to significant growth in area and productivity attribution over the period of study across the agro-climatic zones and Chhattisgarh state as a whole.

Key words : *Chhattisgarh, growth, relative change, rice.*

Introduction

Agriculture sector plays a vital role in Indian economy and is the backbone of the country. Around 55 per cent of population is engaged in agriculture and allied activities and it contributes around 17 per cent to the country's Gross Value Added (Annual Report, 2016-17).Agriculture is the only means of employment for almost all two-thirds of rural people in India and provides food grains to all the raising population in the country. It also provides fodder to sustain livestock comprising of cattle, buffaloes, sheep and poultry etc. Agriculture sector in India is mostly dependent up on rainfall season. The seasonal conditions and monsoon play an important role in the agriculture production.

Agriculture forms the foundation and it is the prime sector of the Indian economy. The performance of the agriculture sector influences the growth of economy and it helps in the development the industrial sector since agriculture sector provides the raw material to the industrial sector. Hence the growth of industrial sector also depends on agriculture sector. According to the estimates of CSO for 2016-17, it accounts about 15.10 per cent in Gross Value Added and provides livelihood to 58.2 per cent of the total population directly or indirectly. The share of agriculture sector in the GDP of the country is declining continuously as it was 55.1 per cent in 1950-51 and 17.4 per cent in 2013-2014. Notwithstanding a steady decline of its share in the GDP, it is still the most important sector for the economy of the country because of two reasons; first, the agriculture sector provides food security to the growing population and secondly, it also provides employment to the workforce as government policies in India also focuses on self-sufficiency and self-reliance in Food grains. After the introduction of green revolution the production and productivity of food grains has increased due to the availability of High Yielding Variety seeds, new technologies and better irrigation facilities. The Food grains production in India has increased from 52 million tonnes in 1951-52 to 272 million tonnes in 2016-17; it was increased by 8 per cent as compared to that of in 2015-16 which was 251.57 million tonnes. The production of wheat, rice and pulses also increased during the same time period. The production of wheat was 93.50 million tonnes and that of rice was 104.32 million tonnes while the pulses recorded 16.47 million tonnes in 2015-16 (Agricultural Statistics at Glance, 2016). Better irrigation facilities, pre monsoon and adoption new technologies were the main factors responsible for the remarkable improvement in the production of Food grains.

The growth rate of agricultural production is generally judged by the performance of food grains and non-food grains production. Of both items of agricultural production, food grain production is more significant due to two reasons. Firstly, it provides the base for subsistence by supplying basic food items and secondly, it is the only group of agricultural produce where Green revolution was introduced firstly and more successfully. Its importance has also increased due to the inception of World Trade Organization (WTO).

In India there had been increasing trend in the production of food grains. The total production of food grains increased from 50.8 million tonnes in 1950-51 to 187.0 million tonnes in the Eighth Plan. The food grains output in the Tenth Plan was 202.9 million tonnes. However, because of drought conditions in the first year of the tenth plan 2002-03, the food grains output declined to 174.8 million tonnes but again rose to 213.2 million tonnes

in 2003-04. Food grain production touched the record level of 259.3 million tonnes in 2010-11 and incesed to 264.77 million tons in 2013-2014.The production of rice has increased from 37.61 MT in 1967-68 to 93.34 MT in 2001-02 and to 104.32 MT in 2015-16.

Materials and Methods

The present study was carried out in the state of Chhattisgarh. Chhattisgarh state consisted of three agro climatic zones *i.e.*, Chhattisgarh Plains, Northern hills, and Bastar Plateau. Thus, the all zones were selected purposively for the study. Chhattisgarh consists 28 districts and all the districts are selected for the study purpose.The data were collected for the last 15 years that is from the year 2002-03 to 2017-18 for all the districts within zone. The data used for the study was entirely secondary in nature and collected from different published source and websites in order to accomplish of the study.

Analysis of data : In order to fulfill the objectives of the study, the collected data were analyzed by using appropriate techniques and tools like absolute change and relative percentage change,linear trend and compound growth rate.

Change in growth pattern : The absolute and relative change was estimated using following formula:

Absolute change = $P_n - P_0$

Relative change (%) = $\frac{P_n - P_0}{P_0}$

Where,

P_n = Triennium Average of current year for area, production and yield

P_0 = Triennium Average of base year for area, production and yield

For estimation of trend growth rate, following equation were used : Trend analysis for area, production and productivity was estimated with the help of linear equation. The linear trend was fitted with the method of least square technique.

$$Y = a + b\ x$$

Where,

Y = Trend value of dependent variable (Area, Production and Productivity)

x = Independent Variable (Time in year)

b = Regression / Trend Coefficient

a = Intercept / Constant

Linear growth rate (LGR) =

? = Mean of dependent variable

Estimation of compound growth rate in area, production and productivity : Growth of any variable indicates its past performance. The analysis of growth was usually used in economic studies to find out the trend of particular variables over a period of time. It clearly indicated the performance of the variable under consideration and hence it can be very well used for making policy decisions. The growth in area, production and productivity under rice was using the exponential growth function of the form :

$$Y = a\ b^t$$

Where,

Y = Trend value (Area, Production and Productivity)

a = Constant

b = Trend Coefficient

t = Independent Variable (Time in year)

Compound growth rate : The compound growth rate per annum over the period for all the variables was calculated from the following formula :

C.G.R. (%) = [Antilog of b-1] x 100

Results and Discussion

Absolute and relative percentage changes and coefficient of variation of area, production and productivity of rice have been estimated during the year of 2002-03 to 2017-18, which has been presented in Table 1. It has been observed from the results that all the parameters i.e. absolute change, relative change and coefficient of variation have shown changes of in area, production and productivity of rice of Chhattisgarh state during the period of study.

It revealed from the table that relative change for the area, production and productivity of rice was observed positive in Chhattisgarh plains, Bastar plateau as well as Chhattisgarh state as a whole except Northern hills of Chhattisgarhthe area of rice was observed to have a negative change (-0.89%) while the production (33.79%) and productivity (35.04%) of rice was observed to have positive change and the maximum (38.48%) coefficient of variation for production of rice was found in the Bastar plateau and minimum in the Northern hills (24.44%) of Chhattisgarh. Thus, it could be concluded that Percentage variability over the period of study was high across agro-climatic zone of Chhattisgarh and state as a whole.

Overall it could be concluded that positive change in production and productivity of rice over the period of study it directly reflects to the impact of involvement of production and productivity of rice.

Table-1 : Absolute and relative percentage change and coefficient of variation in area, production and productivity of rice in agro-climatic zone of Chhattisgarh. (in per cent)

Particulars	Change	Rice		
		Area (in ha)	Production (in tones)	Productivity (in tones/ha)
Chhattisgarh Plains	AC	179200.67	1990523.34	0.60
	RC	6.43	61.95	52.00
	CV	2.68	27.06	24.92
Northern Hills	AC	-4991.67	185058.33	0.34
	RC	-0.89	33.79	35.04
	CV	0.89	24.44	24.55
Bastar Plateau	AC	5284.67	256445.67	0.54
	RC	1.14	85.93	83.91
	CV	2.02	38.48	37.71
Chhattisgarh	AC	179493.67	2302443.34	0.53
	RC	4.71	54.00	47.00
	CV	1.99	26.52	24.90

*AC = Absolute change, RC = Relative change, CV = Coefficient of variation.

Table-2 : Growth in area, production and productivity of rice in agro-climatic zone of Chhattisgarh. (in per cent)

Particulars	Growth Rate	Area (in ha)	Production (in tones)	Productivity (in tones/ha)
Chhattisgarh Plains	SGR	0.50	3.91	3.45
	CGR	0.50***	4.30***	3.79***
Northern Hills	SGR	-0.09	3.32	3.40
	CGR	-0.09*	3.57***	3.67***
Bastar Plateau	SGR	0.15	5.82	5.65
	CGR	0.15*	6.99***	6.83***
Chhattisgarh	SGR	0.38	3.75	3.40
	CGR	0.38***	4.13***	3.74***

SGR = Simple growth rate, CGR = Compound growth rate
***Significant at probability level 0.01, **Significant at probability level 0.05, *Significant at probability level 0.10

The simple and compound growth rates of area, production and productivity of rice by zone and the state have been estimated from 2002-03 to 2017-18, which is given in Table 2.

The result shows that the compound growth rate of rice area, production and productivity of Chhattisgarh plains, Bastar plateau as well as Chhattisgarh state was observed positively significant except Northern hills of Chhattisgarh.

The compound growth rate of rice production of Chhattisgarh state was significant and found to be 4.13 per cent growth during the period contributed for the study which was attributed by area of 0.38 per cent and productivity by 3.74 per cent growth. In case of Bastar plateau of Chhattisgarh the compound growth rate of rice production was significant and found to be 6.99 per cent growth during the period contribution for the study which was attributed by area of 0.15 per cent and productivity by 6.83 per cent growth. In Northern hills of Chhattisgarh the compound growth rate of rice production was observed significant and found to be 3.57 per cent growth during the period contribution for the study which was attributed by area is negatively significant (-0.09%) and productivity by 3.67 per cent growth. In Chhattisgarh plains the compound growth rate of rice production was observed significant and found to be 4.30 per cent growth during the period contribution for the study which was attributed by area of 0.50 per cent and productivity by 3.79 per cent growth.

Overall it could be concluded that the significant growth in production of rice was due to significant growth in area and productivity attribution over the period of study across the agro-climatic zones and Chhattisgarh state as a whole.

Suggestions

From the empirical findings of the study, it is being

suggested that to avoid the variability in area, production and productivity of rice farmers are advice to follow the weather advisory report release by the state weather observatory advisory and timely adopt the package of practices of rice cultivation as per the recommendation release by the state department.

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Non Chemical Management of Wilt Complex Disease of Chilli under Kashmir Conditions

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Abstract

Chilli crop in Kashmir is subjected to many diseases, primarily of fungal origin. Of these fungal disease, wilt a complex disease, occurs in epiphytotic form in several chilli growing areas of the valley and has forced many cultivators to abandon its cultivation. Studies were carried out to find to explore non-chemical option for the management of the disease. The pathogens associated with the disease were isolated and identified as *Fusarium pallidoroseum* (Cooke) Sacc. and *Sclerotiumrolfsii* Sacc. on the basis of their morphological and pathological characteristics. Four locally available botanicals *viz*., *Urticadioica*, *Artemesiaannua*, *Allium sativum* and *Allium cepa* were tested for their efficacy against the disease. Of the four botanicals tested at four different concentrations (2,4,6,8 and 10%) under *in vitro* conditions against the causal pathogens, *A. sativum* extract was the most effective with 100 per cent inhibition of mycelial growth at 10 per cent concentration of both the test fungi. The pot experiment was also conducted to test the efficacy of *A. sativum* extract on wilt incidence at 10 per cent concentration, applied through seedling dip and soil drench method. The extract provided 55.39, 64.52 and 70.59 per cent disease control, when plants were inoculated with *F. pallidoroseum* + *S. rolfsii*, *F. pallidoroseum* and *S. rolfsii*, respectively.

Key words : *Botanical extracts, chilli, fusarium, management, sclerotium, wilt.*

Introduction

Chilli (*Capsicum annum* L.) is an important *Solanaceous* spice crop, grown for its green and red ripe fruits which form an indispensible condiment in every household. The major chilli growing states of India are Andhra Pradesh, Karnataka, Maharashtra, Orissa, Tamil Nadu, Madhya Pradesh, West Bengal and Rajasthan. In Jammu and Kashmir, chilli is grown over an area of 560 hectares with a production of 540 metric tonnes (Anonymous, 2014).The chilli yield under Kashmir conditions is miserably low compared to other parts of India, which of the many factors is mainly attributed to wilt,a complex disease. Chilli wilt epiphytotics are regularly observed in several chilli growing areas of the valley which has forced many cultivators to abandon its cultivation. The disease is reported to be induced by a complex of soil borne pathogens (Madi *et al*., 2017) of fungal and bacterial origin in different parts of the world. Different species of *Fusarium* (Moens and Benaicha, 1990; Koleva and Vitanov, 1990; Hashmi, 1989; Thind and Jhooty, 1985; Kaur, 1993; Wani, 1994), *Phytophthoracapsici* (Fernandez, 1983; Palloix, 1986; Jia, 1992; Hartman and Hwang, 1993; Hwang and Kim, 1995; Xie *et al*., 1999), *Rhizoctoniasolani* (Alavi *et al*., 1986; Mushtaq and Hashmi, 1997; Najar, 2001), *Sclerotiumrolfsii* (Wanghiliar *et al*., 1988; Mathur and Gurjar, 2001), *Ralstonia solanacearum* (Jyothi *et al*., 1993; Chatterjee *et al*., 1997) have been ascribed to chilli wilt disease. Najar (2001) found *F. pallidroseum* and *R. solani*as cause of chilli wilt from Kashmir.

The complex and soil borne nature of disease renders most of the management practices ineffective. The most efficient and economical method to mitigate the menace of soil borne diseases is the use of resistant varieties, however, the chilli cultivars being grown under Kashmir conditions are more or less susceptible to the disease. Moreover, there are limited resistant sources available in the chilli germplasm throughout the world (Naik *et al*., 2007). Although chemical management appears to be the only option for the effective management of the disease, the impracticality of this option to eradicate soil borne inoculum and high cost involvement in soil drenching has rendered it less reliable option. Further, the fungicide carbendazim, most commonly used under Kashmir conditions for the management of chilli wilt disease has failed to provide consistent and sufficient control.Use of pesticides of plant origin have been suggested by some workers as alternative to overcome the ill effects of synthetic chemicals (Shivpuri *et al*., 1997; Ragab *et al*., 2012; Enespa and Dwivedi, 2014). Therefore, the present study was under taken to evaluate some locally available botanicals for the management of chilli wilt disease.

Materials and Methods

Isolation, identification and pathogenecity of associated pathogens : Chilli plants showing typical symptoms of wilt disease were collected and attempted for the isolation of associated pathogens by standard tissue bit technique. The cultures so obtained were purified using hyphal tip method. The pathogenecity of the isolated organisms was established on potted chilli plants (cv. Kashmiri Local) by confirming postulates of Koch using soil inoculation technique as adopted by Najar (2001). The pathogens were identified based on morphological characteristics.

***In vitro* screening of botanicals :** Efficacy of aqueous extracts of following four botanicals was assessed at 2, 4, 6, 8 and 10 per cent concentration by poisoned food technique against the pathogenic fungi found associated with chilli wilt disease.

List of botanicals tested

S. No.	Botanical name	Common name	Local name	Plant part used
1.	*Allium sativum*	Garlic	Rohan	Cloves
2.	*Allium cepa*	Onion	Ganda	Bulb
3.	*Artemisia annua*	Sweet wormwood	Tethwan	Leaves
4.	*Urticadioica*	Stinging Nettle	Soi	Leaves

The plant extracts were prepared following the method adopted by Jadeja (2003). Plant parts to be used were first washed with sterilized distilled water and then shade dried. 100 g of each plant material was crushed in 100 ml of sterilized distilled water for crude extract preparation. The extract was homogenized, filtered and centrifuged at 5000 rpm for 15 minutes. The supernatant was filtered through Whatman No. 1 filter paper. The clear extract so obtained, referred to as 100 per cent stock solution, was used for experiment. 50 ml of double the desired concentration of botanical extract prepared by adding appropriate amount of sterilized distilled water and stock solution was thoroughly mixed with equal volume of double the strength molten sterilized PDA medium contained in 100 ml Erlenmeyer flasks, under aseptic conditions to make a desired concentration of 2, 4, 6, 8 and 10 per cent.After thorough mixing, 20 ml of poisoned food, thus prepared, was poured in 90 mm diameter Petri plate. Mycelial disc of 3 mmdia, taken from 7 days old pure culture of the test fungus, with the help of sterilized cork borer, was aseptically placed in the centre of solidified poisoned PDA. One such mycelial disc on non-poisoned PDA served as check. Five replications were maintained for each concentration including check. The Petri plates were incubated at 25±1°C and observation on mean radial growth was measured in terms of diameter of mycelial growth in Petri plate at the time when fungus in the control plate attained maximum growth (90 mm). The per cent inhibition in growth due to various botanical treatments at different concentrations was computed by the following formula of Vincent (1947).

$$\text{Percent inhibition} = \frac{\text{Radial mycelial growth in check} - \text{Radial mycelial growth in treatment}}{\text{Radial mycelial growth in check}} \times 100$$

***In vivo* management of the disease :** The most effective botanical under *in-vitro* studies was tested under pot experiment for its efficacy in controlling the chilli wilt disease. The experiment was conducted during the year 2018. A randomized block designwas laid consisting of 6 treatments in all, each replicated 3 times. Seedlings raised under sterilized conditions were used for transplanting. The pathogen inoculum was multiplied on sand maize meal agar medium. The medium was prepared by auto claving 90 g dry sieved sand and 10 g maize meal with 40 ml of distilled water at 1.05 kg cm^{-2} pressure for half an hour for three consecutive days. The sterilized medium was then inoculated with respective fungi and incubated for three weeks at 25±1°C with daily shaking of flasks to get uniform growth. The inoculum thus prepared was added to the sterilized sand soil (2:1) potting mixture @ 10 per cent (w/w) by mixing it with upper layer of soil and allowed for 7 days to infest soil (Papavizas and Davey, 1962; Raj and Singh, 1973; Najar, 2001). The botanical extract treatment was applied through seedling dip and soil drench method as per the treatment details, at the time of transplanting and 15 days after transplanting, respectively. The treatment details of the experiment were as under :

T_1	=	No inoculation
T_2	=	*Fusarium pallidoroseum* inoculation
T_3	=	*Sclerotiumrolfsii* inoculation
T_4	=	*F. pallidoroseum* + *S. rolfsii* inoculation
T_5	=	T_2 + seedling dip and drenching with *Allium sativum* extract @ 10%
T_6	=	T_3 + seedling dip and drenching with *Allium sativum* extract @ 10%
T_7	=	T_4 + seedling dip and drenching with *Allium sativum* extract @ 10%

The observation on wilt incidence of each treatment was recorded up to 60 days of transplanting and per cent disease control calculated as per the following formula :

$$\text{Percent disease control} = \frac{\text{Per cent disease in check} - \text{Per cent disease in treatment}}{\text{Per cent disease in check}} \times 100$$

Table-1 : *In vitro* efficacy of various botanicals in inhibiting the radial mycelial growth of *Fusarium pellidoroseum* (cooke) sacc.

Botanical	Radial mycelial growth (mm) at concentration (%)						Per cent mycelial growth inhibition at concentration (%)					
	2	4	6	8	10	Mean	2	4	6	8	10	Mean
Urticadioica	87.80^{y}	80.00^{x}	74.40^{w}	67.00^{v}	58.80^{u}	73.60^{D}	2.44 (8.84)^{l}	11.11 (19.44)^{m}	17.33 (24.54)^{n}	25.56 (30.33)^{o}	34.67 (36.05)^{p}	18.22 (23.84)^{A}
Artemisia annua	79.60^{x}	53.60^{t}	45.40^{r}	31.80^{p}	24.80^{n}	47.04^{B}	11.56 (19.80)^{m}	40.44 (39.47)^{q}	49.56 (44.73)^{s}	64.67 (53.52)^{u}	72.44 (58.32)^{v}	45.73 (43.17)^{C}
Allium sativum	47.00^{rs}	29.60^{o}	26.60^{n}	19.60^{m}	0.00^{l}	24.56^{A}	47.78 (43.71)^{rs}	67.11 (54.99)^{u}	70.44 (57.05)^{v}	78.22 (62.18)^{w}	100.00 (89.39)^{x}	72.71 (61.46)^{D}
Allium cepa	80.20^{x}	73.60^{w}	67.60^{v}	48.20^{s}	39.80^{q}	61.88^{C}	10.89 (19.25)^{m}	18.22 (25.25)^{n}	24.89 (29.91)^{o}	46.44 (42.94)^{r}	55.78 (48.30)^{t}	31.24 (33.13)^{B}
Control	90.00^{z}	90.00^{z}	90.00^{z}	90.00^{z}	90.00^{z}	90.00^{E}	-	-	-	-	-	
Mean	73.65^{e}	59.20^{d}	53.50^{c}	41.65^{b}	30.85^{a}		14.53 (22.90)^{a}	27.38 (34.79)^{b}	32.44 (39.06)^{c}	42.98 (47.24)^{d}	50.13 (58.01)^{e}	
CD (P=0.05)	Botanical		(0.81)						(0.72)			
Concentration			(0.81)						(0.80)			
Botanical × Concentration			(1.80)						(1.60)			

Table-2 : In vitro efficacy of various botanicals in inhibiting the radial mycelial growth of *Sclerotiumrolfsii* sacc.

Botanical	Radial mycelial growth (mm) at concentration (%)						Per cent mycelial growth inhibition at concentration (%)					
	2	4	6	8	10	Mean	2	4	6	8	10	Mean
Urticadioica	90.00^{y}	87.20^{x}	85.00^{uvw}	85.00^{uvw}	83.60^{tu}	86.16^{D}	0.00 (0.00)^{l}	3.11 (8.76)^{m}	5.56 (13.54)^{op}	5.56 (13.54)^{op}	7.11 (15.40)^{qr}	4.27 (10.26)^{A}
Artemisia annua	86.80^{wx}	80.00^{s}	76.20^{q}	72.60^{p}	70.60^{o}	77.24^{B}	3.56 (10.57)^{n}	11.11 (19.39)^{s}	15.33 (23.01)^{t}	19.33 (26.06)^{u}	21.56 (27.64)^{u}	14.18 (21.33)^{C}
Allium sativum	76.40^{r}	62.40^{n}	52.80^{m}	42.80^{l}	0.00^{k}	46.88^{A}	15.11 (22.84)^{t}	30.67 (33.61)^{v}	41.33 (39.99)^{w}	52.44 (46.38)^{x}	100.00 (89.39)^{y}	47.91 (46.44)^{D}
Allium cepa	90.00^{y}	85.60^{vw} x	84.40^{tuv}	82.80^{t}	76.20^{q}	83.80^{C}	0.00 (0.00)^{l}	4.89 (12.65)^{o}	6.22 (14.32)^{pq}	8.00 (16.28)^{r}	15.33 (23.01)^{t}	6.89 (13.25)^{B}
Control	90.00^{y}	90.00^{y}	90.00^{y}	90.00^{y}	90.00^{y}	90.00^{E}	-	-	-	-	-	-
Mean	85.80^{e}	78.80^{d}	74.60^{c}	70.80^{b}	57.60^{a}	-	4.67 (8.37)^{a}	12.44 (18.60)^{b}	17.11 (22.71)^{c}	21.33 (25.56)^{d}	36.00 (38.86)^{e}	
CD (P=0.05)	Botanical		(0.82)						(0.73)			
Concentration			(0.92)						(0.82)			
Botanical × Concentration			(1.80)						(1.64)			

Mean of five replications; Figures in parenthesis are arc sine transformed values
Means followed by same letter (s) are statistically identical.

Results and Discusion

Isolation, identificationand pathogenicity : The isolations made from the diseased chill samples collected from diverse areas, yielded two pathogenic fungi and on the basis of morpho-cultural characters, the isolated fungi were identified as *Fusarium pallidoroseum* (Cooke) Sacc. and *Sclerotiumrolfsii* Sacc.

***In vitro* evaluation of botanicals against *Fusarium pallidoroseum* :** The results on effect of aqueous plant extracts tested at 2, 4, 6, 8 and 10 per cent concentration on the mycelial growth of *F. pallidoroseum* (Table-1) revealed that on an average, maximum inhibition in mycelial growth of the test pathogen was exhibited by *Allium sativum* (72.71%) followed by *Artemisia annua* (45.73%), *A. cepa* (31.24%). The least inhibition of 18.22 per cent in mycelial growth of the test pathogen was exhibited by *Urticadioica.* The inhibitory effect of extract concentrations increased with the increase in concentration. On an average basis, the per cent inhibition in mycelial growth was least (14.53%) at 2 per cent concentration, which increased to 27.38, 32.44, 42.98 and 50.13 per cent at 4, 6, 8 and 10 per cent concentrations,

Table-3 : Effect of seedling dip and drenching with fungicide on chilli wilt incidence.

Details of treatment	Wilt Incidence (%)	Per cent disease control	
T_1	No inoculation	0.00 (0.57)[a]	-
T_2	Inoculation with *Fusariumpellidoroseum*	82.67 (65.86)[f]	-
T_3	Inoculation with *Sclerotiumrolfsii*	68.00 (55.55)[e]	-
T_4	Inoculation with *Fusariumpallidoroseum + Sclerotiumrolfsii*	86.67 (68.88)[f]	-
T_5	T_2 + Seedling dip and drenching with *Allium sativum* extract @ 10%	29.33 (32.77)[c]	64.52
T_6	T_3 + Seedling dip and drenching with *Allium sativum* extract @ 10%	20.00 (26.48)[b]	70.59
T_7	T_4 + Seedling dip and drenching with *Allium sativum* extract @ 10%	38.67 (38.43)[d]	55.39
CD (P=0.05)		4.60	

Figures in parenthesis are arc sine transformed values
Means followed by same letter (s) are statistically identical.

respectively. A significant interaction existed between treatments and their concentrations. At 2 per cent concentration *A. sativum* exhibited maximum (47.78%) inhibition in mycelial growth followed by *A. annua* (11.56%) and *A. cepa* (10.89%). A similar, trend in inhibition of mycelial growth was exhibited by all the treatments, when tested at 4, 6, 8 and 10 per cent concentrations.

***In vitro* evaluation of botanicals against *Sclerotiumrolfsii* :** The data on efficacy of various tested botanicals in inhibiting the mycelial growth of test fungus (Table-2) revealed that on an overall mean basis, *A. sativum* exhibiting maximum inhibition (47.91%) and was followed by *A. annua* (14.18%) and *A. cepa* (6.89%). The extract of *U. dioica* exhibited the least inhibition of (4.27%) mycelial growth of the test pathogen. On an overall basis the extent of mycelial growth inhibition increased with increase in extract concentration. The per cent inhibition in mycelial growth was least (4.67%) at 2 per cent concentration, which increased to 12.44, 17.11, 21.33 and 36.00 per cent at 4, 6, 8 and 10 per cent concentrations, respectively. A significant interaction existed between treatments and their concentrations. At 2 per cent concentration, the aqueous plant extract of *A. sativum* showed maximum inhibition (15.11%) in mycelial growth followed by *A. annua* (3.56%), whereas, least inhibition (0.00%) was exhibited by *A. Cepa*and *U. dioica.* Similarly at 10 per cent concentration, *A. sativum* exhibited maximum inhibition (100.0%) in mycelial growth and similar trend was observed by all the treatments, when tested at 6, 8 and 10 per cent concentrations.

Management of the disease under pot experiment : The pot experiment was conducted to study the effect of seedling dip and soil drenching with most promising botanical extract (*Allium sativum*) found under *in vitro* studies, on chilli wilt incidence. The data presented in Table 3 revealed that all the treatments significantly reduced the wilt incidence. The maximum wilt incidence of 86.67 per cent was observed with the combined inoculation of *F. pallidoroseum* and *S. rolfsii* which was reduced 38.67 per cent (55.39% disease control) with seedling dip and soil drenching of *A. sativum* extract at 10 per cent concentration. Similarly the wilt incidence of 82.67 and 68.00 per cent observed with the inoculation of *F. pallidoroseum*and *S. Rolfsii*was reduced to 29.33 (64.52% disease control) and 20.00 per cent (70.59% disease control) with seedling dip and soil drenching of *A. sativum* extract at 10 per cent concentration, respectively.

The antifungal activities of different plant extracts against many plant pathogenic fungi have been well documented (Dubey and Dwivedi, 1991; Biswas*et al.,* 1995). The effectiveness of *A. Sativum* extract against *F. solani* has been reported previously (Shivpuri *et al*., 1997). The antifungal properties of garlic extract has been attributed to Allicin (diallyl-dithiosulfinate), which is produced by the garlic enzyme alliinase from the alliin (Ankri and Mirelman, 1999).

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Relationship Between Profile Characteristics and Role Performance of Village Agricultural Workers in Odisha

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Abstract

The present study is focused on finding relationship between the profile characteristics and extent of role performance of Village Agricultural Workers (VAWs) working in state agriculture department of Odisha. Analytical Research design was adopted to use information available for critical evaluation. Study was conducted in nine districts of Odisha which were randomly selected from three major revenue administrative divisions Cuttack, Berhampur and Sambalpurwhich was conducted between first week of December 2019 to first week of February 2020. As many as 728 VAWs in the selected nine districts constituted the sampling frame and after discussion with experts and studying various limitations of researcher, 40 percent of VAWs from sampling frame are chosen for the study. Final sample size comprised of 292 VAW respondents. The method of proportional allocation in stratified sampling procedure was adopted for the selection of respondents. Based on different performance studies, a total of 13 profile characteristics were taken to analyze relationship with role performance of VAWs. The results indicated that the level of role performance of the VAWs had positive and significant correlation with preferably organizational Commitment, leadership ability, communication Competence, frequency of visits, self-confidence, VAW's education, organizational climate, orientation towards extension profession, training exposure and service experience. The value of coefficient of multiple determination (R^2) being 0.24 indicated that the positively correlated significant variables jointly could predict 24 per cent of the variation in level of role performance of VAWs.The analysis of these relationship of profile characteristics with role performance would be crucial in finding the attributes which preferably helps in enhancing role performance and would help in designing target specific management interventionslike training modules for enhancing those significant characteristics.

Keywords : *Village agriculture workers, role performance, profile characteristics.*

Introduction

Agriculture has always been the most crucial sector for ensuring food and nutritional security in India with biggest share in GDP of India. It continues to provide living to more than half of total work force and plays an important role in socio-economic fabric of India. Rapid increase in population of country creates enormous pressure upon farming sector in which mostly rural population is engaged. Through experiences of many extension interventions as well as earlierrural development initiatives Itwas realized that greater participation of development beneficiaries in decision makingof an initiative leads to better results. Still Agriculture sector in India has been facing several challenges like average size of land holdings, poor socio-economic condition of farmers, inadequate use of technology, slower adoption, lesser area of irrigation, disastrous consequences of hazards like flood cyclones, inadequate infrastructure and top-down policies leading to slow agricultural growth [1]. One of the other main reason for low agricultural productivity in India has been lack of integration among researchers, agriculture supervisors and adoption of innovations on the part of the client system. In order to achieve a high level of production, it is only not enough to develop farm innovations, but also it is necessary to transfer the farm technology from research system to ultimate farmer users. It was realized that effective and efficient agricultural extension service is an important prerequisite for enhancing adoption of agricultural innovations and practices among the farmers.

Agricultural Extension has undergone various transformations and modification in its approach and application. Today, the traditional agricultural extension approach, i.e., top-down, supply and technology-driven approach almost ceased to be an appropriate model. Participatory approach allowing farmers and agribusinesses are playing a significant role in planning and implementing extension services. Public Extension services in India has been burdened with non-extension duties, lack of qualified public extension professionals, extension professional's unwillingness to work in remote areas, greater focus on State priorities, public agricultural extension delivery is neglected. Further, there are certain challenges to the public extension system like insufficient number of extension personnel, lack of practical training of personnel, ineffective linkages among extension organizations and agricultural research institutions, lack of adequate transport facilities and certain other organizational problems like diverse duties of agricultural extension worker, unskilled extension worker [2].

Role performance of the employees at the grass root

Table-1 : Various characteristics of Village Agricultural Workers of Odisha.

S. No.	Characteristics	Frequency	Percentage	Mean	Standard Deviation
I	**Personal characteristics**				
1	**Age**				
	Old Aged (41 & above) Middle Aged (31-40) Young aged (30 & less)	42 215 35	14.38 73.63 11.99	35.57	5.02
2	**Education**				
	Graduation & above Intermediate Middle school	71 213 8	24.32 72.94 2.74	NA	NA
II	**Professional characteristics**				
1	**Service experience**				
	Long (15 years and above) Medium (6-14 years) Small (Up to5 years)	29 233 30	9.93 79.80 10.27	10.02	4.37
2	**Training exposure**				
	High (28 or more) Medium (13-27) Low (12 or less)	37 217 38	12.67 74.32 13	19.61	7.56
3	**Area under jurisdiction**				
	Large (37 or more villages) Medium (9-36 villages) Small (8 or less villages)	45 167 80	15.41 57.19 27.40	22.60	13.62
4	**Organizational Climate**				
	Favourable (34 or more) Neutral (26-33) Unfavourable (25 or less)	46 217 29	15.75 74.32 9.93	29.27	3.86
5	**Orientation towards extension profession**				
	Very High (33-40) High (25-32) Low (17-24) Very low (8-16)	37 228 27 0	12.67 78.08 9.25	NA	NA
6	**Frequency of visits**				
	High (5-7 visits/week) Medium(3-4 visits/week) Low (Up to 2 visits/week)	12 256 24	4.11 87.67 8.22	3.40	0.70
7	**Organizational Commitment**				
	High (30 0r more) Medium (24-29) Low (23 & less)	60 188 44	20.55 64.38 15.07	26.54	3.09
III	**Psychological characteristics**				
1	**Self Confidence**				
	High (34 or more) Medium (27-33) Low (26 & less)	50 195 47	17.12 66.78 16.10	29.97	3.59
2	**Leadership ability**				
	High (9) Medium (6-8) Low (Up to 5)	33 231 28	11.30 79.11 9.59	6.89	1.16
3	**Job satisfaction**				
	High (More than 136) Medium (106-136) Low (Up to 105)	51 188 53	17.47 64.38 18.15	120.6	15.53
IV	**Communication characteristics**				
1	**Communication competence**				
	High (18 & more) Medium (14-17) Low (Upto 13)	68 188 36	23.29 64.38 12.33	15.75	2.18
Dependent Variable					
I	**Role Performance of VAWs**				
1 2 3	High (50-74) Medium (39-49) Low (38 or less)	42 206 44	14.48 70.55 15.07	43.79	5.66

Table-2 : Relationship between profile characteristics and role performance of VAWs.

Profile characteristics of VAWs of Odisha	Correlation coefficient(r)
(1) Age	0.09NS
(2) Education	0.16**
(3) Service experience	0.11*
(4) Training exposure	0.11*
(5) Area under jurisdiction	0.03NS
(6) Organizational Climate	0.15**
(7) Orientation towards Extension profession	0.14*
(8) Frequency of Visits	0.20**
(9) Organizational Commitment	0.42**
(10) Self Confidence	0.18**
(11) Leadership ability	0.23**
(12) Job satisfaction	0.05NS
(13) Communication Competence	0.23**

*Significant at 0.05 level **Significant at 0.01 level
NS Non-significant

levels is an important criterion for evaluating the effectiveness of an organization and to know their level of performance and delineate the factors responsible for it. Employee's performance refers to an act of fulfilment of the requirement of a given job i.e., the manner in which an employee carries out his/her job efficiently [3]. Enhancing role performance of Grassrootextension workers was necessary as it gives clarification regarding different circumstances in field situation, increased trust of farmers upon themselves, increased motivation of farmers, knowledge regarding group behaviour dynamics and increased empathetic attitude. It is necessary to ascertain which factors are responsible for enhanced or poor role performance among extension workers. Relationship of those factors help state agencies to plan necessary extension intervention, capacity building programmes and training programs for enhanced role performance.Odisha one of the east coast states in India is endowed with diversified climate, terrain, different soil types with favourable conditions for many crops. Still Odisha state has number of challenges like variable climatic conditions as well as frequent natural calamities like drought and cyclones added with poor irrigation facilities, large number of populist schemes, low productivity in crops, lowest farmer's income etc. which certainly making it the second poorest state in India with large number of below poverty line (BPL) people. In Odisha, Village Agricultural Workers (VAWs) is the lowermost unit of the state department organizational structure which directly communicates with farmers in rural setting. Role performance is determined by analysing four broad roles which were technical role, input Supply & quality control, extension &training role and managerial roles. [4] Therefore, study of relationship of profile characteristics with role performance of the Village agricultural workers in the grass root levels is selected as an important criterion for evaluating the effectiveness of state department towards farming community. With changing scenario, timely assessment of role performance of VAWs becomes an essential task, so that needs and gaps can be identified and necessary improvements can be carried out. Thus, in the present study, analysis of the relationship of profile characteristics along with role performance of Village Agricultural Worker of Odisha state agricultural department is chosen in order to gain first-hand knowledge regarding individual performance as well as factors which might be influencing the role performance.

Materials and Methods

Analytical research design was adopted to use facts or information already available to make a critical evaluation.The use of analytical methods was made to ascertain the determinants of role performance by specifying relationship among variables. The Village Agricultural Workers working under state agriculture department of Odisha of the selected locale of the studyconstituted the sampling frame. There were as many as 728 VAWs in the selected nine districts of Odisha which served as the sampling frame for the study. To ensure manageable and reasonable sample, 40 per cent of the VAWs from the sampling frame were chosen for the study. This meant the final sample size comprised of 292 (40% of 728) VAW respondents. The method of probability proportional to size sampling was adopted in selection of respondents.VAWs from each selected district were selected randomly following proportional allocation. Thus, Table clearly indicates that from Cuttack division, a total of 90 VAWs; from Sambalpur division, 97 VAWs and from Berhampur division, 105 VAW respondents were selected for the study based on proportional allocation method; giving a total sample size of 292 respondents. The focus of the study was to study the relationship of profile characteristics of VAWs which are responsible for their level of role performance. Thus, the profile characteristics variables of the VAWs for the present study were selected on the basis of extensive review of literature related to the extension workers, role performance and job performance after thorough consultation with experts. The personal, professional, psychological and communication characteristics of the VAWs were taken for the study. These included VAW's age, education, service experience, area under jurisdiction, training exposure, organisational climate, orientation towards extension profession, frequency of visits, organisational commitment, self-confidence, leadership ability, job satisfaction and communication competence. Appropriate statistical tools such as frequency, percentage, mean, standard deviation was used for finding profile characteristics. The findings of relationship of variables were done by using various statistical methods which were Pearson product moment coefficient of correlation and multiple regression analysis. Primary data in the study were collected directly from VAWs with the help of structured schedule through personal interview method.

Table-3 : Regression analyses of profile characteristics and Role Performance of VAWs.

Personal socio-psychological characteristics	Awareness level		
	Regression coefficient (b)	Standard error (SEb)	't' value
Age	-0.23	0.14	-1.67NS
Education	0.79	0.67	1.16NS
Service experience	0.16	0.28	0.55NS
Training exposure	0.09	0.14	0.63NS
Area under jurisdiction	0.03	0.02	1.34NS
Organizational Climate	-0.01	0.10	-0.11NS
Orientation towards Extension profession	-0.02	0.10	-0.15NS
Frequency of Visits	0.72	0.48	1.50NS
Organizational Commitment	0.65	0.11	6.05**
Self Confidence	0.11	0.10	1.12NS
Leadership ability	0.23	0.17	1.35NS
Job satisfaction	-0.01	0.02	-0.52NS
Communication Competence	0.25	0.16	1.58NS

*,** Significant at 5 and 1% levels, respectively, R^2 = 0.24.

Results and Discussion

The study (Table-1) revealed that majority of the VAWs of Odisha (70.55%) had medium level of role performance followed by 15.07 per cent VAWs who had low level of role performance. The rest 14.38 per cent had high level of role performance.The profile characteristics of VAWs indicated that majority of VAWs were middle aged (73.63%) and had formal education up to intermediate level (72.94%). Professional characteristics revealed that almost four-fifths (79.80%) have service experience of 6-14 years and had medium level (74.32%) of training exposure. Most (57.19%) of the VAWs had area of jurisdiction under 9 to 36 villages and mostly (87.67%) visiting 3 to 4 times a week. It was also found that 78.08 per cent VAWs had high orientation towards extension profession with majority (74.32%) of VAWs perceiving neutral organizational climate in agricultural offices and 64.38per cent are having medium level of organizational commitment. Psychological characteristics revealed that 66.78 percent of VAWs have medium level of self-confidence with moderate job satisfaction (64.38%) and moderate leadership ability (79.11%). Communication characteristics of VAWs shows moderate level of Communication competence of VAWs (64.38%).

The Study revealed (Table-2) that the level of role performance of VAWs had positive and significant correlation with organizational commitment (r=0.42**), Leadership Ability (r=0.23**), Communication competence (r=0.23**), frequency of visits (r=0.20**), self-confidence (r=0.18**), Education (r=0.16**), Organizational Climate (r=0.15**), orientation towards Extension Profession (r=0.14*), training exposure (r=0.11*) and service experience (r=0.11*). It can be seen that variables like Organizational Commitment had strong relationship with the role performance of VAWs, the variables like Leadership Ability, Communication competence, frequency of visits,self-confidence, education of VAWs, organizational Climate, Orientation towards Extension profession, training exposure and service experience had moderate relationship with Role Performance. Study found no significant relationship between Age of VAWs, Area under jurisdiction of VAWs and Job satisfaction with the level of role performance.These findings of insignificant profile characteristicsare in line with [4] which found non-significant relationship with age of Agricultural assistants. Butrelationship of Job satisfaction is not in line with [4] where it is positively correlated with role performance.

Study of variable organizational commitment showed significant relationship with the level of role performance of VAWs. The reason might be the fact that majority of VAWs almost 90 per cent gave medium to high commitment (Table 1) in their work resulting in completion of works as assigned by their superior ranks. They might have understood their roles in rural setting and committed to fulfill all the duties which were assigned time to time. This result is in line with study of [5,6]. Positive relationship with leadership ability of VAWs suggests that majority of respondents over 90 percent showing medium to high leadership skills are able to perform certain level of all the roles expected from them in villages among farmers. Positive relation suggest VAWs are having better decision-making during office hours and average to high motivational skills for promoting government initiatives for farmers. The variable 'Communication competence' showed significant relationship with the level of role performance of VAWs. This might be because VAWs are having good experience of language competency and speaking skills in their area of jurisdiction. Less transfers occur in VAW posts which result in more or less staying in same place of operations for 8-10 years. This subsequently enhances communication skills of VAWs while working with village peoples. This might be the fact which helps in enhancing role performance. Study is in line with [7] in study of role performance of *Pranibandhus*in West Bengal. Self Confidence also showed significant relationship with the level of role performance of VAWs. This might be because VAWs who are ranging from medium to high confidence level could possibly be carrying out different works of agricultural offices ranging from managerial work to training role with utmost clarity. They were not expected to get depressed in tough situations in difficult circumstances which would possibly contribute to higher role performance. [8]

Professional Characteristics like frequency of visits, organizational climate and orientation towards extension profession is positively correlated with the level of role performance. 87 percent of VAWs visit farmer field as well as farm household three to four times a week. This subsequently help in enhancing extension and training role, perhaps helps in communicating important

technologies, organizing meetings and demonstrations which ultimately enhances role performance of VAWs. Subsequently selected *KrushakSathis* also visits VAWs in agricultural offices which helpsin time and energy management of VAWs for other input supply and managerial roles. Organizational Climate has been neutral (74.32%) to higher (15.75%) level in office environment in agriculture offices. This would have always helped the employee to energize and direct towards completion of tasks assigned as well as fulfilling goals. Favourable organizational climate always helps in proper decision making and independence of actions which ultimately would have helped in enhanced role performance. Organizational climate findings are in line with [9]in study of role performance of Field Extension Functionaries (FEFs) in Bangalore. Majority of VAWs had medium level of orientation towards extension orientation which would have always helped them sustain the attitude of serving the rural community for betterment in agriculture. This would always help in enhancing performance in different dimensions of VAWs roles. The study is in line with [10] of the study of agricultural assistants of MaharashtraService Experience, Training exposure and Education of VAWs are having less than moderate correlation with role performance level. Experienced VAWs are having greater role performance as they got higher working, communication, extension, training, learning skills to achieve goals. They carry out multi farious works with greater ease and have greater understanding of mistakes in work. Study is not in line with [4] where Agricultural advisors have non-significant relationship between role performance with service experience Education of VAWs had positive correlation as the educated VAWs understand the basic problems related to farmer issues, understand technical snags in crop production and better communication skills. Study is in line with [4] on study of role performance of Agricultural Assistants. Training exposure of VAWs had positive correlation as VAWs with higher training have better understanding of all the roles expected from them. Medium level of training shows a systematic, structured and suitable training programme can enhance the role performance.

Table-3 reveals that all the 13 variables are taken for multiple regression analysis. Out of 13 variables, Organizational Commitment contributes significantly to the prediction of the level of role performance. Organizational Commitment can be termed as good predictor of role performance of the pooled sample. The 13 characteristics jointly could explain (R^2=0.24) 24 percent of variation in the level of role performance pf VAWs.

Conclusion

Higher level of role performance is always likely to impact positively on VAW and organization'swellbeing. A highly significant and positive correlation of profile characteristics with the level of role performance indicated that extension personnel with higher organizational commitment, higherLeadership Ability, higher Communication competence, high frequency of visits, higher self-confidence, high education of VAWs, favorable organizational Climate, higher Orientation towards Extension profession, high training exposure and greater service experience were likely to influence the level of role performance to greater extent. Where these attributes are at lower level in the VAWs, suitable management strategies like training programme may be adopted to modify their behavioral characteristics for increased performance of their roles.

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Role of Cluster Demonstration in Enhancement of Lentil Production in Katni District of Madhya Pradesh

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Abstract

The present investigation was carried out at the adopted villages of KrishiVigyan Kendra, Katniduring 2016-17 to 2018-19 to demonstrate the improved variety JL 3 and ShekharMasoor 3 with the scientific package and practices to improve the production of pigeonpea. The treatment comprised of scientific package of practices (Improved variety + seed treatment with Trichoderma 10g/ kg of seed and seed inoculation with Rhizobium & PSB culture each @ 10 g/ kg of seed + soil test value based fertilizer application + line sowing + adoption of IPM technique) to assess the yield gap and impact of demonstration. The demonstration plot exhibited higher yield as compared to farmers plot. An average yield of lentil in the demonstrated plot was 11.27q/ha as compare to farmers practices 7.28 q/ha in the three years of pooled data. The improved technology gives the higher return with the high benefit cost ratio as farmer's practices. The observed extension gap, technology gap and technology index were 3.99 q/ha, 4.72 q/ha and 29.34%, respectively. The improved variety with scientific package of practices and technical guidance contributed to increase production of lentiland profitability of the farmers of the district.

Key words : *CFLD, BC ratio, lentil, technology gap, yield.*

Introduction

Pulses are good and chief source of protein in balance diet of poor and vegetarian population of India. Pulses are also an important component of Indian agricultural economy next to food grains and oilseeds in terms of acreage, production and economic value (Chaudhary, 2009; Mandal *et al,* 2019). India accounts for 33% of the world area and 22% of the world production of pulses among which 37% area falls in lentil and 32% of global production (FAOSTAT, 2012).Among the pulses, lentil is recognized as nutritious pulse crop and grown in different agro-ecology of India (Pariha*r et al.,* 2018). In Katni district of Madhya Pradesh, lentil grown in 10.30 thousand ha area with 11639 tonne production. The pulse production is lower than the other pulses because of unavailability of quality seed at desired time, cultivation on marginal and sub marginal lands, injudicious use of fertilizers and non adoption of crop management practices and poor marketing infrastructure (Chandra, 1994; Chaudhary, 2013 and Mandal *et al.,* 2019).

To popularize the improved production technology among the farming community, the demonstration is the best way. This encourages the farmers to assess the impact of demonstrated technology and showing the production potential of demonstrated technology in their own field. This also helps to increase the production of lentil crop and fulfill the demand of increasing population. Keeping this view, KrishiVigyan Kendra, Katni laid out the cluster front line demonstration with the financial support of NFSM- Pulses for popularizing the improved variety along with the scientific package of practices and to assess the yield gap and impact of demonstration. This also needs for providing nutritive diet and increasing the availability of pulses per capita.

Materials and Methods

The present investigation was carried out under cluster front line demonstrations using improved variety JL 3 and Shrkhar Masoor-3 with scientific package of practices by Krishi Vigyan Kendra, Katni during Rabi season in consecutive three years i.e. 2016-17, 2017-18 and 2018-19. The demonstration was conducted in farmer's field of different villages i.e. Padariya, Deori, Umariya Pan, Rahpura, Imaliya, Matwari, Lakhapateri, Bicchiya, Banda, Teori, Sugwa, Kharkhari, Sunhari and Paharua of Katni district of Madhya Pradesh in 0.4 ha area under each demonstration. The soil of the area under study was reddish brown to black soil. The average rainfall of the area was 1170mm. The farmers field were selected accordingly to the potentially and willingness of the farmers and trained properly on improved production technology of lentil. Training programme of farmers was conducted to aware and impart the knowledge about the technology. The improved production technology comprised of Improved variety JL 3 and ShekharMasoor 3 + seed treatment with Trichoderma10 g/ kg of seed and seed inoculation with Rhizobium and PSB culture each @ 10 g/ kg of seed + soil test value based fertilizer application + line sowing + adoption of IPM technique. The sowing of lentil was done in mid October to first week of November. The seed rate was 30 kg/ha. Integrated crop

Table-1 : Gap in adoption of scientific package of practices for lentil under CFLD among farmers.

S. No.	Technology	Improved practice	Farmers practice	Technology gap
1.	Variety	JL 3 ShekharMasoor 3	Local variety/unknown	Full gap
2.	Seed rate	30 kg/ha	40 kg/ha	Full gap
3.	Sowing method	Line sowing	Broadcasting	Full gap
4.	Seed treatment	Trichoderma 10 g/kg of seed and Rhizobium & PSB culture each @ 10 g/ kg of seed	Not followed	Full gap
5.	Fertilizer dose	STV based fertilizer application	Non judicious use of fertilizers	Partial gap
6.	Plant protection measures	IPM	Indiscriminate use of pesticides	Partial gap

Table-2 : Technology gap, extension gap and technology index in lentilunder CFLD.

Year	Variety	Area (ha)	No. of farmers	Average yield (q/ha)		Increase yield over farmer practices	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
				Improved technology	Farmer practices				
2016-17	JL 3	50	125	10.50	6.25	68.00	4.25	4.50	30.00
2017-18	JL 3	30	75	11.20	7.76	44.32	3.44	3.80	25.34
2018-19	Shekhar Masoor 3	30	75	12.12	7.84	54.59	4.28	5.88	32.67
Mean		36.67	91.67	11.27	7.28	55.64	3.99	4.72	29.34

management practices were applied for the proper growth of the plant as per the recommendation of scientist. The crop was harvested at perfect maturity stage and data were recorded in addition to economic analysis. The extension gap, technology gap and technology Index, Benefit cost ratio (BCR) were worked out as per Samui *et al.,* (2000), as given below :

Extension gap = Demonstration plot yield – farmers practice plot yield

Technology Gap = Potential yield- Demonstrated yield

$$\text{Technology Index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \quad 100$$

Results and Discussion

The present investigation carried out three consecutive years i.e. 2016-17, 2017-18 and 2018-19 at farmer's field under cluster front line demonstration programme. The result summarized in the table 1-3.

Gap in Adoption : In the present investigation, farming community was motivated to adopt the scientific package of practices. Full gap was observed in case of use of improved variety, seed rate, sowing method and seed treatment, while partial gap was observed in case of fertilizer dose and plant protection measures (Table-1). Farmers were using old age or unidentified varieties instead of improved high yielding varieties. The main reason of this is lack of awareness and unavailability of seed. Farming community was unaware about the seed treatment and seed inoculation. These practices increase the chance of disease incidence. They also followed the broadcast method of sowing against the line sowing and this leads to higher seed rate against the recommended. Farmers unaware about the soil testing and use fertilizer non judiciously and also adopt indiscriminative use of insecticide due to lack of scientific knowledge, which leads to severe reduction in yield. This emphasized of need to educate the farmers for adoption of new scientific package of practice, which include high yielding variety (JL 3 andShekharMasoor 3 + seed treatment with Trichoderma @ 10 g/ kg of seed and seed inoculation with Rhizobium and PSB culture each @ 10 g/ kg of seed + line sowing + STV based fertilizer application + need based plant protection measures. Cluster front line demonstration programme plays a major role to disseminate the scientific technology to increase the yield potential at farmer's level.

Yield Potential : The average yield of lentil 11.27 q/ha were much higher than as compared to average yield of farmers practices 7.28 q/ha during the three consecutive year. The average percentage increase in yield over the farmer practices was 55.64% was witnessed through scientific package of practice adoption. These results indicate that the CFLD have given the good impact over the farming community of Katni district as they were motivated by the improved production technology. This findings in consonance with the finding of Madal *et al*. 2019, Parihar *et al*. 2018 and Raj *et al.* 2013.

Extension Gap Analysis : The extension gap in the demonstrated yield over the farmers yield were 3.99 (Table-2). This indicate to organize various extension activity i.e. demonstration, training, meeting etc. for encourage the farming community to adopt the scientific

Table-3 : Comparison of economics of Lentil under CFLD.

Year	Cost of cultivation		Gross return		Net return		B:C ratio	
	Improved technology	Farmer practices	Improved technology	Farmer practices	Improved technology	Farmer practices	Improved technology	Farmer practices
2016-17	15,203	13,232	40,950	32,542	25,747	21,308	2.69	2.60
2017-18	17,600	14,900	47,426	32,980	29,826	18,080	2.70	2.20
2018-19	17,900	15,800	50,298	32,536	32,398	16,736	2.81	2.06
Mean	16,901	14,644	46,225	33,347	29,324	18,708	2.73	2.28

package of practice. This helps to revert the trend of wide extension gap. More and more use of latest production technology with high yielding varieties will subsequently change this alarming trend of galloping extension gap (Dhakad *et al.,* 2018). The new technology eventually leads to the farmers to discontinue the old technology (Hiremath and Nagraju, 2010).

Technology Gap Analysis : The technology gap in the demonstrated yield over the potential yield was 4.72. The technology gap may be attributed to the dissimilarity in the soil fertility status, agricultural practices and local climatic conditiona (Mukharjee 2003; Dhakad *et al.,* 2018).

Technology Index : The technology index shows the feasibility of demonstrated technology at farmer's field. The observed technology index of the study was 29.34%. The lower the value of technology index shows the more feasibility of the technology (Jeengar *et al.,* 2006). This will accelerate the adoption of demonstrated technical intervention to increase the yield performance (Dhakad *et al.,* 2018).

Economic Analysis : The cost of input and output prevailed during the demonstration was used for interpretation of cost of cultivation, gross return, net return and benefit cost ratio (Table-3). The cost of cultivation of improved technology adopt in the demonstration plot was higher than the farmers plot. But it also gave the higher net return of Rs. 29,324/ha as compared to farmers practices of Rs. 18,708/ha. This may be due to higher yield observed in the demonstrated plot due to adoption of scientific package of practice. The benefit cost ration of lentil under improved technology was 2.73 as compared to 2.28 in farmers plot. This finding was in consonance with finding of Mokidue *et al.,* 2011; Madal *et al*. 2019, Parihar *et al.* 2018 and Raj *et al*. 2013.

Conclusion

The above result state that the cluster front line demonstration of lentil including improved variety with scientific package of practices was found more productive, profitable and feasible to adopt as compared to farmer practices. It may also be leads to replace the old variety of lentil with the improved variety JL 3 and Shekhar Masoor 3. The wider dissemination of the improved technology among the farming community will be helpful in achieving self sufficiency and sustainability in pulse production.

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In-Vitro Epidemiological Studies on Bhendi Powdery Mildew Caused by Erysiphe *Cichoracearum* D.C.

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Abstract

Bhendi powdery mildew caused by *Erysiphecichoracearum* D.C. is important foliar disease affecting all the stages of the plant growth by causing premature defoliation and resulting 17.0 to 86.6 per cent yield loss in bhendi. Disease first appears on the lower leaves as minute white powdery specks and continue to produce white mycelial growth on various aerial plant parts up to the harvest. To establish relationship between environment factors and disease development present study has been conducted under *in vitro* conditions. After 24 hours of incubation, maximum conidial germination (84.64%) was observed in 1.5 per cent glucose solution, which differed significantly with remaining treatments followed by glucose (79.15%) at 2 per cent concentration. Least conidial germination was noticed in distilled water (64.28%). Maximum conidial germination of 58.12 per cent was observed at 25 ^{0}C, which varied significantly from other temperature levels tested.Poor conidial germination of 8.28 and 20.23 per cent was recorded at lower temperatures of 5^{0}C and 10 ^{0}C respectively.Maximum conidial germination 56.32 per cent was observed at 85 per cent relative humidity, which was significantly superior over other treatments.However, least conidial germination of 8.45 per cent was observed at 50 per cent relative humidity. Study on effect of elevated $CO_2$and temperature on spore germination of *E. cichoracearum* revealed that themaximum spore germination of 50.21 per cent was recorded in treatment T_2 (elevated CO_2 at 550 ± 25 ppm with 2 ^{0}C rise in temperature) followed by treatment T_1 (elevated CO_2 at 550 ± 25 ppm with normal temperature) with spore germination of 46.82 per cent and least spore germination was observed in lab condition (35.90%).

Key words : *Powdery mildew, Erysiphecichoracearum, environment factors, glucose solution, temperature, relative humidity, elevated CO_2.*

Introduction

Bhendi (*Abelmoschus esculentus* (L.) Moench) is globally important annual vegetable belongs to a family malvaceae, it is most broadly distributed vegetable all over the world. Many factors responsible for yield loss of the crop, one of them are the diseases which are the major constraints for low yield of bhendi (Sastry and Singh, 1974). A number of fungal, bacterial and viral diseases have been reported in India. Among the fungal diseases affecting bhendi crop, powdery mildew caused by *Erysiphecichoracearum* is the most important disease causing considerable yield losses. The disease initiates as white minute powdery patches first on the upper surface of leaf and lower older leaves and then spreads to younger ones. Grayish white powdery coating is visible on severely affected leaves. Leaves finally show necrosis resulting in withering, drying and defoliation. Powdery mildew affects plants at all the growth stages and may result yield losses up to 17 to 86.6 per cent (Sridhar and Sinha, 1989). The study on powdery mildew development in relation to environmental factors would also help us to quantify the correlation and the variability among the different independent variables on the dependent variable and further helps in developing suitable auto-regression model. The study on response of powdery mildew disease to changing climate variables (CO_2 and temperature) scenario would help us to predict the outbreak of disease under changing climate conditions well before so that effective control measures can be taken.

Material and Methods

Effect of different concentrations of sugar on conidial germination : Conidial suspension was prepared in sterilized water, the sucrose and glucose solution of 0.5, 1.0, 1.5 and 2.0 per cent were prepared by dissolving required quantity of sugar in 100 ml distilled water. The distilled water and tap water without sugars served as control. A clean surface sterilized three-depression cavity slides were placed with two drops of conidial suspension (4 $\times 10^3$ conidia/ml) under each concentration to get required concentration of 0.5, 1.0, 1.5 and 2.0 per cent. In each treatment, three replications were maintained. The inoculated slides were incubated at room temperature of 25±1^{0}C for 24 hours. Observations on conidial germination was taken at four hours' interval up to 24 hours. The per cent germination was worked out by observing 100 conidia in each replication. The maximum germination of conidia and time required were recorded.

Table-1 : Effect of different concentrations of sugar on per cent conidial germination of *Erysiphecichoracearum.*

Sl. No.	Sugars	Concentration (%)	Per cent conidial germination (%)					
			4 hrs	8 hrs	12 hrs	16 hrs	20 hrs	24 hrs
1.	Glucose	0.5	26.34* (30.88)**	32.11 (34.52)	51.24 (45.71)	54.47 (47.56)	60.56 (51.10)	64.49 (53.42)
2.	Glucose	1.0	23.27 (28.84)	34.11 (35.74)	53.16 (46.81)	62.32 (52.13)	68.96 (56.14)	70.24 (56.94)
3.	Glucose	1.5	30.28 (33.39)	56.34 (48.64)	71.29 (57.60)	75.68 (60.45)	83.26 (65.85)	84.64 (66.93)
4.	Glucose	2.0	33.98 (35.66)	61.91 (51.89)	73.76 (59.19)	80.45 (63.76)	77.20 (61.48)	79.15 (62.84)
5.	Sucrose	0.5	21.98 (27.96)	28.08 (32.00)	51.68 (45.96)	56.74 (48.87)	59.24 (50.32)	62.26 (52.10)
6.	Sucrose	1.0	21.43 (27.58)	27.03 (31.33)	49.56 (44.75)	57.68 (49.42)	64.31 (53.32)	66.74 (54.78)
7.	Sucrose	1.5	31.46 (34.12)	37.98 (38.04)	56.48 (48.72)	68.43 (55.81)	71.14 (57.51)	74.07 (59.39)
8.	Sucrose	2.0	33.42 (35.32)	38.46 (38.33)	60.21 (50.89)	66.98 (54.93)	69.42 (56.43)	71.20 (57.54)
9.	Distilled water	-	5.90 (14.06)	18.40 (25.40)	28.45 (32.23)	43.23 (41.11)	61.42 (51.60)	64.28 (53.29)
10.	Tap water	-	15.26 (22.99)	33.14 (35.15)	44.27 (41.70)	56.20 (48.56)	67.20 (55.06)	77.41 (61.62)
	S. Em. ±		0.21	0.17	0.17	0.17	0.18	0.18
	C.D. at 1%		0.76	0.64	0.62	0.63	0.65	0.68

*Mean of three replications, **Angular transformed value

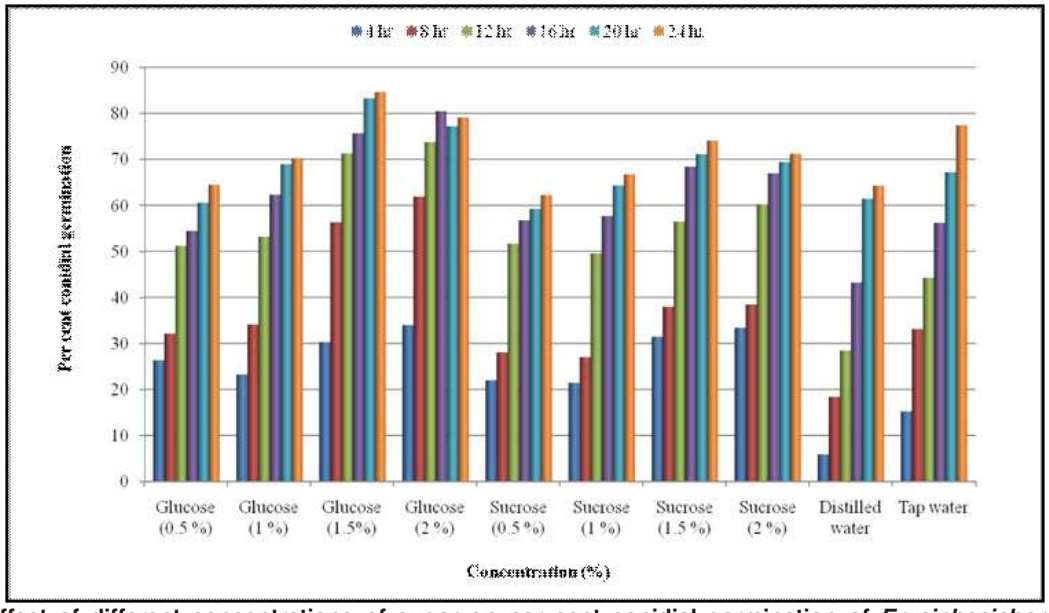

Fig.-1: Effect of different concentrations of sugar on per cent conidial germination of *Erysiphecichoracearum.*

Effect of different temperature levels on conidial germination : The temperature required for conidial germination was studied by cavity slide technique. Two drops of conidial suspension (4 $\times 10^3$ conidia/ml) was mixed with two drops of three per cent glucose solution in cavities to achieve the required concentrations of 1.5 per cent. The cavity slides were placed in moist chambers and incubated for 24 hours at different temperature levels *viz.,* 5, 10, 15, 20, 25, 30, 35, 40 and 45^{0}C in thermo statically controlled incubators. Three replications were maintained for each treatment. The per cent germination was calculated by counting the number of conidia germinated to the total number of conidia observed under microscopic field.

Effect of different relative humidity levels on conidial germination : Effect of different levels of relative humidity on conidial germination was studied by cavity slide technique. Different levels of relative humidity were

Table-2 : Effect of different temperature levels on per cent conidial germination of *Erysiphecichoracearum.*

Temperature (°C)	Conidial germination (%)
5	8.28* (16.70)**
10	20.23 (26.73)
15	31.12 (33.91)
20	43.23 (41.11)
25	58.12 (49.67)
30	50.98 (45.56)
35	28.63 (32.35)
40	12.36 (20.57)
45	9.28 (17.72)
S.Em. ±	0.32
C.D. at 1%	1.19

*Mean of three replications, **Angular transformed value.

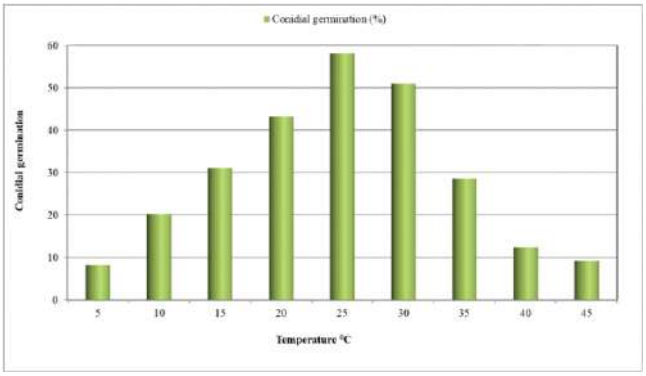

Fig.-2 : Effect of different temperature levels on per cent conidial germination of *Erysiphecichoracearum*.

maintained in desiccators containing various proportion of concentrated sulphuric acid with distilled water. The cavity slides containing conidia in 1.5 per cent glucose solution were then placed in desiccators containing solution of sulphuric acid and distilled water. The different levels of relative humidity maintained were 50, 55, 60, 65, 70, 75, 80, 85, 90, 95 and 100 per cent. The desiccators were incubated at room temperatures of 25 ± 1^{0}C for 24 hours. In each treatment, three replications were maintained. The per cent germination was calculated by the counting number of conidia germinated among the total number of conidia observed under microscopic field.

The influence of climate change variables on spore germination of *E. cichoracearum* : A lab experiment was conducted at Centre for Agroclimatic studies, University of Agriculture Science, in order to study the influence of elevated CO_2 and temperature on conidial germination of *E. cichoracearum* under *in vitro*in various plant growth chambersby applying different temperatures and CO_2 levels. Total five sets of treatments were maintained, which are as follows.

T_1 : Elevated CO_2 @ 550 ± 25 ppm with normal temperature

T_2 : Elevated CO_2 @ 550 ± 25 ppm with 2 ^{0}C rise in temperature

T_3 : Ambient CO_2 @ 410 ± 25 ppm with 2 ^{0}C rise in temperature

T_4 : Ambient CO_2 @ 410 ± 25 ppm with normal temperature

T_5 : Laboratory condition

The per cent germination was calculated by the counting number of conidia germinated among the total number of conidia observed under microscopic field after 24 hours of incubation.

Results and Discussion

Effect of different concentrations of sugar on conidial germination of *E. cichoracearum* : In order to study the effect of different concentrations of sugars on conidial germination of *E. cichoracearum* at different time intervals an experiment was conducted by cavity slide technique as explained in “Material and Methods” and the results of the study presented in the Table-1.

The maximum conidial germination (33.98%) was recorded in 2.0 per cent glucose solution followed by 2.0 per cent sucrose solution (33.42 %) which remained on par with each other, it was followed by 1.5 per cent sucrose and glucose solutions which recorded conidial germination of 31.46 per cent and 30.28 per cent respectively and were on par with each other. Least conidial germination (5.90%) was observed in distilled water followed by tap water (15.26%) at four hours after incubation (Fig.-1).

Maximum conidial germination (61.91%) was observed in 2.0 per cent glucose solution, which was significantly superior over the other treatments followed by 1.5 per cent glucose solution (56.34 %). Least conidial germination (18.40%) was observed in distilled water followed by tap water (33.14%) at eight hours after incubation.

At 12 hours after incubation, maximum conidial germination (73.76%) was noticed in 2.0 per cent glucose solution, which differed significantly over rest of the treatments followed by 1.5 per cent glucose solution (71.29%). Least conidial germination (28.45%) was observed in distilled water followed by tap water (44.27%).

After 24 hours of incubation, maximum conidial germination (84.64%) was observed in 1.5 per cent glucose solution, which differed significantly with remaining treatments followed by glucose (79.15%) at 2 per cent concentration. Least conidial germination was

Table-3 : Effect of different relative humidity levels on per cent conidial germination of *Erysiphecichoracearum.*

Relative humidity (%)	Conidial germination (%)
50	8.45* (16.90)**
55	12.38 (20.60)
60	16.32 (23.83)
65	20.31 (26.79)
70	27.35 (31.53)
75	32.25 (34.60)
80	40.21 (39.35)
85	56.32 (48.63)
90	41.45 (40.08)
95	28.32 (32.15)
100	20.38 (26.84)
S.Em. ±	0.21
C.D. at 1 %	0.78

*Mean of three replications, **Angular transformed value

noticed in distilled water (64.28%). It is evident that, the conidial germination at 1.5 per cent glucose solution differed significantly with rest of the treatments. Hence, glucose solution of 1.5 per cent concentration was selected as a basal medium for further laboratory studies

(80.00%) in 1.5 per cent glucose solution after 24 hrs. of incubation. Divya *et al*. (2015) recorded the maximum conidial germination of *E. polygoni* in 2.0 per cent dextrose solution (75.50%) followed by sucrose at 1.5 per cent (69.17%) and dextrose at 1.5 per cent (68.27%) at 24 hr after incubation. The least conidial germination (57.33%) was observed with sucrose at 0.5 per cent at 24 hr after incubation.

Effect of different temperature levels on conidial germination of *E. cichoracearum* : The effect of different temperature regimes on the conidial germination of fungus was significant. Maximum conidial germination of 58.12 per cent was observed at 25^{0}C, which varied significantly from other temperature levels tested and at 30^{0}C, 50.98 per cent conidial germination was observed (Table-2). This was followed by 20^{0}C, 15^{0}C and 35^{0}C at which the conidial germination was 43.23, 31.12 and 28.63 per cent respectively. The conidial germination percentage at higher temperatures *i.e.*, 40^{0}C, 45^{0}C decreased to 12.36 and 9.28 per cent respectively. Poor conidial germination of 8.28 and 20.23 per cent was recorded at lower temperatures of 5^{0}C and 10^{0}C respectively (Fig.-2).

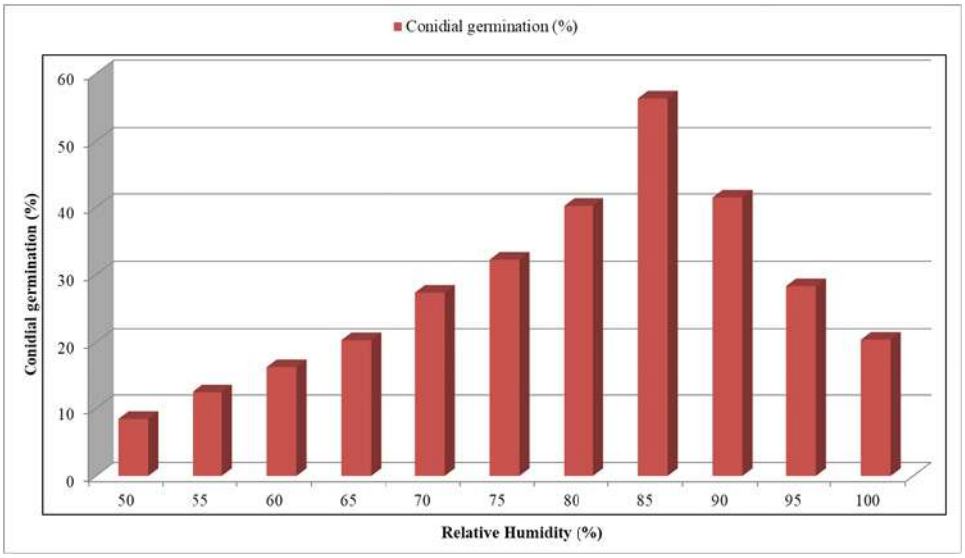

Fig.-3 : Effect of different relative humidity levels on per cent conidial germination of *Erysiphecichoracearum.*

to evaluate the effect of different relative humidity and different temperature levels on conidial germination of *E.cichoracearum.* At different interval of time, distilled water recorded least germination when compared to tap water. The poor germination of conidia in the distilled water could be due to the lack of essential nutrients.

The present findings are in accordance with the results obtained by earlier workers *viz.,* Akhileshwari (2011) found that, spore germination of *E. cichoracearum* is accelerated due to the presence of sugars in the medium and reported the maximum conidial germination

It was observed that neither too high nor too low temperature regimes favoured conidial germination of *E. cichoracearum.* Further, maximum conidial germination was recorded at 25 ^{0}C, hence the temperature of 25 ^{0}C was opted to study the influence of relative humidity and efficacy of fungicides and bio agents on conidial germination under *in vitro* conditions.

Temperature plays an important role among the physical factors, which influences distribution, growth and reproduction of the fungus. The present studies are in fine tune with the reports of earlier workers *viz*., Gupta *et al.*

Table-4 : Effect of elevated CO_2 and temperature on spore germination of Erysiphe cichoracearum in growth chambers.

Sl. No.	Treatment	Spore germination (%)
1.	Elevated CO_2 @ 550 ± 25 PPM with normal temperature	46.82* (43.18)**
2.	Elevated CO_2 @ 550 ± 25 PPM with 2°C rise in temperature	50.21 (45.12)
3.	Ambient CO_2 @ 410 ± 25 PPM with 2°C rise in temperature	44.23 (41.69)
4.	Ambient CO_2 @ 410 ± 25 PPM with normal temperature	40.21 (39.35)
5.	Laboratory condition	35.90 (36.81)
	S.Em. ±	0.41
	C.D. at 1%	1.65

*Mean of four replications, **Figures in the parentheses are arc sine transformed value

a) Elevated CO_2 @ 550 ± 25 PPM with 2 °C rise in temperature

b) Laboratory condition

Plate-1 : Effect of elevated CO_2 and temperature on spore germination of *Erysiphe cichoracearum* in growth chambers.

(2001) who reported maximum germination of conidia at 25^0C while working with cucumber powdery mildew. Divya *et al*. (2015) recorded maximum conidial germination of *E. polygoni* at 20^0C (70.31%) followed by at 15^0C (61.48%) and 25^0C (44.33%). Naik and Kulkarni (2018) studied the effect of different temperature regimes on conidial germination of *E. cichoracearum* under *in vitro* conditions and observed the maximum per cent conidial germination of 48.52 per cent at 25^0C and 46.12 per cent conidial germination at 30^0C which were at par with each other. While, least conidial germination (7.22, 13.19%) was observed at 5^0C and 40^0C respectively.

Effect of different relative humidity levels on conidial germination of *E. cichoracearum* : Results revealed that the effect of different relative humidity regimes on theconidial germination of *E. cichoracearum* was significant. Maximum conidial germination 56.32 per cent wasobserved at 85 per cent relative humidity, which was significantly superior over other treatments (Table-3). This was followed by relative humidity of 90 per cent at which 41.45 per cent conidial germination was observed. The conidial germination of 40.21 per cent, 28.32 per cent and 20.38 per cent was observed at 80 per cent, 95 per cent and 100 per cent relative humidity, respectively. However least conidial germination of 8.45 per cent was observed at 50 per cent relative humidity, followed by 55 per cent relative humidity which recorded the conidial germination of 12.38 per cent (Fig.-3).

It was noticed that the conidia of *E. cichoracearum* germinated even at 55 per cent and 100 per cent relative humidity, indicating the fungus ability to infect both under dry and humid conditions in presence of higher water content. The present studies are in fine tune with the reports of Divya *et al*. (2015) observed that the relative humidity of 80 per cent was optimum for conidial germination of *E. polygoni* (70.50%). The next best level of relative humidity was 85 per cent (64.60%) followed by 90 per cent (61.40%) and 75 per cent (55.80%) and they varied significantly among themselves. Naik and Kulkarni (2018) reported the maximum conidial germination (46.72 %) of *E. cichoracearum* at 85 per cent relative humidity, which was significantly superior to other treatments. Relative humidity of 90 per cent was the next best treatment with 41.86 per cent conidial germination. However least conidial germination (16.31%) was recorded at 65 per cent relative humidity.

Effect of elevated CO_2 and temperature on spore germination of *E. cichoracearum* : The influence of elevated CO_2 and temperature on conidial germination of *E. cichoracearum* under *in vitro* was studied in growth chambers. The results obtained revealed that the maximum spore germination of 50.21 per cent was recorded in treatment T_2 (elevated CO_2 at 550 ± 25 ppm with 2^0C rise in temperature) followed by treatment T_1 (elevated CO_2 at 550 ± 25 ppm with normal temperature) with spore germination of 46.82 per cent and least spore germination was observed in lab condition (35.90%) (Table-4 and Plate-1).

The reason behind this might be the accumulation of more amount of CO_2 coupled with increased temperature (T_2) that might have triggered the spores to undergo for more germination. Based on this finding, we can predict more infection and severity of powdery mildew under such conditions in future.

Similar study on the effect of elevated CO_2 and temperature on conidial germination of *L. taurica* was conducted by Sheetal (2020) found that the, maximum spore germination of 44.64 per cent was recorded in treatment T_2 (elevated CO_2 at 550 ± 25 ppm with 2^0C rise in temperature) followed by treatment T_1 (elevated CO_2 at 550 ± 25 ppm with normal temperature) with spore germination of 40.06 per cent and least spore germination was observed in lab condition (29.49%).

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Assessing Allelopathic Potential of *Aonla* on Germination and Growth of Two Traditional Crops in Pot Culture

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Abstract

Present investigation was carried to assess the effect of different plant part extracts of *Emblica officinalis* at different levels of concentration (15%, 10%,5% and control) on two different test crops mustard and lentil in pot culture. The effect of Aonla leaf, bark and root was found inhibiting and the level of inhibition varied with the concentration of extract of plant parts for both the test crops. In general, the increase in level of concentration of different plant part extracts exhibited decreasing trend for different germination and growth parameters in test crops. Among the different plant parts of *E. officinalis*, the maximum reduction in germination was observed with leaf extracts while minimum in case of root extracts. Amongst the crops, a greater germination percent was recorded in mustard crop by all plant parts of *E. officinalis* in comparison to lentil. Whereas reduction in vigour index was recorded in order - root < bark < leaf for all test crops by *E. officinalis*. It is evident from the investigation that root extract of *E. officinalis* has minimum detrimental effect on all test crops.

Key words : *Emblica officinalis, mustard, lentil, leaf, root, shoot, bark, concentration*

Introduction

The term allelopathy generally refers to the detrimental effect of one species on germination, growth or development of plant of same or another species. Allelopathy has been defined as an adverse influence of one plant or micro-organism on another (Rice, 1984). The detrimental effect is exerted through release of chemical inhibitors (allelo-chemical) from the leaf, bark and root of tree species.

In various traditional agroforestry systems, normally people grow several tree species in or around the agricultural field which is an approach for using available land resources more efficiently but agricultural losses are being experienced by marginal and sub-marginal farmers thus governing the adverse effect of farm trees on cultivated land and standing crops (Bhatt *et al*, 1993). Due to the adverse effect of trees, most of the farmers neglect raising of tree species in combination with crops on their agricultural fields since food crop cultivation is essential for their subsistence. Hence, planting of trees along with food crops has not been carried out on a very large scale.

Suppressing or stimulating effects of tree crops on the annual crops due to allelopathic interaction is the major consideration for selection of crop combination under agroforestry system (Kumari, Neelam *et al*. 2016). Thus, for successful implementation of agroforestry system, proper tree-crop combinations are needed to be recommended for which detailed studies of effect of different tree allelo-chemicals on seed germination and seedling growth of different crops should be carried out. *E. officinalis*, the Indian gooseberry is an important agroforestry tree species of arid and semiarid region of the country **(**Durgesh Nandini and Dhanai C.S., 2020), but the studies on alleleopathic effect of *E. officinalis* are few. Considering the above points in view, an investigation was undertaken to evaluate the allelopathic potential of *E. officinalis* on two traditional field crops under nursery conditions. The results obtained can prove beneficial for the farmers to adopt a promising tree and food crop combination so that the goals of productivity, ecological stability and sustainability can be achieved by practising agroforestry system in lower production regions like Bundelkhand.

Materials and Methods

In bioassay studies, leaves, bark and root were collected from selected plus trees of *E. officinalis*. The collected material was sun-dried and ground separately in a

Table-1 : Effect of *E. officinalis* plant extracts on seed germination % of mustard and lentil.

Concentration	Plant Parts			Mean
	Leaf	Bark	Root	
Germination % of mustard				
15	58.3	60.0	63.3	60.6
10	61.7	63.3	66.7	63.9
5	65.0	68.3	70.0	67.8
Control	73.3	73.6	73.0	73.3
Mean	64.6	66.6	68.0	
$LSD_{0.05}$ for P	NS			
$LSD_{0.05}$ for C	4.7			
$LSD_{0.05}$ for P*C	NS			
Germination % of Lentil				
15	58.3	60.0	65.0	61.1
10	60.0	61.7	68.3	63.3
5	63.3	66.7	70.0	66.7
Control	71.7	71.7	71.7	71.7
Mean	63.3	65.0	68.8	
$LSD_{0.05}$ for P	NS			
$LSD_{0.05}$ for C	5.2			
$LSD_{0.05}$ for P*C	NS			

Table-2 : Effect of *E. officinalis* plant extracts on shoot length (cm.) of mustard and Lentil seedlings.

Concentration	Plant Parts			Mean
	Leaf	Bark	Root	
Shoot length (cm.) of Mustard				
15	2.1	2.3	4.0	2.8
10	2.5	2.7	4.6	3.3
5	3.3	3.8	5.2	4.1
Control	6.2	6.4	6.6	6.4
Mean	3.5	3.7	5.1	
$LSD_{0.05}$ for P	0.3			
$LSD_{0.05}$ for C	0.04			
$LSD_{0.05}$ for P*C	0.6			
Shoot length (cm.) of Lentil				
15	1.1	1.7	1.8	1.5
10	1.3	2.3	2.5	2.0
5	1.4	2.6	2.6	2.2
Control	2.8	3.0	2.9	2.9
Mean	1.7	2.4	2.5	
$LSD_{0.05}$ for P	0.2			
$LSD_{0.05}$ for C	0.3			
$LSD_{0.05}$ for P*C	0.4			

mechanical grinder. A sample of 50,100 and 150 gm (for 5%, 10% and 15% concentration) of leaf, bark and roots was weighed and added to 1000 ml of double distilled water. The solution was kept for 24 hours at room temperature. The resulting brownish dark extractions were filtered through three layers of Whatman no.1 filter paper and stored in dark place for usage whenever required. Thereafter 5, 10 and 15 percent aqueous extract were prepared separately for each component The field experiment was conducted by growing seeds in pots filled with mixture of soil, FYM and sand in the ratio of 3:2:1. Seed sample of both the crops was divided into four replications containing 25 seeds each. The sown seeds were then treated with 50 ml solution of 5%, 10 % and 15% aqueous extracts of leaf, bark and root of *E. officinalis*. The seed germination was observed daily, upto seven days. After the completion of experiment, the shoot and root length (cm.) of the seedling of test crop was measured with the help of measuring scale by selecting five seedlings from each replication and each treatment. The vigour index of the test crop was calculated from the formula :

Vigour index = Germination % (Root length + shoot length)

Results and Discussion

Table-1 shows the effect of concentration of root, bark and leaf extracts of *E. officinalis* on seed germination percentage of mustard and lentil. The effect was found non-significant for mustard crop. With the increase in concentration of extract, reduction in seed germination percent was recorded. The mean germination % recorded a minimum value of 60.6% at 15% concentration whereas maximum value of 73.3% was observed under control (0%). Amongst the plant parts, the lowest mean germination value of 64.6% was noticed in case of leaf extract as compared to extracts of bark (66.6%) and root (68 %). However, the overall minimum germination percentage of 58.3% was recorded at 15% concentration in case of leaf extract and maximum of 73.3 % at control.

Irrespective of plant parts of *E. officinalis*, the concentration of extracts inhibited the mean germination % of lentil significantly. The minimum mean germination percentage (61.1) was registered at 15% concentration and maximum at 0% concentration or control (71.1%). Amongst the plant parts, extract of root registered greater germination i.e. 68.8% in comparison to bark (65.0%) and leaf (63.3%). The results are in agreement with O.P. Awasthi *et al.* (2005). In view of above results, Nandal *et al.,* (1992) reported that allelo chemicals might inhibit some metabolic processes responsible for biosynthesis of GA, protein, a amylase, IAA and ATP, thereby resulting in inhibition of seed germination. The aqueous leaf extracts may contain alkaloids, carbohydrates, tannins, flavonoids, phenolic compounds and starch, of which the alkaloids (Ramanjaneyulu *et al.,* 2011) and phenolics are known to have inhibitory effects (Rice, 1984).

Table-2 shows the effect of different concentrations and different parts (root, bark and leaf) of *E. officinalis* on shoot length of mustard and lentil crops. The plant parts of

Table-3 : Effect of *E. officinalis* plant extracts of root length (cm.) of Mustard and Lentil.

Concentration	Plant Parts			Mean
	Leaf	Bark	Root	
Root length (cm.) of Mustard				
15	1.8	2.9	3.5	2.7
10	2.6	3.5	4.0	3.3
5	2.7	3.8	4.5	3.7
Control	4.5	4.4	4.4	4.3
Mean	2.9	3.6	4.1	
$LSD_{0.05}$ for P	0.4			
$LSD_{0.05}$ for C	0.5			
$LSD_{0.05}$ for P*C	NS			
Root length (cm.) of Lentil				
15	1.6	2.6	2.9	2.4
10	2.4	2.9	3.0	2.8
5	2.5	3.1	3.4	3.0
Control	3.6	3.9	3.7	3.7
Mean	2.6	3.1	3.2	
$LSD_{0.05}$ for P	0.4			
$LSD_{0.05}$ for C	0.5			
$LSD_{0.05}$ for P*C	NS			

Table-4 : Effect of *E. officinalis* plant extracts on vigour index of Mustard and lentil seedlings.

Concentration	Plant Parts			Mean
	Leaf	Bark	Root	
Vigour index of Mustard				
15	189.5	237.2	364.9	263.9
10	241.6	302.1	475.5	339.7
5	309.5	434.6	552.7	432.3
Control	680.2	680.2	680.2	680.2
Mean	355.2	413.5	518.3	
$LSD_{0.05}$ for P	30.6			
$LSD_{0.05}$ for C	35.1			
$LSD_{0.05}$ for P*C	60.7			
Vigour index of Lentil				
15	201.0	331.7	410.9	314.6
10	302.7	392.1	478.5	391.1
5	320.8	464.7	552.1	445.9
Control	570.1	570.1	570.1	570.1
Mean	348.7	439.7	502.9	
$LSD_{0.05}$ for P	49.2			
$LSD_{0.05}$ for C	56.8			
$LSD_{0.05}$ for P*C	NS			

E. officinalis and different concentrations both exhibited significant effect on shoot length of mustard seedlings. An increase in concentration of extract resulted in reduction of mean shoot length in mustard seedlings. The minimum shoot length (2.8 cm) was noticed at 15% concentration of extracts. Irrespective of concentration, the maximum inhibition in shoot length of mustard seedlings was found with leaf extract of *E. officinalis* with a mean value of 3.5 cm in comparison to bark (3.7 cm) and root (5.1 cm) extracts. Similar results have been given for a number of agroforestry tree species by Kumari Neelam *et al.* (2016), Hoque *et al.* (2003), Venkateshwarlu (2001) etc.

The effect of different plant parts and their concentration on shoot length of lentil seedlings was found significant. Irrespective of concentration, the maximum reduction in mean shoot length of seedlings was registered by leaf extracts. The mean shoot length noticed for leaf, bark and root extract was 1.7 cm, 2.4 cm and 2.5 cm, respectively. Irrespective of plant parts, the mean shoot length of seedlings decreased with increase in concentration of seedlings. The mean shoot length at 0% or control, 5%, 10%, and 15% concentration of extracts was recorded 1.5 cm, 2.0cm, 2.2cm and 2.9 cm respectively.

Root Length (cm) : Table-3 displays the effect of different plant part extracts of *E. officinalis* at different concentrations on root length of mustard and lentil crop. As the concentration of extracts increased, a significant reduction in mean root length of mustard seedlings was observed. The maximum root length observed was 4.3 cm at 0% or control and minimum (2.7 cm) at 15% concentration. Amongst the plant parts, the leaf extract inhibited the root length of seedlings much more as compared to bark and root. The mean root length of mustard seedlings observed for leaf, bark and root extract was 2.9cm, 3.6 cm, and 4.4 cm respectively.

The effect of extract of plant parts of *E. officinalis* and their concentrations was found non-significant on root length of lentil. Among the plant parts, the leaf extract registered the minimum mean root length (2.6cm) as compared to bark (3.1cm) and root (3.2cm). Irrespective of plant parts, the 15% concentration of extract registered the maximum reduction in root length (2.4cm). With increase in the extract concentration, the reduction in mean root length was noticed. The results are in conformity with Nandini *et al.* (2020) and C. S. Dhanai *et al.* (2017) Baziramakenga *et al.* (1995) postulated that development of root is highly susceptible to the presence of allelo-chemicals in the rhizosphere because root tissues are more permeable to these chemicals than shoot tissues.

Vigour index : The effect of *E. officinalis* plant extracts on vigour index of mustard and lentil seedlings has been shown in table 4. In case of mustard, amongst the plant parts, root extract produced significantly more vigouros seedlings (518.3) while leaf extracts recorded significantly lower vigour index (355.2). An increase in concentration of extracts resulted in significant reduction of mean vigour index of mustard. The mean vigour index at 15%, 10%, 5%, and 0% or control was recorded 263.9, 339.7, 432.3, and 680.2 respectively. However significantly lower

(189.5) vigour index of seedlings was registered at 15% concentration of leaf extract, while the most vigorous seedlings (680.2) were obtained at 0% or control.

Irrespective of concentration, the root extract registered the higher vigour index (502.9) of lentil seedlings in comparison to bark (439.9) and leaf (348.7).When the concentration of extracts increased, the mean vigour index of seedlings showed a decreasing trend. The 15% concentration of extract registered the minimum vigour index followed by 10% (391.1), 15% (445.9) and 570.1 at 0% or control. However, more vigourous seedlings were observed at 0% or control (570.1) while the least vigour was recorded by concentration of leaf extract (201.3) in lentil crop.

Conclusion

This study concluded that there is notable allelopathic influence of Aonla on seed germination, crop root and shoot growth on mustard as well as lentil crop. The more resistant and versatile crop observed was mustard over Lentil. The leaf extract expressed more inhibitory effect on germination and seedling growth of test field crops as compared to bark and root extract.

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A Study on Forest Dependent Communities in Ghumsur North Forest Division, Odisha

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Abstract

Non-timber forest products (NTFPs) provide a range of products which provides resilience to the livelihood strategies of rural people by reducing their vulnerability to risks (Neumann and Hirsch, 2000). The socio-economic attributes like household size, type of family, age group, literacy rate, land holding, possession of livestock determine the social status and economic condition of individuals. These factors affect the decision making of the individuals in the society. A study conducted with forest fringe villages in Ghumsur North forest division of Odisha revealed that 61.3%male and 38.7% female were involved in NTFP collection in the study area. The literacy level in the study area was in the under high school and above (35%), primary (35%), illiterate (20%) and graduate (10%).Maximum number of family number were up to 4 number (50%), 4 to 8 group (20%), 8 to 12 number (20%) and more than 12 number (10%) were involved in NTFP collection. It found that maximum respondents were in category of small land holding (32.5%), marginal (32.5%), medium (15%) and landless (15%) and large land holding (5%). Maximum people (36.2%) were involved in NTFP agriculture and cattle rearing. Multiple livelihood sources like family occupation, business, service and labours were involved in the occupation. More than (35.40%) of livestock was hen followed by goat (10.45%), duck (5.60%), cow (4.82%) and Ox (0.68%).There was positive correlation of family size with land holding, significant positive correlation of age with types of family, family member as well as the literacy significant positively with employment status and occupation. The study also revealed people are involved in different livelihood activities like NTFPs collection (88.75%), agriculture (81.25%), livestock rearing (78.75%), wage earning (45%) and others i.e. service and allied activities (13.75%). The association study revealed significant and positive correlation between Agriculture and livestock rearing (0.218*), NTFP with wage earning (0.305*) and wage earning with family occupation (0.277*). Significant negative correlation was found between NTFP with others (- 0.730*) and family occupation (-0.416*), and wages with others (-0.206*). It was concluded from the study that the family is nuclear type, population with high male percentage (61.3%) with literacy 80% and 85% of population are having lands, half of the population rear livestock, collection of NTFP and agriculture are the important activities in terms of labour contribution. The NTFP (88.75%) sector generated the highest employment opportunity followed by agriculture (81.25%), wage earning (45%) and other sectors. Among the various sectors, average annual income generated from NTFP was highest (INR.17159.07/-) accounting for 39.6% followed by agriculture contributing 31.9% (INR.13841.26/-) to the total average annual income (INR.43277.76/-) of the respondents.

Key words : *Forest, livelihood, NTFPs, socioeconomic attributes, forest produce.*

Introduction

Non timber forest products (NTFPs) have an important role in the livelihoods of rural people by providing food, medicine, construction materials, engagement and income. FAO (1995) defined the Non-Timber Forest Products (NTFPs) are the goods of biological origin other than wood, derived from forests, other wooded lands and trees outside the forests. Pandey *et al.,* (2016) revealed that NTFPs are associated with socio-economic and cultural life of different communities from varying source of geographical regions which includes 275 million people from India involved in collection and processing of these products for their subsistence and livelihood. Nepstad *et al.,* (1992) stated the NTFP extraction has multiplier effects in the economy by generating employment and income in downstream processing and trading activities.

Non timber forest products (NTFPs) play an important role in the livelihood of the rural people living near the forest. Forest plays an important role particularly in the life of landless and tribal people for income generation and food from forest. According to the World Resource Institute (1990), NTFPs provide livelihood to nearby 500 million people in India. It is estimated that around 50 million people are dependent on non-timber forest produce (NTFP) for their subsistence and cash livelihoods (Shaanker *et al*., 2004). People living in forest areas traditionally depend on local forest products because of easy availability and inexpensive. The products include collection of edible fruits, flowers, tubers, roots and leaves for food and medicines, fire wood for cooking and sale, materials for agricultural implements, house construction and fencing, fodder for livestock as well as collection of a range of marketable non-timber forest products. The income from sale of the forest products for households living in and around forest constitutes about 40 to 60 percent of their total income

Table-1: Socio-economic profile of the NTFPs collection : (n=80)

Sl. No.	Socio-economic characteristics	Num-ber	Percent-age
1.	**Family member of the respondent**		
1.	Up to 4	40	50.0
1.	4 to 8	16	20.0
1.	8 to 12	16	20.0
1.	>12	8	10.0
2.	**Age of the respondents**		
1.	0-18	14	17.5
1.	18-40	20	25.0
1.	41-60	30	37.5
1.	>60	16	20.0
3.	**Gender of the respondents**		
1.	Male	49	61.3
1.	Female	31	38.7
4.	**Literacy of the respondents**		
1.	Illiterate	16	20.0
1.	Primary	28	35.0
1.	High school & above	28	35.0
1.	Graduate & above	8	10.0
5.	**Land holding of the respondents**		
1.	Land less	12	15.0
1.	Marginal	26	32.5
1.	Small	26	32.5
1.	Medium	12	15.0
1.	Large	4	5.0
6.	**Occupation**		
1.	NTFPs + Agriculture + Cattle rearing	29	36.2
1.	NTFPs + Agriculture + Labour	18	22.5
1.	Agriculture + NTFPs + Labour	13	16.2
1.	Business + Agriculture + Family occupation	10	12.5
1.	Govt. service + Agriculture Cattle rearing	10	12.5
7.	**Livestock**	Mean	
1.	Cow	4.82	4.71
1.	Ox	0.68	0.85
1.	Buffalo	0.77	1.43
1.	Goat	10.45	15.16
1.	Pig	0.0	0.0
1.	Hen	15.08	17.91
1.	Duck	5.60	7.75
8.	**Activities**	**Mean**	
	NTFP Collection	3.15	88.75
	Agriculture	2.14	81.25
	Labour	1.76	45.00
	Family occupation	1.59	21.25
	Livestock rearing	2.08	78.75
	Others	1.12	13.75

(Bharat Kumar *et al*., 2010). About 100 million people in and around forests in India derive their livelihood from the collection and marketing of NTFPs (Kumar *et al*, 2000). Socio-personal, agro-economic and psychological attributes very often motivate the people for proper management and sustainable use of forest resources. An attempt was therefore made assess the potential of availability of various NTFPs and the impacts on the socio-economic attributes of the people living in forest areas.

Materials and Methods

The investigation was conducted during 2018-2019 in Mujagarh and Central Forest Range, Ghumsur North Forest Division, Ganjam District of the state has been taken up due to large concentration of tribal population and dependency of people on minor forest produces for their subsistence. Total eight villages, three from each range were selected for the study of socio-economic profile, dependency and marketing of forest products of the forest fringe villages. All the households have been randomly selected from the village. A total of 80 families from 8 villages belonging to 2 reserve forests were selected randomly. The data were collected through a structured survey questionnaire, analyzed with appropriate statistical methods and were interpreted in accordance with the objectives of the study.

Results and Discussion

Different socio economic characteristics like family size, age, literacy, land holding size, livestock and occupation were analysed. Perusal of data in table 1 showed that 50% of respondents have 1 to 4 numbers family size followed by 20% of respondents are both 4 to 8 and 8 to 12 number family size and 10% respondents are >12 number family size. Most respondents were in the age group of 41 to 60 years (37.5%) followed by 18 to 40 years age group (25%), more than 60 years (20%) and 0-18 years were the least respondents (17.5%). Gender of respondents was with an average 49 adult males (%) and 31 adult females (%). The literacy rate was found same for primary education and high school and above (35%) each and graduate and above (10%). 65% respondents had small (32.5%) and marginal (32.5%) land holding followed by landless (15%) and small farmer (15%) and rest 5% of the respondents had more than 2 acres of land. From the survey it was found that mean value of different livestock is 37.40 no's/HH out of which hen (15.08), goat (10.45), duck (5.60), cow (4.82), buffalo (0.77), ox (0.68).They reared livestock for farming and consumption purposes. Poultry with an average of 15.08 numbers per household helped them in selling hen and egg. Maximum number of household families had occupation of i.e.36.2% from NTFPs+ Agriculture + Cattle rearing, followed by 22.5%

Table-2 : Correlations among socio economic variables.

	Age	Literacy	Type of family	Family member	Land holding	Employment status	Occupation	Livestock
Age	1							
Literacy	-.646**	1						
Type of family	.251*	-.275*	1					
0Family member	.347**	-.411**	.814**	1				
Land holding	.142	-.226*	.164	.236*	1			
Employment status	-.075	.315**	-.321**	-.338**	.057	1		
Occupation	.041	.383**	-.214	-.329**	-.186	.207	1	
Live stock	.120	.017	-.242*	-.157	-.108	.018	.258*	1

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table-3 : Correlation of income from different sources.

	NTFP Collection	Agriculture	Labour	Family occupation	Livestock rearing	Others
NTFP Collection	1.000					
Agriculture	-0.056	1.000				
Labour	0.305**	0.018	1.000			
Family occupation	-0.416**	-0.130	0.277*	1.000		
Livestock rearing	0.030	0.218*	0.086	0.146	1.000	
Others	-0.730**	-0.006	-0.191*	0.122*	-0.132	1.000

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

from NTFPs+ Agriculture+ labour,16.2% from Agriculture + NTFPs + Labour, 12.5% from Business + Agriculture + Familyoccupation,12.6% from Govt. Service + Agriculture + Cattle rearing. The maximum number of the respondents was involved in NTFP collection i.e. 88.75% of the respondents were involved in this activity and was the dominant income generating activity. Most of the respondents (81.25%) practiced agriculture in their own land and leased land. In addition, the respondents were also involved in livestock rearing (78.75%) followed by labour (45%), family occupation (21.25%) and other (13.75%). Besides NTFP collection and farming, the villagers depend on livestock rearing and daily wages for their livelihood substantially.

It was inferred from the study that most of the respondent's i.e.50% were having a family size of 1 to 4 members (nuclear family). The nuclear size of family in the study area may be due to awareness among the people. The female to male respondent ratio was found to be 1.58: 1 in the study site. The respondents more from middle aged groups i.e. from 41 to 60 years were mostly collecting NTFPs from the forest. It is an age old traditional practice and young people are not interested as it is a non-remunerative labour intensive practice. It was derived from the study area that around 80% of respondents were educated, it may be due to scopes and facilities provided by Government as well as awareness among people. The mean score of size of land holding was found to be 1.89 which is indicative of preponderance of marginal and small farmers in the surveyed area. Poultry bird (hen) with an average of 15.08 (17.91%) numbers per household constitutes dominant livestock in the study site. They also consume meat and milk product from their goat and sell in the nearby markets as cows and buffalo is the next highest livestock component with 15.16%. Having animals was an economic security for the respondents as was observed in many other studies (Kumar, 2015). Maximum number of household families had occupation of i.e.36.2% from NTFPs + Agriculture + Cattle rearing. The results indicated that selected families earn their maximum income from multiple sources like NTFPs, agriculture and cattle rearing. It might be due to composition of multiple inputs and maximum involved of respondents, was observed by Pervaz (2002). It was found from the study that the collection of NTFP and agriculture are the important activities in terms of labour contribution. Studies on heavy dependency on agricultural labour (79.05%) were also observed earlier (Singh *et al.* 2010). Similar results on forest dependency were observed where the NTFP collection was one of the dominant activities of the forest dwellers (Mahapatra *et al.* 1992). It was found that maximum number of respondents were engaged in NTFPs collection 88.75%, followed by agriculture 81.25%, labour 45%, livestock rearing 78.75% and minimum number of respondents engaged in family occupation. It might be due to plenty availability of NTFPs

Table-4 : Composition of average annual household income derived from different sector (household/year).

Activities	Income generated in INR (days/HH/year)	Percentage
NTFP Collection	17159.07	39.60
Agriculture	13841.26	31.90
Labour	6754.30	15.60
Family occupation	1031.78	2.30
Livestock rearing	3542.57	8.30
Others	948.78	2.30
Total	43277.77	100

Table-5 : Seasonal contribution of employment from different NTFPs.

NTFP	Season	Employment generated (days/HH/year)	Percentage
Sal Leaves	All season	12.75	29.1
Sal seed	May-July	6.28	14.3
Mahua flower	March-May	9.54	21.7
Mahua seed	April-May	2.21	5.3
Siali Leaves	April-June	5.18	11.8
Karanja seed	March-May	3.55	8.3
Bamboo	All season	1.78	4.0
Mushroom	June-August	0.87	1.9
Honey	All season	0.57	1.3
Fuel wood	All season	1.05	2.6

surrounded to the study area and maximum people were illiterate and unemployed in nature.

Perusal of the table-2 showed that age is significantly and positively correlated with type of family (0.215^{*}), family member (0.347^{**}) and negatively correlated with literacy (-0.646^{**}). Family size is significantly and positively correlated with family member (0.814^{**}), ownership of land (0.242^{*}) and negatively correlated with household type (-0.410^{**}), employment status (-0.321^{**}). Family member is significantly and positively correlated with land holding (0.236^{*}) and negatively correlated with type of household (-0.559^{**}), employment status (-0.338^{**}), occupation (-0.329^{**}). Land holding is significantly and positively correlated with type of ownership land (0.338^{**}) and negatively correlated with type of household (-0.237^{*}). Type of land is negatively correlated with (-0.304^{**}), occupation (-0.285^{*}). Type of household is significantly and positively correlated with employment status (0.459^{**}) and occupation (0.327^{**}). Occupation is significantly and positively correlated with income (0.571^{**}) and livestock (0.258^{*}).

Age is positively correlated with marital status, type of family and member of family which indicated with age more people are married with more family members and are in nuclear and joint family system with more land holding. Age is negatively correlated with education which is due to elder people are less educated. Occupation is positively correlated with income and livestock and income is also positively correlated with livestock which might be due to wealthy people invest in income for their livelihood and for more income. The traditional occupation also strengthens the family income.

Perusal of Table-3 showed that NTFPs collection was significant and positively correlated with labour (0.305^{**}) and negatively correlated with family occupation (-0.416^{**}). Agriculture was significant and positively correlated with livestock rearing (0.218^{*}). Labour was significant and positively correlated with family occupation (0.277^{*}) and negatively correlated with other services (-0.191^{*}). Family occupation was significant and positively correlated with other services (0.122^{*}).

NTFPs collection is positively correlated with labour wages and negatively correlated with family occupation and service. People in the study site besides collection of NTFPs also engaged as labourers in forest activities for income generation. Family occupation is positively correlated with others (service) that might be due to the fact that people have invested money in their family occupation while engaged in a job, same trend was observed by Shylajan and Mythili (2007).

Income in the study area was generated from different major activities such as NTFP, agriculture, labour, livestock rearing, family occupation and other, as shown in table 4. NTFP generated the highest average annual income of INR 17159/- accounting for 39.6%. NTFP played the dominant livelihood and income generating activity due to majority of people are unemployed and uneducated in study area, followed by Agriculture contributed INR 13841/- (31.9%), labour contributed INR 6754.3 (15.6%), Livestock rearing contributed INR 3542.57 (8.18%), family occupation contributed INR 1031.78 (2.3%) and others contributed INR 948.78 (2.3%) out of total income of INR 43277/- per HH/year. NTFPs collection was one of the major employments. Provider to the villagers due to the fact that the forest provides a major amount of NTFPs where no employment opportunities in the villages surrounded by rain-fed agricultural land as same observed by Behera (2009), which was constituted with the present finding.

Perusal of data in table 5 indicated that collection of Sal leaf gave the major employment sources among the different NTFPs, contributing 29.1% of the total employment generated by NTFPs. This was because Sal leaves were collected by every family of the study area in all seasons and provides maximum employment to the villagers. Mahua Flower collection was the next important employment generating activity which provides 21.7% to the total employment generated by the NTFPs and collected during March to May. It was followed by

collection of sal seed (14.3%), siali leaves (11.8%), karanja seed (8.10%), mahua seed (5.3%), bamboo (4.0%), fuel wood (2.6%), mushroom (1.9%) and honey (1.3%).

Vidyarthy and Gupta (2002) reported that significant properties of annual income of the household were derived from NTFPs and on an average it contributed to the extent of 80.80% of their total income, similar results were found in the present investigation.

Conclusion

This study carried out to highlight the socioeconomic status and significance of NTFPs in the livelihood of forest dependent communities. NTFP contributed a higher proportion of total household income (about 39.60%), it acted as safety nets in times of food scarcity and during off seasons where agricultural and wage income was negligible. NTFP played a prominent role in both life and livelihood support for the villagers. Socio-personal, agro-economic and psychological attribution very often motivate the people for proper management and sustainable use of forest resources. It was revealed from the study that literacy, family size, age and holding size had better and significant associationship among themselves. The respondents depending on forest for livelihood support were mostly above 51 years, illiterate to primary educated, within family size of 4 members and wage earning and collection of NTFPs as the major occupation. After wage earning, NTFP collection was the most important activity among the respondents as all of them in the area were involved in this activity.

The findings conclude that the respondents depend on forest for their livelihood. The forest department officials have to sensitize these people by using their socio-economic attributes for proper management of the forest and collection of non- timber forest produce. It also includes about the challenges and strategies of NTFP management which will be beneficial in sustainable development of resources and to provide opportunities to the poor section of people of the society.

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Slums, a Corollary of Urbanization–the Case Study of Urban Planning and Slum Management in Allahabad

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Abstract

The evolution of human civilization is a trail from low technology-land based economic activities to high technology -non land based economic activities. Urbanisation is a process of socio-cultural and economic transformation from rural to urban under impact of changing land use pattern and shifting from agricultural to non-agricultural activities. With growing trend of economic development, the standard of living and employment generation have been ensured, yet the differences between have and have not in terms of income and wealth distribution remains a major concern. The deprivation of ownership and need among participants of economy have broadened the rift of production relations of the society. Slums are considered as dilapidated dwellings born of inadequate access to basic necessities due to socio-economic and political constraints. The process of slumisation is a result of unplanned and haphazard urban sprawling that presents a striking feature in urban environment structure. The slum dwellers do not pose any ownership of tenured land nor rights to safe and adequate civic amenities, which puts them to risk of frequent threatening of eviction by local body authorities. The proliferation of environmental problems emerges out of unhygienic living conditions around the city environment. Therefore, to achieve sustainable urban planning and management, it is imperative to have efficient resource management with growing demands as well as adopt co-functional responsibilities between slum residents and urban local bodies. The research paper makes an attempt to highlight the socio-economic and environmental conditions of growing slums and to suggest the strategies for inclusive approach to urban planning and slum management with special reference to city Allahabad, Uttar Pradesh.

Key words *: urbanization, slums, urban growth, slum management, urban planning*

Urbanization, the Concept : The concept of urbanization has varied perspective by various social scientists. While a geographer studies urbanization as the area and size of population within a spatial unit, an economist studies it as a process of development of urban economic development." Urbanization is intrinsically connected, irrevocably enlaced, with development process, as an essential strand in the contemporary economic system."

According to the social thinkers, urbanization indicates the field that differentiates rural and urban population in terms of their socio-cultural attributes. A political thinker perceives the concept of urbanization on the ground of power and status of people in the region. Urbanization, according to Census 2011, the criteria of defining an area as urban area are :

An area having population of 5,000 persons and more.

An area with 75 percent of its population engaged in non-agricultural activities.

An area with density of population of 400 persons per square kilometer.

The phase of urbanization is traced in Indus Valley Civilization where towns grew in association with two cultural streams – the Aryan civilization in north and Dravidian in the south. The urban scene in India witnessed following contribution with advent of British East India Company like creation of - Mumbai (Bombay), Kolkata (Calcutta) and Chennai (Madras), introduction of civil lines and cantonments, introduction of railways and modern industries, improvement of civic amenities and administration. Few towns came up as : (i) Hill station-Shimla, Nainital, Mussoorie, (ii)Port cities-Mumbai, Marmagao, Alleppey, (iii) Industrial cities-Kanpur, Jamshedpur, Asansol. The rate of urbanization in India has accelerated owing to economic liberalization post 1990 and dispersal of urban development activities as city expansion.

Implications of fast Urbanization : Accelerated industrialization and changing land use pattern-agricultural land transformed to non-agricultural land has determined the shift from cultivation to subsequent informal activities by the tillers and cultivators. The scarcity of urban land due to high cost has pushed the rural job seekers and towards city peripherical low-cost land.

The other factors responsible for depopulation from of rural areas are also exodus of large population towards cities due to coercive factors like political turbulence, family disputes, natural calamities etc. The growth of urbanization provides ample scope of human resources potential in secondary and tertiary service sectors, thus improving the dynamics of job opportunities and national income.

Table-1 : Migration Status of sample slum population.

Area / Purpose of migration	Seek job	Family compulsion	No land for cultivation	Attraction of city life	Income opportunities	Other	Total
Within district	44 (19.5)	12 (5.3)	95 (42)	0 (0.0)	75 (33.2)	0 (0.0)	226 (67.3)
Within U.P.	17 (25.8)	3 (4.5)	12 (18.2)	9 (13.6)	25 (37.9)	0 (0.0)	66 (19.6)
Outside U.P.	24 (54.5)	2 (4.5)	3 (6.8)	0 (0.0)	12 (27.3)	3 (6.8)	44 (13.1)
Total	85 (25.3)	17 (5.1)	110 (32.7)	9 (2.7)	112 (33.3)	3 (0.9)	336 (100)

Source : Field Survey, March–June

Table-2 : Distance of main sources of drinking water.

Source	Within premises	Near the premises	Far from premises	Total
Open well	0(0.0)	3 (100)	0 (0.00)	3 (3.5)
Closed well	2 (66.7)	1 (33.3)	0 (0.00)	3 (3.5)
Tap	17 (51.5)	10 (30.3)	6 (18.1)	33 (38.8)
India Mark II	7 (70.0)	3 (30.3)	0 (0.0)	10 (11.8)
Handpump	28 (77.8)	5 (13.9)	3 (8.3)	36 (42.4)
Total	43 (50.6)	29 (34.1)	13 (15.3)	85 (100)

Source : Field Survey, March–June.

But on the other hand, the increasing urbanization calls for demand of basic amenities to meet increasing consumerism for urban population. The urban crisis of major civic amenities like water, electricity, health, sanitation, education become the big concern of the urban society, creating a gap between demand and supply of these amenities. The rampant urbanization is a detrimental to environmental crisis due to improper sewage disposal, industrial effluents, pollution due to traffic congestion, over crowdedness and sprawling of the illegal dilapidated settlements of urban poor called *slums.*

Slumisation, a corollary of urbanization : The slums are characterized as economically low profile, socially secluded and voiceless, environmentally stressed, unplanned and undesired habitat of urban poor. “The classic ‘slum’ was notoriously parochial and picturesquely local place, but the reformers generally agreed with Charles Booth that all slums were characterized by the amalgam of dilapidated housing, overcrowding, poverty and vice versa”

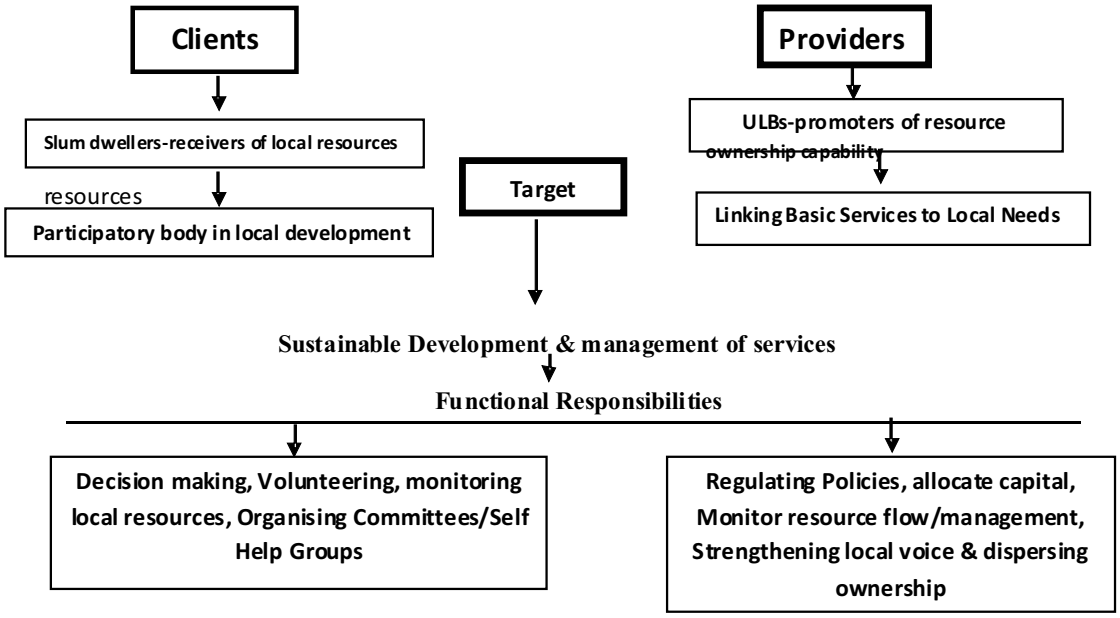
These urban poor encroach upon the public land in absence of adequate space for housing facilities and built their dwellings under city flyovers, beside the railways lines, footpaths or beside the river banks. They are engaged as wage earners, hawkers, vendors, ragpickers, petty traders or taxi drivers and bear no fundamental choice of hygienic and safe living conditions. “The residential milieux into which the humble migrant comes are immensely varied, though universally squalid -the outcome of the poverty of the migrants, the state’s lack of resources to cope with housing problems on this scale and the inability or unwillingness of private landlords to supply the deficiency”

We examine slumisation as process of (i) increasing total population in a slum, the (ii) increasing slum population in a city as percentage of total population. As a corollary of (ii), we examine the increasing slum population as percentage of total population in selected cities in a state or country as a whole. It is a geographic manifestation of the economies based on private properties.

Under Section-3 of the Slum Area Improvement and Clearance Act, 1956, slums have been defined as mainly those residential areas where dwellings are in any respect unfit for human habitation by reasons of dilapidation, overcrowding, faulty arrangements and designs of such buildings, narrowness or faulty arrangement of streets, lack of ventilation, light, sanitation facilities or any combination of these factors which are detrimental to safety, health and morals. As per UN Habitat, a slum is characterized by lack of durable housing, insufficient living area, lack of access to clean water, inadequate sanitation and insecure tenure.

Around 65 percent of city’s population, 12 million people live in slums of Mumbai. As per Census 2011, slum dwellers in Kolkata account for one third of total population of Kolkata. These settlements indicate a marginalized living condition owing to lack of basic amenities and poor workforce. In a developing country like India, the uneven distribution of resources and the economic power makes it vital to adopt pro- poor policies that target equity in share of resources among excluded and marginalized community. The sustainable urban planning and slum management, therefore, requires efficient management of urban resources for all its stakeholders. The nature and scope of slum management and urban planning is an outcome of good urban

Inclusive Approach to Urban Management and Slum Development



governance in terms of both means and its outcome. "With more than 80% of global GDP generated in cities, urbanization can contribute to sustainable growth if managed well by increasing productivity, allowing innovation and new ideas to emerge".

The research papers makes an empirical study to examine social, economic and environment problems of sample slum households and suggest the strategies and suggestions for slum management and urban planning in the city Allahabad, Uttar Pradesh. To identify the socio-economic and environmental challenges, representative sample households of 37 slums out of 185 registered slums were selected in the city region of Allahabad.

The migration status of the sampled households in the slums in the city of Allahabad reflects 19.3 % households as migrants of total households from within the districts as well as from outside the state of Uttar Pradesh. (Table 1)

Lack of productive (arable) landholdings and choice of better income remain the major purposes of migration. A significant proportion migrated in search of employment. It is observed that migrants mostly constituted people from villages at the vicinity of the city (67.3%) who lacked human skills and capital. The implications of such causes of migration are paucity and pressure on housing stock, heath services, sanitation, water and electricity supply in the city where the immigrants migrate from peripheral villages and suburbs. Though, a very few may be absorbed in regular jobs, but a major proportion does not get their aspirations fulfilled and become a part of temporary and marginal workforce. The low profile economic support, therefore, does not allow these migrants in city to purchase high-cost land or house, and force to live in squatters and chawls.

The type of access to educational institutions by school going children in the sample slums state that 61.2% attended private schools, 31.3% attended municipal corporation run schools and 7.0% attended *aganwadis* within their vicinity, rest attended the informal institutions (Maqtabs). The slum dwellers were pessimist towards education system in government run schools. During the survey in Hashimpur slum, a respondent lamented on state of education and expressed that "*sarkari school mein padai nahi hoti, abhi tak mera ladka sign karna bhi nahi sikh paya"*. The respondent being a handicapped family member had to depend on his wife and his two sons for earnings who were ragpickers. The elder son dropped school at primay level to start earning as trolley -puller. Another respondent from Kaladhanada slum of Himmatgunj voiced his concern about negligent education system in municipal schools. He remarked "*sarkari school mein master time par nahi aaten, samay par padahyi nahi hoti"* The situation of school dropouts sets an alarming picture of elementary education due to deviant social behaviour of slumdwellers. 59.0% of total school dropouts held poor economic standard of family as major reason. Dropouts of children from school due to non- interestedness and deviant social behaviour was observed more among boys in comparison to girls.

The study further reveals that of the total sample households 92.1% had private ownership of houses and

rest others were living in hired accommodations who shifted occasionally or seasonally to their native villages. They were found to be male workers who shifted to the industrial belts of the city in search of jobs, eg., cotton mill workers of Chakdondi who occasionally moved to their families living in villages. Study revealed that the households in following slums left their previous place permanently to present areas for better job opportunities : Karbala(8), Hashimpur (7), Rajapur (9), Lal Bihara and Chakdondi (7) each, Chakiya Nayi Basti (9),Chitpur (10), Chakiya (Kasari Masari), GobindpurChilla (10), Mehandauri (15) . On the other hand, few more slums like Benigunj, Kydgunj, Nevada, Ponghat Harijan Basti, Yamuna Bank Road, Kaladhanda, Neem Sarai, Bhavapur had no hired accommodations. These slums faced frequent threats of eviction and demolition by local authorities. Barring a few, in most of the sample slums, residents preferred to live in kutcha or semi -pucca houses .They chose to avoid making pucca permanent houses knowing the fact that they will be subjected to frequent eviction drives. Such unstable and insecure living conditions comfortably escape the eyes of the public authorities. This poses a question mark to slum management policies and sustainable urban resource development.

The situational analysis of health status of people in sample slum revealed that health care non government organization CARE worked towards awareness programs on family planning measures, vaccination, female health and hygiene, family planning, women education through campaigns, street plays, distribution of books and pamphlets. Deliveries of pregnant women was conducted by midwives, *thakuraeens* as most residents held that they cannot afford to visit private hospitals or Primary Health care centres for pre and post- natal care.

The main source of drinking water supply was handpump or tubewells in the sampled slums. 81% of total households availed public handpumps and few had private sources of water supply. An age old well in Chitpur slum remained nonfunctional and was used for garbage disposal. Community owned handpumps and taps were recorded as water supply sources in many houses of Yamuna Bank Road, Fatehpur Bichuwa, Harwara, Lukergunj.

About half of the total slum households who had access to closed well, tap water, India Mark II and handpumps within the premises of the slum locality.34% of total slum households reported portable water availability from 100 metres distance while 13% away beyond 100 metres from their locality. Most of the installed handpumps and taps remained dysfunctional in absence of repair and maintenance.

The employment profile of the sampled households revealed that out of every ten workers were self employed as petty traders, shopkeepers and hawkers. Nearly 66% of total earners were engaged as casual workers like carpenters, transport loaders, painters and house helpers. Females were engaged as semi- skilled or unskilled workers housemaids, basket makers (*banskars*) or beedi makers, and health workers in local NGO. The drudgery of work and physical arduousness involved in work exposed them to health problems and psychological stress. “The quality of democracy can be seriously compromised by economic and social inequality. The later often prevents the underprivileged from participating effectively in democratic institutions, and gives disproportionate power to those who command crucial resources such as income, education and influential connections” .

Approaches for Urban Poverty Alleviation in Allahabad : The task of poverty alleviation, emancipation of urban poor and their social upliftment is under the responsibility of District Urban Development Authority (DUDA), Allahabad. The NGO named CARE International has the approach to understand complex nature of poverty by focusing on the livelihoods of poorer sections and to address their root causes. ASHRA, a project in collaboration with CARE, Uttar Pradesh Government and Kamala Nehru Hospital was started with 50 slums initially in 2002 for which Community Vikas Samiti were formed later in each slum. Certain slum development programs undertaken by DUDA are National Slum Development, Nagariya Swarojgar Yojna, Nagariya Mazdoori Yojna, Girl Child Development Scheme and Construction of houses for weaker sections. “The current capacity constraints of many local bodies implicit is the idea of looking beyond dependence on government and attempting to solve problems through community or local involvement”. The following model explains the *participatory* approach of urban poor and local bodies towards integrated development of cities and slum management.

Following measures suggested that may be initiated by the competent authority well local initiatives of slum residents in the light of the study of slums in the city region of Allahabad :

(i) The housing schemes under Valmiki Ambedkar Malin Basti Awaas Yojna (VAMBAY) need to be adhered to, to fulfill the requirements of poor housing. For this, the local development authority should create awareness of housing schemes for slum dwellers which would be monitored by the state government. The construction of a cluster of houses with a common public toilet based on *’user pays principle’* can be encouraged.

(ii) Productive involvement of women participation as income generators in family can be enhanced by initiating

activities like block painting, candle making, food processing units, dressmaking, laundry, piggery, incense stick making for financial support.

(iii) Night schools and evening classes should be introduced for people who cannot attend school due to daytime jobs. This may reduce the incidence of poor education and help school drop -outs to enter main stream of elementary education.

(iv) Keeping in view the ecological significance of the river sites, the urban planners should restrict the sprawling of slums through alternative upgradation schemes. The prior step must include the efficient management of uncovered drains, ill hygienic sanitation, proper solid disposal and construction of sewage.

(v) The government must have vigilant monitoring system to poverty alleviation and slum management tasks, in absence of which all their efforts would turn futile. There should be Self Help Groups created who would represent the problems of slum dwellers and launch awareness missions and programmes such as door to door campaigns on health, hygiene, sanitation, literacy and child welfare.

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Effective Utilization of Betta Lands through Cultivation of Biofuel and NTFPs for Sustainable Land Use in Uttara Kannada District of Karnataka

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Abstracts

The experiment was carried out in farmers field in Kongod village of Sirsi taluk in during the year 2015-16. In this study betta lands were selected that are under-utilized and fallow with natural cover of the species On the basis of preliminary survey, ten different locations were chosen MPTs (Multi purpose Tree species) namely, *Pongamia pinnata, Simarouba glauca, Mesua ferrea, Madhuca latifolia, Calophyllum inophyllum Syzygium cumini, Myristica malabarica, Emblica officinalis, Sapindus laurifolia, Garcinia indica,* were planted in t betta lands. The experimental results revealed that at the 30 days after planting, the height and collar diameter was significantly higher with *Pongamia pinnata,* that is , 100.21 cm and 11.46 mm respectively. Whereas other species with least were noticed are *Simarouba glauca* with height and collar diameter, 32.01 cm and 6.36 mm respectively. Whereas, the 60 days after planting, the increased height and collar diameter was shown by the *Calophyllum inophyllum* with47.78 cm and 7.77 mm respectively, as compared with least increment was shown by *Mesua ferrea* with height of 33.42 cm and collar diameter of 6.67 mm at 90 days after planting, the increment of collar diameter and height was noticed with *Simarouba glauca* 8.09 mm and 34.76 cm) respectively ,whereas the least recorded with *Mesua ferrea* with the collar diameter of 7.50 mm and height of 34.60 cm.

Key words : *Uttara Kannada, betta lands, TBOs, NTFPs and growth parameters.*

Introduction

The Uttara Kannada district has very rich forest resources that are spread over 3000 km2 and characterized by the cultivation of Areca –spice cultivation by the inhabitant farmers. To mitigate the hunger for land resources and to enhance the productivity of arecanut, the government has extended certain forest privilages in the form of soppin betta for the bonafide use of the cultivators in the Uttara Kannada district. Soppinabetta (or betta in short) which literally means “Hill providing leafy matter”. Physically, it referred to the strips or patches of tree land on the hill slopes adjoining the areca orchards that were traditionally, lopped by the areca cultivators for mulch, animal bedding, manure and fuel wood. Legally, it refers to the specific place of the forest land attached or assigned to a specific orchards plot, conferring exclusive privileges to the owner of the orchard plot.

The kind of betta that meets one at every turn in the garden tracts consists of open forest of mutilated stems from which the branches have been lopped close to the trunk, and on which fresh shoots are allowed to remain for periods varying from one to three years. The indurations, impoverishment and degradation of the soil and necessary consequences of such treatment, and in time such and must become utterly barren for all practical purposes of garden owners of foresters (Anon, 1984). Nearly 70 per cent of betta lands are in degraded condition and have become grasslands instead of being covered by useful tree (Reddy *et al*., 1986).

Betta lands holders have right to dig wells, erect shelters and remove soil and plant areca in the flat land so created. They even have the right to harvest timber upon obtaining permission from and paying some price to the Divisional Forest Officer. This price was a very nominal rate of Re. 1 per tree till 1981, and even today, the rate changed is about half the market price (Anon., 1987). However, an attempt was made to know the developmental activities such as planting of seedlings of different species and practice of setting fire in the betta land. Due to the increase pressure caused by the reckless lopping, uncontrolled grazing forest fires, exploitation of minor forest products, the major betta lands are facing degradation.

In view of this, the sustainable development of betta land is very important by planting the important plants such as TBO’s and NTFP’s in fallow betta land, which will enhance farmers to get an additional income, and also helps in conserving soil moisture and ultimately enhance forest cover of the particular region.

Tree borne oil seeds (TBO’s) and Non-Timber

Table-1 : Location and List of TBOs and NTFPs selected for the study.

Sl No.	Locations/ farmers field	TBOs and NTFPs	Quantity of the seedling distributed (in Nos.)
1.	Kangod	*Pongamia pinnata*	300
2.	Kansuru	*Simarouba glauca*	300
3.	Ajjibaila	*Mesua ferrea*	300
4.	Horle	*Madhuca latifolia*	300
5.	Kesarakoppa	*Calophyllum inophyllum*	300
6.	Neernalli	*Syzygium cumini*	300
7.	Massigadde	*Myristica malabarica*	300
8.	Itagooli	*Emblica officinalis*	300
9.	Bisalakoppa	*Sapindus laurifolia*	300
10.	Jaganahalli	*Garcinia indica*	300

*Each TBO's and NTFP's species for each farmer 300 seedlings were distributed.

Forest Products (NTFP's) provides additional income to the farmers, as well as by cultivating or introducing TBO's which can help rural socio economic condition. Keeping in this views, with the following objectives were taken for this study : (i) To assess the growth performance and survival percentage of TBO's and NTFP's in betta lands of Uttara Kannada district.

Materials and Methods

The experiment was carried out in farmers field in Kongod village of Sirsi taluk in during the year 2015-16. For this study betta lands were selected that are under-utilized and fallow with natural cover of the species such as *Terminalia tomentosa, Careya arborea,* and *Terminalia paniculata* etc. The details of tree species were listed in Table-1.

On the basis of preliminary survey based on the farmer preference, ten different locations were chosen around the Sirsi taluk. And the native species of TBO's namely, *Pongamia pinnata, Simarouba glauca, Mesua ferrea, Madhuca latifolia, Calophyllum inophyllum.* And NTFP's namely, *Syzygium cumini, Myristica malabarica, Emblica officinalis, Sapindus laurifolia, Garcinia indica,* were planted in the different bettalands of Sirsi taluk. Here, the number of location was treated as replication and TBOs and NTFPs treated as treatments and number of seedlings for each treatment was ten. The randomized block design were followed.

Results and Discussion

The experimental results revealed that at the 30 days after planting, the height and collar diameter was significantly higher with *Pongamia pinnata,* that is 100.21 cm and 11.46 mm respectively. Whereas other species with least were noticed are Simarouba *glauca* with height and collar diameter, 32.01 cm and 6.36 mm respectively. Whereas, the 60 days after planting, the increased height and collar diameter was shown by the *Calophyllum inophyllum* with 47.78 cm and 7.77 mm respectively, as compared with least increment was shown by *Mesua ferrea* with height of 33.42 cm and collar diameter of 6.67 mm as per the result obtained in the table 3.At last , that is 90 days after planting, the increment of collar diameter and height was seen in *Simarouba glauca* that is 8.09 mm and 34.76 cm respectively ,whereas the least shown species are *Mesua ferrea* with the collar diameter of 7.50 mm and height of 34.60 cm (Table 2 & 3). these results were conformity with The studies conducted by Rai (1981), on the floristic composition and survival pattern of tropical rain forest tree species of the Western Ghats revealed that the overwood was composed of *Callophyllum elatum* , *Diospyros sps , Euphoria longana* and *Holigarna grahmii* ;the underwood

Table-2 : Growth parameters of TBOs/NTFPs in Bettalands of Uttar Kannada district.

TBOs/NTFPs	30 DAP		60 DAP		90 DAP	
	Height (cm)	Collar diameter (mm)	Height (cm)	Collar diameter (mm)	Height (cm)	Collar diameter (mm)
Pongamia pinnata	100.21	11.46	102.46	12.27	105.62	13.16
Simarouba glauca	32.01	6.36	33.50	7.19	34.76	8.09
Mesua ferrea	32.11	5.98	33.42	6.67	34.60	7.50
Madhuca latifolia	37.36	8.35	39.12	8.46	40.69	9.13
Calophyllum inophyllum	44.65	7.14	47.78	7.77	49.63	8.49
Syzygium cumini	56.11	8.01	58.17	8.81	60.10	9.50
Myristica malabarica	61.42	6.90	63.22	7.67	65.48	8.60
Emblica officinalis	54.80	7.97	57.67	8.86	57.43	9.63
Sapindus laurifolia	40.29	6.40	42.22	7.12	43.85	7.82
Garcinia indica	50.26	7.17	51.54	7.96	52.69	8.76
SEm ±	1.98	0.041	1.96	0.40	2.06	0.42
CV	12.27	17.11	11.71	15.38	11.93	14.74
CD @ (5%)	5.56	1.15	5.52	1.13	5.78	1.19

Table-3 : Percent increment of the height and collar diameter of TBO's and NTFP's 90 DAP*

Sl. No.	Species	Increment in height (%)	Increment in collar diameter (%)
1.	*Pongamia pinnata*	5.12	12.92
2.	*Simarouba glauca*	13.66	21.38
3.	*Mesua ferrea*	7.19	20.26
4.	*Madhuca latifolia*	8.18	8.54
5.	*Calophyllum inophyllum*	10.03	15.77
6.	*Syzygium cumini*	6.65	15.9
7.	*Myristica malabarica*	6.2	15.68
8.	*Emblica officinalis*	4.57	19.77
9.	*Sapindus laurifolia*	8.11	18.15
10.	*Garcinia indica*	4.61	18.15

DAP-Days After Planting

Garcinias and *Myristicas* and the ground mainly that of *Strobilanthes.*

Among the TBO's and NTFP's different species show different result depending site or locality condition that may due to soil, moisture, water holding capacity and the also due to associate species in the surrounding. Therefore, the growth performance vary on different sites and climatic condition of the particular site.

Conclusion

From this experiment results were concluded that most of the biofuel yielding and Non-timber forest products seedling were performed better after 90 days after planting on betta-lands of Uttara Kannada district. Moreover the yields attributes as to be evaluated in subsequent years.

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Effect of Secondary Host Plants on Sandal Wood (*Santalum album*) Growth Performance in Transition Zone of Karnataka

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Abstract

Study investigates the interaction of various secondary host species on potential of Sandalwood (*Santalum album* L.) productivity in Transition Zone of Karnataka. Aim of the present study was to quantify variation in growth performance of sandalwood and to work out their relationship with different host species at field condition in Transition Zone of Karnataka. Secondary host of six different tree species were used as treatments. Sandalwood was planted with a spacing of 5 m X 5 m in pits of 50 $cm^3$with Amla followed by *Pterocapus marsupium*, *Pongamiapinnata*, *Tamarindus indica,* Bamboo and *Eucalyptus tereticornis* in quincunx pattern of plantation design. After 16 year aged of old plantation individual host show mainly for increase in height with periodical mean growth increments in trunk, collar diameter and crown area spread of *S. album* along with bamboo and *T. indica* respectively. The best growth of *S.album* was exhibited in combination with Bamboo followed by *T. indica* and *Pterocapus marsupium* among secondary host of tree species.

Key words : *Sandalwood, secondary host, growth, survival.*

Introduction

The genus Santalum belongs to the family Santalaceae, which comprises herbs, shrubs and small trees. *Santalum album* tree flourishes well from sea level up to 1200 m altitude in regions with different soil types and varying climatic conditions and an annual precipitation of 600–1600mm. Over 90 percent of sandal is distributed in Karnataka (5245 km^2) and Tamil Nadu (3045km^2), rest in Andhra Pradesh (175 km^2), Orissa (35 km^2), Madhya Pradesh (33 km^2) and Maharashtra (84 km^2) (Jeeva *et al.*, 1998).Sandalwood is a suitable candidate for dry land agriculture areas and in agro forestry systems like Silvi-horticulture. In this changing scenario, tree improvement and plantation managers may have to gear up for maximizing productivity of sandal either on private lands and public land. The primary information required for the purpose will be quantified growth variation across individuals with different secondary host trees. These will be crucial for developing efficient management schedules and for selecting superior host performers. It can grow in dry and degraded land Seed collection, handling, storage and germination methods have been standardized in IWST after a series of nursery experiments.

However, *S. album* could survive without hosts for a period of 2 to 3 years, but with poor growth and survival. Sandalwood, being a hemi-root-parasitic tree, root connection with a host species is required for nutrition to young plants as well as to the adult trees. Sandal depends on source of Ca, Fe, N, P, K, Mg, Cu, Zn, nutrients and water derived from its hosts for growth and development (Malcom and Gareth, 2005). Raising plantable quality of sandal seedlings under nursery conditions has been found to be difficult since efficient hosts which enhance the growth of sandalwood need be supplied. Thus, establishment of sandal in plantations with a secondary host is essential. Sandal benefits from a primary host at the nursery stage and from a secondary host in the field (Srinivasan *et al.*, 1992). Poor growth without a primary host even after application of supplementary nutrition has revealed that a secondary host is important for healthy and robust development of sandalwood (Luong, 2002). India has been the world's main source of high quality *S. album* for many years, but the supply has shown a steady decline over the last 10-15 years due to illegal harvesting and to the depredations of spike disease. The situation has been exacerbated by the management approach taken over the last 100 years or so, which had the effect of actively discouraging rural populations from growing sandalwood. There may be several reasons for the current paucity of data on these important traits. Investigation of the suitability of other tree crops as secondary hosts for cultivated sandal which might themselves serve as sources of income until the sandal is to reach commercial size for harvesting. In this context, the aim of the present study was to quantify variation on growth performance of sandalwood and to work out their relationship with suitable secondary host species at field condition in Transition Zone of Karnataka.

Table-1 : Effect of various secondary host plants on growth performance of sandalwood.

Sandalwood in combination with secondary host	Total tree height (m)	GBH (cm)	Survival (%)	Crown spread (sq m)
Emblica officinalis (Amla)	6.73	39.0	94	14.5
Dendrocalamus strictus (Bamboo)	7.35	40.0	98	16.4
Pongamia pinnata	7.05	39.5	94	15.4
Tamarindus indica	7.50	40.3	96	15.7
Pterocarpus marsupium	7.09	38.0	95	16.6
Eucalyptus tereticornis	6.15	38.0	91	15.3
Mean	6.98	39.1	95	15.6
SEm ±	0.11	0.75	0.62	0.39
4459 SED	0.15	1.06	0.88	0.56
CD (0.05)	0.32	2.27	1.87	1.19
CV (%)	3.98	3.84	1.30	5.03
	S	NS	S	NS

S-Significant, NS-Non significant

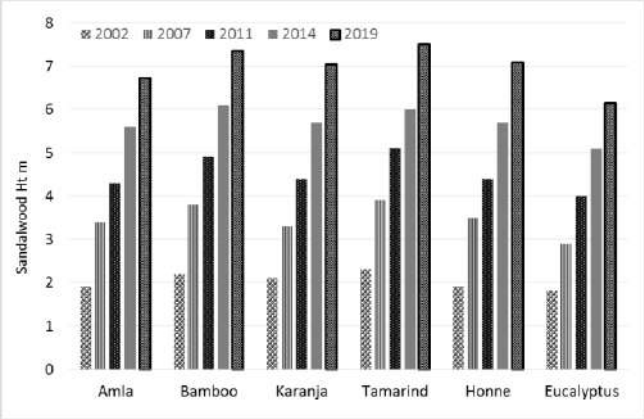

Fig.-1 : Effect of secondary hosts on Periodical Mean height increments of *Santalum album*.

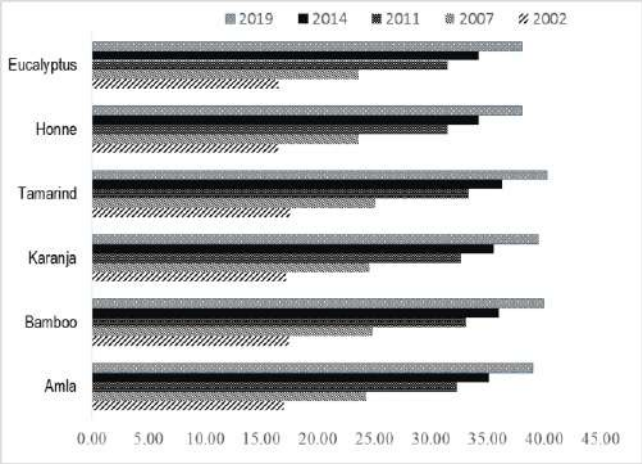

Fig.-2 : Impact of hosts trees on Periodical Mean Girth increments in *Santalum album*.

Materials and Methods

Trees used in the study were Sandalwood established during monsoon in the year 1997 on 18 ha area, 20 ha area in 2011 and 10 ha area in 2014 to understand the potential response of various secondary host on Sandalwood species in Dharwad. The experiment was performed at the Gungaragatti, Dharwadis situated in the Northern Transitional Zone of Karnataka between 15º 15' to 15º 35' N and 75º 20' E longitude with an altitude of 768 meters above the mean sea level, with an average rainfall of 786 mm. Annual rainfall records in the district occur from southwest monsoon extends from June to September, an average of 59 rainy days. Soil consisted of a well drained loamy sand over gravel.

The six initial host species were *Emblica officinalis* (Amla), *Pterocarpus marsupium*, *Pongamia pinnata*, *Tamarindus indica*, Bamboo and *Eucalyptus tereticornis*. The host seeds were collected from natural populations nearby Dharwad, which were from a plantation of unknown origin. In March - April 1996, sites were ripped in pits of 50 cm^3, in lines spaced 5 m apart in Quincunx design. In June–July 1996, the host seedlings (age 6 months) were planted along the lines at 5 m intervals. Six separate secondary host treatments seedlings were planted as the long-term hosts. Each of the six treatments was replicated four times in Randomised Block Design, hosts planted at each site. In June 1997, sowing spots were sprayed with glyphosate to control weeds before the *S. album* seedlings emerged. Initial host survival was determined at the time of planting the *S. album* saplings. Total area of sandalwood is 48 ha in a series of block plantation. The area was well protected from grazing/fire, supported with irrigation during the first two years only and weeded. Survival and growth were recorded periodicals in June 1998 (1 year), June 2002 (5 year later), June 2007 (10 year later), June 2014 (15 year later) and June 2019 (20 year later). The tallest *S. album* seedling at each host spot was measured for height and stem diameter at 20 cm above the ground (Khanna and Chaturvedi, 2011). Statistical analysis survival and growth

(a) Sandalwood + Bamboo host

(b) Sandalwood + *Pterocarpus marsupium*.

Plate : (a) Growth performance of Sandalwood with *Dendrocalamus strictus* host interaction
(b) Growth performance of Sandalwood with *Pterocarpus marsupium* host interaction.

were compared between treatments and between sites using two-way analysis of variance (ANOVA).

Results and Discussion

The data on secondary host treatment means for total tree height (m), Girth at breast height (GBH), survival per cent and crown spread (m) of the 16 years old sandal wood are summarised in Table-1. A statistical analysis shows that total tree height and GBH vary significantly. With the different six secondary host plants species that were tested some clear variation in Sandalwood growth occurred. In 16 year old plantation individual show mainly in increase in height (4.3 m and 4.4 m) with mean periodical growth increment in trunk collar diameter (23.4 cm and 23.0 cm) of *S. album* with near bamboo and *T. indica* respectively. Competitive interaction of *S. album* growth performance was recorded significantly higher nearby secondary hosts viz., *Bamboo* followed by *T. indica* and *P. Marsupium* species (Fig.1). Growth performance interaction with *T. indica* and *Bamboo* plants were exhibited significantly higher for periodical mean increments for total tree height of *S. album* (7.5 m and 7.35 m respectively) among the secondary host species. In the same way of *P. pinnata* and Eucalyptus hosts tree were shown at lower mean periodical growth increment rate when compared to *P. marsupium* and Amla species, which was closely followed by of *S. album.* The results with respect to height and collar diameter were similar with the findings of Veerendra *et al*., (1999) reported that variability in various provenances of *S. album* near host. Intensity of height and diameter increases growth of *S. album* over the years is outcome of interaction between genome and micro-site environment as well as integrated and organized energy conversion of secondary host root system. This means that the better growth potential of *S. album* species even at the harsh sites can be ascribed to the prevailing growing condition. This results confined with that of Ananthpadmanabhe *et al.,*(1988) more than 70 species of host plants have been found to have capacity to become host for Sandalwood.

Survival percentage of *S. album* among the different secondary host tree species, the species like the Bamboo was exhibited superior performance in all growth periodical mean increments. Mean collar diameter of *S. album* was not significantly different between sites and also no interaction between site and host treatment (Fig.2).The results of this study, however, conform to the finding of Nagaveni and Vijayalakshmi (2007) haustorial formation, number of haustoria per plant, varied with the association of different host which influence the inputs of growth and development of Sandalwood plants.

The data on crown spread of *S. album* with different host tree species are presented in Table 1. The rate of crown spreading of the tree species among the different six host tree species the Bamboo and *P. marsupium* shown the good results and periodical mean increments of crown spreading of *S. album* was more near both host species (Plate 1 & 2).There was significant interaction between site and host species for crown spread in all periodical growth mean increment. The higher survival percentage of *S. album* (98.0 and 96.0 per cent) was recorded near Bamboo and *T. indica* host plants respectively. Assessment of survival in Sandal wood plantation showed that host of Bamboo has significantly superior for survival rates. While, at age 16 year, mean survival of Eucalyptus was significantly lower than survival of the other host species which may be due to lack of moisture content, deep root system and as suitable soil. Environmental condition, such as soil, rainfall and climates are very much influential to the growth of *S. album*. The results of this study, however, conform to the finding of Brand *et al.,*(2003) that K appears to be an

important element which *S. album* gains from suitable host species. Similar results on the better survival of Sandalwood was also observed by Chauhan and Aggarwal (2007) recommended that one host per sandal plant and or one host per four sandalwood plants in quincunx formation and natural growth. Considering all these biometric variables of sandalwood, it may be inferred that the secondary host tree species *viz.,* Bamboo and *T. indica* were the most promising and suitable as secondary host for competitive interaction on higher growing nature of *S. album,* which may be utilized for establishment of new plantation in Transition Zone of the Karnataka (Plate 1 & 2).There was no serious pest or disease incidence duringany of the years in Sandalwood plantation.This assumption is consistent with the findings of Ashokan and Natalya (2007) opined the influence of simultaneous planting Sandalwood and host plants.

Sandalwood is typically established using a host to maximise growth at all periodical growth mean increments. It is concluded that the present investigation paved the way for selecting suitable hosts for increasing total tree height, crown spread and collar diameter growth of *S. album* at the degraded site. Similarly, Sandalwood growth could be improved by growing fast near Bamboo followed by *T. indica* and *P. marsupium*. Trials are also needed toassess the effect of different ratios of Amla and *P. pinnata* on combination with *S. album* performance initially to reach commercial size. However, unlike Eucalyptus, relatively fast host growth did not correspond to fast growth on *S. album*. This indicates that fast growing secondary host plants may not always augment the *S. album* growth for harvestable size in short period. Survival and growth variables of *S. album* were lowest near Eucalyptus and this species does not appear to be a suitable among the host tree species growing at the same site. Though sandal is considered to be a slow growing tree under forest conditions (1 cm girth per year), but it can grow at a rate of 3 cm of girth per year under favourable soil and moisture conditions (Fig.2). The experiments suggest that up to age of 16 years the best growth of Sandalwood is achieved near with Bamboo and *T. indica* species among secondary host plants.

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Effect of Seasons, Growth Hormones and Age of Cuttings on Sprouting and Rooting Response of *Sapindus mukorossi* Gaertn. of Garhwal Himalaya

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Abstract

Both the hard wood and juvenuile cuttings of *Sapindus mukorossi* Gaertn. were tested for their capacity to form roots. Cuttings were treated with different concentrations of auxins (IAA, IBA, NAA and 2,4-D) in four seasons (spring, summer, rainy and winter). Hard wood cuttings of *S. mukorossi* rooted only in spring season whereas juvenile cuttings of the same species rooted in three seasons (spring, summer and rainy). Exogenous application of IAA and IBA induced profuse rooting in *S. mukorossi*.

Introduction

Natural resources like forests are the main source of economy in Garhwal Himalaya. But due to over exploitation, some forest tree species including *Sapindusmukorossi* have limited only up to some patches. Vegetative propagation in forest tree species has gained an increasing importance during the years. Rooting response of stem cuttings is an important means of vegetative propagation in forestry and horticulture. It enhances the big advantage of higher genetic uniformity and availability of quality stock for afforestation and reforestation programmes. Some studies have already been conducted on vegetative propagation of species having social forestry / Agroforestry importance in mountains (Pauri and Shamet, 1988; Bhatt and Todaria, 1990). Growth hormones have been shown to promote rooting of shoot cuttings in many woody plants (Shamet and Dhiman, 1991; Gurumurti *et al*, 1994). In spite of this, season of taking the cuttings, nutrient statusand age of the plants are some of the factors, which influence the rooting behavior considerably. The present study was, therefore designed to investigate the impact of growth hormones, season and age of cuttings on sprouting and rooting response of stem cuttings of *Sapindusmukorossi*.

Materials and Methods

The experiment was conducted in the Nursery Department of Forestry, HNB Garhwal University, Srinagar, Uttarakhand, (30°13'26" N Latitude, 78° 48' 04" E longitudes and 550 m asl altitude). The mean annual average rainfall was 750 mm, mean annual relative humidity was 59 % and mean air temperature ranged from 12.4°C (January) to 30.3°C (June).The branch cuttings of *Sapindus mukorossi* were collected from juvenile (Soft wood 1 year old) and healthy mother trees (hard wood 10-15 year old) from nursery of Forestry Department and their natural habitat (Garhwal Himalaya) respectively in four seasons-Spring (February), Summer (May), Rainy (August) and winter (November). After removing the distal ends of branch, branch cuttings (15 – 20 cm) of *Sapindus mukorossi* were treated with different concentrations (100, 200, 500, and 1000 – ppm solutions) of growth hormones IAA, IBA, NAA, 2, 4-D. Both types of cuttings (juvenile and hard wood) were treated separately. Lower 5cm portion of each type of cuttings was dipped in the hormonal solution for 24 hours. 20 cuttings of each type were simarily dipped in the hormonal solution for 24 hours. 20 cuttings of each type were similarly soaked in distilled water to serve as control. After treatment, the cuttings were planted in polythene bags containing 1: 2: 1ratio of sand, garden soil and farmyard manure. For the experiment, a total of 510 poly bags were used including control for one type of cuttings (juvenile / hard wood). These poly bags were arranged in randomized fashion. Poly bags were kept in net house of the experimental garden of Forestry Department at Srinagar (Garhwal). Planted cuttings were watered regularly however water logging was avoided. Observations on sprouting were scheduled after 30, 60, and 90 days after planting. Rooting response of cuttings was recorded by uprooting the cuttings after 90 days. The data were analysed statistically using Statistical Computer Software SPSS 11. The significance level was checked using one way ANOVA.

Results and Discussion

Seasonal Sprouting and Rooting Responseof Hard Wood Cuttings of *Sapindus mukorossi* : *Sapindus mukorossi* showed sprouting response in all the four seasons, however, best sprouting response was observed in spring season followed by rainy season as compared to other seasons (Table-1). Maximum sprouting 80 % was recorded in cuttings treated with IBA 200 ppm, followed (75 %) in IAA, IBA 500 ppm, followed by (75 %) in IAA, IBA 500 ppm in spring season. Average number of sprouts per sprouted cutting remained more or less same with all the

Table-1 : Seasonal effects on sprouting and rooting response of hard wood cuttings of *Sapindus mukorosii.*

Seasons	Spring (90 days)					Summer (90 days)			
Concentration	Sprouting %	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)	Sprouts/ sprouted cutting	Sprout length (cm)	Rooting %	Roots/ rooted cutting	Ave. root length (cm)
Control	45	5	2.00± 0.00	4.20± 0.42	1.60 ± 0.54	2.93 ± 1.10	15	1.66 ± 0.57	1.68 ± 0.55
IAA100	65	-	-	-	1.20 ± 0.44	7.60 ± 3.13	55	1.80 ± 0.83	2.16 ± 1.34
IAA 200	50	-	-	-	1.20 ± 0.44	4.01 ± 1.67	45	2.00 ± 0.00	2.40 ± 0.99
IAA500	75	-	-	-	1.20 ± 0.44	2.93 ± 0.66	55	2.20 ± 1.09	2.82 ± 1.03
IAA 1000	35	-	-	-	1.20 ± 0.44	4.15 ± 1.96	25	1.40 ± 0.54	3.31 ± 1.15
IBA 100	65	10	2.50± 0.70	4.34± 0.83	1.00 ± 0.00	4.90 ± 1.24	50	1.80 ± 0.44	2.68 ± 0.94
IBA 200	80	-	-	-	1.20 ± 0.44	4.62 ± 2.23	40	1.80 ± 0.44	5.35 ± 2.25
IBA 500	75	-	-	-	1.20 ± 0.44	10.1 ± 3.81	45	1.40 ± 0.54	3.40 ± 1.41
IBA 1000	65	-	-	-	2.80 ± 0.44	3.97 ± 2.17	55	1.40 ± 0.54	4.38 ± 2.28
NAA 100	70	5	3.00± 0.00	3.33± 0.90	1.00 ± 0.00	3.48 ± 1.57	40	1.20 ± 0.44	2.78 ± 1.20
NAA 200	40	5	2.00± 0.00	4.20± 0.42	1.00 ± 0.00	3.98 ± 1.58	15	1.00 ± 0.00	2.48 ± 0.80
NAA 500	60	-	-	-	1.00 ± 0.00	4.54 ± 1.23	25	1.20 ± 0.44	2.36 ± 0.68
NAA 1000	60	-	-	-	1.00 ± 0.00	3.68 ± 1.15	20	1.50 ± 0.27	2.55 ± 1.16
2,4 -D 100	5				1.00 ± 0.00	4.00 ± 0.00	-	-	-
2,4 -D 200	5				1.00 ± 0.00	3.30 ± 0.00	-	-	-

Table-1 : Contd…..

Seasons	Rainy (90 days)			Winter (90 days)		
Concentration	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)
Control	15	1.33 ± 0.57	3.17 ± 0.67	-	-	
IAA100	30	1.40 ± 0.54	4.15 ± 1.91	-	-	
IAA 200	25	1.40 ± 0.54	5.34 ± 1.12	3 0	1.40 ± 0.54	2.84 ± 0.77
IAA500	35	2.20 ± 0.44	5.43 ± 1.30	25	1.40 ± 0.54	4.02 ± 1.30
IAA 1000	20	2.00 ± 0.00	3.46 ± 1.05	-	-	-
IBA 100	45	1.60 ± 0.54	6.41 ± 0.98	-	-	-
IBA 200	50	1.60 ± 0.54	5.58 ± 1.10	20	1.80 ± 0.44	3.93 ± 1.49
IBA 500	55	1.60 ± 0.54	6.60 ± 2.35	20	1.800.44	4.40 ± 1.02
IBA 1000	40	2.20 ± 0.83	7.30 ± 1.49	-	-	
NAA 100	25	1.80 ± 0.44	3.83 ± 1.10	-	-	
NAA 200	35	1.80 ± 0.44	4.28 ± 1.30	-	-	
NAA 500	20	1.80 ± 0.44	3.72 ± 1.18	20	1.60 ± 0.54	3.82 ± 0.82
NAA 1000	-	-				
2,4 -D 100	-	-				
2,4 -D 200						

± indicates standard deviation of mean

treatments excluding IBA 1000 ppm which recorded maximal number (2.80) of sprouts per sprouted cutting after 90 days of planting. Maximum sprout length (10.1) was recorded in IBA 500 ppm in spring season. On the other hand on an average maximum 55 and 10 % sprouting was recorded in rainy and summer season respectively (Table-1).

Stem cuttings resulted into well developed rooting only in the spring season (Table-1). Maximum number of rooted cuttings (55 %) was observed with IAA 100 ppm, IAA 500 ppm and IBA 1000 ppm treatments, however, roots per rooted segment werehighest with IAA 500 ppm treatment. Average maximal root length was found with IBA 200 ppm treatment. Control set also induced rooting upto some extent in the spring season (Table- 1). Majority of the mountain tree species did not sprout / root in the winter (Bhatt and Todaria, 1990). Variation in sprouting percent and failure of the cuttings to root in rest of the seasons may be due to low growth activities and lack of appropriate moisture regime at experimental site. As experiment was conducted in the net house, therefore it was not possible to maintain appropriate moisture regime, average 59 % relative humidity and 22 ^{o} C average air temperature was recorded at experimental site during spring (February - April). Thus, it seems that sufficient relative humidity and moderate air temperature favours root initiation in most of the tree species. Similar

Table-2 : Seasonal effects on sprouting and rooting response of juvenile cuttings of *Sapindus mukorosii.*

Seasons	Spring (90 days)						Summer (90 days)					
Concentration	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)	Rooting %	Roots/ rooted cutting	Ave. root length (cm)	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)	Rooting %	Roots/ rooted cutting	Ave. root length (cm)
Control	25	1.40± 0.89	3.28 ± 2.15	20	2.50 ± 1.73	5.18 ± 3.69	30	1.00 ± 0.00	9.94 ± 1.22	30	2.80 ± 0.83	6.99 ± 3.23
IAA100	55	1.20 ± 0.44	4.86 ± 3.21	55	4.80 ± 1.48	8.86 ± 3.69	70	1.20 ± 0.44	10.45 ± 2.24	70	3.60 ± 1.40	9.98 ± 3.92
IAA 200	40	1.00 ± 0.00	6.54 ± 6.23	40	5.20 ± 0.83	8.43 ± 3.33	60	1.00 ± 0.00	13.16 ± 4.42	60	6.40 ± 0.89	8.45 ± 4.08
IAA500	30	1.00 ± 0.00	4.10 ± 2.88	30	7.60 ± 2.07	5.42 ± 2.57	70	1.00 ± 0.00	9.96 ± 3.32	70	7.20 ± 1.78	8.57 ± 3.55
IAA 1000	15	1.00 ± 0.00	1.12 ± 0.25	15	4.00 ± 2.64	5.35 ± 2.87	35	1.00 ± 0.00	9.64 ± 3.32	35	5.20 ± 2.58	9.88 ± 4.17
IBA 100	55	1.20 ± 0.44	6.03 ± 1.90	55	8.00 ± 3.39	6.82 ± 4.06	50	1.00 ± 0.00	10.62 ± 5.32	50	6.20 ± 1.48	9.54 ± 4.40
IBA 200	35	1.00 ± 0.00	5.58 ± 2.56	35	5.80 ± 4.08	7.58 ± 6.10	55	1.40 ± 0.54	10.40 ± 6.90	55	6.25 ± 3.50	9.71 ± 6.76
IBA 500	50	1.00 ± 0.00	7.70 ± 5.10	50	9.00 ± 3.08	18.00 ± 4.38	55	1.00 ± 0.00	10.72 ± 2.17	55	6.00 ± 2.82	7.31 ± 4.52
IBA 1000	20	1.00 ± 0.00	2.47 ± 0.86	20	8.00 ± 2.94	5.09 ± 3.15	20	1.20 ± 0.44	9.30 ± 4.36	20	8.40 ± 2.30	10.18 ± 3.77
NAA 100	30	1.20 ± 0.44	7.33 ± 1.12	30	2.40 ± 0.54	3.10 ± 1.20	25	2.20 ± 0.44	8.75 ± 1.89	25	2.00 ± 0.00	3.16 ± 1.36
NAA 200	35	2.00 ± 0.70	7.37 ± 1.68	35	2.20 ± 0.44	4.20 ± 1.60	30	1.40 ± 0.54	9.15 ± 1.66	30	2.00 ± 0.00	4.17 ± 1.69
NAA 500	20	1.75 ± 0.50	6.01 ± 0.84	20	2.75 ± 0.50	3.50 ± 1.50	15	1.00 ± 0.00	8.70 ± 0.60	15	2.00 ± 0.00	4.41 ± 0.95
NAA 1000	15	1.66 ± 0.57	7.28 ± 1.55	15	2.00 ± 0.00	3.30 ± 1.40	10	1.00 ± 0.00	8.20 ± 1.41	10	2.00 ± 0.00	4.12 ± 1.05

Table-2 : Contd.....

Seasons	Rainy (90 days)						Winter (90 days)		
Concentration	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)	Rooting %	Roots/ rooted cutting	Ave. root length (cm)	Sprouting %	Sprouts/ sprouted cutting	Sprout length (cm)
Control	-	-	-	-	-	-	-	-	
IAA100	10	1.00 ± 0.00	17.25 ± 1.34	10	1.50 ± 0.70	6.26 ± 1.84	20	2.00 ± 1.00	2.81 ± 0.61
IAA 200	15	2.00 ± 0.00	13.10 ± 2.10	15	3.00 ± 0.00	6.20 ± 2.91	25	1.40 ± 0.54	3.35 ± 0.64
IAA500	15	1.66 ± 0.57	11.98 ± 2.54	15	3.33 ± 1.15	4.54 ± 2.77	-	-	-
IAA 1000	-	-	-	-	-	-	-	-	-
IBA 100	40	1.80 ± 1.30	11.56 ± 4.86	40	2.20 ± 0.44	8.69 ± 4.04	25	1.80 ± 0.44	3.47 ± 0.39
IBA 200	60	1.20 ± 0.44	15.66 ± 5.17	60	2.20 ± 0.44	6.00 ± 3.27	20	2.00 ± 0.00	2.87 ± 0.52
IBA 500	15	1.20 ± 0.44	8.57 ± 3.91	15	3.00 ± 0.00	7.62 ± 3.76	25	2.00 ± 0.00	3.56 ± 0.41
IBA 1000	5	1.00 ± 0.00	10.75 ± 0.77	5	1.00 ± 0.00	5.20 ± 1.50	-		-
NAA 100	40	1.00 ± 0.00	12.54 ± 1.72	40	2.20 ± 0.44	3.29 ± 1.32	20	1.25 ± 0.50	3.48 ± 0.19
NAA 200	25	1.20 ± 0.44	10.91 ± 1.70	25	2.00 ± 0.00	3.31 ± 1.22	20	1.50 ± 0.57	3.60 ± 0.32
NAA 500	30	1.00 ± 0.00	11.46 ± 2.33	30	2.20 ± 0.44	4.19 ± 1.90			

± indicates standard deviation of mean.

Table-3 : Overall effect of hormonal concentration and seasons on hard wood and juvenile cuttings of *S. mukorossi*.

Overall effect of hormonal concentrations on hard wood cuttings of *S. mukorossi*	Shoot length	18.478P***
	Sprouts / sprouted	19.411***
	Root length	1.667*
	Roots / rooted	1.522^{NS}
Overall effect of seasons on hard wood cuttings of S. *mukorossi*	Shoot length	89.449***
	Sprouts / sprouted	95.551***
	Root length	64.454***
	Roots / rooted	65.953***
Overall effect of hormonal concentrations on juvenile cuttings of *S. mukorossi*	Shoot length	27.735***
	Sprouts / sprouted	57.482***
	Root length	5.048***
	Roots / rooted	5.049***
Overall effect of seasons on juvenile cuttings of *S. mukorossi*	Shoot length	51.984***
	Sprouts / sprouted	6.926***
	Root length	23.910***
	Roots / rooted	25.329***

***Significant at 0.001, *Significant at 0.05, Ns = non-significant

observations have also been made by other workers (Bhatt,1990; Chauhan, 1994). Hartmann and Kester (1975) also reported that air temperature between 21 to 27°C is favourable for inducing rooting in most of the tropical species.

Seasonal sprouting and rooting response of juvenile cuttings of *Sapindus mukorossi* : Juvenile cuttings of *Sapindus mukorossi* planted during summer recorded excellent sprouting response. IAA 100 and 500 ppm treated segments recorded highest sprouting 70 % in summer season, followed by 60 % in IBA 200 ppm in rainy season as compared to other seasons (Table-2). Sprouts per sprouted cutting were recorded maximum 2.20 in NAA 100 ppm in summer season than other seasons. Average highest sprout length was observed 17.25 cm inIAA 100 ppm in rainy season (Table-2).

Rooting response of juvenile cuttings of *Sapindus mukorossi* was observed in three seasons. Number of sprouted and rooted segments was comparatively higher with IAA treatments 60–70%. Number of roots per rooted cutting was found higher (9.00) in IBA 500 ppm in spring season. Application of IBA 500 ppm induced highest root length (18.00 cm) in spring season. Untreated cuttings also sprouted and rooted to some extent (Table-2). However, for juvenile cuttings of *S. mukorossi* the best sprouting was observed in summer season (April - June). It shows that season really plays important role in the formation of roots in *S. mukorossi*. Significant (P = 0.001) variation were observed in terms of seasonal effects for shoot length, sprouts per sprouted cutting, root length and roots per rooted cutting (Table-4). It also indicates that for hard wood cuttings taken from 10-15 yrs old trees of *S. mukorossi*, the best season for vegetative propagation through cuttings is only spring (Table-1).

Juvenile cuttings of *S. mukorossi* taken from one year old seedlings and treated with auxins and planted during spring, summer and rainy seasons showed both sprouting and rooting response. It shows that the juvenile cuttings of*S. mukorossi*are most favourable as compared to the hard wood cuttings of the same species. Likewise the effect of seasons showed significant (P = 0.001) variations in shoot length, sprouts per sprouted cutting (Table-4). The results of the present investigation and those achieved by other workers for rooting response of various species (Bhatt, 1990; Chauhan, 1994; 1996) indicate wide variations in rooting ability of cuttings and inconsistent effect of different concentrations of auxins. The root shoot attributes of *S. mukorossi* (juvenile) differed significantly (P = 0.001) with different auxin treatments. The important point in case of *S. mukorossi* (juvenile) is that, the response of particular auxin varied with season. While sprout number was higher in NAA 100 ppm treated cuttings in summer, but higher number of roots was induced by IBA 500 ppm during spring. The highest shoot length was observed in IAA 100 ppm during rainy season and root length was higher in IBA 500 ppm during spring. This implies that the root shoot attributes are affected differentially by different auxins in different seasons. Nanda *et. al* (1969, 1970) suggested that effectiveness of exogenously applied auxins changes with seasons and further governed by morpho – physiological conditions related to bud dormancy. IBA 500 ppm proved most effective for inducing root shoot number and root shoot length in stem cuttings of *S. mukorossi*. Bhatt and Todaria (1989) also found that amongst *S. mukorossi, P. cerasoides, Q. leucotricophora* and *L. parviflora*, only *S. mukorossi* rooted very well while other species callus could not differentiate into adventitious roots.

Sprouting and rooting response of species is not

only controlled by seasons and hormonal treatment but also by the age of the mother plant. It is well known that rooting capacity decreases with the ontogenetic development of a plant from juvenile to adult phase (Franclet, 1981; Hartmenn and Kester, 1983). Kanwar *et al.,* (1995) also reported maximum 77.5 % and 60 % rooting using juvenile soft cuttings. Singh *et al*., (2004) reported that in *Albiziaprocera,* significant adventitious rooting took place in soft wood juvenile cuttings taken from seedlings. Varied degree of success has been achieved in *Grewiaoptiva* through vegetative propagation in juvenile soft wood cuttings (Khosla *et al*., 1982; Nagpal and Seghal, 1985; Shamet and Dhiman, 1991; Kanwer *et al*.,1995). The present investigations showed that treatments with higher concentration of IBA were most effective in terms of sprouting and rooting in hard wood as well as juvenile cuttings (Tables 1-3).

Therefore, it can be inferred that seasonal stimuli played a crucial role in sprouting, while hard wood and juvenile cuttings of *S. mukorossi* sprouted in all the four seasons. However, best sprouting was recorded in spring (Feb-April) season for hard wood cuttings of *S. mukorossi*.

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A Bibliometric Studies of Indian Journal of Traditional Knowledge

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Abstract

In the present study, we have investigated the Indian Journal of Traditional Knowledge during the period of 2015-2019. The objective of this study is to analyze the different aspects of this journal like year wise distribution of articles, page length of the articles, distribution of references, Geographical contribution and the authorship pattern of the articles. In this study, out of 503 articles, the maximum 104(20.68%) articles was published in the year 2019. Out of 14501 references in 503 articles, the maximum 3533(24.36%) references produced in the year 2019. From the study it has been found that, not only Indian articles but also foreign articles were published in this journal.

Key words : *Indian journal of traditional knowledge, bibliometric.*

Introduction

Indian Journal of Traditional Knowledge is quarterly journal and it is published in January, April, July and October. Indian Journal of Traditional Knowledge will carry original research paper, review article, short communication etc. in the relevant field. This journal was published since 2002 by the CSIR-NISCAIR. The study highlights the various article of scholarly content published by this journal during 2015-2019.

Review of literature

The study conducted for the journal "Indian Journal of Fisheries" by Jan & Ridwana, (2017) who presented a bibliometric analysis of the journal. The aim of the study is to find out the authorship pattern and citation pattern of articles that appeared in journal. The study covers issue no's 1 to 4 of volumes 46-59 published from 1999-2012 has been carried out. This study demonstrates and elaborates the various aspects like year-wise distribution of articles, rank of cited authors etc. have been analyzed. They found that the maximum 101 articles was published in 2012 and the majority of the contributions are from Kerala.

Another bibliometric study done by Kashyap, (2017) of the Journal of Advances in Library and Information Science. The purpose of the study is to analyse the year wise distribution of article, country & state wise distribution and author productivity. In this study they reported that the highest 69 (20.53%) articles published in the year 2017 and lowest 38 (11.30%) articles published in the year 2012. They also reported that the highest 127 (19.44%) contributors are contributed in the year 2017. Out of 336 contributions the highest 229 (69.60%) contributions are from Tamilnadu.

Swain *et al* (2014) presented a bibliometric analysis of the "Journal of Educational Media and Library Science (JoEMLS)" for the period 2008-2012. In this study, they observed that the Journal of Educational Media and Library Science publications are led by two-author papers, followed by single-author papers and three-author papers. The degree of collaboration was 0.63. The maximum article were contributed by Taiwan. The frequent occurrences of keywords indexed in the articles, like 'bibliometrics', 'information literacy' and 'digital archive', indicate its research focus on promising areas of librarianship. On examination of citations of all the published articles of JoEMLS, it is found that among the 99 published papers, only 17 have received their relative impact as they have been more or less cited in other different published sources.

Verma *et al*, (2017) investigated the "DESIDOC Journal of Library and Information Technology" during the period of 2005-2016. In this study, they examines the various bibliometric parameters such as authorship pattern of articles & references, geographical distribution, major contributions from prolific author, state wise contribution of articles and number of references. They found that India contributed highest publications with 88.95%. The maximum 41.41% articles were contributed by two authors. Out of 553 articles, total 8516 references were cited during the study period. Out of 553 articles, four articles published in the journal were found without references from 2012-Issue 2, 2010- Issue 3&4 and 2011-Issue 6 during the study period.

Methodology of the study

In the present study, the methodology applied is bibliometric analysis which is a statistical method, used to study in detail the different aspect of bibliographic features like year wise distribution of the articles, authorship pattern, geographical distribution, page length of the

articles, distribution of references, etc. published in Indian Journal of Traditional Knowledge from 2015-2019.

Objectives

To study the year wise distribution of articles published in Indian Journal of Traditional Knowledge from 2015-2019.

To study about page length of the articles.

To study the year wise distribution of references.

To study about geographical contribution of articles.

To analyze the authorship pattern of the articles.

To study the Degree of Collaboration.

Data Analysis and Interpretation

Table-1 : Year wise distribution of articles.

Year	Volume no.	No. of articles	Percentage (%)
2015	14	98	19.48
2016	15	100	19.88
2017	16	99	19.68
2018	17	102	20.28
2019	18	104	20.68
Total		503	100

Table-2 : Page length of the articles.

Page length	2015	2016	2017	2018	2019	Total	Percentage (%)
1-5	23	25	17	16	17	98	19.48
6-10	75	72	79	80	72	378	75.15
11-15	-	3	2	5	12	22	4.37
16-20	-	-	1	-	3	4	0.80
More than 20	-	-	-	1	-	1	0.20
Total						503	100

Table-3 : Distribution of references in articles.

Year	Volume no.	References	Percentage (%)
2015	14	2251	15.52
2016	15	2540	17.52
2017	16	3050	21.03
2018	17	3127	21.56
2019	18	3533	24.36
Total		14501	100

Table-4 : Geographical contribution.

S. No.	Country	Contribution	Percentage (%)
1	India	286	56.86
2	Turkey	46	9.15
3	South Africa	20	3.98
4	Iran	17	3.38
5	Pakistan	13	2.58
6	Brazil	10	1.99
7	China	9	1.79
8	USA	8	1.59
9	Mexico	7	1.39
10	Nigeria	6	1.19
11	Saudi Arabia	6	1.19
12	Malaysia	6	1.19
13	Indonesia	5	0.99
14	Ethiopia	5	0.99
15	Philippines	5	0.99
16	Serbia	5	0.99
17	Algeria	4	0.80
18	Egypt	4	0.80
19	Srilanka	4	0.80
20	Thailand	4	0.80
21	Bangladesh	3	0.60
22	Mongolia	2	0.40
23	South Korea	2	0.40
24	Benin	2	0.40
25	Poland	2	0.40
26	Bhutan	1	0.20
27	Bolivia	1	0.20
28	Belgium	1	0.20
29	Belarus	1	0.20
30	Canada	1	0.20
31	Czech Republic	1	0.20
32	Denmark	1	0.20
33	Germany	1	0.20
34	Italy	1	0.20
35	Kenya	1	0.20
36	Lebanon	1	0.20
37	Lithuania	1	0.20
38	Madagascar	1	0.20
39	Morocco	1	0.20
40	Montenegro	1	0.20
41	Nepal	1	0.20
42	Portugal	1	0.20
43	Slovenia	1	0.20
44	Spain	1	0.20
45	Tanzania	1	0.20
46	Tunisia	1	0.20
47	Zimbabwe	1	0.20
Total		503	100

Table-1 shows that the year wise distribution of articles Indian Journal of Traditional Knowledge from 2015-2019. During the study period (2015-2019) total 503 articles were published. The maximum 104 (20.68%) articles were published in the year 2019 followed by 102 (20.28%) articles in 2018, 100 (19.88%) articles in 2016, 99 (19.68%) articles in 2017 and the minimum 98 (19.48%) articles were published in 2015. The range of percentage was varied from 19.48% to 20.68%.

Table-2 shows that 378 (75.15%) articles are of 6-10 page length, 98 (19.48%) articles are of 1-5 page length, 22 (4.37%) articles are of 11-15 page length, 4 (0.80%) articles are of 16-20 page length and 1 (0.20%) article are of more than 20 page length.

Table-5 : Authorship pattern.

Author	2015	2016	2017	2018	2019	Total	Percentage (%)
One	6	5	6	5	-	22	4.37
Two	23	23	17	13	20	96	19.09
Three	17	20	19	22	18	96	19.09
Four	19	19	21	23	16	98	19.48
More than four	33	33	36	39	50	191	37.97
Total	98	100	99	102	104	503	100

Table-6 : Single and Multi author contribution.

Year	Single author		Multi author		Total
	No. of Articles	Percentage (%)	No. of Articles	Percentage (%)	
2015	6	27.27	92	19.13	98
2016	5	22.73	95	19.75	100
2017	6	27.27	93	19.33	99
2018	5	22.73	97	20.17	102
2019	-	-	104	21.62	104
Total	22	100	481	100	503

Table-7 : Degree of Collaboration.

S. No.	Year	Degree of Collaboration
1.	2015	0.94
2.	2016	0.95
3.	2017	0.94
4.	2018	0.95
5.	2019	1.00

Table-3 shows that the distribution of references in the published articles. The maximum of 3533 (24.36%) references were produced in the year 2019, followed by 3127 (21.56%) references in 2018, 3050 (21.03%) references in 2017, 2540 (17.52%) references in 2016, 2251 (15.52%) references in 2015.

Table 4 shows that the Geographical contribution of articles. The maximum numbers of contributions of articles are from India 286 (56.86%), followed by 46 (9.15%) articles from Turkey, 20 (3.98%) from South Africa, Iran 17 (3.38%), Pakistan 13 (2.58%), Brazil 10 (1.99%), China 9 (1.79%), USA 8 (1.59%), Mexico 7 (1.39%), Nigeria, Saudi Arabia and Malaysia each 6 (1.19%) contributions, Indonesia, Ethiopia, Philippines and Serbia each 5 (0.99%) contributions, Algeria, Egypt, Srilanka and Thailand each 4 (0.80%) contributions, Bangladesh 3 (0.60%), Mongolia, South Korea, Benin and Poland each 2 (0.40%) contributions, Bhutan, Bolivia, Belgium, Belarus, Canada, Czech Republic, Denmark, Germany, Italy, Kenya, Lebanon, Lithuania, Madagascar, Morocco, Montenegro, Nepal, Portugal, Slovenia, Spain, Tanzania, Tunisia and Zimbabwe each 1 (0.20%) contribution.

Table-5 shows that the authorship pattern of Indian Journal of Traditional Knowledge which were published during 2015-2019. The maximum of 191 (37.97%) articles were contributed by more than four authors, 98 (19.48%) articles contributed by four authors, 96 (19.09%) articles contributed by two and three authors and 22 (4.37%) articles contributed by single author.

Table-6 shows that a single and multi-author contribution. The maximum 481 (95.63%) articles were contributed by multi-authors and 22 (4.37%) articles contributed by single author.

In Table-7, the degree of collaboration of the authors of Indian Journal of Traditional Knowledge has been estimated according to the formula of K. Subramanayam.

DC = (Nm) / (Nm+Ns)

DC = Degree of Collaboration

Nm = Number of multi-authors Contributions

Ns = Number of single-author Contributions

The value of Nm = 481 and Ns = 22

DC = 481/481+22 = 0.956

Table-7 shows the degree of collaboration is high *i.e.* 481 (0.956 %) in terms of multi-author Collaboration and single-author contribution is less towards the subject during the study period.

Conclusion

In the present study, we have analyzed the various factors of bibliometric study of the Indian Journal of Traditional Knowledge. This study was done for the period from 2015-2019. The total 503 articles were published during the 2015-2019. In this study, we found that the maximum number of articles *i.e.* 104 (20.68%) were published in the year 2019 and the minimum 98 (19.48%) articles were published in 2015. In the study period, 378 (75.15%) articles are of 6-10 page length which was maximum and

the minimum 1 (0.20%) article are of more than 20 page length. The maximum 3533 (24.36%) references were produced in the year 2019. Out of 503 articles, 286 (56.86%) articles were contributed by Indian authors. In author contribution, maximum 191 (37.97%) articles were contributed by more than four authors during the study period. The degree of collaboration was 0.956.

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A Bibliometric Studies of Annals of Library and Information Studies

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Abstract

In the present study, we have investigated the Annals of Library and Information Studies during the period of 2011-2019. The objective of this study is to analyze the different aspects of this journal like year wise distribution of articles, page length of the articles, distribution of references, Geographical contribution and the authorship pattern of the articles. In this study, out of 285 articles, the maximum 38(13.33%) articles was published in the year 2015. Out of 5802 references in 285 articles, the maximum 831(14.32%) references produced in the year 2013. From the study it has been found that, not only Indian articles but also foreign articles were published in this journal.

Key words : *Annals of library and information studies, bibliometric, authorship pattern, geographical contribution.*

Introduction

The term “bibliometric” was first introduced by Alan Pritchard (1969) as “the application of mathematics and statistical methods to books and other media of communication” (Pritchard, 1969). Bibliometric is an important field of library and information science because it represents a unique set of techniques and tools for monitoring and analyzing information resources and managing knowledge in social and organizational contexts. Bibliometric methods are used in the study of the properties and behaviour of recorded knowledge; for analysis of the structures of scientific and research field; and for the evaluation of research activity and administration of scientific information. (Mamdapur *et al.,* 2011). The purpose of this study is to analyze this journal on various aspects like year wise distribution of articles, page length of the articles, distribution of references, geographical contribution and the authorship pattern of the articles, which was published during 2011-2019.

Annals of Library and Information Studies is the quarterly journal in the field of Library and Information Sciences. This journal publishes original research articles, review article, survey report, short communication etc. in the relevant area. It is an open access journal, published since 1954 by the CSIR-NISCAIR. The present chief editor of this journal is Dr. G. Mahesh.

Review of literature

The study conducted for the journal “Library Herald” by Thanuskodi, (2011) who presented a bibliometric analysis of the journal, which mainly covered the number of articles, authorship pattern, subject wise distribution of articles, average number of references per articles, forms of documents cited, year wise distribution of cited journals etc. The study was pointed towards the merits and weakness of the journal which will be helpful for its future development. In his study, they reported that out of total 138 articles, 72 articles was published by single author and rest was published by joint authors. They also showed that the Indian contributors were 89.85% and rest 10.15% are from foreign sources.

Another bibliometric study done by Pandita, (2013) of the journal Annals of Library and Information Studies with the aim to understand the latest publication distribution pattern of the articles published in last decade (2002-2012). The study covered the areas like article distribution, authorship pattern, reference, and geographical distribution of authors, etc. They reported that during the selected period, 310 articles were published. In each issue of each volume, on an average 7.04 articles have been published. They reported that on an average, 17.11 references have been assigned to each article among 5307 references in total study period. During the period of study, researchers from 16 different countries worldwide have contributed research article in the journal. In the study, 65.81% of articles were contributed during study period were based on co-authorship pattern.

Kumar, (2014) presented a bibliometric analysis of the “Library Herald” journal for the period 2011-2014. In this study, they covered the number of articles, authorship pattern, subject wise distribution of articles, average number of references per articles etc. All the studies were pointed towards the merit and weakness of the journal which will be helpful for its further development. The result showed that 114 articles published during the study period. The maximum 65 (57.01%) articles were contributed by single authors and most of the articles were contributed by Indian authors with 89.47%. They concluded that the “Library Herald” is the highly preferred

journal for communication by the library and information science professionals.

Sahu, (2017) investigated the "PEARL : A Journal of Library and Information Science" during the period of 2012-2016. In the study, they analyzed the authorship pattern, distribution of research articles and country-wise distribution of articles. They found that 180 articles were published during the period of 2012-2016 and the maximum 42 (23.33%) articles was published in 2016. Most of the articles (166) were contributed by Indian authors out of 180 articles. The maximum 84 (46.66%) articles were contributed by two authors. The degree of collaboration was 0.616.

Methodology of the Study

In the present study, the methodology applied is bibliometric analysis which is a statistical method, used to study in detail the different aspect of bibliographic features like year wise distribution of the articles, authorship pattern, geographical distribution, page length of the articles, distribution of references, etc. published in Annals of Library and Information Studies from 2011-2019.

Objectives

To study the year wise distribution of articles published in Annals of Library and Information Studies from 2011-2019.

To study about page length of the articles.

To study the year wise distribution of references.

To study about geographical contribution of articles.

To analyze the authorship pattern of the articles.

To study the Degree of Collaboration.

Data Analysis and Interpretation

Table-1 : Year wise distribution of articles.

S. No.	Year	Volume no.	No. of articles	Percentage (%)
1.	2011	58	36	12.63
2.	2012	59	27	9.47
3.	2013	60	37	12.98
4.	2014	61	35	12.28
5.	2015	62	38	13.33
6.	2016	63	32	11.23
7.	2017	64	32	11.23
8.	2018	65	28	9.82
9.	2019	66	20	7.02
Total			285	100

Table-1 shows that the year wise distribution of articles of Annals of Library and Information Studies from 2011-2019. The maximum 38 (13.33%) articles were published in the year 2015 and the minimum 20 (7.02%) articles were published in the year 2019. The range of percentage was varied from 7.02% to 13.33%.

Table-2 shows that 181 (63.51%) articles are of 6-10 page length, 49 (17.19%) articles are of 1-5 and 11-15 page length, 3 (1.05%) articles are of 16-20 page length and more than 20 page length.

Table-3 shows that the distribution of references in the published articles. The maximum of 831 (14.32%) references were produced in the year 2013, followed by 819 (14.12%) references in 2011, 803 (13.84%) references in 2014, 652 (11.24%) references in 2015, 616 (10.62%) references in 2017, 584 (10.06%) references in 2018, 572 (9.86%) references in 2016, 465 (8.01%) references in 2012 and 460 (7.93%) references in 2019.

Table-4 shows that the Geographical contribution of articles. The maximum numbers of contributions of articles are from India 221 (77.54%), followed by 22 (7.72%) articles from Nigeria, 13 (4.56%) from Srilanka, Bangladesh 8 (2.81%), Iran 7 (2.46%), South Africa 3 (1.05%), USA and Tanzania 2 (0.70%) contributions, Sudan, UAE, Kazakhstan, Uganda, Malaysia, Fiji and Brazil each 1 (0.35%) contributions.

Table-5 shows that the authorship pattern of Annals of Library and Information Studies which were published during 2011-2019. The maximum of 134 (47.02%) articles were contributed by two authors, 98 (34.38%) articles contributed by single author, 40 (14.03%) articles contributed by three authors, 8 (2.81%) articles contributed by four authors, 3 (1.05%) articles contributed by five authors and 2 (0.70%) articles contributed by six authors.

Table-6 shows that a single and multi-author contribution. The maximum 187 (65.61%) articles were contributed by multi-authors and 98 (34.38%) articles contributed by single author.

In Table 7, the degree of collaboration of the authors of Annals of Library and Information Studies has been estimated according to the formula of K. Subramanayam.

DC = (Nm) / (Nm+Ns)

DC = Degree of Collaboration

Nm = Number of multi-authors Contributions

Ns = Number of single-author Contributions

The value of Nm = 187 and Ns = 98

DC = 187/187+98 = 0.656

Table-7 shows the degree of collaboration is high *i.e.* 187 (0.656 %) in terms of multi-author Collaboration and single-author contribution is less towards the subject during the study period.

Conclusion

In the present study, we have analyzed the various factors of bibliometric study of the Annals of Library and

Table-2 : Page length of the articles.

Page length	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Percentage (%)
1-5	-	3	5	6	13	4	7	7	4	49	17.19
6-10	26	16	29	21	20	20	20	15	14	181	63.51
11-15	10	6	3	7	5	7	4	5	2	49	17.19
16-20	-	1	-	-	-	1	1	-	-	3	1.05
More than 20	-	1	-	1	-	-	-	1	-	3	1.05
Total										285	100

Table-3 : Distribution of references in articles.

Year	Volume no.	References	Percentage (%)
2011	58	819	14.12
2012	59	465	8.01
2013	60	831	14.32
2014	61	803	13.84
2015	62	652	11.24
2016	63	572	9.86
2017	64	616	10.62
2018	65	584	10.06
2019	66	460	7.93
Total		5802	100

Table-4 : Geographical contribution.

S. No.	Name of countries	Contribution of articles	Percentage (%)
1.	India	221	77.54
2.	Nigeria	22	7.72
3.	Srilanka	13	4.56
4.	Bangladesh	8	2.81
5.	Iran	7	2.46
6.	South Africa	3	1.05
7.	USA	2	0.70
8.	Tanzania	2	0.70
9.	Sudan	1	0.35
10.	UAE	1	0.35
11.	Kazakhstan	1	0.35
12.	Brazil	1	0.35
13.	Uganda	1	0.35
14.	Malaysia	1	0.35
15.	Fiji	1	0.35
Total		285	100

Table-5 : Authorship pattern.

Author	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Percentage (%)
One	14	10	12	12	18	8	9	8	7	98	34.38
Two	14	11	18	18	14	18	17	16	8	134	47.02
Three	7	6	5	3	4	3	6	2	4	40	14.03
Four	-	-	-	2	1	2	-	2	1	8	2.81
Five	-	-	1	-	1	1	-	-	-	3	1.05
Six	1	-	1	-	-	-	-	-	-	2	0.70
Total	36	27	37	35	38	32	32	28	20	285	100

Information Studies. This study was done for the period from 2011-2019. The total 285 articles were published during the 2011-2019. In this study, we found that the maximum number of articles *i.e.* 38 (13.33%) were published in the year 2015 and the minimum 20 (7.02%) articles were published in 2019. In the study period, 181 (63.51%) articles are of 6-10 page length which was maximum and the minimum 3 (1.05%) articles are of 16-20 page length and more than 20 page length. The maximum 831 (14.32%) references were produced in the year 2013. Out of 285 articles, 221 (77.54%) articles were contributed by Indian authors. In author contribution,

Table-6 : Single and Multi author contribution.

Year	Single author		Multi author		Total
	No. of Articles	Percentage (%)	No. of Articles	Percentage (%)	
2011	14	14.28	22	11.76	36
2012	10	10.20	17	9.09	27
2013	12	12.24	25	13.37	37
2014	12	12.24	23	12.30	35
2015	18	18.37	20	10.69	38
2016	8	8.16	24	12.83	32
2017	9	9.18	23	12.30	32
2018	8	8.16	20	10.69	28
2019	7	7.14	13	6.95	20
Total	98	100	187	100	285

Table-7 : Degree of Collaboration.

S. No.	Year	Degree of Collaboration
1.	2011	0.61
2.	2012	0.69
3.	2013	0.67
4.	2014	0.66
5.	2015	0.52
6.	2016	0.75
7.	2017	0.71
8.	2018	0.71
9.	2019	0.65

maximum 134 (47.02%) articles were contributed by the two authors during the study period. The degree of collaboration was 0.656.

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Performance of Medicinal Plants under Fast Growing Timber Trees in Coastal Ecosystem of Odisha

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Abstract

The performance of three medicinal crops viz. *Aloe vera*, *Andrographis paniculata* (Kalmegh), *Curcuma amda* (Mango ginger) was studied in agrisilvicultural system involving two timber species (*Acacia mangium* and *Gmelina arborea*). This experiment was conducted at Agroforestry Research Station Bhubaneswar from 2016-18 in RBD. The two years mean data revealed that overall growth of *Aloe vera* crops was better when intercropped with trees than when grown in pure stand. Shade had absolutely no effect on the growth and economic yield of *Aloe vera.* The initial investment in *Aloe vera* was high due to cost of planting materials but the return was high. The *Aloe vera* recorded net returns of Rs. 70,430 and 62,892/ha with B:C 3.00 and 2.80 when intercropped with *Acacia mangium* and *Gmelina arborea*, respectively in the system, as against a net return of only Rs. 52,902 with B:C 2.51 when grown as a sole crop. High net returns and B:C were due to returns from sale of planting materials and there was no cost for planting material which was included in the cost of cultivation during second year of planting. Mango ginger and kalmegh recorded higher B:C when grown as sole crops than in the system. Soil analysis after annual harvesting from medicinal crops indicated that lower values of available N with mango ginger followed by *Aloe vera* and kalmegh, lower values of available P with *Aloe vera* followed by mango ginger and kalmegh and lower values of available K with kalmegh followed by *Aloe vera* and mango ginger the trend was similar in both the tree species grown.Mango ginger was found to be more exhaustive with higher uptake values of N, *Aloe vera* with P and kalmegh with K . Organic carbon in this system varied from 3.10 g/kg in *Gmelina arborea* + mango ginger to 4.70 g/kg in Acacia mangium + *Aloe vera* combination. Increase in soil reaction and organic carbon was evident due to tree species and crop combination. The available soil moisture content was found to be minimum with *Acacia mangium*. Better moisture storage was evident with *Gmelina arborea*. This corroborates competitiveness of *Acacia mangium* with its growth rate and higher soil moisture utilization as compared to other tree species. In agri-silvi system, minimum soil moisture content was observed with the annual crop kalmegh and maximum with *Aloe vera*. So this crop utilized available rainfall more efficiently than other crops.

Key words : *Silvihorticultural system, Aloe vera, Andrographis paniculata, Curcuma amda, Acacia mangium and Gmelina arborea.*

Introduction

Medicinal plants are the backbone of the traditional medicine ,which means more than 3.3 billion people in the developing countries utilize medicinal plants on regular basis (Davidson,2000) About 12.5% of the total known plant species are documented as medicinal and aromatic plants (MAP) out of it only a few hundred are known to be in cultivation, with dwindling supplies from the natural sources and increasing global demand these medicinal plants will need to be cultivated to ensure their regular supply. Since many medicinal and aromatic plants are grown under the forest cover and are shade tolerant, Agroforestry offers a convenient strategies for promoting their cultivation and conservation. Medicinal and Aromatic plants taken as inter crops in the existing fast growing timber species where tree species are the shade provider. Growing demand for MAPs require research attention to make these valuable plants as remunerative alternative intercrops for small holder in our country (Chadar, 2001).

Materials and Methods

Location and Soil characteristics : The experimental site is situated inside the All India Coordinated Research Project (AICRP) on Agroforestry Station of O.U.A.T., Bhubaneswar. The study area falls in the sub-tropical zone, which is about 60 km away from the Bay of Bengal. The experimental field is fairly levelled and well drained. Soil is sandy loam texture, acidic in reaction and poor in di-basic cations. Soil samples were taken for appropriate physical and chemical analysis.

Experimental Details : The experiment was laid out in a Randomised Block Design (RBD) with three replications, during 2016-2018. It consisted of nine treatments combinations comprising of six silvihorticultural systems involving two silvi tree species (*Acacia mangium* and *Gmelina arborea)* Three control plots of sole cropping of medicinal plants were also maintained for comparing the performance of intercrops under sole and silvihorti systems. The planting geometry of silvi trees was 8 x 2 m^2. At the time of final land preparation well decomposed

Table-1 : Yield of *Aloe vera* (fresh leaves), Kalmegh (dry plants) and mango ginger (rhizomes) from the Silvihorti system, Mean data 2016-2018.

Tree species	Aloe vera leaves (kg/ha)	Kalmegh dry plant (kg/ha)	Mango ginger rhizome (kg/ha)
Acacia mangium	7640	616	3084
Gmelina arborea	7024	720	3010
Control	6244	812	3460

Table-2 : Economics analysis of the Silvihorti system, (in rupees/ha) Mean data of 2016-2018.

Tree species	Intercrops	Fruits/fresh leaves/dry plants/ rhizomes*	Sucker+	Gross return	Net return	B:C ratio
Acacia mangium	Aloe vera	61120	44310	105430	70430	3.00
	Kalmegh	36960		36960	16960	1.85
	Mango ginger	61680		61680	31680	2.06
Gmelina arborea	Aloe vera	56192	41700	97892	62892	2.80
	Kalmegh	43200		43200	23200	2.16
	Mango ginger	60200		60200	30200	2.00
Control	Aloe vera	49952	37950	87902	52902	2.51
	Kalmegh	48720		48720	28720	2.44
	Mango ginger	69200		69200	39200	2.31

*Returns (in rupees) from sale of, fresh leaves in Aloe vera, dry plants in kalmegh and rhizomes in mango ginger.
+Returns (in rupees) from sale of planting materials of Aloe vera.

FYM @ 10 t ha^{-1} and recommended dose of fertilizer was applied in the form of Diammonium phosphate (DAP) and Murate of potash (MOP). The cost involved in production of different silvihorti systems was estimated and converted to per hectare value, then the return obtained from each treatment were evaluated and the net return (Rs ha^{-1}) was worked out by subtracting the cost of cultivation from the gross return obtained. The benefit cost ratio was calculated by dividing the gross return by the cost of cultivation and presented to assess the profitability of different treatments. To determine the significance between the treatment means and to draw valid conclusion, statistical analysis was made. Data obtained from various observations were subjected to statistical analysis by adopting appropriate method of "Analysis of Variance". The difference of the treatments mean was tested using Critical Difference (C.D.) at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Relative performance of three medicinal crops - *Aloe vera*, *Andrographis paniculata*, *Curcuma amda* was studied in silvihorti system involving two timber species (*Acacia mangium* and *Gmelina arborea*). The crops were grown in the alley space between tree rows in the first fortnight of June during the experimental years, 2016-2018. Recommended doses of fertilizer were applied to intercrops.

Mango ginger and kalmegh recorded higher B:C when grown as sole crops than in the effect of tree (126 months old) on growth and yield of intercrops were assessed in relation to their sole crop yields. Overall growth of *Aloe vera* crops were better when intercropped with trees than when grown in pure stand (Table-1). Shade had absolutely no effect on the growth and economic yield of these crops. Leaves/plant and weight/ leave in *Aloe vera* in agroforestry system during dry months were more than in sole crops. Yield recovery for *Curcuma amda* was below 80%.

Cost of cultivation (in rupees/ha)

Aloe vera	-	35000 (includes cost of raising planting materials for sale)
Kalmegh	-	20000
Mango ginger	-	30000

Unit sale price (in rupees)

Aloe vera fresh leaves	-	8/kg
Aloe vera sucker	-	3/sucker
Kalmegh dry plants	-	60/kg
Mango ginger rhizome	-	20/kg

In *Aloe vera*, sucker (planting material) harvesting was started from second year, The initial investment in *Aloe vera* was high due to cost of planting materials but when leaves suckers of the crops was ready for sale, the return was high. The return from the tree component was not considered for the economic analysis. *Aloe vera* recorded net returns of Rs. 70430 and 62892/ha with B:C ratios 3.00 and 2.80 when intercropped with *Acacia mangium* and *Gmelina arborea*, respectively in the system (Table-8), as against a net return of only Rs. 52902 with B:C ratio 2.51 when grown as a sole crop. High net returns and B:C ratios were due to returns from sale of planting materials and there was no cost for planting material which was included in the cost of

Table-3 : Soil fertility status as influenced by trees and crops in silvihorti system, Mean data of 2016-2018.

Sl. No.	Description of samples	pH	Organic carbon (g/kg)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
	Tree with Crop					
1.	*A. mangium* + Aloe vera	4.50	4.7	121.17	45.00	152.8
2.	*A. mangium* + Mango ginger	4.53	4.4	114.59	46.57	169.6
3.	*A. mangium* + Kalmegh	4.69	4.1	123.81	49.55	128.6
4.	*G. arborea* + Aloe vera	4.54	4.0	150.15	42.26	109.3
5.	*G. arborea* + Mango ginger	4.90	3.1	135.66	43.75	125.2
6.	*G. arborea* + Kalmegh	4.87	3.7	156.13	58.25	103.5

cultivation during second year of planting in this system. Mango ginger and kalmegh recorded higher B:C ratios when grown as sole crops than in the system. (Table-2) Our findings are in agreement with those of *Bari and Rahim,* 2012.

Analysis of soil after growing of inter crops (Table-3) *such as Aloe vera*, mango ginger and kalmegh grown with the tree species in silvihorti system indicated lower values of available N with mango ginger,followed by *Aloe vera* and kalmegh, lower values of available P with *Aloe vera* followed by mango ginger, kalmegh and lower values of available K with kalmegh followed by *Aloe vera*, mango ginger and the trend was similar in both the tree species grown. Mango ginger was found to be more exhaustive with higher uptake values of N, *Aloe vera* with P and kalmegh with K. Organic carbon in this system varied from 3.10 g/kg in *Gmelina arborea* + mango ginger to 5.70 g/kg in *Acacia mangium* + pine apple combination. Increase in soil reaction and organic carbon was evident due to tree species and crop combination. Results suggested that soil fertility was either maintained or improved due to agroforestry intervention.

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GGE Biplot Analysis of Genotype-by-Environment Interactions for Single Tree Volume of *Eucalyptus camaldulensis* Dehnh. Clones

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Abstract

A study conducted on the single tree volume of 22 genotypes of *Eucalyptus camaldulensis* across four environments revealed the presence of GxE interaction. The average single tree volume of the clones studied varied from 0.035 to 0.110 cu m across locations with an average of 0.066 cu m. The first two PCs explained 88.8% of the total GGE variation suggesting that the PC1 and PC2 approximated the environment centred data. The use of GGE biplots is useful tool for selection of clones.

Introduction

Eucalypts is a huge genus with more than 3000 species. The genus is popular world over for the ability to survive in a variety of environmental condition (Potts and Gore, 1995) and its potential for high productivity of wood over short rotations (Leslie 2019). Eucalypts is highly recommended for the wide range of economic benefits provided in terms of timber, fuel, and industrial or medicinal oils. It's high pulp yield, rapid growth properties and excellent fiber qualities makes it one of the sought-after genera for paper production (Doughty, 2000). *Eucalyptus camaldulensis* Dehnh commonly known as river red gum is a dominant riparian ecosystem tree species of Australia. It is the most widely planted paper and pulp wood species in the tropics and subtropics especially in countries like India, Thailand and Vietnam (Kien, 2010; Ramadevi *et al*, 2018).

Eucalyptus tree improvement in the country started with the IUFRO coordinated provenance trials for two species viz., *E. camaldulensis* and *E. tereticornis* during 1980s (Varghese, 2008). Provenance trails for *E. camaldulensis* were conducted by Institute of Forest Genetics and Tree Breeding, Coimbatore and selections made from them were established in multiple locations in Tamil Nadu, Kerala, Puducherry and Andhra Pradesh. Multi locational trials are very important as genotypes tend to exhibit differential responses in the environment they are exposed to due to the presence of genotype-by-environment interaction (GEI). The differential response of genotypes across environments is one of the major challenges for a breeder as their performances can't be predicted and a guaranteed yield cannot be promised (Elias *et al*, 2016). Hence it is very important to identify, understand and exploit GEI (Gauch*et al*., 2008). Analysis of GXE aids in selection of superior and stable genotypes across a range of environmental conditions and also helps to identify specifically adapted genotypes for the environments under consideration (Annicchiarico, 2017).

Several stability analytical models are available for quantifying the magnitude of GXE in multilocational trials viz., the additive models, the regression models, AMMI model, GGE biplots etc. (Li *et al*, 2017;). Biplot are multivariate graphical tools which displays the results of a GxE dataset. It helps to understand and visualisethe GxE effects in a multi locational trial (Yan *et al*, 2002; Yan, 2001). GGE (G–genotype effect, GE–genotype × environment interaction effect) biplots remove the E effects and integrates the G with GE interaction effect (Yan *et al*, 2000). GGE biplots are widely used for assessing the stability of agricultural crops (Rajalakshmi *et al*, 2021; Samak *et al*, 2020; Erdemci, 2018; Zhang, 2018; Kadir *et al*., 2018). However, the use of biplots in section and in tree improvement is comparatively very less. Ukalski and Klisk (2016) reported that 54% of total variation was explained by the first principal component (GGE1) and 23% by the second principal component (GGE2) for height growth of 20 European beech genotypes. Ding *et al.,* (2007) also used GGE biplot analysis of multilocational trials of Pinus *radiata* and suggested GGE biplot analysis to be an effective method for GxE interaction analysis. The study on poplar plantations by Sixto *et al.,* (2011) highlighted the use of GGE biplots and illustrated that the biplot technique allowed to easily visualise the differences and similarities along with their response in different environments. The present study attempts to highlight the use of GGE biplot for selection of genotypes in eucalyptus breeding programmes and clonal deployment.

Materials and Methods

To study the stability of the clones for yield, clonal trials planted during 2010; with 21 clones of *Eucalyptus camaldulensis* and one bulked seed lot; at four different locations; Ariyalur and Marakkanam in Tamil Nadu and

Table-1 : Details of the locations of the trials.

Locations		Location name	Latitude (N)	Longitude (E)	Altitude (msl)	Rainfall/annum (mm)
Number	Code					
1.	A	Ariyalur	11° 09'0.00"	79°15'00.00"	67	1119.1
2.	M	Marakkanam	12° 1'31.70"	79°56'30.95"	10	1338.0
3.	K	Karaikal	10° 55'0.01"	79°49'59.99"	66	1387.2
4.	T	Tirupati	13° 38'7.84"	79°25'11.60"	227	905.0

Table-2 : Analysis of variance for the clones across locations.

Source of variation	df	MSS	VR	F pr.
Replication	3	0.001	1.33	
Site	3	0.426	387.24	<.001
Clone	21	0.008	7.59	<.001
Site. Clone	54 (9)	0.003	2.96	<.001
Residual	1182 (135)	0.001		

Karaikal in Puducherry and Tripathi in Andhra Pradesh were chosen as study sites (Table-1). The trials were laid out in Randomised Block Design (RBD) with four replications for each genotype at a spacing of 3X2m. The height and girth at breast height (GBH) were taken for the centre 4 trees. Tree height was recorded using clinometer at a distance of 20 m from the base of the tree and the GBH was measured using a measuring tape. The GBH was converted into Diameter at Breast Height (DBH = GBH/ð). Diameter of the tree at middle height was measured from the photographs of the trees using a Leica Image analyser (QWin 3.1). Volume was calculated using the ðr2h X form quotient; form quotient was calculated for each clone by dividing the mid diameter by the DBH.

ANOVA was performed to confirm the existence of genetic variability among the clones and across locations. Adaptability and stability analysis was done using GGE biplots method with the help of Genstat 7.2. The basic model for a multi environmental trial can be written as

$$Y_{ij} = \mu + G_i + E_j + GE_{ij} + e_{ij}$$

Where, Y_{ij} is the measured yield values of the i^{th}genotype in the j^{th} environment, μ is the grand mean, G_i is the main effect of the i^{th} genotype, E_j is the main effect of the j^{th} environment, GE_{ij} is the interaction effect between the i^{th} genotype and the j^{th} environment and e_{ij} is the random error (Crossa *et al.*,1990).

whereas the GGE biplot model can be written as

$$Yij - ?\cdot j = {}_1 {}_{i1} {}_{j1} + {}_2 {}_{i2} {}_{j2} + {}_{ij}$$

Where, Y_{ij} is the mean across replications for genotype i^{th} (i = 1, ..., g) in environment j^{th}(j = 1, ..., e); $Y_{\cdot j}$ is the mean of environment j across all genotypes and replications; ${}_1 {}_{i1} {}_{j1}$ and ${}_2 {}_{i2} {}_{j2}$ are PC1 and PC2 respectively; ${}_1$ and ${}_2$ are the eigenvalues associated with each PC; ${}_{i1}$ and ${}_{i2}$ are the PC's scores in the ith genotype; ${}_{i1}$ and ${}_{i2}$ are the scores for each PC in the jth environment, and ${}_{ij}$ is the error associated with the model (Yan *et. al.,* 2000; Miranda *et al.*, 2009).

Results and Discussion

The statistical analysis showed that the single tree volume was significantly different across the clones and sites. The interaction between the clone and sites was also significant for all the studied characters with F probability of less than 0.001 (Table-2).

The average single tree volume of the clones studied varied from 0.035 to 0.110 cu m across locations with an average of 0.066 cu m (Fig.-1). The mean single tree volume of the seed lot 301 was better than other genotypes. Clones 196, 9 and 66 outperformed the rest. Tirupati was found to be the most favourable site (0.14 cu m); Ariyalur, an average site (0.6) and Marakkanam and Karaikal (approximately 0.32 for both sites) were found to be poor sites in the study. The mean single tree volume across sites was found to be 0.66 cu m.) have also made similar observations on clones of the same but classifies the clones with average volume of 0.11 as moderate clones and clones with higher values of 0.144 m^3 as high yielding clones. The performance of seed lot 301 is noteworthy indicating the possibilities of using seed lots as planting material, which would also be more economical (Varghese *et al.*, 2017).

The GGE biplots explained the percentage of variation captured by the PCs; the first two PCs explained 88.8% of the total variation suggesting that the PC1 and PC2 approximates the environment centred data. The major outputs of GGE analysis may be understood as; the mega-environment analysis, the test-environment evaluation and the genotype evaluation (Yan *et al.* 2000; Gauch and Zobel 1997). The Which-won-Where view (Fig 1) of the GGE biplot (the polygon view) helps to analyse the mega-environments. Accordingly, the study showed the formation of two mega environments; mega

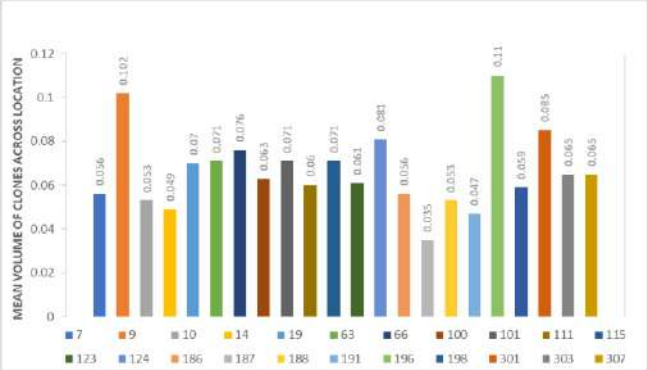

Fig.-1 : Mean volume of the genotypes across locations.

GGE biplots for single tree volume

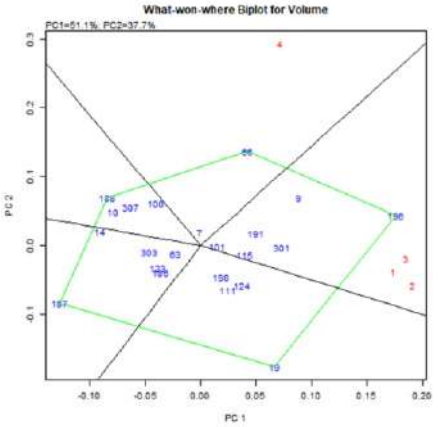

Fig-2 : What-won-where biplot.

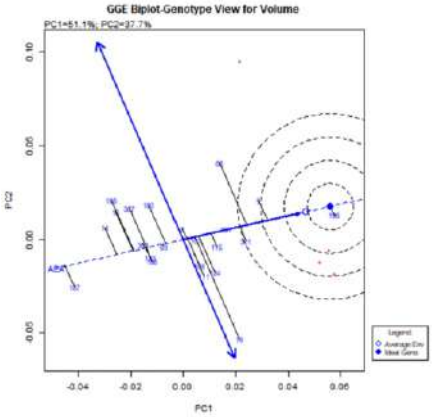

Fig-3 : Average Environment Coordination view on environment-focused scaling for the means genotypes performance and stability.

environment 1 formed by sites Ariyalur (site 1), Marakkanam (site 2) and Karaikal (site 3) on one side and mega environment 2 formed by Tirupati (site 4) alone on another side. The genotype at the vertex (clone 196 for mega environment 1 and 66 for mega environment 2) is the highest yielding one in that mega environment (Singh *et al.*, 2019; Souza *et al.*, 2018). Similar methods of

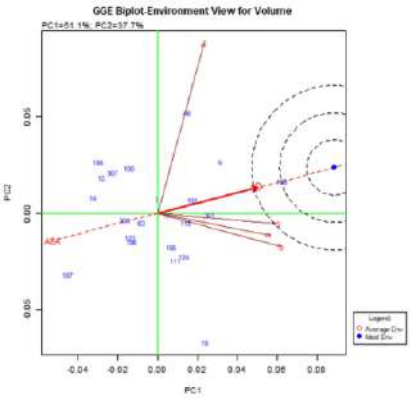

Fig-4 : GGE biplot on environment focused scaling for comparison the environments with the ideal environment.

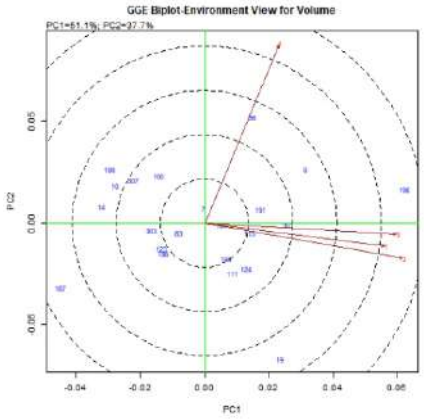

Fig-5 : GGE biplot based scaling for environments.

selection have been used by Ukalski and Klisz (2016) for European beech and Correia *et al.* (2010) for maritime pine. Apart form 196; clones 9, 301, 191, 115 and 101 were found to perform well in the mega environment 1 and clone 66 and 7 in the other mega environment 2.

The Average Environment Coordination (AEC) view helps to identify the ideal genotype and rank the genotypes with respect to their mean single tree volume. It was observed in this study that clone 196>9>66> 301>191>115>124>19>111 with respect to volume (Fig 2) (Yan, 2002). Clones 9, 301, 191 and 115 showed high single tree volume as well as stability. Clone 196 can be regarded as the ideal genotype in terms of achieving high single tree volume and high stability in the environments tested due to its proximity to the ideal environment. Average Environment Coordination (AEC) view of GGE biplot is one of the commonly used visualisation technique in GxE analysis (Dessie *et al.*, 2020; Sharma*et al.*, 2020; Tena *et al.*, 2019).

Fig.-3 is the GGE biplot based on environment and it shows the ability of the test environments in discriminating the genotypes. The distances from the centre of the biplot and angle formed by the sites among them reflects their

discriminating ability and coherence. Site 3, 1 and 2 are considered to be similar environments in this study while site 4 is a completely different environment away from the rest of the environments. The longest vector is the most discriminating site, Tirupati in this case (Fig.-3), but is not representative of the environment for the large angle between the AE axis and the environmental vector (Kumar and Kumar, 2021; Kadir *et al*., 2019). Hence, Karaikal is identified as the ideal environment for the selection of clones in the mega environment comprising of three sites viz., Ariyalur, Karaikal and Marakkanam as per this study. Yan (2002) insists that the environment should be able to represent the site conditions and that they should possess high ability to discriminate the genotypes. The ideal environment provides the best information on differences between genotypes (Gurusamy and Vanniarajan, 2021; Ukalski and Klisz, 2016).

In the Discriminating power vs. Representativeness view of the GGE biplot, an average environment derived from PC1 and PC2 scores of all the environments forms the AEC, the Average Environment Coordination (Fig-4). A straight line called Average Environment Axis (AEA) which passes through the centre of the biplot to Average Environmental coordinate (AEC) represents the relationship between the environments and genotypes (Natraj *et al*., 2020; Abdelmoghny *et al*., 2020). AEC centre represents the ideal testing environment. Environments that have small angles with it like that of sites 3, 2 and 1 are more representative of the mega-environment than those that have larger angle like that of site 4 (Rakshit *et al*., 2012;).

Conclusion

GGE biplot analysis indicated that clone 196 is closest to the ideal genotype, and clone 9 was nearer to the ideal genotype than others and that Karaikal was the ideal environment for bringing out the genotypic differences among the clones studied for volume. GGE eliminated the redundant environments studied by their delineation into two mega environments with best performing genotype in each environment. The average environment coordinate (AEC) view of the biplot explored the mean yield and stability and showed that clone 196 was both productive and stable. GGE biplot technique could be used as an effective visualisation technique for identifying the most ideal genotype for the environments under consideration and for the identification of the most ideal environments in *Eucalyptus camaldulensis* improvement programmes.

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Biomass and Carbon Stock of Tree Species in the JFMC Managed Forest of Khordha Forest Division, Odisha

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Abstract

The study was undertaken in JFMC managed forest of Khordha Forest Division, Odisha for estimation of tree biomass and carbon stock. Samples were taken in different JFMC managed forest sites of Khordha forest division as per the method given by FSI, 2013. It was found that the above ground biomass (AGB) of Rameswar VSS was 110.62 t/ha and the below ground biomass (BGB) was 26.47 t/ha. The total biomass was 128.18 t/ha. The maximum biomass was contributed by *Mangifera indica* (85.53 t/ha). The AGB of Girigobardhan VSS, Badapari was 115.71 t/ha and the BGB of 30.09 t/ha. The total biomass was 145.81 t/ha. The maximum biomass was contributed by *Mangifera indica* (78.67 t/ha) at this site. The AGB of Dhani(S) Panchamauja VSS of Tangi range was 169.47 t/ha.and the BGB was 44.09 t/ha. The total biomass of of Dhani(S) Panchamauja VSS was 213.55 t/ha. The maximum biomass was contributed by *Tectona grandis* (121.09 t/ha). The AGB of Maa Khorakhai VSS was 167.76 t/ha and the BGB was 43.62 t/ha. The total trees biomass of Maa Khorakhai VSS was 211.37 t/ha. The maximum tree biomass was contributed by *Shorea robusta* (127.51 t/ha). The AGB of Dimiria VSS of Ranpur range was 34.10 t/ha and the BGB was 8.87 t/ha. The total biomass of Dimiria VSS was 42.97 t/ha. The maximum biomass was contributed by *Tectona grandis* (18.95 t/ha).The above ground biomass (AGB) of Asurakumari VSS was 80.51 t/ha.and the BGB was 20.93 t/ha. The total biomass of Asurakumari VSS was 101.45 t/ha. The maximum biomass was contributed by *Terminalia tomentosa* (52.30 t/ha). Among different sites studied Khorakhai VSS recorded maximum biomass whereas Dimiria VSS had minimum biomass. Maximum carbon stock (106.78 t/ha) and minimum carbon stock (21.48 t/ha) were found in Dhani (S) Pancha Mauja VSS and Dimiria VSS respectively.

Key words : *Joint forest management, vss, biomass, carbon stock*

Introduction

Climate change is the most important problem of 21st century. Due to climate change, the most commonly felt consequences are irregularities of monsoon, melting of ice from polar region, increase in sea level and rise in temperature. According to the Inter-Governmental Panel on Climate Change (IPCC, 2007), the expected rise in temperature will range from 1.8 to 4.0^{0}C by the year 2100. This is mainly due to increase in the concentration of green house gases in the atmosphere. The main sources of increased atmospheric concentration of carbon dioxide are use of fossil fuel and the land-use changes, which is adversely affecting ecosystems, biodiversity, regeneration, species composition, biomass growth rate and geographic distribution of plant species.

Forests are the most valuable resources on this planet which regulate local and global climate and also influence the earth energy budget. Global forests are spread over about 4 billion hectares of landmass, which is around 30% of earth's surface (FAO, 2005) and around 13 million hectares of forests are lost annually due to Land Use and Land Use Change (LULUC) (FAO, 2005). Thus forest have great role in mitigation of climate change. It has been estimated that emissions from deforestation and forest degradation in developing countries are about 17.4% of global greenhouse gas emissions (FAO, 2007). Therefore reducing emissions from deforestation and forest degradation (REDD) can provide good climate change mitigation opportunity at relatively lower costs along with significant co-benefits. Therefore, the present study was undertaken to assess the biomass production and carbon stock of JFM managed forests as a mitigation strategy for reducing carbon dioxide concentration in the atmosphere.

Materials and Methods

Study Area : The present study was undertaken in Khordha Forest Division, which is situated in the eastern part of Odisha between 19^0 27' N to 20^0 26' N latitude and 84^0 59' E to 86^0 56' E longitude. The total geographical area under the jurisdiction of this Division is 3,588.50 sq. km. and the forest area is 674.66 sq. km., which is 18.79% of the total geographical area of this Division. The details of the studied sites are as follows :

Table-1 : Description of studied forest sites.

Site	Name of JFMC	Forest block	Forest Range	Latitude and Longitude
Site-1	Rameswar VSS	Rameswar	Tangi	Lat-200.14'14" Long-85030'57"
Site-2	Girigobardhan VSS	Badapari	Tangi	Lat-19056'12" Long-85022'26"
Site-3	Dhani south pancha mauja VSS	Dhani south	Tangi	Lat-19057'49'' Long-85019'16''
Site-4	Maa Khorakhai VSS	Mal	Ranpur	Lat-20014' 18'' Long-85048' 10''
Site-5	Dimiria VSS	Dhani (N)	Ranpur	Lat- 2003'27'' Long-85020' 50''
Site-6	Maa Asurakumari VSS	Maninag	Ranpur	Lat- 2004'00'' Long-85016' 39''

Table-2 : Tree biomass and carbon of Rameswar VSS.

Sl. No	Species	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
			< 10	10-30	> 30				
1.	*Acacia auriculiformis*	92	84	8	0	2.06	0.54	2.60	1.30
2.	*Azadirachta indica*	6	2	4	0	0.36	0.09	0.45	0.22
3.	*Bridelia retusa*	50	20	30	0	1.61	0.42	2.03	1.01
4.	*Careya arborea*	18	6	12	0	0.7	0.18	0.88	0.44
5.	*Eucalyptus hybrid*	84	70	14	0	1.63	0.42	2.05	1.03
6.	*Ficus bengalensis*	10	0	4	6	16.35	4.25	20.60	10.30
7.	*Ficus glomerata*	18	10	8	0	0.46	0.12	0.58	0.29
8.	*Lannea grandis*	114	0	114	0	8.92	2.32	11.24	5.62
9.	*Mangifera indica*	30	0	0	30	67.88	17.65	85.53	42.77
10.	*Terminalia bellirica*	12	0	12	0	1.76	0.46	2.22	1.11
	Grand Total	434	192	206	36	101.8	26.47	128.18	64.09

Sampling : For the estimation of biomass, the multi stage random sampling was adopted. In the first stage the sampling unit was the forest range. Out of the total 6 ranges 2 ranges namely the Tangi forest range and Ranpur forest range were selected as sample forest range. In the second stage the sampling unit was the VSS managed forest area. 10% of the VSSs of the range were selected randomly. 30 permanent sample plots of size 0.1 ha are laid in these 6 selected VSS managed forest.

Biomass estimation : The cluster sampling method was used to select the plot of size 0.1 ha. for estimation of biomass, the details are as follows :

Above ground biomass of tree : At each sample plot (.1 ha size,) all trees of diameter 3cm and above were measured at breast height (1.37mt). The trees are enumerated between the months of September to November 2016. The woody volume of trees of each sample plot is calculated using volume equations developed by FSI (2013) for various species. The biomass was calculated from wood density of the said species.

Biomass = volume x wood density

The biomass of branches and foliage was calculated by using area specific and species specific biomass regression equation developed by FSI (2013). Those species which have no biomass regression equation by FSI, the above ground biomass was calculated from biomass expansion factor. Plants were identified with the help of Flora of Orissa (Saxena and Brahmam, 1996).

Below ground biomass : The below ground biomass was calculated from above ground biomass by multiplying with 0.26 as root shoot ratio (IPCC, 2006), Ravindranath & Ostwald (2008) *et al.* and Hangarge *et al*. (2012).

Biomass Carbon stock : The biomass carbon stock was calculated by assuming that the carbon content as 50% of the total biomass (Brown and Lugo, 1982; Dixon, 1994; Ravindranath *et al.,* 1997; Juwarkar., 2011, Sahu *et al.* 2016).

Results and Discussion

The details of biomass and carbon estimation of species for different JFMC managed forests are presented in detail as follows :

1. Biomass and carbon of Tree Species

(i) Rameswar VSS : The above ground biomass of Rameswar VSS was 110.62 t/ha.and the below ground biomass was 26.47 t/ha. The total trees biomass of Rameswar VSS was 128.18 t/ha. The total biomass carbon of tree species of Rameswar VSS was 64.09 t/ha. shown in table-2. The maximum tree biomass carbon was contributed by *Mangifera indica* (42.77 t/h) followed by *Ficus bengalensis* (10.30 t/ha), *Lannea grandis* (5.62 t/ha), *Acacia auriculiformis* (1.30 t/ha) and *Eucalyptus tereticarnis* (1.01 t/ha) etc. The minimum tree biomass carbon was contributed by *Azadirachta indica* by 0.22 t/ha. shown in table-2. The maximum tree biomass carbon was contributed by *Mangifera indica* which might be due to

Table-3 : Tree biomass carbon of Giri gobardhan VSS, Badapari.

Sl. No	Species	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
			< 10	10-30	> 30				
1.	*Adina cordifolia*	28	14	14	0	0.86	0.22	1.08	0.54
2.	*Alangium salvifolium*	24	16	8	0	0.61	0.16	0.77	0.38
3.	*Albizia lebbeck*	4	2	2	0	0.52	0.14	0.66	0.33
4.	*Casearia elliptica*	16	16	0	0	0.11	0.03	0.14	0.07
5.	*Cassia fistula*	42	22	20	0	1.39	0.36	1.75	0.88
6.	*Diospyros melanoxylon*	8	4	4	0	0.19	0.05	0.24	0.12
7.	*Diospyros sylvatica*	948	570	378	0	39.65	10.31	49.96	24.98
8.	*Holarrhena antidysenterica*	16	12	4	0	0.36	0.09	0.45	0.23
9.	*Lagrestromia parviflora*	4	4	0	0	0.06	0.02	0.08	0.03
10.	*Mangifera indica*	40	4	2	34	62.44	16.23	78.67	39.34
11.	*Manilkara hexandra*	26	22	4	0	0.42	0.11	0.53	0.27
12.	*Pavetta crassicaulis*	4	4	0	0	0.05	0.01	0.06	0.03
13.	*Phyllanthus emblica*	2	0	2	0	0.10	0.03	0.13	0.06
14.	*Schleichera oleosa*	8	8	0	0	0.09	0.02	0.11	0.06
15.	*Strychnos nox-vomica*	152	78	74	0	5.58	1.45	7.03	3.51
16.	*Syzygium Cumini*	32	2	30	0	2.71	0.70	3.41	1.70
17.	*Terminalia bellirica*	4	2	2	0	0.51	0.13	0.64	0.32
18.	*Terminalia chebula*	2	0	2	0	0.07	0.02	0.09	0.04
19.	Grand Total	1360	780	550	34	115.71	30.09	145.81	72.90

presence of maximum (30) numbers of trees in > 30cm dia class., which was similar to the findings of Pattnayak *et al*. (2020) was found to that basal area was positively correlated with the above ground biomass carbon. The total tree density was found to be 434 no./ha.which is composed of 192 no. in (<10cm dia), 206 no. in (10-20cm dia) and 36 no in (>30 cm dia). Sudarpandian *et al.* (2013) in a study of tropical dry forest found that the above ground biomass was 102.76 Mg/ha which was close to the findings of the present study.

(ii) Girigobardha VSS, Badapari : The total above ground biomass of Girigobardhan VSS, Badapari was 115.71 t/ha. The below ground biomass was 30.09 t/ha. The total trees biomass of Girigobardhan VSS, Badapari was 145.81 t/ha. The total biomass carbon of tree species of Girigobardhan VSS, Badapari was 72.90 t/ha. The maximum tree biomass carbon was contributed by *Mangifera indica* (39.34 ta/h) followed by *Dyosyros sylvatica* (24.98 t/ha), *Strychonos nox-vomica* (3.51 t/ha), *Syzigium cumini* (1.70 t/ha) and *Cassia fistula* (0.88 t/ha) etc. The minimum tree biomass carbon was contributed by *Pavetta crassicaulis* by 0.03 t/ha. shown in table no. 3. Above-ground biomass (AGB) and carbon stocks of forests are influenced by basal area, stand density and species richness (Poorter 2015; Behera *et al.* 2017). The present finding was less comparared to the reports of FSI (2017) in Carbon stock in India, which was reflected as 82.17 t/ha for moderately dense forest of Odisha which might be due to the presence of large number of trees in <10cm dia. class. Total tree density was 1360 no/ha. which comprised of 780 no/ha(<10cm), 550no (10-30cm) and 3no/ha(>30cm) diameter class.

(iii) Dhani (S) pancha mauja VSS : The above ground biomass, below ground biomass and total tree biomass of Dhani(S) Panchamauja VSS of Tangi range was 169.47 t/ha.,44.09t/ha 213.55 t/ha respectively. The biomass carbon of tree species of Dhani(S) Panchamauja VSS was 106.78 t/ha.which was due to presence of more number of tree and higher dia class in the VSS area. The maximum above ground biomass was contributed by *Tectona grandis* (60.54 t/h) followed by *Dyosyros sylvatica* (13.81 t/ha), *Acacia auriculiformis* (8.28 t/ha) *Albizia lebbeck* (5.09 t/ha) *Pterospermum heyneanum* (4.35 t/ha) etc. The minimum tree biomass carbon was contributed by *Manilkara hexandra* by 0.02 t/ha. due to presence of only 2 number of trees with thinner dia class in the VSS managed forest shown in table-4. The total tree density was found to be 1474 no./ha. which is composed of 486 no. in (<10cm dia), 916 no. in (10-20cm dia) and 72 no in (>30 cm dia). The present finding was less compared to the results of study of Behera *et al.* (2017) on Above ground biomass and carbon stock assessment in Indian tropical deciduous forest the AGB (Mg ha^{-1}) ranged from 290.82–455.99 which was due to presence of more number of juvenile trees per unit area.

(iv) Maa Khorakhai VSS : The above ground biomass of Maa Khorakhai VSS of ranapur range was 167.76 t/ha. The below ground biomass was 43.62 t/ha. The trees biomass of Maa Khorakhai VSS was 211.37 t/ha. The total biomass carbon of tree species Maa Khorakhai VSS was

Table-4 : Tree biomass carbon of Dhani (S) Panchamauja VSS.

Sl. No	Species	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
			< 10	10-30	> 30				
1.	*Acacia auriculiformis*	120	2	114	4	13.14	3.42	16.56	8.28
2.	*Adina cordifolia*	24	12	12	0	0.54	0.14	0.68	0.34
3.	*Aegel marmelos*	30	22	8	0	0.82	0.21	1.04	0.52
4.	*Alangium salvifolium*	2	0	2	0	0.54	0.14	0.68	0.34
5.	*Albizia lebbeck*	52	6	46	0	8.07	2.1	10.17	5.09
6..	*Azadirachta indica*	4	2	2	0	0.46	0.12	0.58	0.29
7.	*Bombax ceiba*	18	0	16	2	2.39	0.62	3.01	1.51
8.	*Bridelia retusa*	18	2	14	2	4.31	1.12	5.43	2.72
9.	*Butea monosperma*	2	2	0	0	0.02	0	0.02	0.01
10.	*Careya arborea*	14	6	8	0	0.73	0.19	0.92	0.46
11.	*Casearia elliptica*	28	22	6	0	0.53	0.14	0.67	0.33
12.	*Casearia graveolens*	6	6	0	0	0.1	0.03	0.13	0.07
13.	*Cassia fistula*	2	0	2	0	0.18	0.05	0.22	0.11
14.	*Diospyros melanoxylon*	6	6	0	0	0.08	0.02	0.1	0.05
15.	*Diospyros sylvatica*	510	276	234	0	21.92	5.7	27.62	13.81
16.	*Ficus glomerata*	12	0	12	0	0.49	0.13	0.62	0.31
17.	*Glycyrrhiza glabra*	12	8	4	0	0.41	0.11	0.52	0.26
18.	*Holarrhena antidysenterica*	10	8	2	0	0.14	0.04	0.18	0.09
19.	*Lannea grandis*	24	2	22	0	1.84	0.48	2.32	1.16
20.	*Mallotus philippensis*	16	8	8	0	1.23	0.32	1.55	0.77
21.	*Manilkara hexandra*	2	2	0	0	0.02	0.01	0.03	0.02
22.	*Mitragyna parviflora*	6	2	4	0	0.14	0.04	0.18	0.09
23.	*Pterospermum heyneanum*	74	20	54	0	6.91	1.8	8.70	4.35
24.	*Schleichera oleosa*	2	0	2	0	0.17	0.04	0.21	0.10
25.	*Semecarpus anacardium*	8	6	2	0	0.47	0.12	0.59	0.30
26.	*Strychnos nox-vomica*	82	38	44	0	2.54	0.66	3.20	1.60
27.	*Syzygium Cumini*	14	4	10	0	0.7	0.18	0.88	0.44
28.	*Tectona grandis*	340	16	262	62	96.1	24.99	121.09	60.54
29.	*Terminalia bellirica*	10	2	6	2	1.86	0.48	2.34	1.17
30.	*Terminalia chebula*	8	6	2	0	0.25	0.07	0.32	0.16
31.	*Terminalia tomentosa*	18	0	18	0	2.37	0.62	2.99	1.49
	Grand Total	1474	486	916	72	169.47	44.09	213.55	106.78

105.69 t/ha. The maximum tree biomass carbon was contributed by *Shorea robusta* (63.76 t/ha) followed by *Tectona grandis* (23.17 t/ha), *Mallotus philippensis* (3.64 t/ha), *Bridelia retusa* (3.25 t/ha) and *Terminalia tomentosa* (2.74 t/ha) etc. The minimum tree biomass carbon was contributed by *Aegel marmelos* by 0.025 t/ha. shown in table no. 5. The total tree density was found to be 916 no./ha.which is composed of 208 no. in (<10cm dia), 614 no. in (10-20cm dia) and 94 no in (>30 cm dia). The present finding was less comparared to the result of study by Mohanta *et al.*(2020) on Carbon stock assessment and its relation with tree biodiversity in tropical moist deciduous forest of Similipal biosphere reserve, Odisha, India reported that the above ground biomass carbon 209.3 Mg C ha^{-1} in sal dominated forest. This is due to presence of trees having lower dia class.

(v) Dimiria VSS : The above ground biomass of Dimiria VSS of Ranpur range was 34.10 t/ha. The below ground biomass was 8.87 t/ha. The total trees biomass was 42.97 t/ha. The total biomass carbon of tree species Dimiria VSS of Ranpur range was 21.48 t/ha. The maximum tree biomass carbon was contributed by *Tectona grandis* (9.47 t/ha) followed by *Mangifera indica* (7.49 t/ha), *Acacia auriculiformis* (1.87 t/ha), *Azadirachta indica* (0.90 t/ha) and and *Lannea grandis* (0.47 t/ha) etc. The minimum tree biomass carbon was contributed by *Glycyrrhiza glabra* by 0.01 t/ha. shown in table no. 6. The result is close to the result of the study by Karmacharya and Singh (1992) on Biomass and net production of teak plantations in a dry tropical region in India reported that in an age series of teak plantations (4, 14 and 30 years old), raised in a dry tropical region in northern India, the aboveground biomass ranged from 25.7 to 76.9 t ha^{-1}. Total tree density was 744 no/ha. which comprised of 478 no/ha(<10cm), 258no (10-30cm) and 8 no/ha(>30cm) diameter class.

Table-5 : Tree biomass carbon of Maa Khorakhai VSS 2016.

Sl. No.	Species	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
			< 10	10-30	> 30				
1.	*Adina cordifolia*	8	0	8	0	1.85	0.48	2.34	1.17
2.	*Aegel marmelos*	2	2	0	0	0.04	0.01	0.05	0.02
3.	*Bridelia retusa*	18	2	8	8	5.16	1.34	6.50	3.25
4.	*Dillenia pentagyna*	14	6	4	4	2.29	0.59	2.88	1.44
5.	*Glycyrrhiza glabra*	8	0	8	0	0.61	0.16	0.77	0.38
6.	*Grewia tilitifolia*	12	0	12	0	1.14	0.30	1.44	0.72
7.	*Kydia calycina*	4	4	0	0	0.07	0.02	0.09	0.05
8.	*Mallotus philippensis*	44	10	30	4	5.77	1.50	7.27	3.64
9.	*Mitragyna parviflora*	12	8	4	0	0.19	0.05	0.25	0.12
10.	*Psydrax dicoccos*	2	0	2	0	0.06	0.02	0.08	0.04
11.	*Pterocarpus marsupium*	8	0	8	0	2.54	0.66	3.20	1.60
12.	*Schleichera oleosa*	10	4	6	0	0.93	0.24	1.17	0.58
13.	*Shorea robusta*	406	86	254	66	101.20	26.31	127.51	63.76
14.	*Sursera serata*	16	0	12	4	3.30	0.86	4.16	2.08
15.	*Syzygium Cumini*	16	4	12	0	1.47	0.38	1.85	0.92
16.	*Tectona grandis*	320	82	234	4	36.78	9.56	46.34	23.17
17.	*Terminalia tomentosa*	16	0	12	4	4.35	1.13	5.48	2.74
	Grand Total	916	208	614	94	167.76	43.62	211.37	105.69

Table-6 : Tree biomass carbon of Dimiria VSS.

Sl. No.	Species	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
			< 10	10-30	> 30				
1.	*Acacia auriculiformis*	64	28	36	0	2.97	0.77	3.74	1.87
2.	*Azadirachta indica*	40	26	14	0	1.42	0.37	1.79	0.90
3.	*Bridelia retusa*	12	2	10	0	0.60	0.16	0.76	0.38
4.	*Diospyros sylvatica*	12	4	8	0	0.54	0.14	0.68	0.34
5.	*Ficus retusa*	8	2	6	0	0.38	0.10	0.48	0.24
6.	*Glycyrrhiza glabra*	2	0	2	0	0.09	0.02	0.11	0.05
7.	*Holarrhena antidysenterica*	4	4	0	0	0.02	0.01	0.03	0.01
8.	*Lannea grandis*	16	0	16	0	0.75	0.20	0.95	0.47
9.	*Mangifera indica*	20	6	6	8	11.89	3.09	14.98	7.49
10.	*Strychnos nox-vomica*	10	2	8	0	0.40	0.10	0.50	0.25
11.	*Tectona grandis*	556	404	152	0	15.04	3.91	18.95	9.47
	Grand Total	744	478	258	8	34.10	8.87	42.97	21.48

(vi) Asurakumari VSS : The above ground biomass of Asurakumari VSS was 80.51 t/ha. The below ground biomass was 20.93 t/ha. The total trees biomass was 101.45 t/ha. The total biomass carbon of tree species Asurakumari VSS was 50.72 t/ha. The maximum tree biomass carbon was contributed by *Terminalia tomentosa* (26.15 t/ha) followed by *Tectona grandis* (6.84 t/ha), *Albizia lebbeck* (3.95 t/ha)), *Madhuca longifolia* (2.53 t/ha) and *Holarrhena antidysentrica* (2.30 t/ha) etc. The minimum tree biomass carbon was contributed by *Ficus retusa* by 0.44 t/ha. shown in table no. 7. Total tree density was 468 no/ha.which comprised of 150 no/ha(<10cm), 264no (10-30cm) and 54 no/ha (>30cm) diameter class.

The maximum tree biomass and carbon was contributed by Dhani (S) Pancha mauja VSS (213.55 t/ha and 106.78 t/ha) which was due to presence of more number of tree/ha, closely followed by Maa Khorakhai VSS (211.37 t/ha and 105 t/ha). Although the number of trees were less but more number of trees are in higher dia class in Maa Khorakhai VSS. The minimum tree biomass and carbon was contributed by Dimiria VSS (42.97 t/ha and 21.48 t/ha) due to presence of more number of young plants (<10cm dia.) as shown in the table no.8.

The tree biomass and biomass carbon ranged between 42.97 t ha^{-1} to 213.55 t ha^{-1} and 21.48 t ha^{-1} to 106.78 t ha^{-1} respectively which was similar to the result of the study by Naveenkumar *et al.* (2017) on Biomass and carbon stocks of a tropical dry forest of the Javadi Hills, Eastern Ghats, India who who reported that the total tree (juvenile + adult tree) aboveground biomass ranged from 99 to 216 Mg/ha. The result also came in the range of result of the study by Das and Singh (2016), on tropical

Table-7 : Tree biomass carbon of Maa Asurakumari VSS.

Sl. No	Species	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
			< 10	10-30	> 30				
1.	*Albizia lebbeck*	16	0	6	10	6.27	1.63	7.90	3.95
2.	*Cassia fistula*	18	12	6	0	0.85	0.22	1.07	0.53
3.	*Diospyros melanoxylon*	16	0	16	0	3.36	0.87	4.23	2.12
4.	*Diospyros sylvatica*	56	32	24	0	2.73	0.71	3.44	1.72
5.	*Ficus retusa*	8	0	8	0	0.70	0.18	0.88	0.44
6.	*Holarrhena antidysenterica*	46	14	32	0	3.66	0.95	4.61	2.30
7.	*Madhuca longifolia*	8	0	0	8	4.02	1.04	5.06	2.53
8.	*Pterocarpus marsupium*	16	0	16	0	1.50	0.39	1.89	0.94
9.	*Syzygium Cumini*	38	34	4	0	0.99	0.26	1.25	0.63
10.	*Tectona grandis*	122	54	66	2	10.86	2.82	13.68	6.84
11.	*Terminalia bellirica*	8	0	4	4	4.08	1.06	5.14	2.57
12.	*Terminalia tomentosa*	116	4	82	30	41.51	10.79	52.30	26.15
	Grand Total	468	150	264	54	80.51	20.93	101.45	50.72

Table-8 : Tree biomass carbon of defferent VSS managed forest of Khordha Forest Division.

Name of VSS	Trees/ha	Dia class (cm)			AGB (t/ha)	BGB (t/ha)	TB (t/ha)	TBC (t/ha)
		< 10	10-30	> 30				
Rameswar	434	192	206	36	101.8	26.47	128.18	64.09
Girigobardhan	1360	780	550	34	115.71	30.09	145.81	72.90
Dhani (S) Panchamauja	1474	486	914	72	169.47	44.09	213.55	106.78
Maa Khorakhai	916	208	614	94	167.76	43.62	211.37	105.69
Dimiria	744	478	258	8	34.10	8.87	42.97	21.48
Maa Asurakumari	468	150	264	54	80.51	20.93	101.45	50.72

moist decidous forest, tropical decidous forest and semi-evergreen forest reported that the AGB ranged from 30.2 to 151.1 t/ha, 9.2 to 99.1 t/ha and 42.1 to 158.6 t/ha respectively. However our result was less than the stated report in Carbon stock in Indian forest by FSI(2017) that biomass carbon in tropical moist deciduous forest was 123.50t/ha, 96.58t/ha and 67.07 t/ha and in tropical dry deciduous forest 153.19t/ha, 135.60 t/ha and 48.37 t/ha for very dense, moderately dense and open forest which were JFMC managed forest and larger number of trees are in juvenile stage.The result of the study was higher than the study by Salunki *et al. (*2016**)** for dry deciduous forest and moist deciduous forest where the AGB was 31.8 t/ha and 20.7 t/ha respectively and Pattnayak *et al.* (2020) reported in Secondary tropical dry deciduous forest where the AGB varies from 2.1 to 20.6 Mg C ha^{-1} which were managed and protected by JFMC members.

Conclusion

The biomass and biomass carbon were varying considerably among different JFMC managed forests. The JFMC managed forests showed variation in tree density per hectare as well as in different diameter classes. Most of the trees are in the diameter class 0f <10cm and 10-30cm and very less number of trees in >30cm diameter class in different forests studied. The forests could be classified into young and juvenile forest in all the sites which needs to be protected for growing into mature forest. Similarly JFMC manage forests with less tree density needs to be restocked to increase the tree density/hectare. Protection and restocking of the forest will be helpful in increasing the biomass \as well as the carbon stock of the JFMC managed forests.

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Role of Pretreatments on the Quality of Dehydrated Fruits and Vegetables

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Abstract

India is the second largest producer of fruits and vegetables. They contribute more than 30% of the agriculture GDP. Out of the total production of fruits and vegetables nearly 76 percent is consumed in fresh form, while wastage and losses account for 20 to 40 %. Only 2-3 percent of production is being processed Drying is one of the oldest method and most traditional method. By reducing the moisture up to a certain level in fruits and vegetables, the microbiological spoilage and deteriorative chemical reactions are greatly minimized. In addition to preservation, drying lowers the cost of packaging, storage and transportation by reducing both the weight and volume of the final product (Doymaz and Kocayigit 2011). In fruits and vegetables many deteriorative reactions occur when they are subjected for processing. These reactions may be enzymatic or non enzymatic. Pretreatments are given to fresh products before drying to prevent the changes that occur during processing. The use of pre treatment on crops before drying is aimed at preventing fruits and vegetables from darkening. Many light coloured fruits such as apples darken rapidly when cut and exposed to air. If not pretreated, these fruits will continue to darken after dried (Lewicki et al. 2002 and Hartz, 2008). Pretreatments given to fruits and vegetables are blanching, acid dip, alkaline dip, sulphuring,CaCl2, Syrup and salt blanching, honey dip, fruit juice dip, Hydrogen peroxide. The commonly used pre treatments are sulphiting, syrup blanching.

Key words : *Dehydration, pre-treatments, fruits, vegetables.*

Introduction

India has a wide range of agro climatic conditions suitable for cultivating different fruits and vegetables and occupied second place in the production of fruits and vegetables after china. The production of fruits and vegetables during 2019-20 is 99.06 million MT, and 191.07 million MT respectively. Even though the production is high, 20-30% of the fruits and vegetables are lost due to several reasons like improper handling, poor storage systems, lack of processing. By proper processing we can prevent the loss of fruits and vegetables to some extent. In India processing of fruits and vegetables is very low i.e 2-3% when compared to other countries. The value of processed food in India is about Rs.43,798 crores (APEDA 2021). There are so many processing techniques like canning, freezing, dehydration, intermediary moisture foods. Among them dehydration is the best method for preserving the food.

Dehydration is the process of removal of moisture from the fruits and vegetables up to 3-5%. In addition to moisture loss, drying lowers the cost of packaging, storage and transportation by reducing both the weight and volume of the final product (Doymaz and Kocayigit. 2011). Drying is used to process fruits like grapes, prunes, apricot and vegetables like onion, garlic, mushroom, potato, leafy vegetables. During drying fruits and vegetable loss their quality due to many reactions Reactions occurring during drying can result in quality losses, particularly nutrient losses and other deteriorations caused by browning reactions. Reactions during drying may be classified as browning reactions and nutrient losses. Moreover, there occur also structural changes, which affect quality of dried fruits and vegetables.

Browning Reactions : Browning reactions in foods are of widespread occurrence and become evident when food materials subjected to processing or to mechanical injury. They are important in terms of the alteration of appearance, flavour, and nutritive value. Browning is considered to be desirable if it enhances the appearance and flavour of a food product in terms of tradition and consumer acceptance like in the cases of coffee, maple syrup, beer, and in toasting of bread. However, in many other instances, such as fruits, vegetables, frozen and dehydrated foods, browning is undesirable as it results in off-flavours and colours. Rate of browning reactions depends on temperature of drying, pH and moisture content of the product, time of heat treatment, concentration and nature of the reactants. There are two main mechanisms of browning reactions: (i) Non-enzymatic browning (Maillard reactions, caramelization, ascorbic acid oxidation), (ii) Enzymatic browning.

(1). Enzymatic Browning : Enzymatic browning is caused by a group of enzymes collectively called “phenolase” or “ polyphenol oxidase”. This type of browning occurs in many fruits and vegetables, such as

potatoes, apples, and bananas, when the tissue is bruised, cut, peeled, diseased, or exposed to any number of abnormal conditions. The injured tissue rapidly darkens on exposure to air, due to the conversion of phenolic compounds to brown melanins. Phenolase group includes enzymes phenoloxidase, catecholase, tyrosinase and ascorbinase. Phenolase is extensively distributed in plants such as roots, citrus fruits, plums, bananas, peaches, pears, melons, olives, tea, mushrooms, and others. It has a molecular weight of 128.000 and a copper content of 0.2 %. The freshly prepared enzyme contains copper in the cuprous form, but it slowly oxidizes to the cupric form on aging.

Phenolase in the pure form is colourless. Concentrated solutions of phenolase are most stable at the neutral pH. But, heating for a short time at 60°C inactivates enzyme. Phenolase is also inhibited by substances, which form stable complexes with copper such as H_2S, KCN, CO or p-aminobenzoic acid. In plants, there are large number of naturally occurring o-diphenolic compounds, which are oxidizable by phenolase. Actually the mechanism of action of phenolase on o-diphenolic compounds is very complicated. Since the copper is the prosthetic group of the enzyme, it has been postulated that the activity of phenolase is based on the change of the copper from the cupric to the cuprous state. Simply phenolase catalyse the oxidation of colourless phenolic compounds into o-quinones, which are red to brown in colour. O-quinones are precursors of the brown colour in cut fruits and vegetables. When they combine with amino acid derivatives, forms highly collared complexes. The initial reaction, involving the conversion of the phenolic compound to the corresponding quinone, is dependent upon the presence of the phenolase, its copper prosthetic group and oxygen. Advantage may be taken of this in order to control or prevent enzymatic browning in foods. This type browning is a serious problem during the dehydration process if any injury to the plant tissue, poor handling can result in phenolase activation.

Control of Enzymatic Browning

Heat : The application of heat to the food at a high temperature for an adequate length of time will inactivate phenolase and all other enzymes present. Several problems may arise through the use of heat. The fruit or vegetable becomes cooked and this in turn leads to unfavourable texture changes and the development of off-flavours. Such problems may occur for instance in the processing of potatoes, apples, pears, and peaches. There is a close relationship between temperature and time with respect to the heat-treatment of foods. It is essential to control the heating time very carefully at high temperatures, so that the enzymes are inactivated, thereby avoiding changes in flavour and texture. A balance should be worked out in terms of each particular raw material and desired food product.

Sulfur dioxide and sulphites : Sulfur dioxide and sulfates, usually sodium sulfate, sodium bisulfte, and sodium meta bisulfte, are powerful inhibitors of phenolase, and are widely used in the food industry. One can employ gaseous sulfur dioxide or dilute aqueous solutions of the sulfites. The gas will penetrate at a faster rate into the fruit or vegetable, but the sulfite solutions are easier to handle, as in the form of a dip in the processing plan, or as a spray. There are advantages and disadvantages in the use of sulfur dioxide or sulfites. They can be used in cases where the application of heat would result in undesirable textural changes and the development of off -flavours. They have antimicrobial properties and also assist in preserving vitamin C. However, their use in food material may result in an objectionable flavour and odour, or may bleach the natural colour of the food. It is toxic at high levels, and can be detected organoleptically. Perhaps the most serious disadvantage of using sulfur dioxide or sulftes in food stuffs is their adverse destructive effect on vitamin B or thiamine. In spite of these drawbacks, this group of phenolase inhibitors is widely used in food processing, due to the effectiveness and low cost of these substances.

Acids : This is a widely used method for controlling enzymatic browning. The acids are present naturally in tissues, particularly citric, malic, phosphoric and ascorbic acids. In general their action is to lower tissue pH and thus to decrease the rate of enzymatic browning. The optimum pH of phenolase lies within the range 6-7, and below 3 there is virtually no enzymatic activity. Citric acid, often in conjunction with ascorbic acid or sodium bisulfite, has long been used as a chemical inhibitor of enzymic browning. Cut fruit, such as peaches is often immersed in dilute solutions of these acids prior to processing. Citric acid possesses a double inhibitory effect on phenolase, not only by lowering the pH of the medium, but also by chelating with the copper. A much more significant inhibitor of phenolase is ascorbic acid. It does not have a detectable flavour at the concentration used. It possess a corrosive action upon metals, in addition, its vitamin value is well known. Ascorbic acid reduces the o-quinones formed by phenolase to the original *o*-dihydroxphnolic compounds, which in turn prevents the formation of brown substances.

(2). Non-Enzymatic Browning : In the preparation and processing of foods, one is soon acquainted with the phenomenon of browning associated with heated and stored products. In contrast to those reactions discussed in the previous section, these do not require enzymatic catalysis and are referred to as non enzymatic. In general, browning reactions are deleterious to the nutritional value

of the food concerned, and can occur during processing as well as during storage of food products. These reactions not only reduce the nutritional value, but also other changes which might render the food unacceptable to the consumer. Non-enzymatic browning occurs in dried foods during protracted storage. There are three main reasons for non enzymatic browning : (i) Maillard reaction, (ii) Caramelization, (iii) ascorbic acid oxidation.

Maillard Reaction : The Maillard reaction is the action of amino acids and proteins on sugars. The carbohydrate must be a reducing sugar because a free carbonyl group is necessary for such a combination. The end product is the melanoidins, which are brown pigments. The mechanism of reaction has three stages : (i) Initial stage (colourless) a. Sugar-amine condensation b. Amatory rearrangement (ii) Intermediate stage (colourless to yellow) c. Sugar dehydration d. Sugar fragmentation e. Amino acid degradation (iii) Final stage (highly collared) f. ado condensation g. aldehyde-amine polymerization, formation of heterocyclic nitrogen compounds

Caramelization : This process is another example of nonenzymic browning involving the degradation of sugars in the absence of amino acids or proteins. It was soon established that when sugars are heated above their melting points they darken to a brown coloration. This soon associated with changes in flavor. The main disadvantage of this reaction is the production of unpleasant, burned, and bitter products which can arise if this process is allowed to proceed uncontrolled. This reaction may be slowed down by bisulfites, which react with sugar to decrease the concentration of aldehydic form.

Ascorbic acid oxidation : A further mechanism appears to operate during the discoloration of dehydrated vegetables in which ascorbic acid is involved. The formation of de hydroascorbic acid and di ketogluconic acids from ascorbic acid is thought to occur during final stages of the drying process and is capable of interacting with the free amino acids, nonenzymatically, producing the red to brown discoloration.

Inhibition of non-enzymatic browning : Several factors can affect the formation of collared complexes in food products. Among there are pH, temperature, moisture content, time, concentration and nature of reactants. The rate of browning increases with rising temperature. Since these reactions have been shown to have a high temperature coefficient, lowering of the temperature during the storage of food products can help to minimize these processes. Those reactions being moisture dependent for optimum activity can be inhibited by reducing the moisture content through dehydrating procedures.

In attempting to carry out these procedures one must ensure that the dehydrated product is suitable for sale in that form, and that the product is suitably packaged so as not to permit moisture uptake during storage. Since the Maillard reaction is generally favoured at the more alkaline conditions, if this type of browning is involved, lowering of the pH might provide a good method of control. Gas packaging is extremely useful in excluding oxygen by using an inert gas. This reduces the possibility of lipid oxidation, which in turn could give rise to reducing substances capable of interacting with amino acids. While this reaction does not appear to influence the initial carbonylamino reaction, exclusion of oxygen is thought to effect other reactions involved in the browning process. Chemical inhibitors have been used to advantage in limiting browning reactions during the production and storage of a variety of foods. Among those widely used are sulfites, bisulfites, thiols and calcium salts. Sulphites proved successful in controlling a variety of browning processes. Bi sulphites inhibit the conversion of D-glucose to S-hydroxymethyl- furfural, as well as the conversion of ascorbic acid to furfural by complexing through the reducing group. Consequently the formation of furfurals is blocked, thus preventing the production of the coloured pigments. They can also block the carbonyl group of the reducing sugars involved in the carbonyl amino reaction. Calcium chloride was reported to be a possible inhibitor of browning. Its inhibitory effect is due to the chelation of calcium with the amino acids. Although the various inhibitors discussed can prevent to varying degrees of success browning from occurring, it is important to realize that the nutritional value of the foods have been seriously reduced.

(3). Nutrient losses : Dehydrated fruits and vegetables are concentrated sources of energy. However some vitamin potency, especially the heat sensitive vitamins, may be lost during drying. Vitamin A and C are sensitive to oxidative degradation, where as thiamine is sensitive to heat and sulphuring and riboflavin is light sensitive. Processing steps that affect nutrient in drying are pretreatments, especially sulphuring, blanching, drying and storage. Sulphur dioxide is a strong reducing agent, which causes a total destruction of thiamine, whereas it protects oxygen sensitive vitamins like vitamin A and vitamin C. Sulphur dioxide enhances approximately 50 % retention of vitamin C during drying. Moreover, it decreases the loss of carotene during drying as low as to 10-15 %. Blanching is an essential step for minimizing nutrient losses. It stabilizes pectin, so that higher rehydration capacity and lower rehydration losses are achieved. Blanching inactivates enzymes, thereby decreases carotene and thiamine loss appreciably. On the other hand it causes loss of ascorbic acid.

Drying time, temperature and oxygen availability during drying are critical aspects with respect to vitamin loss. During drying, loss of fat-soluble vitamins (vitamins A and E) is due to the oxidation of lipids (peroxides and radicals) with vitamins. Sun drying causes large losses in carotene and ascorbic acid. Rapid drying is important for the retention of greater amounts of ascorbic acid. In spray drying and freeze drying nutrient losses are minimum. Proteins are heat sensitive, overheating during drying may reduce the PER (protein efficiency ratio) and make proteins unavailable to body. Storage temperature and packaging materials are important for nutrient losses. Ascorbic acid is easily lost under aerobic storage conditions. Therefore, storage under carbon dioxide atmosphere is used to protect ascorbic acid and carotene contents. In general, niacin, Vitamin B and pyrodoxine are stable during drying.

(4). Physical changes : A factor often greatly affecting the drying rate of the product is the shrinkage of the solid as moisture is removed. Fibrous materials such as vegetables and other foodstuffs undergo shrinkage during drying. The most important affect of shrinkage is that there may be developed a hard layer on the surface, which is impervious to the flow of liquid or vapour moisture and slows the drying rate. In many, foodstuffs, if drying occurs at too high temperatures, a layer of closely packed shrunken cells, which are sealed together, forms at the surface. This layer act as a barrier to moisture migration and is known as 'case hardening'. Sometimes to decrease the effects of shrinkage, it is desirable to dry with moist air, which decreases the rate of drying so that the effects of shrinkage on hardening at the surface are greatly reduced. In dried fruits and vegetables, shrinkage influences textural properties of the product. Since it results in casehardening, it resists or prevents full rehydration. Sometimes, a freeze/thaw cycle prior to dehydration is used to improve rehydration characteristics of dried products. The effect of freeze or thaw cycle can be attributable to increase internal porosity caused by cavities left by large ice crystals. Changes in textural properties of the product is determined by the integrity of cell wall and the relative mobility of cell wall content upon breakage of cell wall.

(5). Storage stability : Darkening and loss of flavour are the major types of deteriorations of dried fruits and vegetables in storage. Sulphur dioxide content, storage temperature, light, packaging material, moisture content, antimicrobial treatment and trace elements are major factors affecting storage stability. Only free sulphite is effective in retarding the formation of pigment materials.

Sulphur dioxide helps to maintain a light, natural colour during storage. Darkening rates during storage is inversely proportional to sulphur dioxide content. Therefore, any condition accelerating sulphur dioxide loss, in turn accelerates the darkening of the product. Storage temperature is of vital importance in relation to maintenance of quality. Storage of dried fruits and vegetables should be at relatively low temperatures to maximize storage life. There is an important effect of temperature on loss of sulphur dioxide from the dried product during storage. A 20°F increase in temperature increases the rate of sulphur dioxide loss approximately 3 times. Moreover at higher temperatures, the rate of change in flavour also increases. Light, during storage, is detrimental for quality. It causes a reduction in carotene content, increases the rate and amount of sulphur dioxide loss, and thereby increases the rate of darkening. In addition, it also affects riboflavin content. Light during storage is detrimental for quality. It causes a reduction in carotene content, increases the rate and amount of sulphur dioxide loss and thereby increases the rate of darkening. In addition, it also affects riboflavin content. Packaging material used and the package environment is another major factor in terms of storage stability. The type of package used varies with expected storage conditions. Packaging may be done under vacuum, nitrogen or atmospherically. Dried foods have a moisture content below 20 % and a water activity 0.7 or below. Dried fruits and vegetables must be protected from rodents and insects during storage. Fumigation is often used to prevent insect infestation during storage and before packaging. In addition to fumigation, antimycotic agents are used to stabilize most prunes and figs against mould growth at 30-35 % moisture. Sorbic acid and sorbate salts are used as dips or sprays to prevent moulding, sulphur dioxide or sulphite salts are used to preserve fruits during drying from colour changes and browning. Potassium sorbate dip is the most effective one.

To control deteriorative reactions occur during dehydration of fruits and vegetables must undergo some pretreatments. Pretreatments are generally given to the fresh products before drying to prevent the changes occur during processing. The main objectives of treating the food before drying is to improve the flavour and colour, minimize the nutrient loss,to stop decomposition and destruction of harmful microbes during drying, to ensure even drying, to stop enzymatic action and to extend storage life.

To obtain a dried product of excellent quality, the raw produce must be harvested and handled properly. But to control the deteriorative reactions we have to give pretreatments like blanching, sulphuring, syrup and salt blanching, acid dip, alkaline dip,$CaCl_2$,H_2O_2 to the fruits and vegetables which are subjected to the dehydration. The commonly used pre treatments are sulphiting, syrup blanching (Lewicki *et al*. 2002). If not pretreated, fruits will

continue to darken after dried (Lewicki *et al*. 2002 and Hartz, 2008).

Commonly Used Pretreatments

Blanching : Blanching is carried out by hot water or steam. Water blanching is done by Placing the produce into the boiling water for 5 minutes and immediately transfer to the cool water to prevent cooking. Steam blanching is done by Steaming the produce over hot boiling water in a steamer for 2 minutes. Blanching denatures the enzymes in the product. The degree of enzyme inactivation indicates the effectiveness of the blanching treatment.Blanching reduces the drying time, removes intercellular air from tissues, causes softening of texture, retards the development of objectionable odours and flavours during storage by enzyme inactivation, retains carotene, proteins and ascorbic acid during storage. Maintain original colour**.**Water blanching leaches the water soluble vitamins,over blanching makes the produce to lose colour, flavour and poor texture after drying.

Sulphuring : Sulphur dioxide treatment is the commonly used in the fruit and vegetable processing industry. It prevents enzyme catalysed oxidative changes, inhibit microbial deterioration and facilitate drying by plasmolysing the cells. Fruits are generally sulphured by placing them in an adjustable vented compartment containing burning sulphur, for vegetables sulphite solution treatment is given to for controlled absorption. Bi sulphites inhibit the conversion of D-glucose to S- hydroxy methyl- furfural, as well as the conversion of ascorbic acid to furfural by complexing through the reducing group (OH). Consequently the formation of furfurals is blocked, thus preventing the production of the coloured pigments.Maintains attractive colour, preserves carotene, ascorbic acid, inhibit microbial deterioration by plasmolysing the cells.Undesirable textural changes and the development of off flavours. It is toxic at high levels, and can be detected organoleptically. It has adverse effect on thiamine.

Syrup and salt blanching : The main principle involved in the salt and syrup blanching is osmotic dehydration. Osmotic dehydration is the phenomenon of removal of water from lower concentration of solute to higher concentration through semi permeable membrane results in the equilibrium condition in both sides of membrane. Osmotic dehydration found wide application in the preservation of food-materials since it lowers the water activity of fruits and vegetables. Osmotic dehydration is preferred over other methods due to their colour, aroma, nutritional constituents and flavour compound retention value. In osmotic dehydration the solutes used are generally sugar syrup and salt (sodium chloride). Osmotic dehydration is the best process to preserve them for long duration. Osmotic dehydration could be very much beneficial for banana, jackfruit, sapota, mango, guava and pineapple. Salt is also act as osmotic agent for vegetables like tomato and onion.

Acid dip : Use of an acid pre dip before sulfuring provides better colour stability to a product. A dip of 1% ascorbic acid and 0.25% malic acid has been used to retard enzymatic browning in peaches. Steeping of mushrooms in 1% citric acid for 16 hours results better quality dried products in respect of colour, appearance, rehydration properties and keeping quality. They reduce the pH of the foods, because phenolase activity is high at 6-7. Acid dips like ascorbic acid improves the nutrition and also prevent the microbial attack.

Alkaline dip : This treatment generally used for fruits that are dried as whole like grapes and prunes. Dipping in alkaline solutions form fine cracks on the skin. Sodium carbonate 0.5% is used at a temperature ranging from 93 to 100°C. Oleate esters dips accelerate moisture loss by causing the wax plates on the grape skin to dissociate thus, facilitating water diffusion.Reduces the drying time by dissolving wax on the fruits. Ensure faster drying by forming cracks on the skin and improves the texture.

Calcium chloride : Calcium chloride improves the texture of fruits and vegetables. Calcium chloride was reported to be a possible inhibitor of browning. Its inhibitory effect is due to the chelation of calcium with the amino acids. The calcium ions make bridges between peptic molecules in the middle lamella being responsible for cell cohesion. So that texture of the dried product is improved .

Hydrogen peroxide : Hydrogen peroxide is one of the sanitizer used in treating the surface of fruits and vegetables against pathogenic micro-organisms. Soak treatment of hydrogen peroxide (30%) for 30 min improves whiteness of dehydrated *Agaricus bisporus* but, adversely affected the texture, taste and flavour.

Fruit juice dip : Fruit juice dip is done for fruits which lost their natural taste during osmosis. Fruit juice dip is done after osmosis to retain their original flavour because osmosis removes the water from the tissue along with the flavouring compounds. To retain the original flavour of fruit, dip in the fruit juice of that particular fruit. For example pine apple contain slight acidic flavour but during osmosis it lost its acidic flavour to retain the acidic flavour of pineapple again dip the fruits in pineapple juice for 1 minute and drain.Retain their original flavour. Improves the taste and appearance.

Honey dip : Honey dip is preventing the fruit from darkening after drying. For dipping of fruits in honey, solution is prepared by honey, water (1:4) ratio, let fruit

soak 3-5 minutes, dried after draining. Honey dip adds extra energy to the dried food and improves appearance.

Conclusion

Pretreatments improve the quality of dehydrated fruits and vegetable products. Because there is a loss of colour, flavour, texture, nutritional value during dehydration. So that by giving the various pre treatments before dehydration both sensory and nutritive value dehydrated product has been improved. Among all the treatments osmotic dehydration is the best process because it removes half of the moisture before drying and there is a less loss of heat sensitive nutrients.

Future prospects

In future there is a need to improve the treatments like protein dips to improve the protein content because fruits are poor sources of proteins. This could possibly be done by tying it up chemically, so it would be unavailable to react, but available to the human body. Because of the stress on safety aspect being laid at present ,an alternative procedure is needed that could replace sulphur dioxide for retarding browning.

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An Economic Status of Gothan under Godhan Nyay Yojana and Marketing of Value Added Products of Cow Dung in Raipur District of Chhattisgarh

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Abstract

The present study seeks to examine the identification of value added products by using cow dung purchased at Gothan under Godhan Nyay Yojana, the cost and returns of different value added products and business performance at Gothan and to suggest policy intervention options for betterment of Godhan Nyay Yojana (GNY) of the state. The study was confined to Arang block of Raipur district. Out of 61 active Gothans, Baihaar, Bancharod and Goinda Gothans were selected on the basis of basic amenities developed in Gothan categorized as modern, moderate and poor Gothan, respectively. The provision has been given by the Chhattisgar Government under the GNY that farmers and cattle rears sold the cow dung at Gothans at Rs 2 per kg, after procuring cow dung Women Self Help Groups prepared the different products. The cost of production of vermicompost was Rs 5.65 per kg and sold it at Rs 10 per kg. The cost of preparations of gamla, diya, agarbatti and mushroom was Rs 5 per piece, Rs 1.3 per piece, Rs 110 per kg and Rs 30 per kg, respectively. The selling price of gamla, diya, agarbatti and mushroom was Rs 10 per piece, Rs 3 per piece, Rs 180 per kg and Rs 140 per kg, respectively. The Baihar Gothan was conducted the business of Rs 569160 and net income was obtained of Rs 245740. Bancharoda Gothan was conducted a business of Rs 269800 and net income was obtained of Rs 125175. Goinda Gothan was conducted the business of Rs 190000 and net income was obtained of Rs 82650 in year of 2020-21 (COVID-19 period).

Introduction

Cow dung is a “gold mine” due to its wide applications in the field of agriculture, energy resource, environmental protection and therapeutic applications. Cow dung may not only act as a substitute for chemical fertilizers because it supplements organic matter, but also as a conditioner for soil (Garg and Kaushik 2005; Yadav *et al.* 2013; Belanger *et al.* 2014). It not only improves the different properties of soil but also acts as a source of microorganisms producing biological nematicidal agents with no negative effect on environment (Gupta *et al.* 2016).

Livestock status in India : As per the 20th Livestock census, the total livestock population shows an increase of 4.6 per cent over the Livestock census 2012. Total Bovine population (Cattle, Buffalo, Mithun, and Yak) is 302.79 million in 2019 which shows an increase of 1.0 per cent over the previous census. The total number of cattle in the country is 192.49 million in 2019 showing an increase of 0.8 per cent (Table-1).

Livestock status in Chhattisgarh : Chhattisgarh is rich in livestock wealth with 158.72 lakhs animals. The total population of livestock was increased by 5.56 % over the previous census (2012). Among the States, Chhattisgarh has the eleventh position in total number of bovine population (11158.68 thousand), which comprised of 2.67 lakhs crossbred cattle, 97.17 lakhs non-descript cattle and 11.75 lakhs buffaloes. The bovine population (Cattle and Buffalo) is 70.31% of total livestock population, which declined of 0.37% over the previous census (Table-2).

Godhan Nyay Yojana : Godhan Nyay Yojana is the scheme recently launched in Chhattisgarh state on 20 July 2020, on the occasion of Hareli, the first festival of the state by the Chhattisgarh Government. This scheme main aims at boosting the rural economy by procuring cow dung at Rs 2 per kg from farmers and cattle rearers initially in the rural area later in the urban area too.

The procuring of cow dung is being done at the Gothan, the cowshed built at village panchayat level. In the state around over 5000 cow sheds have been identified to be built in the selected village panchayat. Out of the above total, around 50 per cent has been built and the other half is being built. Later on, every village panchayat and every village would be covered under the scheme.

Procured cow dung turned into vermin-compost by Women Self-Help Group (WSHG) in the Gothan and later the vermicompost is being sold to the farmers at Rs 10 per kg to encourage for using the vermicompost and discouraging the chemical one. Women Self Help Groups (WSHGs) also prepared different value added products, such as pot (gamla), diya, agarbatti and mushroom.

The income from this scheme will supplement and complement the agriculture income of the farmers and cattle owners. The recuperation of the GNY has seen to boost up the rural economy of the state.

Objectives : In view of the above facts, the present study has been undertaken with following specific objectives :

To identify the value added products by using cow

Table-1 : Total number of bovine during 20th livestock census-2019 of Major States.

S. N.	States/UTs	Total (In Thousands)	Rank
1.	Uttar Pradesh	51806.1	1
2.	Madhya Pradesh	29042.32	2
3.	Rajasthan	27605.78	3
4.	Bihar	23030.96	4
5.	Gujarat	20154.12	5
6.	West Bengal	19652.42	6
7.	Maharashtra	19528.62	7
8.	Jharkhand	12539.08	8
9.	Karnataka	11443.48	9
10.	Assam	11274.98	10
11.	Chhattisgarh	11158.68	11
12.	Andhra Pradesh	10797.24	12

Source : 20th livestock census, 2019.

Table-2 : Livestock population in Chhattisgarh state.

(In lakhs)

Species	2012 Livestock Census	2019 Livestock Census	Relative % Change
Cattle (Indigenous) (Includes : Non Descript + Improved			
Total (Male and Female)	96.34	97.17	0.86
Female Cows in Milk	11.42	12.08	5.78
Breedable Indigenous Cow	31.52	31.68	0.51
Cattle (Exotic)			
Total (Male and Female)	1.77	2.67	50.85
Female Exotic Cows in Milk	0.46	0.75	63.04
Breedable Exotic Cow	0.87	1.31	50.57
Total Cattle	98.11	99.84	1.76
Total Cow in Milk	11.88	12.83	8.00
Total Breedable Cows	32.39	32.99	1.85
Buffalo			
Total (Male and Female)	13.9	11.75	-15.47
Female Buffalos in Milk	1.8	1.81	0.56
Total Breedable Buffalos	3.95	3.76	-4.81
Total Bovine	112.01	111.59	-0.37
Total Bovine in Milk Total	13.68	14.64	7.02
Breedable Bovine	36.34	36.75	1.13
Goats	32.25	40.05	24.19
Sheep	1.66	1.80	8.43
Pigs	4.39	5.27	20.05
Horse, Pony, Donkey, Mule	0.05	0.008	-84.00
Total Livestock	150.36	158.72	5.56
Poultry Backyard	62.86	85.6	36.18
Poultry Commercial	116.69	101.52	-13.00
Total Poultry	179.55	187.12	4.22

Source : 20th livestock census, 2019.

dung under Godhan Nyay Yojana in Raipur district of Chhattisgarh.

To estimate the cost and returns of different business held under Gothans.

To suggest policy intervention options for betterment of Godhan Nyay Yojana of the state.

Research Methodology

In Arang block of Raipur district of Chhattisgarh state there are total 61 active Gothans are establish, among them, Baihaar, Bancharod and Goinda Gothans were categorized on the basis of basic amenities developed in Gothan and area occupied by Baihar Gothan is 25 acre of land and has 1239 animal populations, Bancharoda Moderate Gothan which have 14 acre of land and has 623 animals and Goinda Gothan which have 5 acre of land and has 835 animal populations, which is presented Table-3.

On the basis of table 3, Baihar, Banchroda and Goinda Gothans were considered for conduction the study. A Model Gothan includes at least five acres of land, cattle protection trench, storage space for fodder and water, shed or tree cover, water facility with solar pump and tube well, proper drainage system, cemented pavilion for seating arrangements of the workers and visitors and animal fodder can also be grown in Gothans. These all facilities are available in Baihar Model Gothan, few facilities absent in Bancharoda Gothan and almost facilities are absent in Goinda Gothan.

In the selected Gothan 20 to 30 villagers were sell the cow dung in each selected Gothan per day. In selected Gothan of Baihar, Bancharoda and Goinda villages 50, 40 and 55 farmers and cattle rears were sell the cow dung, respectively. Total registered cow dung sellers of selected Gothans were 145 and total number of selected cow dung sellers was 25. Gothan is not only subsidiary source of income of farmers but it also generates employment opportunity. Presently, 4 to 5 Women Self Help Groups (WSHGs) are working in selected Gothan for different economic activities.

Results and Discussion

Value added product by using cow dung under Godhan Nyay Yojana : Under the GNY Scheme, the state government proposed to purchase cattle dung at Rs 2 per kilogram and plan to make different products from it through Gothan Samiti and self help groups (SHG). The payment has been made to the sellers of cattle in 15 days of intervals. The different women self help groups were involved for preparation of vermin compost and other products *viz.,* Agarbattis or Dhupbatti (different kinds of incense sticks), Diya, Pot (gamla) and Mushroom. These economic activities are providing employment and generating the income of farmer's cattle rearers and WSHGs. The details of economic activities performed by women self help groups are presented in Table-4.

Cost and returns of different business held under Gothans

Gross income and net income of Baihar Gothans : The

Table-3 : Demography of selected Gothans.

Name of the Gothan	Village location	Present scenario	Total area of Gothan (in acres)	Animal population	Total dung purchased since the advent of the GNY scheme (in Qtl.)
Baihar	Baihar Arang	Fully developed	25	1239	1552
Bancharoda	Bancharoda Arang	Partially developed	14	623	686
Goinda	Goinda Arang	Undeveloped	5	835	740

Table-4 : Value added products prepared by cow dung and its price.

Products by using cow dung	Price (Rs.)
1. Vermin-compost (in kg)	10
2. Gamla (in piece)	10
3. Diya (in piece)	3
4. Agarbatti (in kg)	180
5. Mushroom (Other products) (in kg)	140

gross income, net income and total expenses of Baihar sampled Gothans were estimated in Rs/Annum and presented Table-5. It reveals that Baihar Gothan is modern Gothan having full amenities and it was conducted a business of Rs 569160 per annum by selling of vermicompost, pot (gamla) , diya, agarbatti and mushroom production and obtain the net income of Rs 245740 per annum. The total expenditure on doing the economic activities was Rs 323420 per annum. In this Gothan there were 5 WSHGs involved for doing all the economic activities and hence earned the profit or net income of Rs 206860, which comprised of commission charges for production of vemicompost of Rs 117720, pot of Rs 6000, diya of Rs 6800, agabatti of Rs 67760 and mushroom of Rs 8580 per annum.

Thus, it could be concluded that production of vermicompost is most profitable economic activity performed by WSHGs of Baihar Gothan followed agarbatti, mushroom, diya and pot.

Gross income and net income of Bancharoda Gothan: The gross income, net income and total expenses of Bancharoda sampled Gothans were estimated in Rs/Annum and presented Table 6. It reveals that Bancharoda Gothan is moderate Gothan having few amenities and it was conducted a business of Rs 269800 per annum by selling of vermicompost, pot, diya, and mushroom production and obtain the net income of Rs 125175 per annum. The total expenditure on doing the economic activities was Rs 144625 per annum. In this Gothan there were 4 WSHGs involved for doing all the economic activities and hence earned the profit or net income of Rs 100875, which comprised of commission charges for production of vemicompost of Rs 73575, pot of Rs 7500, diya of Rs 9350 and mushroom of Rs 10450 per annum.

Thus, it could be concluded that production of vermicompost is most profitable economic activity performed by WSHG of Bancharoda Gothan followed mushroom, diya and pot.

Gross income and net income of Goinda Gothans : The gross income, net income and total expenses of Goinda sampled Gothans were estimated in Rs/Annum and presented Table-7. It reveals that Goinda Gothan is poor Gothan most of the amenities were absent and it was conducted a business of Rs 190000 per annum by selling of vermicompost and obtain the net income of Rs 82650 per annum. The total expenditure on doing the economic activities was Rs 107350 per annum. In this Gothan there were 1 WSHGs involved for doing all the economic activities and hence earned the profit or net income of Rs 62130 per annum as commission charge for production of vemicompost.

Suggestions for betterment of Godhan Nyay Yojana and policy intervention options : The aims of GNY to boost up the rural economy by procuring the cow dung at constructed Gothans from each gram panchayat. The purchased cow dung has converted into various values added products by involving the WSHGs viz, vermicompost, gamla, diya etc. Despite WSHGs can also be start up other economic activities in free time e.g., mushroom cultivation, manufacture the agarbatti, fodder cultivation and so on. For considerable improvement of GNY, the suggestions invited from cow dung sellers, members of WSHGs and personnel of Gothan samiti have undertaken for the betterment of GNY, which is presented in table-8.

It inferred from the response of cow dung sellers have taken on Gothan is near to villages, dispensation of trolley for carrying cow dung and provision of loans to less number of cattle rears. Out of 25 sampled cow dung seller all reported that Gothan is near to village whereas, 20 and 22 cow dung sellers were reported that dispensation of trolley for carrying the cow dung was available and provision of loan to less number of cattle rears.

The suggestion of members of WSHGs of all the sampled Gothans have undertaken on different aspects to the improvement of Gothan. All the members were agreeing to arrange extra pit for production of compost required. The availability of raw materials for value added products in proximity of Gothan. They reported that Gothan is far away from villages and suggested that it

Table-5 : Expenditure and income received by Baihar Gothan in Rs per annume.

Particulars	Cost (in Rs.)	Price (in Rs.)	Total production	Gross income (in Rs.)	Total expenditure (in Rs.)	Net income (in Rs.)
1. Vermicompost (per kg)	5.65	10	360 quintal	360000	203400	156600
2. Gamla (per piece)	5	10	1200 piece	12000	6000	6000
3. Diya (per piece)	1.3	3	4000 piece	12000	5200	6800
4. Agarbatti (per kg)	110	180	968 kg	174240	106480	67760
5. Mushroom (per kg)	30	140	78 kg	10920	2340	8580
Total				569160	323420	245740
Net income earned by WSHGs						206860
Net income earned by Gothan samitis						20880
Net income earned by Co-operative societies						18000

Table-6 : Expenditure and income received by Bancharoda Gothan in Rs per annume.

Particulars	Cost (in Rs.)	Price (in Rs.)	Total production	Gross income (in Rs.)	Total expenditure (in Rs.)	Net income (in Rs.)
1. Vermicompost (per kg)	5.65	10	225 quintal	225000	127125	97875
2. Gamla (per piece)	5	10	1500 piece	15000	7500	7500
3. Diya (per piece)	1.3	3	5500 piece	16500	7150	9350
4. Mushroom (per kg)	30	140	95kg	13300	2850	10450
Total				269800	144625	125175
Net income earned by WSHGs						100875
Net income earned by Gothan samitis						13050
Net income earned by Co-operative societies						11250

Table-7 : Expenditure and income received by Goinda Gothan in Rs. per annume.

Particulars	Cost (in Rs.)	Price (in Rs.)	Total production	Gross income (in Rs.)	Total expenditure (in Rs.)	Net income (in Rs.)
Vermicompost	5.65	10	190 quintal	190000	107350	82650
Total				190000	107350	82650
Net income earned by WSHGs						62130
Net income earned by Gothan samitis						11020
Net income earned by Co-operative societies						9500

Table 8 : Suggestions of cow dung sellers, members of WSHGs and personnel of Gothan Samitis for betterment of Godhan Nyay Yojana.

S. No.	Particulars	No. of perceptions	
Cow dung sellers		Yes	No
1.	Gothan is near to village.	25	—
2.	Dispensation of trolley.	20	5
3.	Provision of loans to less number of cattle rears.	22	3
Women's Self Help Groups			
4.	Arrangement of extra vermicompost pit.	10	—
5.	Availability of raw materials for values added products in proximity of the Gothan	10	—
6.	Provide training on skill development for values added products from cow dung.	8	2
7.	Awareness program sponsored by the state Agriculture department w.r.t., for use of vermicompost in place of chemical fertilizers.	10	—
Gothan Samitis			
8.	Improve the veterinary facilities.	32	—
9.	Employment of labours for caring of cattle's.	29	3
10.	Timely maintenance and repair of Gothan.	30	2

should be near to village. The several value added products from cow dung are produce from other states of the country e.g. paper, cloths, wall putty, emulsion paint, distemper, carry bag etc. Therefore, proper training required for members of WSHGs. All members were wanted to do the skill development training for different aforesaid value added products. The members of WSHGs were suggested for launch a program on awareness for use of vermicompost in place of chemical fertilizers to improve the soil health.

The suggestions were also asked from personnel of Gothan samiti on improvement of veterinary facilities and employment of labour for caring of cattle's in Gothan, and timely maintenance and repairing of Gothan.

Despite of suggestions made by cow dung sellers, members of WSHGs and personnel of Gothan samiti, as a researcher suggested that cow urine of stay cattle in Gothan should be used for preparation panch gavya and pesticide, which will improve the earning of Gothan. It is also being suggested that to promote the use of vermicompost in kitchen gardening, cultivation of horticulture crops and nursery rises through advertisement.

Conclusion

From the empirical findings of study, it has been concluded that moderate and poor Gothan should upgraded up to modern Gothan so that they will improve their total turnover by considering the more economic activities as conducted modern Gothan i.e., Baihar. Therefore, it being suggested that infrastructural facilities should be developed in Bancharoda and Goinda Gothan as developed in Baihar Gothan, which helps to increase the income of these two Gothans so that SHGs will attract to join for doing the economic activities. Moreover, cow dung sellers and members of SHGs will be able to reap benefits from the Godhan Nyay Yojana scheme.

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Effect of Organic with Biofertilizer and Inorganic Fertilizer on Yield and Economics of Onion (*Allium cepa* L.) Variety N-53

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Abstract

The present investigation entitled "Effect of Organic with Biofertilizer and Inorganic Fertilizer on Yield and Economics of onion *(Allium cepa* L.) cv-N-53" was conducted during the year 2017 and 2018 in the experimental field of department of Horticulture, at MJRP University, Jaipur, (Rajasthan) India. The objectives of experimentation were to assess the effect of inorganics, organic sources, bio-fertilizers with reduced level of inorganic fertilizers on yield and economics of the treatments and NPKS status of soil before and after completion of crop. The experiment consisted of thirteen treatments. The results were revealed that the yield components of onion *viz.,* bulb diameter (4.88), weight of bulb (52.39 g), yield per plot of bulb (16.00 kg) and yield per hectare (26.67 t) followed by treatment T_1 with the application of 100 percent recommended dose of NPKS 120:60:60:40 Kg ha^{-1}. The bulb yield of onion was increased 91.56 per cent over recommended dose of 100 % NPKS (120:60:60:40 kg/ha) through inorganic fertilizers. After final harvesting of onion, the maximum available nitrogen NPKS (198.18 kg ha^{-1}, 26.96 kg ha^{-1}, 278.15 kg ha^{-1} and 18.10 kg ha^{-1}), were resulted with the application of T_8 treatment in comparison T_7. The application of integrated nutrients also improved the post harvest fertility status of the soil after harvest of the crop. As far as economics is concerned, benefit cost ratio 8.24 was recorded by the application of (NPKS 120:60:60:40 kg ha^{-1}) in T_1 100% RDF. Which was found closely followed with T_8 (25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}).

Introduction

Onion (*Allium cepa L.*) belongs to family Alliaceae, having chromosome 2n=16. Onion is the fore most widely cultivated bulb crop. It is an erect annual herb that can reach a height of 75-90 cm and grown during winter season.

Onion bulb is strongly contracted subterranean shoot with thickened, fleshy leaves as food organs and bulb is composed of carbohydrates (11.0 g), proteins (1.2 g), fiber (0.6 g), moisture (86.8 g) and energy (38 cal). Biseds, vitamins like vitamin 'A' (0.012 mg), vitamin 'C' (11 mg), thiamine (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg), and minerals like phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) are also recorded per 100 g material (Anonymous, 1978). Onions have wider use in manufacture of soaps, ketchups, onion flakes (dehydrated) and food seasoning besides being used as salad and pickle. The smell and pungency is due to the oil known as "Allyal propyl disulphide". Extracts of onion are being used in the prevention of 'atherosclerosis' and 'coronary heart disease' as they can inhibit the aggregation of human blood platelets to form the clots, which have the potential for arterial blocking. It has properties of lowering blood sugar and lipid with good coagulation efficiency. The bulb is useful as diuretic and heart stimulant.

The primary centre of origin of onion lies in Central Asia. The Near East and the Mediterranean are the secondary centers of origin. It is an ancient crop have been utilized in medicine, rituals and as a food in Egypt and in India since 600 B.C. References of onion as food were also found in Bible and Quran. The genus Allium is very large with more than 500 species, which are perennial and mostly bulbous plants. Out of these, only seven species are in cultivation. However, *Allium cepa* (onion) and *Allium sativum* (garlic) are the two major cultivated species grown all over the world.

In India, onion occupies about 12.17 lakh hectare areas under cultivation with total production of 192.99 lakh MT. Maharashtra is the leading producer of onions, contributing 31.6 per cent of the area and 32.9 per cent of the total country production followed by Gujarat and Karnataka. Other states growing onion are Orissa, Andhra Pradesh, Tamil Nadu and Madhya Pradesh .

In Rajasthan, Alwar is the leading producer of onion followed by Jhalawar, Bharatpur, Bhilwara, Jaipur, Tonk, Chitorgarh, Jhunjunu, Sikar etc.

Table-1 : Treatments detail with their symbol.

S.No.	Treatment combination	Notation
1.	100% RDF(NPKS 120:60:60:40 Kg/ ha^{-1})	T_1
2.	NSKE (6q/ha) + VC (30q/ha) + *Azotobacter* + PSB (sole organic)	T_2
3.	NSKE(6q/ha) + VC (30q/ha)	T_3
4.	75% RDF of NPKS + NSKE(6q/ha)	T_4
5.	50% RDF of NPKS + NSKE (6q/ha)	T_5
6.	75% RDF of NPKS + VC (30q/ha)	T_6
7.	50% RDF of NPKS + VC (30q/ha)	T_7
8.	25% RDF of NPKS + NSKE(6q/ha) + VC (30q/ha)	T_8

*RDF-Recommended Doses of Fertilizer through inorganic fertilizer
*VC-Vermicompost, *NSKE-Neem Seed Kernel Extract

Organic farming is not new in India and is being followed from ancient times. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal, farm wastes and aquatic wastes) and other biological materials along with beneficial microbes (biofertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly, pollution free environment.

Biofertilizers, which are eco-friendly and more economical can play an important role in reducing the dependence on chemical fertilizers. They activate beneficial microorganisms present in the soil, utilize atmospheric nitrogen for fixation in the soil and improve the availability and uptake of existing nutrients besides exerting other beneficial effects. Nevertheless, in the present situation of Indian agriculture, particularly looking at the availability of the organic manures and existing gap between the demand and supply of vegetables, organic farming could not be taken as a complete substitute for chemical fertilizers and pesticides. Rather organic sources should be used only as a supplement for partial replacement of the chemical fertilizer. Thus, an integrated nutrient management strategy for judicious combination of both organic and inorganic sources is the demand of the present era. It will be more economically viable and also help in attaining sustainability in production and maintaining soil health and eco-friendly environment.

Materials and Methods

The present investigation on “Effect of Organic with Biofertilizer and Inorganic Fertilizer on Yield and Economics of onion *(Allium cepa* L.) cv-N-53” was carried out during the year 2017 and 2018 in the experimental field of department of Horticulture, at MJRP University, Jaipur, (Rajasthan) India. The details of the experiment performed, materials used and techniques employed for studies have been described briefly.

The experiment was laid out at Horticulture farm, Department of Horticulture, Mahatma Jyoti Rao Phoole University, Jaipur, which is situated at 26^0 05’ North latitude and 75^0 20’ East longitude and an altitude of 427 meters above mean sea level, in Jaipur district of Rajasthan. This region falls under agro-climatic zone IIIA (Semi-Arid Eastern Plain) of the state of Rajasthan. The field had fairly leveled topography and clay loam texture.

The climate of this Zone is typically semi-arid and characterized by extremes of temperature both in summer and winter with low rainfall and moderate relative humidity. Maximum temperature in summer is as high as 47^0 where as minimum temperature in winters falls around 0^0C. The average rainfall of the locality is approximately 400 to 500 mm; most of which is received in rainy season from July to September. Yearly pan evaporation ranges from 1.3-17.5 mm per day. Since climatic conditions influence growth, yield and quality of agricultural produce, therefore, the mean weekly weather parameters for the crop growing seasons were recorded at meteorological observatory.

The experiment was started in *Rabi* season October 2017 and completed in March 2018.

The experiment consisted of 13 treatments in combinations of recommended dose of fertilizers and organic manures along with biofertilizers. The various treatments with their symbols are presented in Table were sown in randomized block design in three replications. Each entry was planted in a plot size of 3 x 2 m^2 accommodating 5 rows of 4 m length, keeping row to row and plant to plant distance of 15 cm and 10 cm, respectively. All the recommended package of practices was followed to raise a good and healthy crop.

Raising a crop for bulb production, onion seeds were sown on nursery beds to raise seedlings. Raised beds of about 3 meter long, 1 meter width and 15cm above the ground level were prepared. The nursery beds were well manured with farmyard manure @ 20 kg per bed. Seeds were sown on well prepared beds in lines with a spacing of 10 cm apart and covered with soil. Seed beds were irrigated regularly with the help of watering can. Seed sowing was taken in October 2017 *(rabi)*. The seedlings were ready within eight weeks for transplanting.

The field was well prepared and manured with the incorporation of vermicompost and NSKE as per the treatment Combination at the time of transplanting. At transplanting, the main field was marked and made furrows 15 cm in row to row and 10 cm plant to plant. The healthy seedlings were dipped into bio fertilizers *Azotobacter* @ 2 kg per ha and P-solubilizing bacteria @ 2 kg per ha and transplanted in main field on 5^{th} December 2017.

Table-2 : Effect of INM on yield attributes and onion yield cv. N-53.

Treatments	Treatment detail	Weight of bulb (g)	Bulb yield (Kg plot^{-1})	Bulb yield (t ha^{-1})
T_1	100% RDF(NPKS 120:60:60:40 Kg ha^{-1})	47.05	14.65	24.42
T_2	NSKE C (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic)	42.00	12.38	20.64
T_3	NSKE (6 q ha^{-1}) + VC (30q ha^{-1})	42.35	13.36	22.27
T_4	75% RDF of NPKS + NSKE (6 q ha^{-1})	42.69	13.65	22.75
T_5	50% RDF of NPKS + NSKE (6 q ha^{-1})	48.00	13.88	23.14
T_6	75% RDF of NPKS + VC (30 q ha^{-1})	47.75	13.64	22.74
T_7	50% RDF of NPKS + VC (30 q ha^{-1})	47.65	13.25	22.09
T_8	25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1})	52.39	16.00	26.67
	SEm±	0.76	0.23	0.38
	CD at 5%	2.32	0.68	1.14

Table : Effect of INM on economics of onion cv. N-53.

Treatments	Treatment detail	Returns (Rs ha^{-1})		B : C ratio
		Gross	Net	
T_1	100% RDF(NPKS 120:60:60:40 Kg ha^{-1})	549485	489991	8.24
T_2	NSKE C (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic)	464343	394858	5.68
T_3	NSKE (6 q ha^{-1}) + VC (30q ha^{-1})	501100	431945	6.25
T_4	75% RDF of NPKS + NSKE (6 q ha^{-1})	511977	447818	6.98
T_5	50% RDF of NPKS + NSKE (6 q ha^{-1})	520604	457779	7.29
T_6	75% RDF of NPKS + VC (30 q ha^{-1})	511602	444443	6.62
T_7	50% RDF of NPKS + VC (30 q ha^{-1})	496974	431149	6.55
T_8	25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha)	600120	529630	7.51
	SEm±	8448	8448	0.13
	CD at 5%	25626	25626	0.39

Yield attributes : Bulb length (cm), Bulb weight (g), Bulb yield per plot (kg).

Economics of the treatment : The relative economics of different treatments were estimated on the basis of cost of treatment and yield per hectare. The net income was calculated by subtracting the treatment cost from gross income. It was expressed on net excess income over control.

Gross return (Rs ha^{-1}) = Return from bulb yield

Net return (Rs ha^{-1}) = Gross return-Total cost of cultivation (Rs ha^{-1})

$$\text{B:C ratio} = \frac{\text{Net return (Rs. ha}^{-1})}{\text{Total cost of cultivation (Rs. ha}^{-1})}$$

Statistical analysis : To test the significance of variation in the data obtained from various growth, yield and quality characters the technique of analysis of variance was adopted as suggested by Fisher (1950) for randomized block design. Significance of difference in the treatment effect was tested through 'F' test at 5% level of significance and CD (critical difference) was calculated wherever the results were significant.

Results and Discussion

While presenting the results of the field experiment entitled "Effect of Organic with Biofertilizer and Inorganic Fertilizer on Yield and Economics of onion *(Allium cepa* L.) cv-N-53" significant variation in the criteria used for various evaluation of treatments were observed.

Yield

Bulb yield (kg plot^{-1}) : An examination of data (Table) revealed that 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) recorded the highest bulb (16.00 kg) and lowest with NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic).

Bulb yield (t ha^{-1}) : A perusal of data presented in Table reveals that 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) produced the highest bulb yield (26.67t ha^{-1}) and this treatment recorded significantly higher bulb yield over all other treatments.

Returns (Rs ha^{-1}) : The onion crop fertilized with 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) fetched significantly higher gross (600120) as well as net (529630) returns over all other treatments.

B/C ratio : The highest BC ratio was recorded with 100% RDF (8.24) which was significantly superior over all other treatments. Further, 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) treatments recorded 2nd highest BC ratio which was also significantly superior over all other treatments except 100% RDF.

Yield attributing and yield : In the case of onion crop, yield is certainly of paramount importance. On reviewing the data computed in Table, it is observed that there was sizeable and significant improvement in crop production following crop fertilization with NPKS in combination with organic manure. Thus, the maximum benefit in bulb yield

was accrued with the application of NPKS at 100% recommended dose. In fact, the bulb yield per unit area largely depends upon performance of individual plants.

The weight of bulb and bulb yield in the present study showed significant improvement due to NPKS application at increasing rates. Thus, the maximum value of all these yield parameters was attained with application of 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) which was at par with 100% RD of NPKS (120:60:60:40 kg/ha). The increase in yield attributes with increasing levels of NPKS is a reflection of better performance of plant with respect to growth parameters at higher level of NPKS. The increased yield per ha may be attributed to more number of bulbs and their weight. These results are in agreement with the findings of Ali *et al.* (2008), Patil *et al.* (2008) and Shukla *et al.* (2013).

The significant interactive effect as a consequence of organic manures and fertilizer application on yield attributes might be due to supply of additional plant nutrient and increasing availability of native soil nutrients due to increased microbial activity. Another reason could be efficient and greater partitioning of metabolites and adequate location of nutrients to developing plant structures. NSKE/VC as a source of organic matter is also known to favourably improve soil structure; increases water holding capacity and provide energy for nitrogen fixation by free living heterotrophic microorganisms. Thus marked increase in various yield components can be ascribed not only to adequate supply of assimilates/ nutrients but also to their pivotal role in improving physico-chemical and biological properties of soil, thereby, enhancing root growth and synthesis of cytokinnin. Further, greater assimilating surface at reproductive development and improvement in nutritional condition of bulb under integrated nutrient management seems to have provided congenial environment for bulb growth because of adequate supply of metabolites and nutrients.

Neem cake is rich in plant nutrients and in addition to that it contains alkaloids like Nimbin and Nimbidin, which have nitrification inhibiting properties and release N slowly. The improved yield is due to neem cake application in brinjal. It is gaining popularity because it is environmental friendly and also the compounds found in it help to increase the nitrogen and phosphorous content in the soil. It is rich in sulphur, potassium, calcium, nitrogen, etc (Mulani *et al.*, 2007). It is used to manufacture high quality organic or natural manure, which does not have any aftermaths on plants, soil and other living organisms. The application of 25% nitrogen through neem cake and 75% through poultry manure was found superior in the enhancement of the growth, yield and quality parameters of bitter gourd. The application of nutrients like neem cake, different nitrogen levels, and biofertilizers has a significant and vital effect on yield and quality attributes of chilli (Kamal *et al.*, 2012) and asserts the highest dry weight of root, dry weight of rhizome per plant and total dry matter yield from neem cake applied at 2.0 t/ha in turmeric (Codling *et al.*, 2002).

Economics of treatments : The value of the results so far discussed will be judged by the cultivator only in terms of the net income he would derive by adopting the measures suggested growing the onion crop. With increased returns in term of yield, data were computed to show the increase in yield per hectare as affected by the different treatments. The net incomes that would accrue after deducting the cost of labour, fertilizer, etc. were also calculated. It is seen that a minimum net income of Rs. 394858 per hectare was obtained when crop was fertilize with NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) + Azotobacter + PSB (sole organic) alone and that net income reached to its maximum amounting to Rs. 489991 per hectare in plots were 100% RDF(NPKS 120:60:60:40 Kg ha^{-1}) was applied. Economic analysis of the treatment further indicated that the treatment T_1 (100% RDF (NPKS 120:60:60:40 kg ha^{-1}) as the most economical one with the maximum B:C ratio (8.24:1).

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Integrated Nutrient Management Practices for Growth and Quality of Onion (*Allium cepa* L.) Variety N-53

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Abstract

The present investigation entitled "Integrated Nutrient Management for growth and quality of onion *(Allium cepa* L.) cv-N-53" was conducted during the year 2017 and 2018 in the experimental field of department of Horticulture, at MJRP University, Jaipur, (Rajasthan) India. The objectives of experimentation were to assess the effect of inorganics, organic sources, bio-fertilizers with reduced level of inorganic fertilizers on growth and quality of onion. The experiment consisted of thirteen treatments. The results were revealed that the application of 25 per cent recommended dose of NPKS + NSKE 6 q ha^{-1} + VC 30 q ha^{-1} (T_8) recorded significantly maximum growth parameters in terms of plant height at 90 and 120 DAP (18.98 and 41.84 cm) respectively, number of leaves per plant (8.00) and neck thickness (0.72) 120 DAP followed treatment T_1 by 100 percent recommended dose of NPKS 120:60:60:40 Kg ha^{-1}. The quality parameters were revealed that the maximum value of TSS (15.27%), ascorbic acid (12.98 mg) and protein content (5.51%) was achieved by combined application of 25 percent recommended dose of fertilizer of NPKS + NSKE 6 q ha^{-1} + VC 30 q ha^{-1} (T_8). However, treatments T_1, T_6, T_7 and T_5 were at par with each other in respect to quality parameters.

Introduction

Onion (*Allium cepa L.*) belongs to family Alliaceae, having chromosome 2n=16. Onion is the fore most widely cultivated bulb crop. It is an erect annual herb that can reach a height of 75-90 cm and grown during winter season.

Onion bulb is strongly contracted subterranean shoot with thickened, fleshy leaves as food organs and bulb is composed of carbohydrates (11.0 g), proteins (1.2 g), fiber (0.6 g), moisture (86.8 g) and energy (38 cal). Biseds, vitamins like vitamin 'A' (0.012 mg), vitamin 'C' (11 mg), thiamine (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg), and minerals like phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) are also recorded per 100 g material (Anonymous, 1978). Onions have wider use in manufacture of soaps, ketchups, onion flakes (dehydrated) and food seasoning besides being used as salad and pickle. The smell and pungency is due to the oil known as "Allyal propyl disulphide". Extracts of onion are being used in the prevention of 'atherosclerosis' and 'coronary heart disease' as they can inhibit the aggregation of human blood platelets to form the clots, which have the potential for arterial blocking. It has properties of lowering blood sugar and lipid with good coagulation efficiency. The bulb is useful as diuretic and heart stimulant.

The primary centre of origin of onion lies in Central Asia. The Near East and the Mediterranean are the secondary centers of origin. It is an ancient crop have been utilized in medicine, rituals and as a food in Egypt and in India since 600 B.C. References of onion as food were also found in Bible and Quran. The genus Allium is very large with more than 500 species, which are perennial and mostly bulbous plants. Out of these, only seven species are in cultivation. However, *Allium cepa* (onion) and *Allium sativum* (garlic) are the two major cultivated species grown all over the world.

In India, onion occupies about 12.17 lakh hectare areas under cultivation with total production of 192.99 lakh MT. Maharashtra is the leading producer of onions, contributing 31.6 per cent of the area and 32.9 per cent of the total country production followed by Gujarat and Karnataka. Other states growing onion are Orissa, Andhra Pradesh, Tamil Nadu and Madhya Pradesh.

In Rajasthan, Alwar is the leading producer of onion followed by Jhalawar, Bharatpur, Bhilwara, Jaipur, Tonk, Chitorgarh, Jhunjunu, Sikar etc.

Onion, being a nutrient loving crop, responds well to added fertilizers. The uses of inorganic fertilizer help in

Table-1 : Treatments detail with their symbol.

S.No.	Treatment combination	Notation
1.	100% RDF(NPKS 120:60:60:40 Kg/ ha^{-1})	T_1
2.	NSKE (6q/ha) + VC (30q/ha) + *Azotobacter* + PSB (sole organic)	T_2
3.	NSKE(6q/ha) + VC (30q/ha)	T_3
4.	75% RDF of NPKS + NSKE(6q/ha)	T_4
5.	50% RDF of NPKS + NSKE (6q/ha)	T_5
6.	75% RDF of NPKS + VC (30q/ha)	T_6
7.	50% RDF of NPKS + VC (30q/ha)	T_7
8.	25% RDF of NPKS + NSKE(6q/ha) + VC (30q/ha)	T_8

*RDF-Recommended Doses of Fertilizer through inorganic fertilizer
*VC-Vermicompost, *NSKE-Neem Seed Kernel Extract

achieving maximum yield of onion. Among the major nutrients, nitrogen, phosphorus and potash play an important role in nutrition of onion plants in relation to growth and quality of bulb. This might be due to beneficial role played by nitrogen in synthesis of protein through amino acid. Phosphorus play role in process of photosynthesis which ultimately leads to the accumulation of large amount of carbohydrates. Potash activates numerous enzymes affecting metabolic events and carbohydrates movement.

Materials and Methods

The present investigation on "Integrated Nutrient Management for growth and quality of onion *(Allium cepa* L.) cv-N-53" was carried out during the year 2017 and 2018 in the experimental field of department of Horticulture, at MJRP University, Jaipur, (Rajasthan) India. The details of the experiment performed, materials used and techniques employed for studies have been described briefly.

The experiment was laid out at Horticulture farm, Department of Horticulture, Mahatma Jyoti Rao Phoole University, Jaipur, which is situated at 26^0 05' North latitude and 75^0 20' East longitude and an altitude of 427 meters above mean sea level, in Jaipur district of Rajasthan. This region falls under agro-climatic zone IIIA (Semi-Arid Eastern Plain) of the state of Rajasthan. The field had fairly leveled topography and clay loam texture.

The climate of this Zone is typically semi-arid and characterized by extremes of temperature both in summer and winter with low rainfall and moderate relative humidity. Maximum temperature in summer is as high as 47^0 where as minimum temperature in winters falls around 0^0 C. The average rainfall of the locality is approximately 400 to 500 mm; most of which is received in rainy season from July to September. Yearly pan evaporation ranges from 1.3-17.5 mm per day. Since climatic conditions influence growth, yield and quality of agricultural produce, therefore, the mean weekly weather parameters for the crop growing seasons were recorded at meteorological observatory.

The experiment consisted of 13 treatments in combinations of recommended dose of fertilizers and organic manures along with biofertilizers. The various treatments with their symbols are presented in Table were sown in randomized block design in three replications. Each entry was planted in a plot size of 3 x 2 m^2 accommodating 5 rows of 4 m length, keeping row to row and plant to plant distance of 15 cm and 10 cm, respectively. All the recommended package of practices was followed to raise a good and healthy crop.

Raising a crop for bulb production, onion seeds were sown on nursery beds to raise seedlings. Raised beds of about 3 meter long, 1 meter width and 15cm above the ground level were prepared. The nursery beds were well manured with farmyard manure @ 20 kg per bed. Seeds were sown on well prepared beds in lines with a spacing of 10 cm apart and covered with soil. Seed beds were irrigated regularly with the help of watering can. Seed sowing was taken in October 2017 *(rabi)*. The seedlings were ready within eight weeks for transplanting.

The field was well prepared and manured with the incorporation of vermicompost and NSKE as per the treatment Combination at the time of transplanting. At transplanting, the main field was marked and made furrows 15 cm in row to row and 10 cm plant to plant. The healthy seedlings were dipped into bio fertilizers *Azotobacter* @ 2 kg per ha and P-solubilizing bacteria @ 2 kg per ha and transplanted in main field on 5^{th} December 2017.

Vegetative growth attributes : Plant height (cm) at 90 and 120 DAP, Number of leaves per plant at 90 and 120 DAP, Neck thickness (cm), Equatorial diameter of bulb (cm), Polar diameter of bulb (cm).

Quality attributes : TSS, Sulphur content in bulb (%),Ascorbic acid (mg/100g)

Statistical analysis : To test the significance of variation in the data obtained from various growth, yield and quality characters the technique of analysis of variance was adopted as suggested by Fisher (1950) for randomized block design. Significance of difference in the treatment effect was tested through 'F' test at 5 % level of significance and CD (critical difference) was calculated wherever the results were significant.

Results and Discussion

While presenting the results of the field experiment entitled "Integrated Nutrient Management for growth and quality of onion *(Allium cepa* L.) cv-N-53" significant

Table-2 : Effect of INM on plant height in onion cv. N-53 (Days after planting).

Treatments	Treatment detail	Plant height (cm)	
		90 Days	120 Days
T_1	100% RDF(NPKS 120:60:60:40 Kg ha^{-1})	18.82	40.02
T_2	NSKE C (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic)	15.78	36.00
T_3	NSKE (6 q ha^{-1}) + VC (30q ha^{-1})	15.80	36.33
T_4	75% RDF of NPKS + NSKE (6 q ha^{-1})	17.10	38.66
T_5	50% RDF of NPKS + NSKE (6 q ha^{-1})	16.56	37.64
T_6	75% RDF of NPKS + VC (30 q ha^{-1})	17.09	39.62
T_7	50% RDF of NPKS + VC (30 q ha^{-1})	17.42	37.13
T_8	25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1})	18.98	41.84
	SEm±	0.12	0.33
	CD at 5%	0.37	0.98

Table-3 : Effect of INM on number of leaves and Neck thickness in onion cv. N-53

Treatments	Treatment detail	No of leaves $plant^{-1}$	Neck thick ness (cm)
T_1	100% RDF(NPKS 120:60:60:40 Kg ha^{-1})	7.60	0.68
T_2	NSKE C (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic)	5.80	0.56
T_3	NSKE (6 q ha^{-1}) + VC (30 q ha^{-1})	5.75	0.59
T_4	75% RDF of NPKS + NSKE (6 q ha^{-1})	5.78	0.60
T_5	50% RDF of NPKS + NSKE (6 q ha^{-1})	5.70	0.61
T_6	75% RDF of NPKS + VC (30 q ha^{-1})	5.92	0.60
T_7	50% RDF of NPKS + VC (30 q ha^{-1})	5.88	0.63
T_8	25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1})	8.00	0.72
	SEm±	0.11	0.01
	CD at 5%	0.32	0.03

variation in the criteria used for various evaluation of treatments were observed.

Plant height : At 90 (Days after planting) DAP : Data presented in Table indicated that 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) recorded significantly higher plant height (18.98 cm) over all the treatments but remain at par with 100%RDF (18.82 cm).

At 120 DAP : At 120 DAP maximum plant height (41.84 cm) recorded under the treatment 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) which was significantly higher over rest of the treatments .

Number of leaves $plant^{-1}$: Significantly higher number of leaves $plant^{-1}$ was recorded when crop was supplied nutrient through 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}). This treatment recorded 8.0 more leaves $plant^{-1}$ as compared to treatment with 100% RDF (NPKS 120:60:60:40 kg ha^{-1}).

Neck thickness : Table show that maximum neck thickness (0.72 cm) was recorded with the treatment 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) which was significantly superior over all the treatments. Further the lowest neck thickness was recorded under the treatment NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic).

Polar diameter : The treatment 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) recorded maximum polar diameter which was significantly higher over rest of the treatments but found remain at par with 100%RDF (NPKS 120:60:60:40 Kg ha^{-1}) and both these treatments increase polar diameter by 0.60 and 0.58 cm over treatment NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) + *Azotobacter* + PSB (sole organic).

Equatorial diameter : The maximum equatorial diameter (6.00 cm) was recorded with the treatment 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) which was significantly higher over rest of the treatments but found at par with the treatment 100%RDF (NPKS 120:60:60:40 Kg ha^{-1}).

Crop maturity : Data presented shows that varying any treatment did not significantly influence the crop maturity of the test crop.

Bulb length : A reference to data indicates that different fertilizer combinations failed to produce significant influence on bulb length.

Bulb diameter : It is noted from data presented in reveals that 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) recorded the maximum bulb diameter (4.88 cm) which was significantly superior all other treatments

combinations. Further minimum bulb diameter (3.89cm) was recorded under the treatment 50% RDF of NPKS + NSKE (6 q ha^{-1}).

Bulb weight : It is clear from data depicted in that 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) recorded the maximum bulb weight (52.39 g) which was significantly superior over rest of the treatments.

Quality parameters

TSS : A perusal of data table revealed that 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) recorded the maximum TSS (15.27%) which was significantly superior over all other treatments under the study.

Ascorbic acid : A reference of the data depicted in Table reveals that when crop fertilized with 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) gave the maximum ascorbic acid (12.98%) which was significantly higher over all other treatments.

Protein : It can be inferred from data in Table that significantly higher percent of protein content (5.54) was recorded with the treatment with 100% RDF which significantly superior over other treatments but remain at par with 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}).

Sulphur : A reference of the data reveals that the maximum sulphur content was recorded when crop fertilized with 25% RDF of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) followed by 100% RDF (NPKS 120:60:60:40 Kg ha^{-1}.

Moisture : An examination of data presented in Table reveals that the minimum moisture content was recorded when crop fertilized with 100% RDF. This treatment remain at par with all other treatments but statistically superior over 50% RDF of NPKS + NSKE (6 q ha^{-1}).

Plant growth : Reference to Table makes it clear that the plant growth as judged by plant height at 90 and 120 DAP and number of leaves $plant^{-1}$ was improved significantly by the application of NPKS and organic manures. The vigorous growth of onion in terms of these parameters at higher level of NPK might be due to higher uptake of N, P and K. Since nitrogen is a constituent of chlorophyll, the increase of which with added nitrogen might have resulted in increased synthesis of photosynthates, leading to better vigour. The second major nutrient phosphorus being essential constituent of cellular protein and nucleic acid might have encouraged meristematic activity of plants resulting in increased plant height and number of leaves per plant. The other major nutrient potassium is an activator of enzymes involved in protein and carbohydrate metabolism and plays an important role in the translocation of photosynthates from leaves to seed yield. The added potassium might have resulted in increased synthesis and translocation of photosynthates, which were further utilized in building up of new cells leading to better vigour and more number of leaves per plant. Several workers like Malagi (2001), Tiwari *et al.* (2002) and Shrawan Singh *et al.* (2004) have also reported increased plant height with increased levels of nitrogen, phosphorus and potassium.

The beneficial effect of applied sulphur on plant growth may be due to fact that sulphur influences the formation of protein and chlorophyll, is constituent of plant structural material and increase root development. According to Lakkineni and Abort (1994) sulphur plays a key role in the plant metabolism and is a constituent of number of organic components. Kumar and Singh (1994) pointed out that sulphur deficiency induced a marked depression in enzymatic activity of onion plants. They recommended application of sulphur in onion cultivation for obtaining the better growth of onion plants. Kumar and Singh (1995) also observed significantly better growth in onion plants supplied with sulphur.

The beneficial effects of sulphur in increasing vegetative growth are also in conformity with findings of Jaggi and Dixit (2005), Joshi *et al.* (2005) and Khan *et al.* (2007).

The positive influence of organic fertilization on growth parameters and overall growth of crop seems to be on account of its direct as well as indirect effects. The indirect effects are augmentation of microbial population and their activities (decomposition of organic matter), solubilization of insoluble phosphate along with greater availability of primary nutrients as well as micronutrients. Besides, it markedly influence physical properties of soil (water holding capacity, soil aggregates etc.). The direct effect relates to the uptake of humic substances or its decomposition products which influence growth and metabolic process in the plants. Experimental evidence suggests that soluble humic acids effect biochemical mechanism and processes within plant cells such as membrane permeability and transport, ATP production, chlorophyll content, photosynthesis and nucleic acid synthesis, thereby, improve overall growth and development.

Application of decomposed material has significant beneficial effect on plant growth. This could be due to increase in the availability of essential nutrients such as N and P in available form to plants. The deoiled cake helped in nitrification and resulted in better availability of N for plants and thus resulted in enhanced N uptake by plants, resulting in better growth parameters (Kiran, 2017).

Quality parameter : The results revealed that application of recommended dose of nutrient to onion *viz*., 25% RDF

of NPKS + NSKE (6 q ha^{-1}) + VC (30 q ha^{-1}) significantly improved quality parameters of bulb. In the present investigation, higher nutrient content in bulb and subsequently uptake was recorded with the aforesaid treatments that lend support to enhance quality parameters under the effect. This finding is closely associated with Jat *et al*. (2003), Yadav *et al*. (2007) and Chaudhary *et al.* (2013). This could also be explained on the basis of better availability of desired and required nutrients in crop root zone resulting from its solubilization caused by the organic acid produced from the decaying organic matter and also the increase uptake by sorghum roots due to their mycorrhizal filaments increasing the ascribing area of roots.

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Effect of Integrated Weed Management Practices on Yield and Economics of Clusterbean (*Cyamopsis tetragonoloba* L. Taub.)

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Abstract

An experiment was conducted on a randomized block design during kharif season of 2017 at Research Farm, ITM University, Gwalior; Madhya Pradesh. The experiment consisted eight weed management practices (Imazethapyr @ 70 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Quizalofop @ 50 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Fenoxaprop-p-ethyl @ 70 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Imazethapyr + Imazamox @ 50 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Pendimethalin @ 750 g a.i./ha (PE) + 1 HW at 20 DAS, Hand weeding at 20 DAS + Hoeing at 40 DAS, Weed free and Weedy check) with 3 replications. The result showed that the Weed free treatment recorded significantly effective values of weed parameters viz. total weed population (/m2) & weed control efficiency (%) and crop parameters viz. plant population/m^2, number of leaves/plant, absolute growth rate (g/day), seed yield/plant (g), seed yield (kg/ha), weed index (%), net monetary return (?/ha) and return/day (?/ha) over rest of the treatments. The next effective was Hand weeding at 20 DAS + Hoeing at 40 DAS; which was at par with Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS and Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS.

Key words : *Clusterbean, economics, weed management practices, weed index, yield and yield attributes.*

Clusterbean is an annual kharif arid legume grown for green fodder, vegetable, green manuring, gum and seed purpose. India is the largest grower and producer of clusterbean in the world. It contributes 82% share in the world's total production. In India, clusterbean is being grown in the area of 4.28 million hectares with a production of 2.45 million tonnes of clusterbean seed with an average productivity of 572 kg/ha. In M.P., clusterbean is cultivated as pure crop in 75289 hectares (as mixed crop in 54784 hectares) area with production of 39299 tonnes of clusterbean seed and an average productivity of 522 kg/ha. About 80% area of the state is in Gird zone, which consist of Bhind, Morena, Gwalior, Shivpuri, Sheopur, Datia and Guna Districts (Anonymous, 2018).

In the recent years, besides its conventional uses, it has emerged as an industrial crop, due to presence of galactomannan (gum) in its endosperm, which is around 30-35% of seed weight. Saxena et al. (2004) reported that the competition between weeds and crop caused 53.7% reduction in seed yield and if keeping the crop weed-free for the initial 30 and 40 days reduced the weed dry weight by 63.4 and 75%, respectively. Therefore, there is a need to create an environment that is detrimental to weeds and favourable to crops. Hence, weed control needs to be restored during initial period of crop growth. Hand weeding is a traditional and effective method of weed control; but it is very costly, so it was felt necessary to evaluate herbicides which can be the best alternative to traditional practices (Yadav *et al.,* 2011). "A year's seeding is seven year's weeding" and thus Indian agriculture has been defined as a "confrontation with weeds". The welfare of mankind is highly dependent on farmer's ability to control the growth of weeds. Thus, it is necessary to concentrate more on weeding out the undesirables than for any other activity related to increasing agricultural production.

In most of the legumes, the early growth period is the most critical stage at which stress of any kind affects the economic yield. Weed competition is one such important stress during this period. This growth period is often marked by weather conditions that do not permit the traditional methods of weed control. Besides, this period coinciding with the season of peak labour activity leading to scarcity of labour for weeding.

In the last four decades, considerable developments have been taken place in chemical weed control, thereby increasing the crop returns by reducing the cost of production. However, much needed information on the right kind of herbicides, the time, rate and method of application and residual effects on the succeeding crops are lacking in our country.

Therefore an experiment was conducted to study the effect of weed management practices on yield and economics of clusterbean.

Materials and Methods

An experiment was conducted during the kharif season of 2017 at the Research Farm, ITM University, Gwalior; Madhya Pradesh. The experiment consisted eight weed management practices (Imazethapyr @ 70 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Quizalofop @ 50 g a.i./ha

Table-1 : Effect of integrated weed management practices on weed population, weed control efficiency, plant population, number of leaves/plant, absolute growth rate and seed yield/plant of clusterbean.

Treatment	Total weeds population/m^2	WCE (%)	Plant population m^{-2}	Number of leaves/plant	Absolute growth rate (g/day)	Seed yield/plant (g)
W_1	0.868 (6.67)	88.84	28.56	115.56	0.185	4.02
W_2	0.926 (7.56)	87.28	28.11	113.00	0.170	3.32
W_3	0.884 (6.78)	88.64	28.22	114.00	0.178	3.75
W_4	0.785 (5.11)	91.42	29.22	133.22	0.245	6.72
W_5	0.964 (8.45)	85.77	28.89	132.11	0.237	6.22
W_6	0.816 (5.67)	90.49	29.33	137.11	0.256	7.33
W_7	0.000 (0.00)	100.00	29.67	150.44	0.307	10.01
W_8	1.551 (34.56)	0.00	27.67	99.22	0.100	1.94
S.E.(m)±	0.056	1.71	1.26	4.27	0.016	0.36
C.D. (P=0.05)	0.170	5.20	NS	12.95	0.049	1.10
Transformation	Log(x+1)					

W_1, Imazethapyr @ 70 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_2, Quizalofop @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_3, Fenoxaprop-p-ethyl @ 70 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_4, Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_5, Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS; W6, Hand weeding at 20 DAS + Hoeing at 40 DAS; W_7, Weed free; W_8, Weedy check; NS, Not-significant.

(PoE) at 20 DAS + 1 HW at 40 DAS, Fenoxaprop-p-ethyl @ 70 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Imazethapyr + Imazamox @ 50 g a.i./ha (PoE) at 20 DAS + 1 HW at 40 DAS, Pendimethalin @ 750 g a.i./ha (PE) + 1 HW at 20 DAS, Hand weeding at 20 DAS + Hoeing at 40 DAS, Weed free and Weedy check) with three replications. The soil of experimental field was a sandy clay loam with uniform topography.

The recommended dose of fertilizer (20 N + 40 P_2O_5 + 20 K_2O kg/ha) was applied in clusterbean as basal. The studied for selected yield attributes by using three plants in randomized manner in each plot. All other agronomic practices were adopted as per recommended package of practices. Observations on yield attributes were recorded at the time of harvesting of crop. All the data thus obtained, were statistically analyzed using the F-test procedure given by Gomez and Gomez (1984). The difference between treatment means were compared with the critical differences (CD) at 5% level of probability (P=0.05).

Results and Discussion

Weed Parameters : The complete control of total weeds was recorded under weed free treatment. The next effective treatment was Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS over rest of the treatments; while maximum population was registered under weedy check.

The significantly higher weed control efficiency (100%) was recorded under weed free treatment. The next effective treatments was Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS (91.42%); while minimum was recorded under weedy check over rest of the treatments (Table-1).

The superiority of Imazethapyr + Imazamox @ 50 g a.i./ha over rest of the herbicidal treatments may be due to their broad-spectrum effects by combination of two molecules; which enhance weed controlling ability over rest of the herbicides. The broad-leaf weeds were unaffected by Quizalofop @ 50 g a.i./ha and Fenoxaprop-p-ethyl @ 70 g a.i./ha due to their molecular makeup is based on controlling only narrow-leaf weed flora. The results are in conformity with the findings of Singh and Punia (2012), Patel *et al.* (2014), Singh *et al.* (2014), Yadav et al. (2014) and Singh *et al.* (2016).

Crop Parameters : The range of plant population is 27.67 to 29.67/m2 was noted at harvest stage. All the integrated weed management practices increased number of leaves/plant and AGR (g/day) over weedy check. The significantly maximum values (150.44 & 0.307 g/day; respectively) were registered under weed free treatment over rest of the treatments (Table-1). The next effective treatment was Hand weeding at 20 DAS + Hoeing at 40 DAS (137.11 & 0.256 g/day; respectively); which was at par with Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS (133.22 & 0.245 g/day; respectively) and Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS (132.11 & 0.237 g/day; respectively).

The integrated weed management practices showed significant impact upon seed yield/plant, seed yield and weed index (Table-2). Maximum values (10.01 g, 2973 and 0.00%; respectively) were registered under weed free treatment, while minimum was recorded under weedy check treatment (1.94, 539 and 81.45%; respectively). The next effective treatment was Hand weeding at 20 DAS + Hoeing at 40 DAS (7.33, 2164 and 25.99%; respectively); which was at par with Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS

Table-2 : Effect of integrated weed management practices on seed yield, weed index, net monetary return & return/day of clusterbean.

Treatment	Seed yield (kg/ha)	Weed index (%)	Net monetary return (₹/ha)	Return/day (?/ha)
W_1	1146	61.13	44995	405
W_2	934	68.09	31450	283
W_3	1058	64.23	39538	356
W_4	1964	33.42	93782	845
W_5	1797	39.11	83972	757
W_6	2164	25.99	106266	957
W_7	2973	0.00	149201	1344
W_8	539	81.45	12563	113
S.E.(m)±	144	4.20	8739	79
C.D. (P=0.05)	436	12.75	26508	239

W_1, Imazethapyr @ 70 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_2, Quizalofop @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_3, Fenoxaprop-p-ethyl @ 70 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_4, Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS; W_5, Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS; W_6, Hand weeding at 20 DAS + Hoeing at 40 DAS; W7, Weed free; W_8, Weedy check.

(6.72, 1964 and 33.42%; respectively) and Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS (6.22, 1797 and 39.11%; respectively).

The increase in yield under these treatments may be attributed to concomitant reduction in weed dry matter that accounted for reductions in crop-weed competition, which provided congenial environment to proper utilization of growth factors viz., space, light, moisture and nutrient by the crop and henceforth attained superior values of yield parameters of clusterbean. Similar results were also confined by findings of Sharma *et al.* (2014).

The integrated weed management practices showed significant impact upon net monetary return and return/day (Table-2). Higher values were registered under weed free treatment (₹ 146201/ha and ₹ 1344/ha; respectively), while minimum was recorded under weedy check treatment (₹ 12563/ha and ₹ 113/ha; respectively). The next effective treatment was Hand weeding at 20 DAS + Hoeing at 40 DAS (₹ 106266/ha and ₹ 957/ha; respectively); which was at par with Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS (₹ 93782/ha and ₹ 845/ha; respectively) and Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS (₹ 83972/ha and ₹ 757/ha; respectively).

This may be due to efficient utilization of growth factors which result in better crop growth and development during all stages owing to weed free environment. Thus result lower accumulation of dry matter in weeds and lower crop-weed competition associated with effective availability of moisture and nutrients to clusterbean crop. These results are in line with the work of Jakhar *et al.* (2013), Rawat *et al.* (2013), Yadav *et al.* (2013), Sharma (2014), Singh *et al.* (2014), Singh *et al.* (2016), Gupta *et al.* (2017) and Sharma *et al.* (2018).

Conclusions

For obtaining optimum plant growth and higher yield of clusterbean under semi-arid tract and sandy clay loam soils; weed free situation were gave superior performance. Under the lack of labourer areas; Imazethapyr + Imazamox @ 50 g a.i./ha at 20 DAS + 1 HW at 40 DAS and Pendimethalin @ 750 g a.i./ha + 1 HW at 20 DAS was applicable, which gave better yield over rest of the weed management practices.

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Varietal Adoption of Maize Crop in Flood Affected Areas—A Study in Morigaon District of Assam

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Abstract

The study was carried out in two different flood situations *viz.,* low and high flood intensive area of Morigaon district of Assam. The study reveals that maize based cropping system was dominant in both the situations. Only 17.5% farmers adopted recommended varieties of maize crop and more proportion of adopters was found in case of low flood intensive areas as compare to high intensive flood areas. The maize variety P3401(Pioneer) was adopted by majority of farmers(48.33%) in case of low flood intensive areas while in high flood intensive areas Bumper and DE222 (Delta) were adopted by majority farmers. High yield, recommendation of peer farmers, colour and quality of cob, disease resistance are some important reasons for adoption of maize varieties in flood affected areas. High yielding, quality cob and disease resistance are important reasons for adoption of maize varieties as it compensated the loss of flood. Private extension and farmer to farmer extension approach may be more effective means for transfer of maize varieties in flood affected areas.

Introduction

Agriculture is the main source of livelihood for more 75 % people of Assam with 51.28% area utilized for crop production. Rainfed agriculture is the main farming practice in Assam. The state has received annual average rainfall 210cm and mostly distributed from the month of May to August. Recurring flood and its damage to agriculture is main problems of farmers and it is more prominent inthe districts like, Nagaon, Morigaon, Darrang, Barpeta, Lakhimpur, Dhemaji, West Karbi anglong, Majuli, Sibsagar, Dibrugarh and Tinsukia. During 2020, around 2200 villages were under water and 87000 ha of crop area was damaged (Brahmaputra flood report, http://enmwikipedia.org). Even after, farmers of flood affected district had been trying to adapt themselves with the situation though few of them migrated to other occupations and places. From last few years farmers of few districts namely Nagaon, Morigaon, Darrang, Barpeta, changed their cropping pattern and introduced maize as main crop in their cropping system and area under this crop has been increased to 31000 ha in 2017-18 from 18363 ha in 2007-08. (Annon, 2019-20; Kalita and Bora, 2019). Maize being the queen of cereal occupy third most important cereal crop in the world after wheat and rice with respect to area and production. It is the most versatile emerging crop having wider adoptability under varied agro-climatic condition. Globally maize is used 17% as staple food, 61% as feed and 22% in industrial purpose from the total production. In India, it also occupy a very important position as industrial crop globally by 83%, which is used as feed, starch and bio fuel industry (http://iimr.icar.gov.in).

Farmers of few flood affected districts had already been adopted maize based cropping system for escaping damage of crop and ultimately help them to reduce loss caused by flood. Farmers adopted the maize varieties according to land situation, frequency, intensity and time of occurrence of flood. Maize varieties plays crucial role in the coping mechanisms against the flood. Hence, the present study was designed to assess the varietal adoption of maize crop by farmers in flood affected areas.

Research Methodology

The present study was conducted in Morigaon district of Assam which is situated in the western part of the state in between 26.15° N latitude and 92° E longitude covers almost 1551 sq km of area stretching across fertile alluvial plains, forest and grass/ grazing land, wetland water bodies. The district Morigaon has been selected purposively as it is one of major district in terms of area and production of maize as well as area affected by flood. A stratified random sampling designed was followed for selection of total 120 respondents. Based on average flood water depth and average inundation period the sample area was classified to two different situations.

Situations	ADO circles	Coordinates	Depth of flood water (cm)	Inundation period (days)
Situation I (Low intensive)	Mayong, Gosorguri	26015.709'N, 092002.334'E 26026.023'N, 092035.637'E	30-45	4-7
Situation II (High intensive)	Geruwa Lahorighat	26020.711'N, 092014.151'E 26024.678'N, 092018.982'E	46-90 cm	8-15

Data were collected by personal interview method through suitable structured schedule. Appropriate statistical tools were used for analysis of data.

Results and Discussion

Profile characteristics of maize growing farmers : The findings revealed that majority of the respondents belonged to the adult group which was in between 36-50 years with a average age of 47, with an average formal educational experience 9.73 years, having a large family (64.17%) with a members of more than 7 nos. Majority (89.17%) of the farmers were highly experienced with an average year of 25.75. Most of the respondents were small farmers with 1.95 ha of land holding. 58.33% of the respondents had low institutional linkage i.e. they visited average 12days in a year to the different institution (Govt., Non Govt., Private companies).77.50% of the respondents were medium level of market accessibility with an average visit of once in 2-3 days. It was noticed that most of the farmers had medium level of training exposure (75%) with an average 4.57 of training days attended on different trainings. (Table-1)

Table-1 : Profile characteristics of maize growing farmers.

(N=120)

Sl. No.	Profile Characteristics	Maxi-mum	Mini-mum	Mean
1.	Age (Years)	68	26	47.93
2.	Educational Experience (Years)	18	0	9.73
3.	Size of family (No's)	10	4	2.61
4.	Land holding (ha)	7.76	0.54	1.95
5.	Farming Experience (Years)	48	8	25.75
6.	Institutional Linkage (No of days visit in a year)	50	2	12.93
7.	Market Accessibility	6	3	4.43
8.	Training Exposure (In days)	9	2	4.57

Maize based cropping system followed by farmers : Table-2 revealed the cropping system followed by the respondents with respect to their flood situation. In situation –I about 14 different maize based cropping system were found while in situation–II 18 different cropping systems were found. The finding from Table-2 reveals that in situation I, Maize - Maize /Mustard - Pumpkin and Maize-Maize-Vegetable, were the most dominant cropping system followed by the respondents while in situation–II, Maize-Maize-Jute cropping system was mostly followed. The reasons may be farmers of high flood intensive areas cultivate jute crop to escaping damage cause by flood. Farmers adopted maize based cropping system as it helps farmers to compensate loss of flood. The most common maize based cropping system followed in flood affected areas were Maize-Maize/Mustard-Pumpkin; Maize-Maize-Vegetable; Maize-Maize-Jute and Maize- Maize- Pumpkin. Farmers of flood affected areas adopted maize based cropping system to ensure production and reduce losses due to flood.

Extent of adoption of recommended varieties of maize by farmers of different flood situation : It is observed from the Table-3 that majority respondents (82.5%) did not adopt the recommended varieties. only 17.5% respondents adopt the recommended varieties of maize. Vivek and Diara are only two recommended varieties of maize was found in the sample area and these two varieties were adopted by only 17.5% respondents. This may be due to the non availability of recommended variety in the market, lack of awareness about other recommended varieties or may be due to the superior quality of other variety as compared to the recommended ones. In Situation I 25% respondents were adopters but in Situation II only 10% were adopt the recommended variety.

Varietal adoption of maize in different flood situation : From the table-4 it was revealed that respondents used only two recommended variety, they are Vivek and Diara. The other variety which they have used to cultivate are P3401 (Pioneer), DE222 (Delta), Maharaja-92, Sun Vaaman, Bumper. Some respondents used only one variety while some other respondents used combination of two varieties. In Situation I, majority of the respondents (48.33%) used P3401variety followed by Diara (13.33%) where as in situation II combination of Bumper and DE222 variety was mostly used by the farmers i.e. 23.33% which was followed by DE222 (Delta) variety (21.67%). In situation-1, P3401 (Pioneer) was the most popular and adopted variety while in situation-II, DE222 along with pioneer were the most adopted varieties. Similar finding was reported by Pavithra *et al, 2018* for Pioneer variety.

Area wise varietal adoption of maize in different flood situation : The Figure-3 reveals that P3401 (Pioneer) occupy the maximum maize cultivation area, which is almost 40.63% followed by DE222 (Delta) (28.64%), Vivek (12.91%), Bumper (8.83%), Diara (7.28%), Maharaja-92 (1.17%), Sun Vaaman (0.53%) in the flood affected areas. In Situation, P3401 (Pioneer) variety occupy the maximum area with a percentage of 53.51 followed by Vivek (16.49%), DE222 (14.74%), Diara (13.16) and Maharaja-92 (2%). But in Situation II DE222 (Delta) variety occupy the maximum area (45.87%) which was followed by P3401(Pioneer), Bumper (19.78%), Vivek (8.48%) and Sun Vaaman (1.20%). Results of Situation I and II were clearly described in Fig.-1 and 2 respectively.

Reasons behind the adoption of non recommended maize variety : The following table described about the reasons of being adoption of non recommended varieties according to the farmers.

Table-2 : Maize based cropping system followed by the respondents across the situations.

Cropping system	Frequency (%) of respondents		
	Situation-I	Situation-II	Total
Maize-Maize/Mustard-Pumpkin	10 (16.67)	4 (6.67)	14(11.67)
Maize-Maize/Mustard-Vegetable	6 (10)	1 (1.67)	7 (5.83)
Maize-Maize-Pumpkin	5 (8.33)	4 (6.67)	9 (7.50)
Maize-Maize-Vegetable	10 (16.67)	4 (6.67)	14 (11.67)
Rice/Maize-Maize-Vegetable	3 (5)	3 (5)	6 (5)
Rice/Maize-Maize-Pumpkin	3 (5)	0 (0)	3 (2.50)
Rice/Maize-Maize/Mustard-Pumpkin	2 (3.33)	2 (3.33)	4 (3.33)
Rice/Maize-Maize/Mustard-Vegetable	1 (1.67)	0 (0)	1 (0.83)
Rice/Maize-Maize/boro paddy-Pumpkin	0 (0)	4 (6.67)	4 (3.33)
Rice/Maize-Maize/Boro paddy	0 (0)	1 (1.67)	1 (0.83)
Rice/Maize-Maize	2 (3.33)	3 (5)	5 (4.17)
Maize-Maize-Corainder	5 (8.33)	0 (0)	5 (4.17)
Maize-Maize/Mustard-Coriander	4 (6.67)	0 (0)	4 (3.33)
Maize-Maize/Boro paddy-Vegetable	0 (0)	6 (10)	6 (5)
Maize-Maize/Boro paddy-Jute	0 (0)	6 (10)	6 (5)
Rice/Maize-Maize/Boro paddy-Jute	0 (0)	1 (1.67)	1 (0.83)
Maize-Maize-Jute	0 (0)	9 (15)	9 (7.5)
Maize-Maize/Boro-Jute/Vegetable	0 (0)	5 (8.33)	5 (4.17)
Maize-Maize-Jute/Vegetable	0 (0)	2 (3.33)	2 (1.67)
Rice/Maize-Maize/Mustard	3 (5)	2 (3.33)	5 (4.17)
Maize-Maize/Mustard	3 (5)	2 (3.33)	5 (4.17)
Rice/Maize-Maize-Coriander	3 (5)	0 (0)	3 (2.50)
Rice/Maize-Maize-Jute/Vegetable	0 (0)	1 (1.67)	1 (0.83)

Table-3 : Distribution of respondents according to the adoption and non adoption of recommended variety of maize in different flood situation.(N=120)

	Frequency (%)	
Flood Situation	Adopter	Non Adopter
Situation-I	15 (25)	45 (75)
Situation-II	6 (10)	54 (90)
Total	21 (17.5)	99 (82.5)

size and vibrant yellow colour with good shelling percentage. The variety DE222 is superior in grain quality and the plant height is shorter than the other variety which is easy to manage and the cob colour is attractive. It has also the resistant of draught and cob rotting. The cob colour with orange yellow Maharaja-92 is found to be mild tolerance to all most all diseases; but the yield is less as

Table-4 : Distribution of respondents according to the variety in different flood situation. (N=120)

Vareties	Frequency(%) of adopter		
	Situation-I	Situation-II	Total
Vivek (Recommended)	4 (6.67)	6 (10)	10 (8.33)
Diara(Recommended)	8 (13.33)	0	8 (6.67)
Vivek+Diara(Recommended)	3 (5)	0	3 (2.50)
P3401(Pioneer)	29 (48.33)	8 (13.33)	37 (30.83)
P3401 (Pioneer)+Maharaja -92	6 (10)	0	6 (5.00)
DE222 (Delta)	7 (11.67)	13 (21.67)	20 (16.67)
DE222 (Delta)+Sun Vaaman	0	3 (5)	3(2.50)
DE222 (Delta)+P3401(Pioneer)	3 (5)	10 (16.67)	13(10.83)
Bumper	0	6 (10)	6 (5.00)
Bumper+DE222(Delta)	0	14 (23.33)	14(11.67)

Salient features of the maize varieties adopted by the farmers : Table-6 revealed the different characteristics of maize varieties adopted by the farmers. 90 days duration of P3401 variety gives high yield (15-16q) with uniform cob compared to the other adopted varieties. Both Bumper and Sun Vaaman varieties' cobs are good in size and grains are bold.

Table-5 : Reasons for the adoption of non recommended varieties of maize by the farmers.

Sl. No.	Variety	Reasons for adoption	Frequency (%)
1.	P3401 (Pioneer)	Gives high yield	43
		Recommended by most of the peer farmers	20
		Easily available	11
2.	Maharaja-92	Easily available	3
		Gives good yield	4
		Recommended by company personnel	2
3.	Sun Vaaman	Recommended by company personnel	3
4.	DE222 (Delta)	Colour and quality of the cob is very good	40
		Resistance to cob rot disease	10
		Easily available	20
5.	Bumper	Grains are very bold	12
		Gives very good yield	7
		Recommended by peer farmers and company personal	13

Table-6 : Characteristics of maize varieties adopted by the farmers in flood affected areas.

Sl. No.	Variety	Sowing time	Duration of the crop (days)	Yield	Special characteristics	
		Kharif	Rabi			
1.	P3401	Mid April-Mid May	Mid Oct-mid Nov.	90	15-16Q	Gives high yield Cob size is uniform Cob colour is good Shelling percentage is more
2.	DE222	Mid April-Mid May	Mid Oct-Mid Nov	120	13-16 Q	Easy to manage due to short plant with small tillers Superior in grain quality Cob colour is very good Resistance to drought and cob rotting
3.	Maharaja-92	Mid April-Mid May	Mid Oct-mid Nov	110-115	10-12Q	Tolerant to most of the disease and pest Cob colour is very vibrant (Orange yellow in colour)
4.	Sun Vaaman	Mid April-Mid May	Mid Oct-mid Nov	110-115	12 -14 Q	Size of the cob is good
5.	Bumper	Mid April-Mid May	Mid Oct-mid Nov	120	12-15 Q	Cob size is large Grains are bold

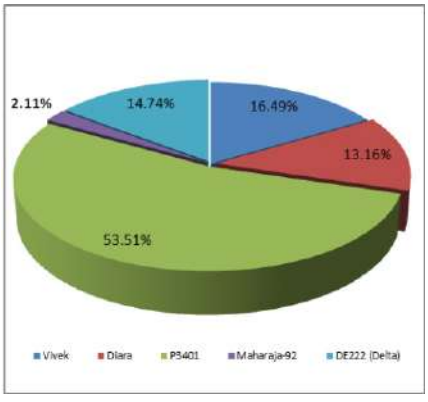

Fig.-1 : Area coverage by maize varieties in situation I

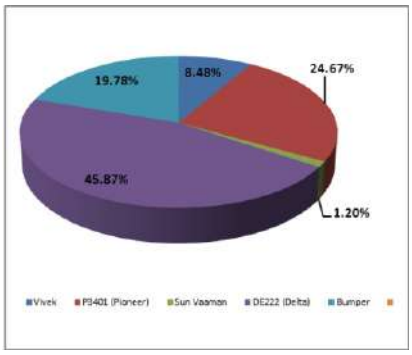

Fig.-2 : Area coverage by maize varieties in situation II

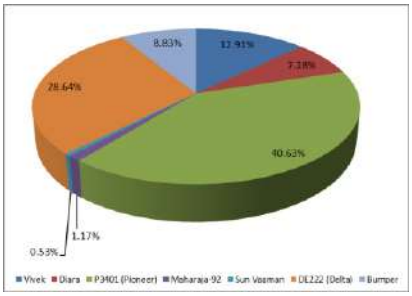

Fig.-3 : Area coverage by maize varieties in flood affected areas

Conclusion

Farmers from flood affected areas changed their cropping system from rice based to maize based cropping system to cope up with flood damages. Considering the intensity of flood farmers adopted different maize based cropping system. Farmers to farmers extension and private extension system play important role for promoting maize varieties which are not even recommended by state department of agriculture. Maize-Maize/Mustard-Pumpkin and Maize-Maize-Vegetable cropping system were mostly followed by farmers which implies the suitability of this cropping system in other flood affected areas. Only 17.5% respondents adopted recommended varieties and rest farmers adopted non recommended varieties namely P3401 (Pioneer), DE222 (Delta), Maharaja-92, Sun Vaaman and Bumper. This may be due peer pressure and constant persuasion of personnel from companies, high yield as well as made it easy available for farmers. Similar sincere efforts have to put forward by public extension system for popularizing the recommended varieties. For popularizing varieties both formal and informal seed channel need to be strengthened and varietal improvement of the recommended varieties if needed may be undertaken.

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Analysis of Growth Rates and Constraints of Cotton Production in Krishna District of Andhra Pradesh

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Abstract

The current research on cotton has been considered for the study with the objectives of analysing the pattern of Growth in Area, Production and Productivity and Constraints in Production and Marketing of Cotton in Krishna district of Andhra Pradesh.To calculate the growth rate of cotton area, production, and productivity in the study region (Krishna district) as well as the state, 10 years of data (2010-2011 to 2020-2021) were obtained from the Andhra Pradesh Agricultural statistics records. Compound Growth Rate Technique was used for the analysis. There was a slight decline in area of cotton production in Krishna district from 2010-11 to 2019-20. Although both production and productivity in Krishna district grew, the increase in cotton production was not substantial. Andhra Pradesh cotton area growth was deemed to be Non-Significant. The analysis of the constraints and were based on the opinions of the farmers in the survey.

Key words : *Compound growth rate, non-significant, cotton, constraints.*

Introduction

The Indian economy is agrarian, and agriculture is its cornerstone, serving as the backbone of the rural livelihood security system. It provides a living for approximately 58 percent of the Indian people .Agriculture has been and continues to be the lifeline of the Indian economy, as economic security is largely dependent on agricultural and allied sectors. Agriculture and related sectors contributed 17.8 percent of India's gross value added (GVA) at current prices in FY20, with the food processing industry accounting for the lion's share.India is one of the world's top cotton producers, accounting for around 26% of global cotton output. India has become one of the world's top cotton consumers, accounting for around 23% of global cotton consumption. In terms of area and output, Andhra Pradesh contributes 12.6% of Indian production of cotton, and 14%. Cotton is produced as a kharif plant on the eastern tracts of Andhra which have light red and black soils. Cotton is mostly grown as a Rain fed Crop. The cropped area is 46,797 ha for cotton in Andhra Pradesh district in Kharif (2020).

Objective

To Analyze the Pattern of Growth in Area, Production and Productivity of Cotton in Krishna district and Andhra Pradesh State.

To study the constraints in Cotton Production and Marketing.

Research Methodology

The study was done based on the secondary Data. To calculate the growth rate of cotton area, production, and productivity in the study region (Krishna district) as well as the state, 10 years of data (2010-2011 to 2020-2021) were obtained from the Andhra Pradesh Agricultural statistics records. The raw data collected was compiled and processed in such a way that the results of the analysis were utilized to research the objectives. Compound Growth Rate Technique was used for the Analysis.

Compound Growth Rate : To calculate the Compound Growth Rates (CGR) of Area, Production and Productivity the following formula is used.

$$Y = aB^t$$

$$\text{Log } Y = \text{Log } a + t \text{ Log } B$$

Where, Y = Area/Production/Productivity
a = Constant
B = Regression coefficient
t = time in year

Compound Growth Rate (%) = (Antilog B-1)100

Results and Discussion

There was a modest drop in the area of cotton production (2010-11 to 2019-2020) in Krishna district since the CGR was negative (i.e.-0.03), according to the study. Cotton area increase in Andhra Pradesh was determined to be Non-Significant (0.036). A positive CGR was recorded for both production and productivity in this area, indicating that production and productivity had grown, but the growth in cotton production was Non- significant (0.04) in Krishna district.

Production Constraints : As a result of the survey, farmers' opinions on the factors affecting the adoption of

Table-1 : CGR in Area, Production and Productivity of cotton in Krishna district and Andhra Pradesh (2010-11 to 2019-2020).

S. No.	Items	Krishna district	Andhra Pradesh
1.	Area	-0.03* (0.05)	0.036 NS (0.15)
2.	Production	0.04 NS (0.18)	0.08* (0.05)
3.	Productivity	0.07** (0.01)	0.045* (0.05)

Brackets show p-value **denote 5% level of significance *denote 10% level of significance NS denote Non-Significant

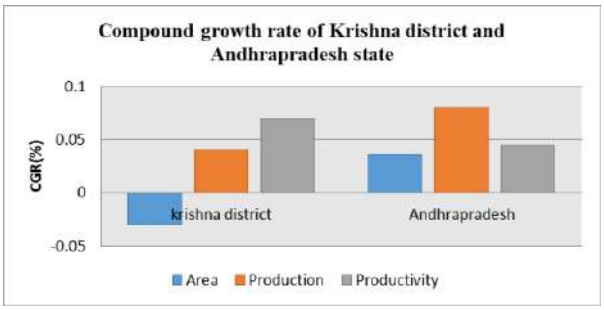

Fig.-1 : Graph depicting the CGR of Cotton in Krishna district and Andhra Pradesh.

Table-2 : Constraints in Cotton Production.

S. No.	Production Constraints	Number of Respondents					Rank
		Marginal (n = 26)	Small (n=22)	Medium (n =17)	Large (n=10)	Overall (n=75)	
1.	Unavailability of labour in time	21	20	14	7	62	2
2.	Damage due to pest and disease	22	19	15	8	64	1
3.	Lack of Technological knowledge	24	21	11	4	60	3
4.	Costly improved Technology	15	16	9	5	45	6
5.	Poor Irrigation	9	8	5	4	26	8
6.	Financial problems	19	15	15	3	52	4
7.	Unavailability of input in time	16	12	13	6	47	5
8.	Less agronomic practices	14	13	11	3	41	7

Table-3 : Constraints in Cotton Marketing.

S. No.	Marketing Constraints	Number of Respondents					Rank
		Marginal (n=26)	Small (n=22)	Medium (n=17)	Large (n=10)	Overall (n=75)	
1.	Low price at the time of harvesting	23	19	15	5	62	1
2.	Lack of Marketing Intelligence	25	18	13	4	60	2
3.	Lack of storage facilities	19	18	15	7	59	3
4.	High transportation cost	20	15	13	6	54	4

various enhanced technologies and practices were acquired and presented in the table. The most significant production constraint was identified as pest and disease damage (Rank-1), followed by labour shortages (Rank-2), a lack of technological expertise (Rank-3), and financial difficulties. (Rank-4).

Marketing Constraints : Low market prices at harvest time (Rank-1) were reported by the majority of farmers. Poor marketing intelligence (Rank-2) and storage facilities (Rank-3) were also cited by farmers as important marketing constraints .Major marketing limitation for large farmers was lack of storage facilities, while the main marketing constraint for most marginal farmers was lack of marketing information.

Conclusion

There was a slight decrease in the area of cotton production (2010-11 to 2019-2020) in Krishna district .The increase in area in Andhra Pradesh was Non-Significant. The production and productivity of cotton in Krishna district and Andhra Pradesh had grown**,** but the growth in cotton production was Non-significant in Krishna district**.**The most significant production constraint was identified as pest and disease damage (Rank 1). In general, the large farmers reported that damage due to pests and diseases, as well as a lack of available manpower, were the significant production restrictions. Finance was cited as the main barrier to performance for medium farms. Low market prices at harvest time (Rank-1) were reported by the majority of farmers. Major marketing limitation for large farmers was lack of storage facilities.

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Daughters of Soil : Feminization of Agriculture and Empowerment of Women

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In the post liberalization era the Indian agriculture underwent a sea change and registered high incidence of the phenomenon of feminization of agriculture. The female operational holdings in India augmented from about 13 per cent in 2010-11 to about 14 per cent in 2015-16. (10th Agriculture Census (2015-16). Evidently agriculture that contributes to about 16 per cent of the GDP, is progressively becoming a female activity. This sector employs 80 per cent of all economically active women especially living in rural areas comprise 33 per cent of the agricultural labour force and 48% of self employed farmers. The NSSO reports that 18 percent of farm families in India are headed by women. This phenomenon has been reasoned by the Economic Survey 2017-18 as due to rising male migration from rural to urban areas in search of better income opportunities.

Phenomenon of Feminization of Agriculture in India : However this feminization was not complemented with empowerment of women. The present study unravels the ground realities based on empirical evidences of a sample of 448 rural women workers including a major share of agricultural labourers. The macro data also shows lower pays for women compared to their male counterpart. The labour force participation rates by sex show differences in participation. It is lowest in states with higher share of workers in agriculture. Women in agriculture are visible more as agricultural labourers, marginal workers and even as cultivators with mearge land holding to subsist on. Therefore, to understand the causal factors, constraints impeding the participation and policy approaches to overcome it, we delve to understand.

Thus, what becomes evident from the above trends is that India is registering an increased participation of women, particularly by women in the agricultural sector as agri-labourers and even resultant cultivators. This process is referred as feminization of Indian agriculture. With urbanization and consequential migration of males to urban areas has triggered the trend of feminization of Indian agricultural workforce.

Empowerment of Women and Feminization of Agriculture : With employment gaining a central position in the prescriptions of poverty alleviation, it becomes imperative to study its influence on '*empowerment*' especially in the context of women, when voluminous literature have come up on '*feminization*' of poverty and hunger. Though participation of women in workforce has been visually recognized as important in developed and developing countries yet review of various studies on female work participation and empowerment reflect on the fact that sheer economic participation devoid of control over resources and ability to shape and make one's choices, women's empowerment seems only a myth. Equally important factors in determining empowerment status of women are the nature and quality of work and the labour processes involved.

There has been much debate in the gender and development literature on how to achieve women's status within the patriarchal family. Paula Kantor raises two important questions regarding women and work. "Does access to income earning opportunities improve women's status within the patriarchal family or do social norms and practices jaundice and intervene to make access to resources alone insufficient to challenge intra-household gender relation in some contexts?"

Another issue in relation to empowerment potential of women's economic participation is the form the participation takes. Thus, "the location and labour process of the work can intervene in the relationship between access to income and improvements in women's status."

Empowerment of women is largely determined by their economic status in the society. The changing global ambience throws up lucrative economic opportunities at the same time it puts forth new challenges which can be pragmatically faced by a woman only when she is armed with education, skill, knowledge and information. Some gender analysts present a complex picture of women and work. Though it is true that economic participation of women is an essential precondition for an improvement in their status, yet, it is important to note that women often face social and ideological constraints when seeking, obtaining and performing work outside households, with responsibilities for child bearing and rearing.

The objective of increasing female employment can — in the context of long working hours and added household duties — contribute to what has been termed "time famine", with negative effects on woman's health and well-being. Finally, it is important to analyze the

Table-1 : Village-wise Age-group Categorizes of Respondents.

Age	Age Groups					
	15-24 yrs	**25-34 Yrs**	**35-44 Yrs**	**45-54 Yrs**	**55-59 Yrs**	**60 & above**
	24 (5.4)	**162 (36.2)**	**104 (23.2)**	**61 (13.6)**	**48 (10.7)**	**49 (10.9)**
Head of the Hhd.	Head of Household's Relation with the Respondent					
	Self		Husband		Others	
	88 (19.6)		331 (73.9)		29 (6.5)	
Type of Family	Nuclear		Joint (without in-laws)		Joint (with in-laws)	
	220 (49.1)		99 (22.1)		129 (28.8)	
Marital Status	Currently Married		Widow	Separated	Deserted	
	403 (90.0)		32 (7.1)	3 (0.7)	10 (2.2)	
Caste	SC		OBC		General	
	230 (45.3)		104 (23.2)		141 (31.5)	
Education	No Education	Up to Primary		Middle	Up to High School	
	315 (70.3)	69 (15.4)		36 (8.0)	28 (6.3)	
Avg. Hhd. Size	Kazipur	Kanakpur	Rikhipur	Chak Garibdas	Chak Abhayram	Chak Kriparam
	8.0	13.1	11.3	6.3	8.1	6.4

Source : Field Survey, July-September.

Table-2 : Age-wise Educational Status of the Respondent.

Educational Status	Age Groups						Total
	15-24	**25-34**	**35-44**	**45-54**	**55-59**	**60 & above**	
No education	11 (45.8)	92 (56.8)	79 (76.0)	48 (78.7)	37 (77.1)	48 (98.0)	315 (70.3)
Up to primary school	8 (12.5)	33 (0.6)	15 (4.8)	7 (4.9)	6 (2.1)	0 (0.0)	69 (2.9)
Middle school	5 (20.8)	11 (6.8)	8 (7.7)	6 (9.8)	5 (10.4)	1 (2.0)	36 (8.0)
Up to High School	0 (0.0)	26 (11.1)	2 (1.9)	0 (0.0)	0 (0.0)	0 (0.0)	28 (4.5)
Total	24 (100.0)	162 (100.0)	104 (100.0)	61 (100.0)	48 (100.0)	49 (100.0)	448 (100.0)

Source : Field Survey, July-September.

specific content and character of work — and especially its physical arduousness.

The present analysis on empirical assessment of empowerment of women presents a critical assessment of the empowerment status of women with respect to work participation of rural women. To ascertain the marked difference in the status of empowerment between working and non-working women, representative sample from both rural working and non-working females was chosen comprising a sample 448 women respondents selected randomly from the four blocks of Allahabad District.

One out of five households was found to be female headed. With the male partners migrating in search of better income generation activities to places like Surat, Rajkot, Delhi and Mumbai, the female members with little capital assets in their control are left behind bound to hearth.

Reviews on feminization of poverty reflect that female-maintained households are very often among the poorest because of wage discrimination, occupational segregation patterns in the labour market and other gender-based barriers. Family disintegration, population movements between urban and rural areas within countries and internal displacements are factors contributing to the rise of female-headed households. In nearly three-fourths of the total households, husbands were heads of the households. 50 percent of the sample families were nuclear families.

As clearly visible in the Table-2 the level of illiteracy increases with age. Only six per cent of the respondents had completed high school. Among the literate the largest proportion are those who have completed primary school and less than primary. The hierarchy of educational attainments falls with increasing age. Almost all the respondents above 59 years of age were illiterate. At the other end of the spectrum, the proportion of respondents who have completed at least high school, although still very low, a trend of interest in higher education is seen among the younger age group.

Table-3 : Category-wise Distribution of Female Workers in the Sample Villages.

Name of Village	Cultivators	Agricultural Labour	Hhd. Worker	Other Workers	Total Workers	FWPR
Kazipur	5 (19.2)	20 (76.9)	0 (0.0)	1 (3.8)	26	53.1
Kanakpur	7 (25.9)	13 (48.1)	5 (18.5)	2 (7.4)	27	47.4
Rikhipur	17 (40.5)	20 (48.8)	1 (2.4)	4 (9.5)	42	42
Trans Ganga	28 (29.5)	53 (55.8)	6 (6.3)	8 (8.4)	95	46.1
Chak Garibdas	3 (5.9)	10 (19.6)	1 (2.0)	37 (72.5)	51	44.0
Chak Abhaydas	9 (19.6)	17 (37.0)	0 (0.0)	20 (43.5)	46	52.9
Chak Kriparam	1 (3.8)	8 (30.8)	2 (11.5)	15 (57.7)	26	66.7
Trans Yamuna	13 (10.6)	35 (28.5)	3 (3.3)	72 (58.5)	123	50.8
Total	42 (19.3)	88 (40.6)	9 (4.1)	79 (36.2)	218	48.7

Source : Field Survey, July-September.

Table-4 : Autonomy in Decision Making among Working Women.

Occupational Categories	Issues												
	Trivial Issues		Issues Related to Children		Issues Related to Own Self				Critical Issues				
	IC	QA	PC	EC	OH	GO	PO	VS	EM	BH	BB	PD	CE
Agri. Labour	VH	VH	VH	H	H	H	M	M	(VL)	(L)	(VL)	(L)	H
Self Emp.	VH	VH	VH	VH	M	VH	H	M	(VL)	(L)	(VL)	(VL)	H
Regular Emp.	VH	VH	H	VH	H	H	H	M	(L)	(L)	(L)	(L)	H
Casual Labour	VH	VH	H	H	H	VH	M	H	M	M	M	M	H
Cultivator	VH	VH	H	M	M	H	M	M	(VL)	M	M	M	H
Family land workers	VH	VH	M	(L)	(L)	M	(L)	(L)	(VL)	(VL)	(VL)	(VL)	M
Supervisory Work on family land	VH	H	(L)	(L)	M	H	M	(L)	(VL)	(VL)	(VL)	(VL)	M

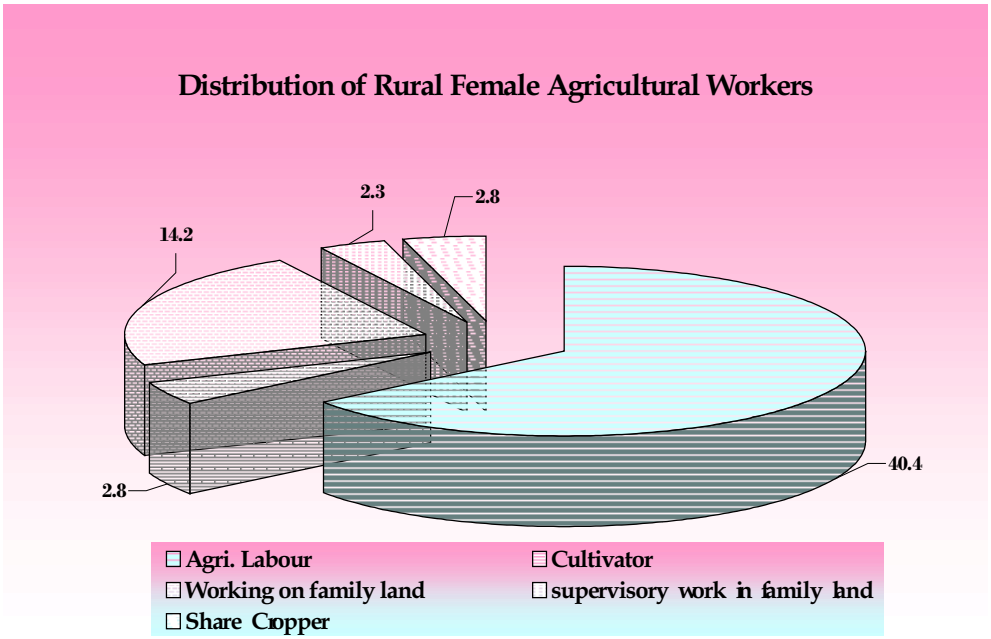
Note : Very High (VH) =above 80%, High (H) =60-80%, Moderate (M) =40-60%, Low (L) =20-40%, Very Low (VL) = Below 20%

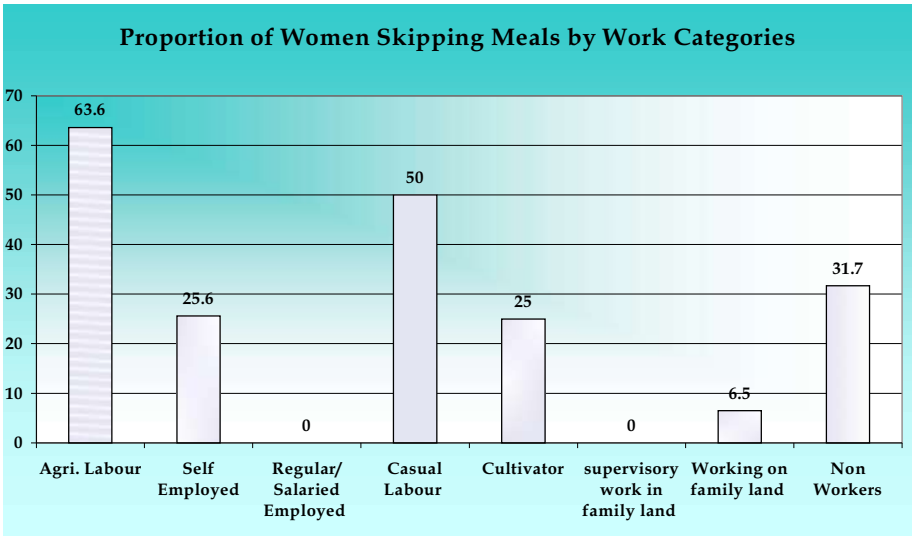
1. In making in what items to cook (IC)
2. Answering Freely to Questions asked (QA)
3. Purchasing requirements for Children (PC)
4. Education of Children (EC)
5. Obtaining Health Care for Own Health (OH)
6. Going for Outings (GO)
7. Purchasing Requirements for Own Self (PO)
8. Visiting and staying with friends, parents & relatives (VS)
9. Expenditure on Marriages. (EM)
10. Borrowing Money for Household Demands (BH)
11. Borrowing Money to Start Business. (BB)
12. Paying Back Debts (PD)
13. Control over Using Money earned/saved(CE)

Source : Field Survey, July-September

Work Participation Rates of Rural Women : A Comparison of Census and Field Data sets : Compared to the Census 2001 the work participation rate of female sample respondents was found to fairly high. This was due to the basic difference in the concept applied. According to Census 2001, work is defined as participation in any economically productive activity with or without compensation, wages or profit. Such participation may be physical and/or mental in nature. Work involves not only actual work but also effective supervision and direction of work. It even includes part time help or unpaid work on farm, family enterprise or in any other economic activity. All persons engaged in 'work' as defined above are workers. Persons who are engaged in cultivation or milk production even solely for domestic consumption are also treated as workers. Though the same definition was adopted for the identification of working population, yet the proportion of female workers is high in the survey as compared to Census 2001, because of possible underreporting or other reasons to be explored. Most of the workers working in family owned fields (both as workers or providing supervisory role) did not consider themselves as workers. It required in-depth probing and creating understanding that the real status was revealed. For example, Rikhipur, which shows comparatively higher Work Participation Rate (41 percent) in the sample population, has a very low FWPR in the Census (1.7 percent).

During the survey it was found that most of the women worked in own (family) farms from dawn to dusk





but did not consider themselves as workers. When asked are you employed. The spontaneous answer was

"I don't get free time from my family responsibilities like working on farm, feeding cattle and weeding the fields etc. I have to work and supervise in the fields from dawn to dusk."

A comparison of the work participation rates of females as according to the Primary Census Abstract and as reflected in the primary survey shows higher participation rates in the primary survey. The Work Participation rate of the Trans Ganga region according to primary survey was 45.6 percent. This proportion of FWPR in the Trans Yamuna region in the primary survey was nearly two times the FWPR in the Census. These inflated figures as reflected in the primary data point out to very important findings :

The participation of women respondents has been very high in the subsistence work, home-based work or informal work. These sectors are also termed as 'difficult to measure' sectors.

There exist gaps in the formulation of concepts and its actual gendered implementation.

Another plausible reason for higher FWPR could be over representation of scheduled castes. As there is a tendency among women of the lower social strata to actively support low family income, thus, participation of such women groups (which constitutes 45 percent of the sample respondents) is high. On the other hand rural women of higher social

order face stringent social restrictions, thus, with restricted mobility their participation in the labour market is low.

Another conceivable reason for such inflations could be because the empirical survey included a number of women who undertook milk production for household consumption. Though this component was introduced only in 2001 Census but in the sample villages of Chaka a number of women SHGs had not entered the second phase of funds system during the enumeration period of the Census 2001. Most of the women who were reported to be engaged in milk production in the primary survey had entered the second phase of funds wherein they were given credit to buy cattle to promote self employment. This lag period in the enumeration of the Census and the primary field survey could be one reason for non-reporting of a number of women who were earning from milk production captured in the field survey.

According to Census the cultivator's category includes a person who is engaged in cultivation of land owned or held from Government or held from private persons or institutions for payment in money, kind or share. Cultivation includes effective supervision or direction in cultivation. To net those workers who could neither be included in the cultivator's category nor could be marked as agricultural labourers, a separate category i.e., working or providing effective supervision on own family land (not owned by self) and working as family labour in family land were made. Nearly one-fifth of the female population was engaged working on land owned by the family.

At this juncture it is also interesting to point out that in 80 percent of the women cultivators were either deserted or separated or their spouse had migrated (made yearly visits) in search of work. The impact of male labour migration or absence on women taking up family responsibilities either as cultivators (including share croppers), agricultural labourers, etc. leads to high responsibility for keeping the family farm imposed on women left behind. However, in the paucity of the resources for enhancing productivity, the yields are not satisfactory. The remittances by migrants go to meet social and religious obligation etc. These findings drive home the point that responsibility on women does not make for more equitable gender relations. While family farm management does provide for a measure of food security it is laid unilaterally on the shoulders of women.

Consequential Impact : This validates two facts which emerge from our study reinforcing the importance of female work participation.

Female income can necessarily alleviate state of poverty of the family, i.e., enhancing female employment is supposed to be one of the prescription to poverty alleviation. As female earnings are mostly used for meeting household needs though women work or income earned is supposed to be secondary to men's work or income.

The shift of agricultural responsibility on women (who lack resources for enhancing productivity or yields not satisfactory) does not make for more equitable gender relations.

With no or low economic value given to their activities, the contribution of women is seriously underestimated, and there is no adequate reward of recognition for the burden of work that women carry. In fact, the failure to value most of their work reduces women to virtual non-entities in most economic transactions-such as property ownership or offering collateral for bank loans.

This table shows magnitude of autonomy in decision making across occupational categories. Broadly, looking into the behavioral pattern of decision making we can divide the working women into three categories. Though, working women in all categories displayed very high autonomy in trivial issues, in issues relating children autonomy was restricted for family land workers and women as supervisory work on family land.

In issues relating own self, autonomy was again restricted in these two occupational categories. Most important difference comes when we look into critical issues. Infact, three distinct categories emerge. First category comprising the family land workers and supervisory workers on family land had very low decision making autonomy. The second category of agricultural labourers, self employed and regular and salary employed had low to very low autonomy. Interestingly, the third category of causal labourers and cultivators had moderate autonomy in critical financial issues.

To list some challenges faced by women farmers are :

Lack of Institutional Credit : Due to lack of ownership of land women farmers are infringed to approach banks for institutional loans as banks generally deem land as collateral.

Non-recognition : The present study as well as several other studies had concluded that women's contribution in agricultural sector remains highly understated.

Lack of Property Rights : Women generally do not possess land rights consequently they lack assertive power or say.

Contract farming : Female farmers are largely

excluded from modern contract-farming arrangements because they lack secure control over land, family labour and other resources required to guarantee delivery of a reliable flow of produce.

Innovation in Agriculture : As women in rural areas are mostly illiterate or lack technical know-how, they often lag behind in use of modern agricultural techniques. Also with use of modern methods of farming, female agricultural labourers loose their work.

Lack of Training : Attempts by the government to impart them training in poultry, apiculture and rural handicrafts is trivial given their large numbers.

Gender discrimination : The 17-country study by Corteva Agriscience revealed that almost 78% women farmers in India face gender discrimination.

Access to resource and inputs : Compared to men, women generally have constrained access to resources and modern inputs (seeds, fertilizers, pesticides) to make farming more productive.

Lack of access to financial credit (aggravated due to lack of financial knowledge and illiteracy)

Lack of access to resources and modern inputs (most farm machinery is difficult for women to operate)

Increased work burden (on-farm and off-farm productive activities) with lower compensation. (triple burden of work-Care giving work, reproductive work and work in the paid labour market challenges overall performance and competence of women workers)

Way Ahead : The vision of empowerment of women will remain challenged without empowering and addressing the peripherals. These women farmers remain unheard, underestimated and hidden. They assert in establishing their identity at grassroots level and facing patriarchal inhibitions and gendering typecasting. Gender based discrimination perpetuates in manifold ways: women are not recognized as farmers in Indian policies thereby denying them of institutional supports of the bank, insurance, cooperatives, and government departments. According to the estimates by FAO if women had equal access to productive resources as men, they could compound yields on their farms by 20-30 per cent thus, increasing the total agricultural output in developing countries by up to 4 per cent.

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Self Help Groups in Empowering Women : A Case Study of Mungeli District of Chhattisgarh

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Abstract

Self Help Groups has now become a modern economical weapon for fighting against poverty. Many big and small institutions are taking part in it vigorously, still it has long way to become successful. The impact of the SHGs in empowerment of women was analyzed on the economic status, income generation, annual savings and annual expenditure of respondents in pre and post SHGs period. It was found from the results of the study that in post SHGs period the annual income, annual savings as well as annual expenditure were found to be increased as compared to their pre SHGs period. In the study 50 respondents from 5 SHGs were seen to have a positive impact upon the empowerment and livelihood, SHGs also had impact upon the households and the society. SHGs provide loans to their respondents and skills required to begin an economic activity and thus, reduced their dependence upon their husbands and family for economic resources. After women start earning they were also found to be capable of buying small assets with their savings, the awareness level of respondents also found to be increased due to experience and knowledge from various activities, programmes and campaigns. The respondents of the SHGs receive some indirect benefits after joining the SHGs as well i.e., women were start participating in local government and social programs, the communication skills and self-confidence of the respondents were increased, as they were start earning their family poverty levels were reduced, women were found place in their family's financial decision making and the family violence get reduced.

Key words : *Self help groups (SHGs), women empowerment,*

Introduction

Chhattisgarh is a one of the states of India, which is located at the central-east of the country. Chhattisgarh have tremendous agricultural and allied opportunities and called as "Rice Bowl of India." The Chhattisgarh state is also a one the heavily forested state 33% of the state's area is under forest (3rd most in the total forest area in the country).

Chhattisgarh state have total geographical area of 135192 square kilometre (ninth largest state of the country) with 29 district having population of 2.5545crores (17th most populated state of the country) among them 1.2832crores are men and 1.2712crores are women (according to the census 2011). That means almost 50% of the population of the state are women. The State which have 50% female population, so without the growth of female, without empowering them socially, economically, politically and in all the other dimension, the real growth of the state as well as of the country can't be possible.In Chhattisgarh the literacy rate is 70.28%, but the literacy rate for the men is 80.27% and for the women 60.24% (according to the census 2011). We see the difference of literacy rate between men and women. The wide gap between male and female literacy rate in Chhattisgarh indicate an enduring gender bias in the state. The status of women in society is a major cause of concern that influence biases against women, the Chhattisgarh government has accorded high priority in ensuring gender equality in education, political participation as well as in economic and employment opportunities. Several definitive measures have been taken by the state government for improving the status of women in society. Initiatives like 33% reservation in education for the girl students in higher education, 33% seats are reserved in elections of political seats for women, 50% reservation to women in Panchayati Raj Institution, 33% reservation in government jobs. This type of initiatives from the Chhattisgarh state government really help the women to develop and improve the female as well as encourage female to stand out for their self, step out from home for the education, for participating in political elections and all the other opportunities the gets. The female literacy rate has increased by 8.39% between 2001 and 2011 census is remarkable and also show the efforts of government to up-lift the female of the state.

Self help groups (SHGs) : SHG is an approach through which efforts are made by the government and the non-government organizations with an intention to pool both human and material resources to improve women of our society.

Informal association of people who are came together to find ways to improve their standard of living, the members of the SHGs are self-governed and similar in

economic background. The members of the SHGs collect their saving and deposit it in bank, in return they receive easy access to loan with a small rate of interest to start their micro unit enterprise. Mainly the members of SHGs are women and consequently the participation of the women in SHGs are increasing year after year. The rapid growth of SHGs and increasing in SHGs formation is now turned into an empowerment movement in our state as well as our country. The Self Help Groups approach in India has taken strong roots as an effective way to take the poor to a new domain of an economic empowerment and social upliftment.

What is Empowerment : Empowerment is a degree of autonomy and self-determination in people and communities, which is enables them to represent their interest in a responsible way, acting on their own authority. Empowerment is when both gender of the society gets equal opportunity in every aspect of life. Specifically in Indian context where women after they reach a certain age are forced or questioned about when to get married, when and how many children to have, where they work, how to spend their money, whether they can move around freely. It has to be change, It is important to understand that the feminine in the society is as important as masculine in the society.

Materials and Methodology

Mungeli District is consists of 3 blocks Mungeli, Pathariya and Lormi. Out of three blocks, Mungeli was selected purposively on the basis of maximum number of Self Help Groups. 50 respondents form 5 SHGs were selected from the 2 Villages Keshalikala and Banki of Mungeli Block, Mungeli District of the Chhattisgarh. From the village Keshalikal 3 SHGs were selected namely Safura Mata Self Help Group, Jai MaaLaxmi Self Help Group and Jai Bharat Mata Self Help Group, these three groups were engaged in making of spices i.e. mixture of spices (garam masala), turmeric powder and chilli powder. And from the village Banki 2 SHGs were selected namely Jai Maa Shakti Self Help Group and Shree Radhe Krishna Self Help Group these two groups were engaged in making of vermin-compost.Three SHGs which were working on spices was categorized as SHG1 and two SHGs working on vermi-compost was categorized as SHG2.

The primary data were collected directly from the respondents of SHGs through pre tested interview schedule. The secondary data were collected from the Agricultural Statistics Report of Chhattisgarh, Krishi Vigyan Kendra and Department of Agriculture of Mungeli District. The data was pertains to the year 2020-21.

Analytical Tools :

1. Cost of production : The expenditure incurred in producing a unit quantity of output is referred as cost of the production. The cost of production is a summation of Total Variable Cost and Total Fixed Cost.

Cost of Production = Total Variable Cost + Total Fixed Cost

(a) Variable Cost : The variable cost includes of raw materials, labour charges, electricity charges, water charges, maintenance charges of machinery etc. And the summation of all the variable costs is called as Total Variable Cost.

(b) Fixed Cost : The fixed cost include costs like taxes, insurance, land rent, infrastructure etc. And the summation of all the fixed costs is called as Total Fixed Cost.

2. Gross Income : It is referred as total amount of money you get for your product.

Gross Income = Physical Quantity Price/unit

3. Net Income : Gross income minus total cost is referred as net income.

Net Income = Gross Income – Total Cost

4. Input-Output Ratio : it indicates the relation between the quantity of material used in the production and the quantity of final output.

Input-Output Ratio = Gross income/Total Income

5. Benefit Cost Ratio : here we compare the present worth of cots with present worth of benefits. It is a profitability indicator.

B/C Ratio = Net Income/Total cost.

Results and Discussion

It was observed from the table-1 that cost of production of per tonne of vermi-compost was found Rs. 4009.90 and the gross income was found Rs. 10,000 the net income from one tonne of vermi-compost was Rs. 5990.10 and the input output ratio and benefit cost ratio of vermi-compost was 1:2.49 and 1:1.46 respectively.

Table-1 : Costs and Return of Vermi-Compost (Per Tonne).

Particulars	Price in Rs.	Percentage of total cost
Variable Costs		
Agricultural wastes & cow dung	820	20.44
Earthworm/culture	750	18.7
Labour charges	755	18.82
Electricity and water charges	80	1.99
Packaging cost	300	7.48
Interest on variable cost (10%)	270.50	6.74
Total Variable Cost (A)	2975.50	74.20
Fixed Costs		
Land rent	150	3.74

Working Shed	415	10.34
Tools and machinery	375	9.35
Interest on fixed cost (10%)	94.40	2.35
Total Fixed Cost (B)	1034.40	25.79
Total Cost (A + B)	4009.90	100
Gross Income	10,000	
Net Income	5990.10	
Input Output Rato	1 : 2.49	
Benefit Cost Ratio	1 : 1.46	

respectively. The gross return was 160, 180 and 130 for mixture of spices, chilli powder and turmeric powder respectively. The net income per Kg. for mixture of spices was 63 Rs. chilli powder 76 Rs. and for turmeric powder the net income was 55 Rs/Kg. The input output ratio for the mixture of spices was 1:1.64, for chilli powder and turmeric powder the input output ratio were 1:1.73. The benefit cost ratio of mixture of spices was 1:0.64 and chilli

Table-2 : Costs and Returns of different Spices.

Sr. No.	Particular	Costs of Spices (Rs./Kg.)		
		Mixture of Spices (Garam Masala)	Chilli Powder	Turmeric Powder
1.	Raw material cost	78 (80.41)	85 (81.73)	56 (74.66)
2.	Packaging cost	4 (4.12)	4 (3.84)	4 (5.33)
3.	Labour cost	10 (10.30)	10 (9.61)	10 (13.33)
4.	Other cost	5 (5.15)	5 (4.80)	5 (6.66)
5.	Total variable cost	97 (100)	104 (100)	75 (100)
6.	Sale price	160	180	130
7.	Gross income	160	180	130
8.	Net returns	63	76	55
9.	Input output ratio	1:1.64	1:1.73	1:1.73
10.	Variable cost ratio	0.60	0.57	0.57
11.	Benefit cost ratio	1:0.64	1:0.73	1:0.73
12.	Variable cost ratio in % age	60%	57%	57%

Table-3 : Business Performance of SHG1 (SHGs working on Spices).

Sr. No.	Products	Total sale in Kg/year	Net returns/ Kg. in Rs.	Net returns/ year in Rs.
1.	Mixture of spices	817	63	51,471
2.	Chilli powder	512	76	38,912
3.	Turmeric powder	683	55	37,565
	Total	2012		1,27,948

Table-4 : Business Performance of SHG2 (SHGs working on Vermi-compost).

Sr. No.	Product	Total sale in tonnes/ year	Net returns/ tonne in Rs.	Net returns/ year in Rs.
1.	Vermi-compost	14.7	5990	88,053

Table 5 : Impact of SHGs in Annual Income of Respondents.

Sr. No.	Annual income	Pre SHG period (no. of respondents)	Post SHG period (no. of respondents)
1.	Nill	8	0
2.	Below 24000	26	8
3.	24000 to 40000	13	32
4.	Above 40000	3	10
	Total	50	50

It was observed from the table-2 that total three types of spices were produced by the SHGs i.e. mixture of spices (garam masala), chilli powder and turmeric powder. The total cost was found to be Rs. 97, 104 and 75 for mixture of spices, chilli powder and turmeric powder powder and turmeric powder's benefit cost ratio was 1:0.73. The Variable cost ratio was 0.60, 0.57 and 0.57 for mixture of spices, chilli powder and turmeric powder respectively.

It was seen from the table-3 that the SHGs working on Spices have sale 817 Kg. mixture of spices, 512 Kg. chilli powder and 683 Kg. turmeric powder total 2012 Kg. of spices in a year. The net returns from mixture of spices was Rs. 51,471, from chilli powder the net returns was Rs. 38,912 and from turmeric powder the net returns was Rs. 37,565 that makes total returns of Rs. 1,27,948 in a year.

The table 4 revealed that SHGs engaged in making of vermin-compost have sold 14.7 tonnes of vermin-compost in a year. They received Rs. 88,053 as net returns from that.

The table-5 represents the annual income of SHGs respondents in pre and post SHGs period. The annual income of respondents was categorized in 4 different slabs. It was found that in post SHGs period the annual income generation of SHGs respondents was increased as compared to their pre SHGs period.

The table-6 shows the annual savings of respondents of SHGs. The data reveals that after the joining of SHGs the annual savings of SHGs respondents were increased as compared to their pre SHGs period.

Annual expenditure of SHGs respondents were presented in table-7. It was observed from the data that after the joining of SHGs not only their income and savings was increased but their expenditure was also

Table-6 : Impact of SHGs in Annual Savings of Respondents.

Sr. No.	Annual savings	Pre SHG period (no. of respondents)	Post SHG period (no. of respondents)
1.	Nill	9	0
2.	1000 to 3000	24	17
3.	3000 to 5000	10	21
4.	Above 5000	7	12
	Total	50	50

Table-7 : Impact of SHGs in Annual Expenditure of Respondents.

Sr. No.	Annual expenditure	Pre SHG period (no. of respondents)	Post SHG period (no. of respondents)
1.	Below 24000	25	12
2.	24000 to 40000	21	31
3.	Above 40000	4	7
	Total	50	50

Table-8 : Some Indirect Benefits Received by the Respondents after Joining of SHGs.

Sr. No.	Particular	Percentage (%) of Respondents
1.	Better economic status	82
2.	Financial decision making	66
3.	Generating employment and income	50
4.	Participating in social and Government programmes	76
5.	Increase in communication skills	86
6.	Increase in self confidence	92
7.	Reduction in family violence	26
8.	Reduction in poverty level of family	28
9.	Better nutritional status	56

increased after joining the SHGs as compared to their pre SHGs period.

Suggestions

The following suggestions are made to remove the problems observed during the study.

Education and skill orientation training facilities should provide to the members of SHGs.

The market related information should provide time to time, to the SHG members.

Adequate and timely finance should be given to SHGs.

Motivation programme for the respondents should be conducted.

Review of Self Help Groups must be done.

Regular meeting schedule.

The process of loan should be easier and friendly to the SHGs.

Education on monetary and financial matters as well as standard accounting should be given to the SHGs members.

Conclusion

14% of the respondents had not having any income before joining the SHGs. But after joining the SHGs they all are engaged in some income generation activities and all the respondents has a significant improvement in their income since joining SHGs. After becoming the members of SHGs it was found that not only income and savings of the respondents were increased in post SHGs period but their expenses was also found to be increased as compared to their pre SHGs period in the area under study. The respondents of SHGs were benefitted in income generation, annual savings and annual expenditure, but they also received some indirect benefits after joining the SHGs. women were start participating in local government and social programs, the communication skills and self-confidence of the respondents were increased, as they were start earning their family poverty levels were reduced, women were found place in their family's financial decision making and the family violence get reduced, Increase in communication skills, the self-confidence of the respondents were also found to be increased and nutrition status was also better, they became more aware of their rights. 50 respondents from 5 SHGs were seen to have a positive change upon the economic empowerment. SHGs provide loans to their respondents and skills required to begin an economic activity and thus, reduced their dependence upon their husbands and family for economic resources. After women start earning they were also found to be capable of buying small assets with their savings, the awareness level of respondents also found to be increased due to experience and knowledge from various activities, programmes and campaigns.

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Impact of Mulching on Agriculture

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Abstract

As the population of India is continuously rising we have to adopt some means of sustaining our agricultural growth and it can be done through conservation farming. The best way out is the adoptions of the age old practice of Mulching in our agricultural fields. Mulching has become an important practice in modern field production due to benefits such as increase in soil temperature, reduced weed pressure, moisture conservation, reduction of certain insect pests, higher crop yields, and more efficient use of soil nutrients. Mulching is a soil andwater conserving and weed management practice through soil solarisation also in which any suitable material is used to spread over the ground between rows of crops or around the tree trunks. This practice helps to retain soil moisture, prevents weed growth and enhances soil structure. There are various types of mulching such as surface mulching, vertical mulching, polythene mulching, pebble mulching, dust mulching live vegetative barriers, straw mulching etc. Mulching proves to be beneficiary though increment in soil moisture, reduction in soil erosion, maintenance of soil temperature etc. It helps in improvise in soil structure, soil fertility and soil biological regime. Though also mulching is having many advantages it shows some limitations as it may harbour some pests and diseases. Mulching has many strategic effects on soil ecosystem, crop growth, and climate. Mulch insulates the soil, helping to provide a buffer from cold and hot temperatures that have a crucial activity in creating beautiful and protected landscapes.

Key words : *Mulching, conservation farming, soil ecosystem, soil erosion, soil moisture*

Introduction

We have realized that the green revolution saved us once but now its dependence on heavy use of fertilizer and pesticides are polluting our environment and degrading our soils. Excessive irrigation is bringing problems of soil erosion and salinity of soils. Though a lot of irrigation schemes have been developed we still have only 1/3rd of our agriculture under irrigation. So what is the way out? What do we do to restore the health of our soils? What do we do to add nutrients to our soils? What do we do to maintain a good micro-flora and a fine balance of micro-organisms in the soil? What do we do to conserve the moisture in the soil? What do we do to control the weeds in our fields? The answer is simple, to adopt the age old practice of Mulching in our agricultural fields. So what is Mulch? It is a protective covering, usually of organic matter such as leaves, straw, or peat, placed around plants to prevent the evaporation of moisture, and the growth of weeds. The word mulch has probably derived from the German word “molsch” means soft to decay, which apparently referred to the gardener’s use of straw and leaves as a spread over the ground as mulch.

Mulching is the process or practice of covering the soil/ground to make more favorable conditions for plant growth, development and efficient crop production. Mulch technical term means ‘covering of soil’. While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching. The research as well as field data available on effect of synthetic mulches make a vast volume of useful literature. When compared to other mulches plastic mulches are completely impermeable to water; it therefore prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface. In this manner it plays a positive role in water conservation. The suppression of evaporation also has a supplementary effect; it prevents the rise of water containing salt, which is important in countries with high salt content water resources. Thus, it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Dilip Kumar et al., 1990). In addition mulch can effectively minimize water vapour loss, soil erosion, weed problems and nutrient loss (Van Derwerken and Wilcox, 1988).

Crop growth parameters : Plastic mulch induces the early crop emergence, so that it increased the biomass production at early stages of the crop growth. Li *et al.,* (1999) reported that plastic film mulching leads to earlier seedling emergence and earlier spike differentiation, which help to develop more spikelets and more grains per spike in wheat. The improvement in soil moisture and topsoil temperature under plastic mulch hastened seedling emergence by 8 days on average in wheat.

Plants in mulching treatments entered the maturation phase sooner and their maturation period was longer. This change is favorable to partition assimilate that is stored in vegetative organs, thus facilitating development of the reproductive organs of wheat plants. It increases the duration of reproductive period so the yield will be maximized (Li, *et al.,* 2004).

Effect of mulching on weed control : The principle aim of mulching is to cut off the light to the weeds and to suppress their growth. Since every type of the mulch covers soil and perform physical pressure to the weeds. Mulching is a favorable tool for controlling the weed populations in nursery as well as field conditions, however, the phenomenon of weeds reduction is not fully understood till now. Wilen *et al*. (1999) found that there was 92% reduction of weed population as compared to non-mulched treatment. When mulch is spread on the soil surface, they act as barriers in the passing of light resulting in reduced germination of small-seeded weed species. Different types of mulches (15 different mulch types) were used in comparison to non-mulched, and outcomes of the study showed that there was no difference between all mulch types but a significant difference exists for reduction of weeds with bare soil treatment (Stinson *et al.* 1990; Mohtisham *et al.* 2013; Kader *et al.* 2019). Mulches act as physical obstacles in the emergence of weeds (Ahmad *et al.* 2015; Ahmad *et al*. 2020); however, when the organic mulches decompose, they quickly come out the soil surface.

Soil temperature : Soil temperature under plastic film is usually high and also it is based on the color of the plastic mulches. The black plastic-film mulched plots had significantly lower soil temperature (1 to 2.80 C) than the clear plastic-film mulched plots. Because much of the solarenergy absorbed by black plastic-film mulch is lost to the atmosphere through radiation and forced convection (Anikwe *et al.,* (2007) observed that the unmulched plots had the lowest soil temperature (about 1-3.80 C lower) at different times since planting compared to plastic film mulched plots. Among different mulching techniques plastic film mulching increases soil surface temperature by influencing the heat balance and thus increased the soil temperature and it also positively influenced the crop emergence (Aniekwe *et al.,* 2004).

Soil health improved by mulching : It also protects soil surface to erosion from the high-speed wind and surface runoff. It restricts the rainwater flow rate and hence restricts the soil and water runoff. Rainwater surface runoff does not arrive in direct contact and rainwater runoff slows down and increases the infiltration amount of water which indicates the more available soil moisture for plant use. Organic mulches are also improved the soil characteristics. It improves the soil physical, chemical and biological properties. These mulches are slowly decomposed, and they increase organic content in the soil which helps to keep the soil loose. These organic contents become food for the useful earthworms and other micro-organisms available in the soil. The organic mulches also improve the organic carbon in the soil. More the organic carbon, more the fragile of the soil. It facilitates the better root penetration and root development and extraction of nutrients from a deeper layer of the soil. It improves root growth of the crop, increases the infiltration of water, and water retention capacity of the soil. The organic mulches attract most of the soil beneficial micro-flora which in turn act on the degradable wastes and aids in the release of plant nutrients.

Organic Mulch :

Straw : Paddy and wheat straw are the commonest mulchingmaterials used for fruit and vegetable production. Though straw is poor in nutrient value but after decomposition, it makes soil more fertile. Among organic mulching materials, straw has a long life in comparison to other mulches (grasses, leaves and leaf mould).

Grass Clipping : This is one of the most abundantly and easily available mulch materials across the country. It provides nitrogen to the soil, if incorporated fresh. However, application of green grass in rainy season may result into the development of its own root system which will be detrimental to plant growth. Therefore, use of dry grass as mulch material is suggested.

Dry leaves : Leaves, an easily available material, are good for mulching. Though leaves are good for protecting dormant plants during winter by keeping them warm and dry but due to lightweight they may be blown away even by light wind. To counter this problem, it requires anchoring which can be done with stones, chipped bark and covering with net or some form of sheet.

Newspaper : Newspaper mulching helps to control weeds. One to two cm thick sheet of newspaper should be used and edges should be fastened with materials like pebbles, gravels, etc. The application of newspaper mulch should be avoided on a windy day.

Bark clippings : These are good mulch materials as they are long lasting and allow proper aeration to the soil underneath. Hardwood bark clippings contain more nutrients than softwood but bark clippings are not easily and abundantly available, and some bark products may cause phytotoxicity.

Saw dust : Saw dust, obtained during finishing operation of wood, is very poor in nutritive value as it contains only

Table-1 : Mohammad Abdul Kader *et al* (2019).

Attributes	Organic mulching	Plastic mulching
Materials type	Bio-based cellulose, chips, leaf, paper	Acetate, polyethylene, polymeric material
Costing	Cheap	Expensive
Labor	Not laborious	Laborious during setting and removing
Weed control	Effective but grass material growsweed	High weed competition except the transparentcolor
Solarization	Not effective in most of the cases	Most effective by boosting soil temperature
Fragments	Degradable to soil	Problematic and contaminated after 1-2 seasons
Durability	Temporary and decay over time	Long-lasting, 2–3 crop seasons
Water infiltration	Increases	Restricts water flow
Degradability	Naturally decompose and add nutrients	Discarded and buried that polluted soil

half the nutrients of straw. It decomposes slowly. Being acidic in nature, it should not be used in acidic soils.

Compost : The compost is one of the best mulch materials. It increases microbial population, improves the soil structure and provides nutrients. It is the excellent material for improving the health of soil Organic Mulching Limitations: Mulches can keep the soil too moist, restricting oxygen in the root zone on poorly drained soils. If mulch is applied close to or in contact with the stem, trapped moisture creates an environment conducive to development of diseases and pests. Many organic type of mulches also encourage and provide breeding locations for snails, slugs, mice, etc. that may attack the plants. Certain types of mulches such as hay and straw contain seeds that may become weeds.

Inorganic Mulch

Gravel, Pebbles and Crushed stones : These materials are used for perennial crops. Small rock Layer of 3-4 cm provides good weed control. But they reflect solar radiation and can create a very hot soil environment during summer.

Plastic mulch : Both, black and transparent films are generally used for mulching. Advancement in plastic chemistry has resulted in development of films with optical properties that are ideal for as pecific crop in a given location. There is need to understand the optimum above and below ground environment of a particular crop before the use of plastic mulch.

Black plastic film : It helps in conserving moisture, controlling weed and reducing outgoing radiation.

Reflective silver film : It generally maintains the root-zone temperature cooler.

Transparent film : It increases the soil temperature and preferably used for solarization.

Selections of mulching

In broad, the choice of selection of an appropriate mulching material depends on the types of materials, ecological locations, colors, thickness, perforations and availability of materials, cost-effectiveness, and feasibility of the crop (Wang *et al*. 2015). The comparative attributes of the selection of organic and plastic mulching are discussed in Table-1.

Suitability of mulching : Mulch can be used in fields before and after crop plantation as well as around the young plants. It is especially useful for high-value vegetable crops, and for growing crops in dry areas, during dry season cropping and in places where the soil is easily eroded by heavy rains (Larentzaki *et al*. 2008; Li *et al.* 2013). The use of plastic film mulch in agriculture is generally recommended for profitable row crops. Use of plastic mulch has the advantages of being lightweight, easy handling, and better coverage compared to organic mulch (Haapala *et al.* 2014).

Conclusion

The beneficial effects of organic and synthetic mulches for crop production have been widely discussed by many researchers. Research has shown that mulch provides many benefits to crop production such as protecting the roots of the plants from heat and cold, creating congenial condition for the plant growth by temperature moderation, reducing salinity and weed control and thereby improving the yield and quality of the crop. Mulching has become an important water conservation practice in modern agricultural production in arid and semi-arid environments. The mulch material protect soil surface from sunlight which reduces evaporation by preserving soil water and altering soil temperature. The utilization of water within soil root zone is a crucial phenomenon to increase water use efficiently and save the water resources by mulching. Therefore in the days to come, farmers will make use of this innovative technique that helps them conserve moisture, avoid weeds and improve soil health tremendously while producing more. This will also go a long way in the world achieving food security sustainably.

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