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Research Article

Field Level Response in Brinjal Genotypes against Shoot and Fruit Borer, *Leucinodes orbonalis* (Guenee.) (Lepidoptera:Pyralidae)

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Abstract

The present investigations were carried out at college of Horticulture, Venkataramannagudem during rabi 2016-17 and kharif 2017-18 seasons to assess the field level response of 60 brinjal genotypes and 3 check cultivars against shoot and fruit borer *Leucinodes orbonalis* (Guenee). The experiment was laid in Augmented Block Design with eight blocks. Results revealed that significant differences among tested genotypes and the check cultivars with regard to mean per cent shoot infestation, fruit infestation and yield per plant. The pooled mean per cent shoot infestation ranged from 9.01 to 34.99, fruit infestation 12.73 to 46.77 per cent and yield 0.211 to 1.484 kg per plant. The genotype IC 136061 recorded the lowest shoot infestation (9.01%), fruit infestation (12.73%) and highest yield (1.484kg/plant) whereas Dommeru Local (Susceptible check-1) registered highest shoot infestation (34.99%), fruit infestation (46.77%) and VR 02 with lowest yield (0.211 kg/plant) among the tested genotypes.

Keywords: Brinjal genotypes, Field screening against shoot and fruit borer

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Introduction

Brinjal is infested by more than 70 insect pests [1] of which shoot and fruit borer, *Leucinodes orbonalis* (Guenee) is one of the important pests. During the past two decades, this crop has been increasingly ravaged by brinjal shoot and fruit borer which reduces the yield and inflicts colossal loss in production. The losses caused by pest vary from season to season because moderate temperature and high humidity favour the population build-up of the pest [2], [3].

Chemical control is widely used means of managing insect pests in brinjal. The most important problem with chemical use is the retention and persistence of insecticide residues on the surface of vegetables. When these vegetables are consumed by human beings, traces of the insecticides enter the body and may cause serious health problems. Repeated use of broad-spectrum synthetic chemicals also results in insecticide resistance in insect pests, environmental contamination, bioaccumulation, bio magnification of toxic residues and disturbance in ecological balance [4].

To avoid these hazards, alternate control measures for the pest are needed. Use of resistant varieties is recognized as an important tool in bio intensive pest management system [5]. The use of resistant varieties is the safest control measure which can be integrated with other control methods. Selected resistant brinjal varieties can be used in combination with other control methods to manage this insect pest economically and in an environmentally safer way. It is not necessary that the varieties be highly resistant. Even a very low level of resistance can play a vital role in managing an insect pest when it is combined with other control methods that result in a reduced use of insecticides [6]. Screening of different brinjal varieties for resistance has been carried out by many workers. Different varieties have been field tested in different countries around the world. The physico-morphic and biochemical characteristics of plants and fruits [7, 8] are associated with attraction, feeding and oviposition of the insect pests.

A good knowledge of genetic resources may help in identification of desirable cultivars for better commercial cultivation. In this regard, the present study was undertaken to screen sixty brinjal genotypes and three checks against shoot and fruit borer under field conditions during rabi 2016-17 and kharif 2017-18 seasons.

Material and Methods

The present study was conducted during 2016-17 rabi and 2017-18 kharif season at college of Horticulture, Venkataramannagudem to evaluate the field level response in brinjal genotypes against shoot and fruit borer infestation with 60 brinajal genotypes and 3 checks (One resistant, two susceptible checks). The experiment was laid in Augmented Block Design with eight blocks [9]. The following definitions and relations hold for augmented block design:

- c = Number of check cultivars
- v = Number of tested genotypes
- b = Number of blocks
- n = v / b = Number of tested genotypes per block
- p = c + n = Number of plots per block
- N = bc + v = b (c + n) = total number of plots in the experiment

The total number of blocks is determined by the need to have at least 10 degrees of freedom for error in the analysis of the yield data. This, in turn, is determined by the number of check varieties (c) used in the trial. In the analysis of variance of check varieties, the experimental error has (b-1)(c-1) degrees of freedom. As a result, the minimum number of blocks, b, must be such that the following relation holds: $b > (10/(c-1)) + 1$. Accordingly, $b > (10/3) + 1$, $b > 5$. In constructing the design, the checks are randomly assigned to plots within each block, and then the v tested genotypes are assigned at random to the remaining plots in the experiment.

Raised nursery beds of 10 m x 1 m x 15 cm were prepared and the seeds of sixty brinjal genotypes and three checks were sown in rows spaced at 15 cm. The seedlings were transplanted in the main field at 35-40 DAS in a single row of 5m length with a spacing of 70 cm X 60 cm. The checks were planted in a randomized manner after every eight test genotypes in each block. Recommended agronomic package of practices were adopted for raising the crop excluding the plant protection measures.

Shoot Infestation

Five plants were tagged in each genotype and checks at random. The shoot infestation was recorded by counting the healthy as well as infested shoots (withered tender shoots) from randomly tagged plants of each genotype and checks at fortnightly intervals from 15 days after transplantation to final harvest. The damaged shoots were clipped off above the point of damage without destroying the larva inside after each observation. Mean per cent shoot infestation of each genotype was calculated following the formula developed for assessment of infestation [10].

$$\text{Per cent shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

Fruit infestation

Data on fruit infestation was recorded from the randomly tagged plants of each genotype at each harvest. At the time of harvesting, the whole plant was thoroughly observed, healthy and infested fruits were harvested and number of healthy and infested fruits per plant of each genotype was counted. Destructive sampling method was adopted to assess the fruit damage. The weight of healthy and infested fruits was also recorded. The observations were recorded at each harvest of 15 days interval till final harvest. The per cent fruit infestation was worked out on number basis following the formula [10].

$$\text{Per cent fruit infestation} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

Categorization of brinjal genotypes based on the mean per cent fruit infestation

On the basis of mean per cent fruit infestation, the genotypes were categorized into six grades as per the scale developed [11].

Grade	Category	Level of fruit infestation (%)
1	Immune	0% fruit infestation
2	Highly resistant	1-10% fruit infestation
3	Moderately resistant	11-20% fruit infestation
4	Tolerant	21-30% fruit infestation
5	Susceptible	31-40% fruit infestation
6	Highly susceptible	Above 40% fruit infestation

Yield

Yield on weight basis from tagged plants of each genotype was recorded starting from first harvest to final harvest.

Only healthy fruits were considered for recording the yield data.

Statistical analysis

Statistical analysis after appropriate transformation of data was undertaken [12]. Data was analyzed through statistical analysis software for Augmented block design [13] using the mean values.

Analysis of variance

The first step of the analysis is to construct a two- way ANOVA using the data of check varieties across blocks, consequently, the resulted mean square error is used to adjust the tested genotypes mean for the block effect. Also, the resulted mean square error is used to estimate four orders of least significant differences LSD as follows:

Considering MSE is an estimate of mean square error computed from a two- way ANOVA, then,

- **LSD** to compare between two check variety means = t $_{0.05}$ (2 MSE / b) $_{0.5}$.
- **LSD** to compare between adjusted yield mean of two tested genotypes in the same block = t $_{0.05}$ (2 MSE) $_{0.5}$.
- **LSD** to compare between adjusted yield mean of two tested genotypes in different blocks = t $_{0.05}$ (2 MSE (c + 1)/c) $_{0.5}$.
- **LSD** to compare between adjusted yield mean of tested genotype and a check variety mean = t $_{0.05}$ (MSE (b+1) (c+1)/ bc) $_{0.5}$ where, for all LSD values, tabulated t value has (b-1) (c-1) degrees of freedom (df)

Results and Discussion

Pooled observations recorded on response in brinjal genotypes against shoot and fruit borer *L. orbonalis* with reference to shoot infestation, fruit infestation and yield during rabi 2016-17 and kharif 2017-18 are presented in **Table 1**. The pooled per cent shoot infestation ranged from 9.01 to 34.99. The genotype IC 136061 recorded with lowest shoot infestation (9.01%) whereas Dommeru Local registered with highest shoot infestation (34.99%).

None of the genotypes under the present investigation were found completely free from the attack of shoot and fruit borer with particular reference to shoot infestation. Among the tested genotypes, only one genotype IC 136061 (9.01%) recorded with shoot infestation in the range of 1.00 to 10.00 per cent.

Among the tested genotypes and checks, twenty-six genotypes and resistant check (Bhagyamathi) registered with shoot infestation in the range between 10.01 to 20.00 per cent, thirty-four genotypes were identified with shoot infestation in the range between 20.01 to 30.00 per cent and two check cultivars (Tadepalligudem Local, Dommeru Local) were registered with mean shoot infestation above 30.00 per cent.

The mean per cent fruit infestation ranged from 12.73 to 46.77 per cent. IC 136061 was identified as the most promising genotype against shoot and fruit borer which recorded lowest fruit infestation (12.73%) whereas Dommeru Local registered with highest fruit infestation (46.77%). Fourteen genotypes were categorized as moderately resistant (11-20% fruit infestation), twenty-six genotypes were categorized as tolerant (21-30% fruit infestation), eighteen genotypes as susceptible (31.0 to 40.0% fruit infestation) and four genotypes and two check cultivars were categorized as highly susceptible as they recorded fruit infestation above 40.00 per cent.

The mean marketable fruit yield ranged between 0.211 to 1.484 kg plant^{-1}. The genotype IC 136061 recorded with highest yield (1.484 kg plant^{-1}) and lowest yield of 0.211 kg plant^{-1}was recorded in genotype VR-02. In the remaining genotypes and check cultivars, the yield was in the range of 0.298 to 1.089 kg plant^{-1}

The mean per cent shoot infestation, fruit infestation and yield of sixty tested genotypes and three check cultivars are presented in Table 1. As before mentioned, there were four LSD values to compare the significant differences among tested genotypes and three check cultivars allowing all possible comparisons to be made to select the elite genotypes for further crop improvement programme.

Comparison among the three check cultivars

The mean data revealed that Dommeru Local was recorded with highest shoot infestation (34.99%), fruit infestation (46.77%) followed by Tadepalligudem Local (30.96% and 43.79%) and Bhagyamathi (16.59% and 22.14%) confirming the high susceptibility character of Dommeru Local. With regard to yield, the pooled data revealed that Bhagyamathi recorded the highest mean fruit yield (0.894 kg plant^{-1}) followed by Dommeru Local (0.788 kg plant^{-}1) and Tadepalligudem Local (0.451 kg plant^{-1}).

Table 1 Response of brinjal genotypes against shoot and fruit borer, *L. orbonalis* during *Rabi* 2016-17 and kharif 2017-18 (Pooled data)

S. No	Block number	Genotype	Mean per cent shoot infestation			Mean per cent fruit infestation				Total Yield (Kg/plant)		
			Rabi 2016-17	Kharif 2017-18	Pooled	Rabi 2016-17	Kharif 2017-18	Pooled	Category	Rabi 2016-17	Kharif 2017-18	Pooled
1	1	IC 136148	10.10 (18.53)	11.97 (20.24)	11.34 (19.68)	16.00 (23.57)	14.79 (22.61)	15.39 (23.09)	MR	1.064	1.113	1.089
2	1	IC 135912	11.10 (19.46)	13.02 (21.15)	12.06 (20.32)	16.33 (23.83)	15.83 (23.44)	16.08 (23.64)	MR	1.035	1.066	1.051
3	1	IC 136299	12.78 (20.94)	15.36 (23.07)	14.07 (22.03)	16.45 (23.93)	15.83 (23.44)	16.14 (23.69)	MR	0.763	0.810	0.787
4	1	Pb.Shree	19.46 (26.17)	21.53 (27.64)	20.49 (26.91)	25.75 (30.49)	26.04 (30.68)	25.89 (30.59)	T	0.658	0.680	0.669
5	1	IC 136096	18.30 (25.32)	20.43 (26.87)	19.36 (26.10)	24.58 (29.72)	24.16 (29.44)	24.37 (29.58)	T	0.620	0.613	0.617
6	1	IC 136017	17.86 (24.99)	20.87 (27.18)	19.36 (26.10)	24.25 (29.50)	22.29 (28.17)	23.27 (28.83)	T	0.701	0.725	0.713
7	1	IC 089888	17.39 (24.64)	18.55 (25.51)	17.97 (25.08)	21.25 (27.45)	21.04 (27.30)	21.14 (27.37)	T	0.780	0.755	0.768
8	1	IC 144515	16.95 (24.31)	19.71 (26.36)	18.33 (25.35)	21.46 (27.59)	20.41 (26.86)	20.93 (27.22)	T	0.600	0.631	0.616
9	2	IC 136231	16.33 (23.83)	18.19 (25.24)	17.26 (24.54)	20.41 (26.86)	19.37 (26.11)	19.89 (26.48)	MR	0.734	0.746	0.740
10	2	IC 136451	17.53 (24.75)	19.77 (26.40)	18.65 (25.58)	22.37 (28.23)	32.08 (34.50)	27.22 (31.36)	T	0.655	0.726	0.691
11	2	IC 144525	15.35 (23.06)	17.95 (25.06)	16.65 (24.08)	19.27 (26.03)	19.58 (26.26)	19.42 (26.15)	MR	0.711	0.700	0.706
12	2	Swarnamani	19.72 (26.36)	21.87 (27.88)	20.85 (27.16)	25.62 (30.41)	25.41 (30.27)	25.52 (30.34)	T	0.693	0.659	0.676
13	2	IC 136455	25.02 (30.01)	26.78 (31.16)	25.90 (30.59)	34.00 (35.66)	33.33 (35.26)	33.66 (35.46)	S	0.374	0.412	0.393
14	2	IC 136308	21.19 (27.40)	23.46 (28.97)	22.32 (28.19)	27.18 (31.42)	27.25 (31.46)	27.21 (31.44)	T	0.399	0.427	0.413
15	2	IC 136296	14.29 (22.21)	15.36 (23.08)	14.82 (22.64)	17.06 (24.39)	16.83 (24.22)	16.94 (24.31)	MR	0.739	0.922	0.831
16	2	IC 136041	13.47 (21.53)	15.00 (22.78)	14.23 (22.16)	16.62 (24.06)	15.83 (23.44)	16.23 (23.75)	MR	0.772	0.863	0.818
17	3	IC 136290	21.82 (27.84)	23.66 (29.10)	22.74 (28.48)	29.79 (33.08)	29.58 (32.94)	29.68 (33.01)	T	0.380	0.380	0.380
18	3	Anamalika	24.84 (29.89)	23.31 (28.87)	24.07 (29.38)	33.64 (35.45)	33.75 (35.51)	33.69 (35.48)	S	0.443	0.454	0.449
19	3	DBR-08	24.52 (29.68)	26.35 (30.88)	25.43 (30.28)	31.12 (33.91)	32.50 (34.75)	31.81 (34.33)	S	0.375	0.382	0.379
20	3	BVB-71-1	24.37 (29.58)	26.61 (31.05)	25.49 (30.32)	33.75 (35.51)	33.33 (35.26)	33.54 (35.39)	S	0.388	0.355	0.372
21	3	P. Bindu	25.26 (30.17)	25.86 (30.56)	25.56 (30.37)	34.79 (36.14)	33.54 (35.39)	34.16 (35.76)	S	0.385	0.416	0.401
22	3	JB-02	20.74 (27.09)	23.07 (28.70)	21.90 (27.90)	26.66 (31.09)	26.87 (31.22)	26.77 (31.15)	T	0.718	0.698	0.708
23	3	AB-02	26.42 (30.93)	27.59 (31.69)	27.00 (31.31)	40.83 (39.71)	38.95 (38.62)	39.89 (39.16)	S	0.309	0.333	0.321
24	3	A. Kurmakar	25.80 (30.52)	27.04 (31.33)	26.42 (30.93)	37.91 (38.00)	37.08 (37.51)	37.50 (37.76)	S	0.270	0.325	0.298
25	4	KS 331	22.21 (28.11)	23.56 (29.04)	22.88 (28.58)	29.58 (32.95)	30.00 (33.21)	29.79 (33.08)	T	0.464	0.457	0.461
26	4	Aryana	16.77 (24.17)	19.55 (26.24)	18.16 (25.22)	23.75 (29.16)	21.41 (27.56)	22.58 (28.36)	T	0.457	0.489	0.473
27	4	DRNKV-	26.34	26.28	26.31	39.75	38.75	39.25	S	0.311	0.322	0.317

		104-43	(30.87)	(30.84)	(30.86)	(39.08)	(38.49)	(38.79)				
28	4	Green long	27.32 (31.51)	29.27 (32.75)	28.29 (32.13)	43.49 (41.26)	42.50 (40.68)	43.00 (40.97)	HS	0.295	0.290	0.293
29	4	IVBL-116-131	26.40 (30.91)	26.91 (31.25)	26.65 (31.08)	38.50 (38.35)	37.91 (38.00)	38.20 (38.17)	S	0.362	0.360	0.361
30	4	VR-02	26.93 (31.26)	27.83 (31.84)	27.38 (31.55)	42.50 (40.68)	42.08 (40.44)	42.29 (40.56)	HS	0.186	0.236	0.211
31	4	JB-03-06	17.12 (24.44)	19.55 (26.24)	18.33 (25.35)	25.21 (30.13)	23.12 (28.74)	24.16 (29.44)	T	0.520	0.577	0.549
32	4	IC 136260	25.32 (30.21)	24.37 (29.58)	24.84 (29.89)	35.20 (36.39)	35.00 (36.27)	35.10 (36.33)	S	0.349	0.367	0.358
33	5	JB-64	23.64 (29.09)	24.97 (29.98)	24.30 (29.53)	30.62 (33.60)	30.83 (33.73)	30.72 (33.66)	S	0.365	0.427	0.396
34	5	IC 136309	20.07 (26.61)	22.40 (28.25)	21.23 (27.44)	26.45 (30.95)	26.66 (31.09)	26.56 (31.02)	T	0.478	0.502	0.490
35	5	BH-02	22.67 (28.43)	23.40 (28.93)	23.03 (28.68)	30.83 (33.73)	31.66 (34.24)	31.25 (33.98)	S	0.453	0.437	0.445
36	5	IC 136306	19.12 (25.92)	20.58 (26.98)	19.85 (26.45)	25.00 (30.00)	25.62 (30.41)	25.31 (30.20)	T	0.539	0.521	0.530
37	5	IC 203589	14.68 (22.52)	15.57 (23.24)	15.12 (22.88)	17.79 (24.94)	16.66 (24.09)	17.23 (24.52)	MR	0.829	0.895	0.862
38	5	IC 215021	26.43 (30.93)	25.48 (30.32)	25.95 (30.63)	41.04 (39.83)	39.33 (38.84)	40.19 (39.34)	HS	0.293	0.326	0.310
39	5	IC 137751	15.85 (23.46)	17.01 (24.36)	16.43 (23.91)	19.16 (25.96)	18.95 (25.81)	19.06 (25.88)	MR	0.775	0.888	0.832
40	5	IC 154517	14.80 (22.62)	15.83 (23.44)	15.31 (23.03)	17.71 (24.88)	16.66 (24.09)	17.18 (24.49)	MR	0.723	0.723	0.723
41	6	IC 136292	18.94 (25.79)	19.81 (26.43)	19.37 (26.11)	25.20 (30.13)	25.41 (30.27)	25.31 (30.20)	T	0.741	0.740	0.741
42	6	IC 213564	21.54 (27.65)	22.52 (28.33)	22.03 (27.99)	28.33 (32.16)	27.91 (31.89)	28.12 (32.02)	T	0.542	0.580	0.561
43	6	JB-15	23.14 (28.75)	23.14 (28.75)	23.14 (28.75)	32.50 (34.75)	30.38 (33.44)	31.44 (34.10)	S	0.438	0.449	0.444
44	6	IC 136258	22.99 (28.65)	24.16 (29.44)	23.57 (29.04)	30.00 (33.21)	30.41 (33.47)	30.20 (33.34)	S	0.608	0.609	0.609
45	6	IC 136222	24.82 (29.88)	25.64 (30.42)	25.23 (30.15)	32.91 (35.01)	32.50 (34.75)	32.70 (34.88)	S	0.546	0.539	0.543
46	6	IC 136189	17.41 (24.66)	18.84 (25.72)	18.12 (25.19)	22.70 (28.45)	21.66 (27.74)	22.18 (28.10)	T	0.634	0.643	0.639
47	6	IC 136249	21.23 (27.43)	21.20 (27.42)	21.21 (27.42)	27.08 (31.36)	27.50 (31.62)	27.29 (31.49)	T	0.405	0.477	0.441
48	6	IC136293	26.58 (31.03)	27.06 (31.34)	26.82 (31.19)	42.50 (40.68)	41.25 (39.96)	41.87 (40.32)	HS	0.330	0.340	0.335
49	7	IC 136251	22.81 (28.52)	21.41 (27.56)	22.11 (28.05)	30.41 (33.47)	29.54 (32.92)	29.97 (33.19)	T	0.501	0.505	0.503
50	7	A.Nidhi	13.63 (21.66)	14.09 (22.05)	13.86 (21.86)	17.08 (24.41)	17.29 (24.57)	17.18 (24.49)	MR	1.043	1.097	1.070
51	7	Jaware Brinjal	18.42 (25.41)	20.76 (27.10)	19.59 (26.27)	25.00 (30.00)	26.25 (30.82)	25.62 (30.41)	T	0.621	0.642	0.632
52	7	IC 136307	19.93 (26.51)	21.01 (27.28)	20.47 (26.90)	25.83 (30.54)	26.24 (30.81)	26.03 (30.68)	T	0.469	0.459	0.464
53	7	BLR-24	15.55 (23.22)	16.41 (23.90)	15.98 (23.56)	20.62 (27.01)	20.83 (27.15)	20.72 (27.08)	T	0.719	0.732	0.726
54	7	S.Pratibh	16.19 (23.72)	16.65 (24.08)	16.42 (23.90)	17.08 (24.41)	18.00 (25.10)	17.54 (24.75)	MR	0.690	0.736	0.713
55	7	JB-07	15.38 (23.08)	16.15 (23.70)	15.76 (23.39)	17.66 (24.85)	17.25 (24.54)	17.46 (24.69)	MR	0.888	0.902	0.895
56	7	IC 136061	8.84 (17.30)	9.18 (17.64)	9.01 (17.47)	14.41 (22.31)	11.04 (19.40)	12.73 (20.86)	MR	1.371	1.597	1.484
57	8	DRNKV-02-104	21.02 (27.28)	22.69 (28.45)	21.85 (27.87)	27.08 (31.36)	26.95 (31.27)	27.02 (31.32)	T	0.526	0.527	0.527

58	8	IC 136589	24.07 (29.38)	25.14 (30.09)	24.60 (29.73)	31.25 (33.98)	32.08 (34.50)	31.66 (34.24)	S	0.542	0.553	0.548
59	8	A.Abhilamb	26.29 (30.84)	27.10 (31.37)	26.69 (31.11)	35.83 (36.77)	34.16 (35.76)	35.00 (36.26)	S	0.276	0.281	0.279
60	8	IC 136311	26.63 (31.06)	26.18 (30.77)	26.40 (30.92)	36.25 (37.01)	35.83 (36.77)	36.04 (36.89)	S	0.335	0.352	0.344
1		Dommeru Local-SC-1	33.71 (35.49)	36.27 (37.03)	34.99 (36.26)	48.24 (43.99)	45.83 (42.61)	46.77 (43.14)	HS	0.788	0.809	0.799
2		Tadepalli gudem Local-SC-2	30.13 (33.29)	31.79 (34.32)	30.96 (33.81)	44.16 (41.64)	43.41 (41.21)	43.79 (41.43)	HS	0.451	0.460	0.456
3		Bhagyamathi-RC	16.38 (23.87)	16.81 (24.20)	16.59 (24.04)	21.50 (27.62)	22.78 (28.51)	22.14 (28.07)	T	0.894	1.000	0.947
		Mean	39.26	27.673	28.073	39.24	32.77	32.95		0.541	0.584	0.563
Ci-Cj		CD (P=0.05)	1.70	1.70	1.70	2.00	2.10	2.10		0.12	0.15	0.14
		SEM±	1.580	1.58	0.580	0.67	0.70	0.69		0.041	0.052	0.047
BiVi-BiVj		CD (P=0.05)	4.90	4.90	4.90	5.80	6.00	5.90		0.35	0.44	0.40
		SEM±	1.63	1.63	1.640	1.93	2.05	1.95		0.116	0.146	0.132
Vi-Vj		CD (P=0.05)	5.70	5.70	6.00	6.70	7.00	6.80		0.43	0.53	0.48
		SEM±	1.888	1.88	2.015	2.22	2.33	2.26		0.142	0.178	0.162
Ci-Vj		CD (P=0.05)	4.10	4.10	4.40	4.90	5.10	4.90		0.31	0.39	0.35
		SEM±	1.379	1.37	1.450	1.62	1.69	1.64		0.103	0.129	0.117

Figures in parentheses are arc sin transformed values.
Ci – Cj (Critical difference between two control treatments), BiVi – BiVj (Critical difference between two augmented treatments in the same block), Ci – Vj (Critical difference between control treatment and augmented treatment) Vi – Vj (Critical difference between two augmented treatments in different blocks)

The overall mean per cent shoot infestation of the three check cultivars differed significantly from each other. Pair wise comparison for the response in check cultivars - Dommeru Local vs Bhagyamathi, Tadepalligudem Local vs Bhagymathi and Dommeru Local vs Tadepalligudem Local showed significantly high difference whereas pair wise comparison for the response against fruit infestation in check cultivars - Dommeru Local vs Bhagyamathi, Tadepalligudem Local vs Bhagymathi showed significantly high difference while Dommeru Local vs Tadepalligudem Local showed significant difference only. Yield data of the three check cultivars indicated that there is no significant difference in the yield performance of Bhgayamathi and Dommeru Local. These two checks were found to have significantly high difference with Tadepalligudem Local.

Comparison among the tested genotypes in the same block

The results revealed that significant and non-significant differences in the response against shoot infestation, fruit infestation and production of marketable fruit yield were observed among the eight tested genotypes (IC 136148, IC 135912, IC 136299, Pb. Shree, IC 136096, IC 136017, IC 089888 and IC 144515) in the first block. Significant difference was not observed in pair wise comparison of response between IC 136148-IC 136299 and IC 136096-IC 136017. Significant difference was observed between IC 136148-Pb. Shree, IC 136148-136096 and IC 136148-IC 144515 for shoot infestation whereas significant difference in response against fruit borer was not observed in pair wise comparison among IC 136148, IC 135912, IC 136299,IC 089888and IC 144515. These genotypes were differed significantly with the remaining genotypes of the block for fruit infestation. Significant difference in fruit yield was observed between IC 136148 to IC 136096 and IC 144515. IC 135912 also showed significant difference in yield with IC 1336096 and IC 144515. Significant difference in yield was not observed among IC 136148, IC 136192, IC 136299, Pb.Shree, IC 136017 and IC 136780.

In the second block out of the eight genotypes (IC 136231, IC 136451, IC 144525, Swarnamani, IC 136455, IC 136308, IC 136296 and IC 136041) significant differences among the genotypes against shoot borer infestation was observed. IC 136231, IC 136451, IC 144525, Swarnamani, IC 136308 was on par and no significant difference was observed in the level of infestation. IC 136296 and IC 136041 are on par to each other but differed significantly with other genotypes of the block. Genotype IC 136041 recorded lowest shoot infestation (14.23) in second block.

IC 136231, IC 144525, IC 136296 and IC 13604 showed significantly high difference with IC136451, Swarnamani, IC 136455, IC 1363081 in pair wise comparison for response against fruit infestation. Non- significant difference in production of marketable fruit yield was observed in pair wise comparison with genotypes IC 136231, IC 136451, IC 144525, Swarnamani, IC 136296 and IC 136041.These six genotypes showed significant difference in yield with IC 136455 as it recorded lowest yield in the block.

Concerning the third block (IC 136290, Anamalika, DBR-08, BVB-71-1, P.Bindu, JB-02 and AB-02) all the genotype except JB-02 showed non-significant response against shoot borer infestation and the genotype JB-02 recorded with lowest per cent shoot infestation (21.90). Significant and non- significant differences among the genotypes were observed for the response against fruit infestation. Pair wise comparison of IC 136290 with Anamalika, DBR-08, BVB-71-1 and P.Bindu revealed non- significant difference in the response where as significant difference was recorded with the remaining genotypes A.Kurmakr and AB-02. JB-02 registered high fruit yield and showed significant difference with other genotypes in the block.

In the fourth block (KS 331, Aryana, DRNKV-104-43, Green long, IVBL-116-131, VR-02, JB-03-06 and IC 136260) significant difference in response was not observed between Aryana and JB-03-06 but, these two genotypes showed significantly high difference with other genotypes in the same block for shoot infestation. Significant difference in response was observed between Aryana-KS 331, Aryana -DRNKV-104-43,Aryana-Green long, Aryana-IVBL-116-131, Aryana-VR-02 and Aryana-IC 136260 while non-significant response was observed between Aryana-JB-03-06. Significant difference in production of marketable fruit yield was not observed among the eight genotypes.

In the fifth block out of the eight test genotypes (JB 64, IC 136309, BH-02, IC 136306, IC 203589, IC 215021,IC 137751 and IC 154517) most of the pair wise comparisons showed on par response but the genotype IC 203589 and IC 154517 showed significant difference with other genotypes in the same block. IC 203589 showed highly significant difference with the remaining genotypes of the block as it recorded 17.23 per cent fruit infestation. Genotype IC 203589 recorded with highest marketable fruit yield and was significantly different from other genotypes in the block.

Results with the sixth block genotypes (IC 136292, IC 213564, JB-15, IC 136258, IC 136222, IC 136189, IC 136249 and IC 136293) indicated that IC 136292, IC136189 showed significant difference in the response for shoot infestation. With regard to fruit infestation, IC 136189 showed significant difference in the response with the remaining genotypes and non-significant differences were observed between IC 136292-IC 213564-JB-15, IC 136258,IC 136222 and IC 136249. These six genotypes showed significant difference in response against fruit infestation in pair wise comparison with IC 136293. All the genotypes were on par to each other and there was no significant difference in yield among the genotypes.

The results of the seventh block genotype (IC 136251, A. Nidhi, Jaware Brinjal, IC 13607, BLR-24, S. Pratibh, JB-07 and IC 136061) indicated that no significant difference was observed in the pair wise comparison between A.Nidhi-BLR-24 and S.Pratibh-IC 213564. Genotype IC 136061 recorded the lowest per cent shoot infestation (9.83) and was significantly superior over other genotypes.

A. Nidhi, JB-07, IC 136061 showed significant differences in response to per cent fruit infestation with the remaining genotypes in the block while non-significant response was observed among the three genotypes. IC 136061 showed significant difference with other genotypes as it was recorded highest marketable fruit yield (1.569 kg plant^{-1}) among all the genotypes under present study. A. Nidhi (1.043 kg plant^{-1}) also showed significant difference in fruit yield with Jaware Brinjal, IC 136307, BLR-24 and S. Pratibh.

Among the eighth block genotypes (DRNKV-02-104, IC 136589, A.Abhilamb and IC 136311) significant difference was observed with DRNKV-02-104 and other genotypes in this block were on par with each other for shoot infestation. Significant difference was not observed in pair wise comparison among the genotypes for fruit infestation as well as marketable fruit yield within the block.

Comparison among the tested genotypes in different blocks

Comparison of tested genotypes of different blocks showed significant and non-significant response against shoot infestation. Highly significant differences were observed between IC 136148 - IC 136311, IC 144525 - IC 136222 and IC 203589 - IC 136293 and non-significant differences were observed in pair wise comparisons between IC 136299 - A. Nidhi, IC 136296 - IC 203589 and Jaware Brinjal -IC 13601. Highly significant differences were observed between IC 136148-IC 136451, IC 136296-A.Abhilamb, Anamalika -S. Pratibh, IC 136293–A. Nidhi and IC 136041-Green long and non- significant differences were observed in pair wise comparisons between IC 089888-JB-03-06,DBR08-JB-64, A. Nidhi-IC 136299 for fruit infestation

The tested genotypes in different blocks showed significant and non-significant response with marketable fruit yield per plant. Highly significant differences were observed between IC 136148 - IC 136311, IC 136061 - IC 136292, IC 203589 - DRNKV-104-43 and A. Nidhi – A. Kurmakar. Non-significant difference was observed in pair wise comparisons between IC 135912 - A. Nidhi, IC144525 - IC 154517 and KS 331 - BH-02.

Comparison among the tested genotypes and three check cultivars

The tested genotypes were superior to check cultivars in the response against shoot infestation. The resistant check Bhagyamathi was on par in response with most of the test genotypes while Dommeru Local and Tadepalligudem Local were significantly different in performance with test genotypes. Significant difference was not observed between Bhagymathi-IC 144525, Bhagyamathi-IC 136041, Bhagyamthi-IC 203589, Bhagyamathi-IC 137751, Bhagyamathi-BLR-24 and Bhagyamathi-JB-07.

Conclusion

The results showed that the tested genotypes exhibited wide variability among themselves and with checks. IC 136061 recorded with less shoot infestation, fruit infestation and highest yield (kg/plant) surpassed the other genotypes and checks, indicated that this genotype can be exploited in future in crop improvement programme. The very low shoot and fruit infestation was attributed due to physicomorphic and biochemical factors of shoot as well as fruit. However, the results could not be compared for want of relevant literature on specific genotypes.

The above findings are in agreement with the findings [14] who recorded a mean per cent shoot infestation ranged from 1.38 to 9.96 per cent. Similar response with brinjal germplasm was observed [15] where shoot infestation ranged from 1.92 to 39.51 per cent. It was observed that in the summer season the fruit borer infestation was in the range of 29.63 % to 52.04 % and 28.4 % to 53.67 % on number and weight basis respectively, while the shoot borer incidence ranged from 10.43 to 32.46%. Among the tested genotypes, none was found to be immune to the pest [16]. Hybrid Sweta was best in reducing the shoot and fruit damage by *L.orbonalis* Guenee recorded on the number basis mean shoot and fruit damage of 8.0 and 8.7 per cent [17]. The mean number of shoots infested in 35 genotypes of brinjal ranged 2.97 - 16.42 per cent. Genotype Kallakurichi recorded the maximum shoot infestation (16.42%) and the lowest infestation of 2.97 % was registered in Sm 14318[18]. The present findings also get support from the findings of [19] where the minimum mean infestation in fruits were found in genotype Punjab Sadabahar, 2010/BRLVAR-3, 2010/BRLVAR-1, 2010/BRLVAR- 4 while maximum mean infestation in fruits was recorded in Swarnamani. Brinjal. Genotype IC 136299 was recorded the significantly lowest infestation of 6.60 per cent and it was less preferred by brinjal shoot and fruit borer, while genotype IC 345271 (34.66 %), IC 545919 (36.62 %), IC 203585 (34.13 %) and IC 136455(33.90 %) were highly preferred by the pest and recorded significantly more damage and in remaining genotypes the shoot infestation were ranged from 13.95 per cent to 32.17 per cent [20].Shoot and fruit infestation trend observed in this study was hither to observe by other workers [21-25].

References

[1] Kalawate, A and Dethe, M.O. 2012. Bioefficacy study of biorational insecticide on brinjal. Journal of Biopesticides. 5(1): 75-80.

[2] Shukla, A and Khatri, S.N.2010. Incidence and abundance of brinjal shoot and fruit borer Leucinodes orbonalis Guenee. The Bioscan. 5(2): 305-308.

[3] Kumar, R.S and Arumugam, T. 2015. Screening of brinjal genotypes against shoot and fruit borer. Insect Environment. 20 (4). 144-148.

[4] Harish, D.K., Agasimani, A.K., Imamsaheb, S.J and Patil, S.S. 2011.Growth and yield parameters in brinjal as influenced by organic nutrient management and plant protection conditions. Research Journal of Agricultural Science. 2: 221-225.

[5] Lit, M.C.2009. Combined resistance of eggplant, Solanum melongena L., to leafhopper, Amrasca biguttula (Ishida) and the eggplant borer, Leucinodes orbonalis Guenee. M.Sc. thesis, University of Los Baños, Laguna, Philippines.pp. 191.

[6] Srivastava, K.P.1993. A text book of applied entomology, Vol. II. Kalyani Publishers, India. pp 55-309.

[7] Bhushan, S., Chaurasia, H.K and Shanker, R.2011.Efficacy andeconomics of pest management modules against brinjal shoot andfruit borer (Leucinodes orbonalis). The Bioscan. 2011, 6(4): 639-642.

[8] Showket, A., Dar, A.,Wani, R., Bashir, A and Kandoo, A. 2017. Biochemical Basis of Resistance in Brinjal genotypes against shoot and fruit borer (Leucinodes orbonalis, Guenee). Chemical Science Review and Letters. 6(23): 1931-1940.

[9] Federer, W.T.1956. Augmented (or hoonuiaku) designs. Hawaii Plant Research.55: 191–208.

[10] Wakil, W., Ashfaq, M., Ghazanfar, M.U., Afzal, M and Riasat, T. 2009. Integrated management of Helicoverpa armigera in chickpea in rainfed areas of Punjab, Pakistan. Phytoparasitica. 37: 415-420.

[11] Mishra, P.N., Singh, Y.V and Nautiyal, M.C.1988. Screening of brinjal varieties for resistance to shoot and fruit borer, Leucinodes orbonalis Guenee. (Lepidoptera: Pyralidae). South Indian Horticulture. 36 (4):188-192.

[12] Gomez, K.A and Gomez, A.A.1984. Statistical procedures for agricultural research (2 ed.) John wiley and sons, NewYork. pp. 680.
[13] Rathore, A., Prasad, R and Gupta, V.K.2004. Computer aided construction and analysis of augmented Designs. Journal of the Indian Society of Agricultural Statistics. 57(SV):320.
[14] Wagh, S.S., Pawar, D.B., Chandele, A.G and Ukey, N.S.2012. Biophysical mechanism of resistance to brinjal shoot and fruit borer, Leucinodes orbonalis Guenee in Brinjal. Pest Management in Horticultural Ecosystems. 18 (1): 54-59.
[15] Rameash, K., Sivaraj, N., Sarath babu, N and Chakrabarty, S.K.2015.Screening brinjal genotypes for resistance to shoot and fruit borer, Leucinodes orbonalis and analyzing the geographic divergence of resistance through divagis. The Bioscan.10 (2): 923-928.
[16] Nisha Rani., Shirin Akhtar., Preeti Kumar and Rahul Verma, K.2018. Screening of local and exotic eggplant genotypes for tolerance to shoot and fruit borer. International Journal of Current Microbiology and Applied Sciences.7: 4553-4559.
[17] Elanchezhyam, K., Baskaran., Mulari, R.K and Rajavel, D.S. Field screening of brinjal varieties on major pests and their natural enemies. Journal of Biopesticides.1(2) : 113-120.
[18] Niranjana, R.F., Devi, M., Shanika, W and Philip, R.S.2015.Influence of biophysical characteristics of brinjal varieties on the infestation of brinjal shoot and fruit borer, Leucinodes orbonalis Guenée. Journal of University, Ruhuna. 3(1): 21-28.
[19] Devi, P., Gawde, P and Koshta, V.K. 2015. Screening of some brinjal cultivars for resistance to shoot and fruit borer (Leucinodes orbonalis Guenee).The Bioscan. 10 : 247-251.
[20] Javed, S., Vijaya Lakshmi, K., Narendra Reddy, C., Vidya Sagar, B and Shanthi, M. 2017. Study of screening of different brinjal genotypes against brinjal shoot borer, L. orbonalis. Contemporary Research in India. 7(3):236-241.
[21] Singh, J.P., Gupta, P.K., Chandra, U., Singh, V.K and Singh, A.K.2016. Field screening of brinjal germplasm against brinjal shoot and fruit borer (Leucinodes orbonalis Guenee.) at different stages of plant. International Journal of Plant Protection. 9 (1):84-90.
[22] Madhukar, K., Swati, S., Gurve Wilson, D and Mary, C.A. 2015. Screening of brinjal germplasm against shoot and fruit borer and phomopsis blight. Environment and Ecology. 33 (4B): 1887-1891.
[23] Hossain, M.M., Shahjahan, M., Salam, M.A and Begum, M.A. 2002. Screening of some brinjal varieties and lines against brinjal shoot and fruit borer, Leucinodes orbonalis Guenee. Pakistan Journalof Biological Science. 5: 1032-1040.
[24] Yousafi, Q., Afzal, M and Aslam, M. 2016. Screening of brinjal (Solanum melongena L.) varieties for resistance to brinjal shoot and fruit borer (Leucinodes orbonalis G.). Pakistan Journal of Zoology. 48 (6): 1649-1663.
[25] Amin, S.M.R., Alam, M. Z., Rahman, M. M., Hossain, M.M and Mian, I.H. 2014. Study on Morphological Characteristics of Leaves, Shoots and Fruits of Selected Brinjal Varieties/Lines Influencing Brinjal Shoot and Fruit Borer Infestation. International Journal of Economic Plants. 1(1):001-008.

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