Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 9 : 22-26 (January-2021) Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Assessment of Fruit Borer Resistance for Quality Chilli Production

Umesh Babu B.S.[1], B.V. Tembhurne[1*] and A.G. Sreenivas[2]
[1]*Department of Genetics and Plant Breeding, University of Agricultural Sciences, Raichur 584104 Karnataka*
[2]*Department of Agricultural Entomology, University of Agricultural Sciences, Raichur 584104 Karnataka*
**Corresponding Author Email : bvtembhurne@gmail.com*

Abstract

Fruit borer is the main factors limiting the production in quantity and quality of chillies, not only in India but also worldwide. Therefore, thirty genotypes with different genetic background were evaluated and selected for fruit borer (*Helicoverpa armigera*) (Lepidoptera : Noctuidae) resistance in chilli. The experiments were conducted in field as well as laboratory conditions for two years to confirm the resistant genotypes during 2016-2017 and 2017-2018. The genotypes, Raichur bullet and G-4-L, showed resistance and Rajput exhibited moderately resistance reaction to fruit borer under both caged and laboratory conditions. Therefore, these genotypes can be used as donors for fruit borer resistance breeding programme in future. This study proposed identification of fruit borer resistance sources for providing more opportunity to the breeder to improve the fruit quality and enhance the yield.

Key words : *Chilli, Capsicum annuum, fruit bore, Helicoverpa armigera, quality.*

Introduction

Chilli (*Capsicum annuum* L.) is a new world genus from the night shade family which is most important commercial crops, grown in almost all parts of the world as well as in India. Capsicum is derived from the Greek word “Kapsimo” meaning to bite (1, 2). Chilli fruits have been a part of human diets since about 7,500 BC, and are one of the oldest cultivated crops. India is the largest chilli producer has vast potentiality to increase the production in order to promote export, besides meeting its domestic requirements. India is largest consumer and exporter of chilli in the world with a dry chilli production of 2149 thousand MT from an area of 752 thousand ha during 2017-2018.

A number of biotic factors could be attributed to low productivity and quality of chilli. The pests which cause yield loss in chilli are thrips, mites and fruit borer complex. No doubt the former two pests are major of constrains but the later one is also next in order. The fruit borer *Helicoverpa armigera* (Hubner) commonly known as gram pod borer is a serious polyphagous pest occurring on chilli, cotton, tomato, bhendi, chickpea, pigeonpea, maize, sorghum and many other crops, inflicting substantial crop losses every year (3). The loss caused by fruit borers is to an extent of 90 per cent (4). By using chemicals/ pesticides we face many problems like environmental contamination, insecticide resistance in insect pests and may cause serious health problems to humans. To tackle this problem we need to control the pests without disturbing environment and human health, hence using resistant varieties will be the solution.

The occurrence of *Helicoverpa armigera* in chilli was first time reported by (5). Later (6,7,8) reported complete destruction of the fruit by *H. armigera*. larvae in chilli plants, caused upto 77, 30 and 61.2 per cent fruit damage respectively. During 1993 Dharwad and Belgaum districts of Kamataka had become a hotspot for *H. armigera* due to increase area of chilli production and also lost half of their production.

Though the pest has been studied at greater depth on other crops like cotton, redgram chickpea etc., on chilli it is very meager. Fruit borer population can be reduced and manageable by early sowing (9) and late sowing (10) as the damage caused by fruit borer is location specific favorable environmental condition. Most of the existing varieties of chilli are having export quality but susceptible to fruit borer which is affecting the quality and yield. Hence, there is need to develop the resistant source to this pest as well as to improve the existing export quality chilli varieties. Keeping in view the experiments were conducted to identify the chilli genotypes resistance to fruit borer.

Materials and Methods

Thirty chilli genotypes with different genetic background were used for screening of fruit borer (*Helicoverpa armigera*) resistance in chilli. These genotypes were sown during 2016-2017 at college of Agriculture, Raichur using Randomized Complete Block Design under unprotected field conditions and providing cages using Completely Randomized Block Designby following the recommended agronomic practices. The genotypes were categorized

Received : November-2020 Revised : December-2020 Accepted : December-2020

into resistance and susceptible to fruit borer in chilli. Further to confirm the resistant reaction of selected genotypes against fruit borer was screened at laboratory and evaluated.Among the thirty genotypes promising seven genotypes were selected and each were again screened for further confirmation of resistance reaction to fruit borer and evaluated during 2017-2018.

Observations were recorded from five randomly selected plants from each replication to calculate per cent pod damage. The damage made by fruit borer was determined on the basis of per cent fruit infestation for estimating resistance and susceptibility of different chilli genotypes against fruit borer. The per cent fruit infestation was calculated using the following formula given by (11).

$$\text{\% Fruit infestation} = \frac{\text{Number of infected fruits}}{\text{Total number of fruits}} \quad 100$$

Genotypes were grouped into resistance/susceptible category on the basis of rating (1-6 scale) (with 1=highly resistance and 6=highly susceptible) as given in Table-1. (12).

Table-1 : Scale for grouping of genotypes into resistance and susceptible to fruit borer.

Rating	Damage level	Rating
1.	No damage	Highly resistance
2.	0.1-10.0% fruit damage	Resistance
3.	10.1-20.0% fruit damage	Moderately resistance
4.	20.1-30.0% fruit damage	Moderately susceptible
5.	30.1-40.0% fruit damage	Susceptible
6.	40.1 % fruit damage and above	Highly susceptible

The seedlings of different chilli genotypes were transplanted in pots of 30 x 30 cm size for screening in green house. Larvae were collected and reared in the laboratory at 25-28º C and 65 per cent relative humidity (RH) was maintained individually in plastic vials on natural feeding. Once the genotypes set the fruits, one larva (3rd instar larvae) of the fruit borer *Helicoverpa armigera* (Hubner) were released and enclosed with nylon cage. Further observations on the damage made by each fruit borer recorded separately at regular intervals and after every observation of fruit damage, the damaged fruits were removed and the larvae which were released earlier are allowed to feed freshly.

Because of variations in insect populations and staggered flowering of chilli genotypes, it is difficult to compare the genotypic performance across seasons and locations. Hence, the standardized technique *i.e.* detached fruit assay method was used to screen the genotypes (13) under laboratory conditions for confirming their resistance towards *Helicoverpa armigera*. The bioassay boxe's were kept in the laboratory at 27±2º C, 65-75% RH. The experiments were terminated after 96 hours when >80 per cent of the fruit area was damaged of fruit by larvae.

Results and Discussion

A typical symptom of damaged fruits with circular hole at the base of the pedicel was observed within 2-3 days of inoculation in protected condition using cages. It may be due to creating favorable environment by providing cages and forcing fruit borer to depend upon fruit for feeding and infect it without any choice to survive. Premature dropping of flower and podswere noticed after infection of the fruit borer. Young larvae feed on flower buds and young fruit by making a circular hole. Later, the larvae feed on seeds usually with its head inside the fruit and rest of the body outside. Per cent fruit damage by *Helicoverpa armigera* under caged condition during 2017-2018 is presented in Table-2. However, in natural condition when trials were conducted in field, we were unable to get the fruit borer (*Helicoverpa armigera*) damage. It may be due to early sowing causing unfavorable environmental condition to fruit borer survival. The results were in concordance with findings of (3), where we managed to reduce the fruit borer population by early sowing.

Each fruit borer *Helicoverpa armigera* (Hubner) were released and enclosed with nylon cage and damage per cent was recorded during December 2016 to January 2017 on different chilli genotypes. High infestation occurred as soon as the crop came into flowering and decreased as the season processed.

The larval damage/fruit of the pest was recorded on different chilli during this period, the damage per cent of chilli fruits ranged from 7.41 per cent to 52.80 per cent. KA2-L had significantly the highest damage and was statistically at par with damage on ENT-1 the lowest per cent damage was recorded on Raichur Bullet which was statistically at par with BhootJalokia and Rajput. A perusal of data presented in Table-2 revealed that damage per cent was the highest in fourth week of December which decreased with the advancement of days and was found to be first week of January indicating thereby the mean per cent was more in the month of December as compared to January.

The two genotypes each Raichur Bullet and G-4-L and BhootJalokia and Rajput showed resistance and moderately resistance to *Helicoverpa armigera* respectively under caged condition. However, nine genotypes like; BCH-42, HDC-75-1, JCH-42, LCA-310, PBC-80, P-3, Pant C-1-B, G-4-S and 9608U exhibited moderately susceptible and eleven genotypes *viz*; ACB1-L, ACB1-S, ENT-1, Jabalpur Local, KBCH-1, LCA-960, Lipstick, M-262, Sitara, SUM-17 and Tiwari

Table-2 : Per cent fruit damage by *Helicoverpa armigera* under caged condition during 2016-2017.

Sl. No.	Genotypes	Per cent fruit damage after release of fruit borer				Average % fruit damage	Damage score
		1st Week	2nd Week	3rd Week	4th Week		
1.	Raichur bullet	5.00 (12.92)*	06.25 (14.48)	14.28 (22.20)	11.11 (19.47)	09.16 (17.27)	R
2.	G-4-L	9.52 (17.97)	05.88 (14.03)	06.25 (14.48)	08.33 (16.78)	07.41 (15.81)	R
3.	Bhootjalokia	20.00 (26.57)	30.00 (33.21)	12.50 (20.70)	14.28 (22.20)	19.19 (25.66)	M.R
4.	Rajput	15.00 (22.79)	11.11 (19.47)	13.33 (21.41)	18.18 (25.24)	14.40 (22.22)	M.R
5.	BCH-42	25.00 (30.00)	22.00 (27.97)	27.00 (31.31)	25.00 (30.00)	24.75 (29.81)	M.S
6.	HDC-75-1	44.44 (41.81)	26.66 (31.09)	23.07 (28.71)	20.00 (26.57)	29.93 (32.04)	M.S
7.	JCH-42	25.00 (30.00)	19.04 (25.87)	33.33 (35.26)	40.00 (39.23)	29.30 (32.59)	M.S
8.	LCA-310	28.57 (32.31)	30.76 (33.68)	33.33 (35.26)	20.00 (26.57)	28.16 (31.95)	M.S
9.	PBC-80	05.50 (13.56)	20.00 (26.57)	41.66 (40.20)	50.00 (45.00)	29.27 (31.58)	M.S
10.	P-3	30.00 (33.21)	31.25 (33.99)	25.00 (30.00)	30.76 (33.68)	29.25 (32.72)	M.S
11.	PantC-1-B	20.00 (26.57)	46.15 (42.79)	25.00 (30.00)	20.00 (26.57)	27.78 (31.48)	M.S
12.	G-4-S	38.80 (38.53)	38.46 (38.33)	21.42 (27.57)	16.66 (24.09)	28.83 (32.13)	M.S
13.	9608-U	47.05 (43.31)	30.76 (33.68)	22.24 (28.14)	14.28 (22.20)	28.57 (31.83)	M.S
14.	ACB1-L	46.31 (42.88)	29.41 (32.84)	37.50 (37.76)	60.00 (50.77)	38.30 (41.06)	S
15.	ACB1-S	43.75 (41.41)	38.46 (38.33)	30.00 (33.21)	28.57 (32.31)	35.19 (36.31)	S
16.	ENT-1	28.07 (31.99)	30.00 (33.21)	35.71 (36.70)	44.44 (41.81)	34.68 (35.92)	S
17.	Jabalpur local	33.33 (35.26)	25.00 (30.00)	28.57 (32.31)	40.00 (39.23)	31.72 (34.20)	S
18.	KBCH-1	40.00 (39.23)	55.00 (47.87)	47.36 (43.49)	46.00 (42.71)	47.09 (43.57)	S
19.	LCA-960	14.28 (22.20)	58.83 (50.09)	33.33 (35.26)	33.33 (35.26)	34.94 (35.70)	S
20.	Lipstick	30.00 (33.21)	50.00 (45.00)	25.00 (30.00)	25.00 (30.00)	32.50 (34.55)	S
21.	M-262	44.00 (41.55)	57.00 (49.02)	53.84 (47.20)	44.00 (41.55)	49.71 (44.83)	S
22.	Sitara	33.33 (35.26)	20.00 (26.57)	50.00 (45.00)	40.00 (39.23)	35.83 (36.51)	S
23.	SUM-17	42.10 (40.45)	43.75 (41.41)	35.29 (36.45)	35.71 (36.70)	39.21 (38.75)	S
24.	Tiwari	44.44 (41.81)	50.00 (45.00)	40.00 (39.23)	25.00 (30.00)	39.86 (39.01)	S
25.	KA2-L	63.33 (52.73)	31.25 (33.99)	66.66 (54.73)	50.00 (45.00)	52.80 (46.61)	H.S
26.	Sankeshwar-1	44.44 (41.81)	40.00 (39.23)	61.53 (51.67)	54.54 (47.60)	47.85 (45.07)	H.S
27.	Sankeshwar-2	44.44 (41.81)	42.85 (40.89)	40.00 (39.23)	44.44 (41.81)	42.93 (40.93)	H.S
28.	Sankeshwar-3	40.00 (39.23)	45.45 (42.39)	50.00 (45.00)	66.66 (54.73)	50.52 (45.33)	H.S
29.	B. Dabbi	31.25 (33.99)	41.66 (40.20)	23.07 (28.71)	20.00 (26.77)	28.99 (32.36)	M.S
30.	B. Kaddi	25.00 (30.00)	14.28 (22.20)	23.07 (28.71)	20.00 (26.77)	20.58 (26.81)	M.S
S.Em ±							1.31
CD at 1%							4.91
CV (%)							7.72

*Figures in parentheses are arc sin transformed values
R = Resistant, MR = Moderately resistant, MS = Moderately susceptible,
S = Susceptible, HS = Highly susceptible

registered susceptible reaction. Moreover, genotypes KA2-L, Sankeshwar-1, Sankeshwar-2 and Sankeshwar-3 exhibited highly susceptibility. Whereas, the check varieties B. Dabbi and B. Kaddi are moderately susceptible to fruit borer (*Helicoverpa armigera*).

Grouping of chilli genotypes for fruit borer resistance based on fruit damage percentage under laboratory condition using detached fruit essay method was done during 2017-2018 and presented in Table-3. The genotype Raichur Bulletand G-4-L were grouped under highly resistant and ENT-1, KA2-L were grouped highly susceptible to fruit borer. Genotypes, BCH-42, HDC-75-1, JCH-42, LCA-310, PBC-80, P-3, PantC-1-B, G-4-S, 9608-U were grouped under moderately resistance, B. DABBI, B. KADDI, KBCH-1, M-262, Sankeshwar-1, Sankeshwar-2, Sankeshwar-3 were grouped under moderately susceptible and ACB1-L, ACB1-S, Jabalpur Local, LCA-960, Lipstick, Sitara, SUM-17 and Tiwari were grouped as susceptible. (14) reported that trichome density in the foliage is the indication of resistant. The reason is trichome interlocking the bracts and protect the buds may be enhancing the resistance to fruit borer in these genotypes of chilli. The findings are similar to those exhibited by (15) in chilli. However, genotype KA2-L (52.80%) showed significant highest fruit damage and it was at par with Shankeswar-3 (50.52%), M-262 (49.71%), Sankeshwar-1 (47.85%) and Sankeshwar-2 (42.93%). These susceptibilities are in acquaintance with previous report of (16). Low pungency and low phenol content may be the cause of fruit borer susceptibility.

Table-3 : Grouping of chilli genotypes for fruit borer resistance based on fruit damage percentage under laboratory condition during 2017-2018.

Scale	% Fruit Damage	Rating	Genotypes
1	0.00	Highly resistance	Raichur Bullet, G-4-L
2	0.1 - 10.0	Resistance	BhootJalokia, Rajput
3	10.1 - 20.0	Moderately resistance	BCH-42, HDC-75-1, JCH-42, LCA-310, PBC-80, P-3, PantC-1-B, G-4-S, 9608-U
4	20.1 - 30.0	Moderately susceptible	B. DABBI, B. KADDI, KBCH-1, M-262, Sankeshwar-1, Sankeshwar-2, Sankeshwar-3,
5	30.1 - 40.0	Susceptible	ACB1-L, ACB1-S, Jabalpur Local, LCA-960, Lipstick, Sitara, SUM-17, Tiwari
6	40.1 and above	Highly susceptible	ENT-1, KA2-L

Table-4 : Per cent fruit damage at different days after release of *Helicoverpa armigera.*

Genotypes	7^{th} day	14^{th} day	21^{st} day	24^{th} day	Mean
Raichur Bullet	9.22 (17.67)	6.94 (15.27)	6.59 (14.87)	8.45 (16.84)	7.80 (16.21)
G-4-L	12.34 (20.56)	7.79 (16.20)	8.97 (17.42)	8.65 (17.10)	9.44 (17.89)
Rajput	18.43 (25.42)	16.08 (23.64)	15.91 (23.50)	16.45 (23.92)	16.72 (24.13)
ENT-1	37.62 (37.83)	34.41 (35.91)	35.64 (36.65)	30.19 (33.32)	34.47 (35.95)
ACB1-L	17.10 (24.42)	17.55 (24.76)	18.95 (25.80)	19.64 (26.30)	18.31 (25.33)
HDC-75-1	14.68 (22.52)	15.63 (23.28)	22.37 (28.22)	14.32 (22.23)	16.75 (24.15)
KA2-L (Check)	57.52 (49.32)	52.44 (46.39)	48.92 (44.38)	51.79 (46.02)	52.67 (46.53)
S.Em (+)	2.08	1.31	1.51	1.29	
CD (0.01)	5.26	3.87	3.65	3.37	

(a) Raichur Bullet

(b) G-4-L

(c) Rajput

Plate-1 : Chilli genotypes resistance to fruit borer (*Helicoverpa armigera*) using cages.

The experiment was repeated during 2017-2018 to confirm the resistance source for fruit borer (*Helicoverpa armigera*) in chilli by selecting promising seven genotypes for fruit borer resistance based on resistance/susceptible reaction and are presentedin Table-4.

From the mean data, the tested genotypes Raichur bullet and G-4-L showed resistance and Rajput exhibited moderately resistance reaction to fruit borer under both caged and laboratory conditions although they have been forced to feed on the fruits of these genotypes by repeating the trials twice (Plate-1). It reveals the relative amount of heritable qualities possessed by the plant which influences the ultimate degree of damage done by the fruit borer (*Helicoverpa armigera*). Similar finding was also reported by (17) where seven selected genotypes of chilli and capsicum were grouped as resistant.

Conclusions

Since fruit borer have threatened cultivation of chilli crop, the preliminary work to find resistance sources for this pest was initiated. Two genotypes like Raichur Bullet and G-4-L identified as highly resistance to fruit borer. The genotype resistant to fruit borer were found to be promising but needs further evaluation trials for yield, stability tests over seasons and different environment for fruit borer infestation. The identified resistant genotypes may not necessarily have desirable agronomic traits and thus, may not be directly introduced for wide scale cultivation but can be used as donors for fruit borer resistance breeding programme in future.Furthermore genetic studies are also needed in order to understand the genetics of inheritance of resistant to fruit borer and to employ them successfully in resistance breeding programme against *Helicoverpa armige*ra Hubner.

Acknowledgement

The authors are thankful to Science and Engineering Research Board (SERB), DST, Govt. of India as the work is funded by research grant SB/EMEQ-176/2014

References

1. Tembhurne B.V. and Babu K. (2020). Development of male sterility based powdery mildew resistant high yielding F_1 hybrid in chilli (*Capsicum annuum* L.). *Frontiers in Crop Improvement*, 8(1): 31-33.
2. Basu S.K. and De A.K. (2003). Capsicum: Historical and botanical perspectives. In: De AK (ed.) The genus Capsicum. *Taylor and Francis, London,* pp 1-15.
3. Reed W. and Pawar C.S. (1982). *Heliothis*: a global problem. *Proceedings of International Workshop on Heliothis Management Problem,* pp. 9–14.
4. Reddy M.S. and Reddy G.S. (1999). An eco-frlendly method of control *Helicoverpa armigera* (Hubner). *Insect Environ.,* 4(1): 143-144.
5. Mayeux R.S. and Wene G.P.(1950). Control of serpentine leaf minor on pepper. *J. Econ. Ent.,* 43(5): 732-733.
6. Katagihallimath S.S. (1963). Chrlli (*Capsicum, annum* L.) a new host plant of *Heliothisarmigera* Hubner. *Curr. Sci*., 32: 46-44.
7. Murthy K.S. and Lakhminarayan (1993). Losses due to chilli pests. *All India seminar on crop losses due to insect pest*, held at APAU Hyderabad 7-9th January.
8. Rao M.D. and Ahmed K. (1995). Evaluation of certain insecticides for the control of the pests' complex on chilli in Andhra Pradesh. *Pesticidis.* pp. 41-44.
9. Hossain M.M., Khalequzzaman K.M., Islam M.A.M. ,Mondal M.T.R. and Alam S.N. (2019). Effect of different sowing dates for the management of chilli Pests. *Malaysian J. Medical and Bio. Res*., 6(2): 71-76.
10. Udikeri S.S., Sujay Y.H., Giraddi R.S. and Goudar S.B. (2018). Effect of date of planting and spacing on the activity of fruit borer (*Helicoverpa armigera* Hub.). *Int. J. Curt. Mic. App. Sci.,* 7: 4933-4940·
11. Kashyap R.K. and Verma A.N. (1986). Screening of tomato genotypes for susceptibility to fruit borer, *Heliothis armigera* (Hubner). *Indian J. Ent.,* 48(1): 46-53.
12. Rahman M.M., Rahma S.M.M. and Akter A. (2011). Comparative performance of some insecticides and botanicals against chilli fruit borer (*Helicoverpa armigera*). *J. Expt. Sci.,* 2(1): 27-31.
13. Sharma H.C., Pampapathy G. and Kumar B. (2005). Standardization of cage techniques to screen chickpeas for resistance to *Helicoverpa armigera* in greenhouse and field conditions. *J. Econ. Ent.,* 98: 210-216.
14. Selvanarayanan V. Narayanasamy P. (2004). Antixenosis resistance in tomato against fruit borer, *Helicoverpa armigera* (Hubner). *Int. J. Trop. Insect Sci.,* 24: 201–206.
15. Akshata K.,Gopali J.B. and Allolli T.B. (2018). Screening of elite genotypes of chilli (cv. *Byadgidabbi*) against pest complex. *J. Ent. Zool. Studies.,* 6(3): 696-701.
16. Rajput V.S., Prajapati B.G., Rebari G.N. and Choudhary N. (2017). Screening of different genotypes against major insect pests of chilli (*Capsicum annuum* L.).*J. Ent. Zoo. Studies.,* 5(5): 1552-1554.
17. Shivaramu K. and Kulkarni K.A. (2008). Screening of chilligermplasm for resistance to *Helicoverpa armigera* (Hubner). *Pest Management Hort. Ecos.,*14(1): 51-58.