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Screening of brinjal cultivars resistance against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee)

[1] A Sharma, [2] RS Rana, [3] KC Sharma, [4] A Kumar, [5] S Singh

[1, 3, 4, 5] Department of Entomology, Dr. YS Parmar University of Horticulture and Forestry, Nauni Solan, Himachal Pradesh, India

[2] Department of Seed Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni Solan, Himachal Pradesh, India

Abstract
The present studies on screening of some brinjal cultivars against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) was carried out during 2016 in the field conditions in the Department of Entomology, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan. Eight brinjal cultivars *viz.* 'Brinjal Long (F1)', 'DS-407', 'Ganesh', 'Long Green', 'Neelkanth', 'Prapti', 'Pusa Purple Cluster' and 'Pusa Purple Long' were evaluated against brinjal shoot and fruit borer, *L. orbonalis* (Guenee) under field conditions. Egg and larval count of *L. orbonalis* was made on these cultivars. The per cent shoot infestation in different brinjal cultivars were evaluated on basis of number of shoot damaged. None of the cultivars were found to be tolerant to shoot attack of *L. orbonalis* infestation but considerable variation of infestation was recorded among different cultivars. The per cent fruit damage varied from 6.66% to 46.63% recording the minimum fruit infestation in 'DS-407' and 'Ganesh' while the maximum fruit infestation was observed in 'Prapti' which was at par with 'Pusa Purple Long' and 'Neelkanth'.

Keywords: brinjal, eggplant, *leucinodes orbonalis*, brinjal shoot and fruit borer

1. Introduction
Brinjal (*Solanum melongena* L.) or eggplant belongs to family Solanaceae and is a species of night shade which in British English is commonly known as aubergine. It is also known as brinjal, melongene, garden egg, or guinea squash (Tsao and Lo, 2006) [41]. Brinjal is one of the widely used vegetable crops and is popular in many countries *viz*. Central, South and South East Asia, some parts of Africa and Central America (Harish *et al*., 2011) [13]. In Himachal Pradesh, 28 species of insect pests and mite have been reported to be associated with brinjal, of which the brinjal shoot and fruit borer (*Leucinodes orbonalis* G.), jassid (*Amrasca biguttula* Ishida and *Amrasca devastans* Distant), hadda beetle (*Henosepilachna* (*Epilachna*) *vigintioctopunctata* Fabricius), aphids (*Aphis gossypi* Glover), white flies (*Bemisia tabaci* Gennadius and *Trialeurodes vaporariorum* Westwood), brinjal leaf roller (*Eublemma olivacea* Walker), brinjal mealy bug (*Phenacoccus insolitus* Green) are found to be abundant on this crop (Patial and Mehta, 2008) [31].

Among these, the brinjal shoot and fruit borer has been reported to be the serious pest which reduces the crop yield up to 60-70% and inflicts the colossal loss in production (Singh and Nath, 2010) [38]. This pest has a very wide host range. Besides brinjal, it attacks other solanaceous plants such as *S. tuberosum* L. (Potato), *S. aculeatissimum* Jacq. (Indian nightshade), *S. indicum* L. (Black nightshade), *S. myriacanthum* Dunal (Kota bengena), *S. torvum* Swartz (Turkey berry), *Lycopersicon esculentum* Mill. (Tomato), *Capsicum annum* L. (Bell pepper) and some weeds (Anonymous, 2011) [4]. The brinjal shoot and fruit borer is active during the rainy and summer seasons and has specific nature of feeding behaviour. In early stage of the crop growth, the larva bores into the shoots resulting in drooping, withering and drying of the affected shoots due to disruption of the vascular system and translocation of food materials. At later stage of the plant growth, the larvae bore generally through calyx and later into the flower buds and fruits, the bored holes are invariably plugged with excreta (Butani and Jotwani, 1984) [7]. The infested fruits become unfit for human consumption due to loss of quality and lose their market value. It has also been reported that there could be reduction in vitamin C content in the infested fruits (Ali *et al*., 1980; Dhandapani *et al*., 2003) [2, 9]. Indiscriminate use of synthetic chemicals for the controlling insects pest of crop plants resulted hazardous effects causing serious problem including pest resistance, secondary pest outbreak, pest resurgence and environmental pollution. In view of this out the resistance/tolerant brinjal cultivars against brinjal shoot and fruit borer.

2. Materials and Methods
For the experiment eight brinjal cultivars were used. The experiments were laid out in Randomized Block Design (RBD) with three replications. The seeds of eight brinjal cultivars were sown in the experimental farm of the Department of Entomology on 25th February 2016. After two months, brinjal seedlings were transplanted in the field on 20th April 2016 at a recommended spacing of 60×45 cm.

- **Shoot and fruit infestation:** Eight brinjal cultivars were screened for the infestation of the brinjal shoot and fruit borer. For this purpose, five plants of each cultivar were selected and the data on the following parameters were

recorded.

- **Number of eggs/plant on each cultivar:** Number of eggs/plant were recorded by randomly selecting five plants per cultivar in each replication. Data were recorded at four days interval starting from the first appearance of eggs till the infestation of the brinjal shoot and fruit borer was over.
- **Number of larvae/plant on each cultivar:** Number of larvae/plant were recorded by randomly selecting five plants per cultivar in each replication. Data were recorded at four days interval till the infestation of brinjal shoot and fruit borer was over.
- **Shoot damage:** The total number of terminal shoots drying/drooping from randomly selected ten plants were counted. After each observation, the damaged shoots were removed. The per cent shoot infestation were calculated using the following formula:

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

- **Fruit damage:** The number of infested and un-infested fruits from each cultivar were counted from ten randomly selected plants and per cent fruit infestation was calculated using the following formula:

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

- **Fruit weight loss:** The weight of infested and un-infested fruits from twenty randomly selected plants from each cultivar was recorded and per cent fruit weight loss was calculated using the following formula:

$$\text{Per cent fruit weight loss} = \frac{\text{Weight of damaged fruits}}{\text{Total weight of brinjal fruits}} \times 100$$

Based on the mean infestation throughout growing season, the brinjal cultivars were categorized as per the grade index of Subbaratnam and Butani (1981) [40]:

Table 1: Grade index for fruit infestation/damage by *Leucinodes orbonalis*

Grade	Per cent infestation	
	Shoot	Fruit
Tolerant	< 2.0	< 15
Moderately tolerant	2.1-3.0	16-25
Susceptible	3.1-5.0	26-40
Highly susceptible	> 5.0	> 40

3. Results and Discussion

i) Egg

A perusal of data presented in Table 1 reveals that egg count/plant ranged from 1.90 to 5.54 eggs/plant among eight cultivars. The maximum egg count of 5.54 eggs/plant was recorded on 'Prapti' which was statistically at par with the egg count of 5.20 eggs/plant and 5.29 eggs/plant as observed in 'Pusa Purple Long' and 'Neelkanth' whereas, the egg count on 'Pusa Purple Cluster', 'Long Green' and 'Brinjal Long (F1)' was 3.83 eggs/plant, 3.49 eggs/plant and 3.77 eggs/plant, respectively. The minimum egg count of 1.90 eggs/plant was recorded on cultivar 'DS-407' which was statistically at par with the egg count of 2.30 eggs/plant as observed in 'Ganesh'. A comparison of egg count of brinjal shoot and fruit borer during July and August reveals that the maximum egg count was during the month of July (3.97 eggs/plant) and it was statistically at par with the egg count observed during the month of August (3.86 eggs/plant). When the comparison of the egg count in different interval was recorded it was found that the highest egg count of 4.66 eggs/plant was during the fourth interval whereas, the lowest egg count of 2.90 eggs/plant was observed during the first interval.

ii) Larva

Fruits of eight brinjal cultivars *viz*. 'Brinjal Long (F1)', 'DS-407', 'Ganesh', 'Long Green', 'Neelkanth', 'Prapti', 'Pusa Purple Cluster' and 'Pusa Purple Long' were also observed for the infestation of brinjal shoot and fruit borer. A perusal of data presented in Table 2 reveals that larval count/plant ranged from 0.90 to 2.89 larvae/plant among eight cultivars. The highest larval count of 2.89 larvae/plant was recorded on 'Prapti' which was statistically at par with the larval count of 2.83 larvae/plant and 2.77 larvae/plant as observed in 'Pusa Purple Long' and 'Neelkanth' whereas, the larval count on 'Pusa Purple Cluster', 'Brinjal Long (F1)' and 'Long Green' was 2.06 larvae/plant, 2.16 larvae/plant and 2.30 larvae/plant, respectively. The larval count in 'Ganesh' was 1.30 larvae/plant and the minimum larval count of 0.90 larvae/plant was recorded on cultivar 'DS-407'. A comparison of larval count during July and August reveals that the maximum larval count was during the month of August (2.31 larvae/plant) and it was significantly different with the larval count observed during the month of July (1.99 larvae/plant). When the comparison of the larval count in different interval was recorded it was found that the highest larval count of 2.48 larvae/plant was observed during the seventh interval which was statistically at par with the larval count of 2.41 larvae/plant, 2.40 larvae/plant and 2.28 larvae/plant observed during the fourth, sixth and third intervals, respectively. The larval count in the second interval was 1.84 larvae/plant and the minimum larval count of 1.46 larvae/plant was recorded in the first interval.

Response of different brinjal cultivars to egg and larval population had been the focus of many researchers who assessed the genetic susceptibility of brinjal cultivars against the brinjal shoot and fruit borer. Various workers had reported varied degree of shoot and fruit damage in both resistant and susceptible brinjal genotypeswhich more or less corroborate the present studies (Mishra *et al*., 1988; Lit *et al*., 2002; Elanchezhyan *et al*., 2008; Mannan *et al*., 2009 and Javed *et al*., 2011) [27, 22, 10, 25, 16]. Atwal and Verma (1972) [6] reported the abundance of brinjal shoot and fruit borer during monsoon period. Many workers also observed maximum population increase of moth between 22 to 35ºC during monsoon period. Lal (1975) [21] observed this borer throughout the year except during severe winter. Parkash (1978) [29] reported that maximum population (10 larvae/10 fruits) of brinjal shoot and fruit borer on brinjal shoots as well as on fruits was observed during the months of July - September when the mean atmospheric temperature was above 30ºC and relative humidity ranged between 60-70%. Mehto *et al*. (1980) [26] also observed this pest round the year on brinjal crop. Pawar *et al*.

(1986) [32] reported incidence of this pest during kharif crop and summer seasons. Gupta *et al*. (1987) [12] also found that abiotic factors (Temp., RH, Rainfall and Sunshine hours) are responsible for population build up. Patel *et al*. (1988) [30] and Dhamdhere *et al*. (1995) [8] found moderate temperature and high humidity favoured the population build-up of brinjal shoot and fruit borer during the summer. Many of the earlier workers have also reported the incidence of BSFB throughout the year in different regions of South East Asia (Mall *et al*. 1992, Khan and Al-salem 2007) [24, 18]. Singh *et al*. (2000) [39] reported that brinjal shoot and fruit borer infestation was more serious on shoots during July to October ranging from 73.33% to 86.66% with an intensity of 2.09 borers/plant and to zero level in the month of October which subsequently decreased with the advent of winter season. Mahesh and Men (2007) [23] reported that the infestation commenced from August with 21.2% infestation and reached its peak during mid-October with 35.3% infestation at temperatures ranging between 21.4 and 33°C and relative humidity of 45-86% with 2.7 mm rain and hot sunshine.

Table 1: Egg count/plant of brinjal shoot and fruit borer on different brinjal cultivars

Cultivars	Mean egg count in indicated months																Interaction (Cultivar×Interval)							
	July, 2016							Mean	August, 2016							Mean								
	I	II	III	IV	V	VI	VII		I	II	III	IV	V	VI	VII		I	II	III	IV	V	VI	VII	
Brinjal Long (F1)	1.60	4.40	4.00	5.40	3.80	4.40	5.00	4.09	4.00	4.00	3.40	3.20	3.80	2.80	3.00	3.46	2.80	4.20	3.70	4.30	3.80	3.60	4.00	3.77[b]
DS-407	0.00	2.00	2.20	3.40	1.80	1.60	2.40	1.91	2.40	1.80	1.40	2.40	1.60	1.80	1.80	1.89	1.20	1.90	1.80	2.90	1.70	1.70	2.10	1.90[a]
Ganesh	0.00	2.20	2.20	5.00	2.80	2.20	3.20	2.51	2.20	2.20	2.20	1.80	1.80	2.20	2.20	2.09	1.10	2.20	2.20	3.40	2.30	2.20	2.70	2.30[a]
Long Green	0.80	2.40	3.00	5.40	3.80	4.40	5.00	3.54	4.00	3.40	3.20	3.80	3.80	2.80	3.00	3.43	2.40	2.90	3.10	4.60	3.80	3.60	4.00	3.49[b]
Neelkanth	2.00	3.00	7.00	5.80	5.40	6.00	4.80	4.86	5.60	5.40	6.00	5.60	5.40	6.00	6.00	5.71	3.80	4.20	6.50	5.70	5.40	6.00	5.40	5.29[c]
Prapti	4.20	5.40	5.00	7.20	5.00	7.20	6.40	5.77	5.20	4.80	6.20	4.80	5.20	6.40	4.60	5.31	4.70	5.10	5.60	6.00	5.10	6.80	5.50	5.54[c]
Pusa Purple Cluster	1.00	2.20	4.60	5.60	4.20	4.40	6.00	4.00	5.00	3.40	3.40	2.80	3.80	3.60	3.60	3.66	3.00	2.80	4.00	4.20	4.00	4.00	4.80	3.83[b]
Pusa Purple Long	1.80	4.60	4.60	9.00	4.80	4.40	6.40	5.09	6.60	4.60	7.00	3.40	6.40	5.60	3.60	5.31	4.20	4.60	5.80	6.20	5.60	5.00	5.00	5.20[c]
Mean	1.43[a]	3.28[b]	4.08[de]	5.85[g]	3.95[cde]	4.33[e]	4.90[f]	3.97	4.38[ef]	3.70[bcd]	4.10[de]	3.48[bc]	3.98[cde]	3.90[cde]	3.48[bc]	3.86	2.90[a]	3.49[b]	4.09[c]	4.66[d]	3.96[c]	4.11[c]	4.19[c]	

$CD_{(P=0.05)}$: Cultivar (C) = 0.42
Months (M) = N/S
Intervals (I) = 0.39
C×M = N/S
C×I = N/S
M×I = 0.56
C× M×I = 1.58

Table 2: Larval count/plant of brinjal shoot and fruit borer on different brinjal cultivars

Cultivars	Mean larval count in indicated months																Interaction (Cultivar×Interval)							
	July, 2016							Mean	August, 2016							Mean								
	I	II	III	IV	V	VI	VII		I	II	III	IV	V	VI	VII		I	II	III	IV	V	VI	VII	
Brinjal Long (F1)	0.80	1.20	2.00	2.00	2.40	2.40	2.40	1.89	2.80	2.40	2.20	2.40	1.80	2.80	2.60	2.43	1.80	1.80	2.10	2.20	2.10	2.60	2.50	2.16[c]
DS-407	0.00	0.60	1.40	1.80	0.80	0.60	0.80	0.86	0.80	1.00	0.40	1.00	0.80	1.60	1.00	0.94	0.40	0.80	0.90	1.40	0.80	1.10	0.90	0.90[a]
Ganesh	0.00	0.80	1.60	2.20	1.40	1.20	1.80	1.29	1.60	1.20	1.20	1.20	1.80	1.00	1.20	1.31	0.80	1.00	1.40	1.70	1.60	1.10	1.50	1.30[b]
Long Green	0.20	1.60	2.80	2.80	2.20	2.60	2.20	2.06	3.60	2.60	2.40	2.40	2.00	2.20	2.60	2.54	1.90	2.10	2.60	2.60	2.10	2.40	2.40	2.30[c]
Neelkanth	1.00	1.80	2.80	3.60	2.40	2.60	3.00	2.46	3.60	3.20	2.80	2.40	3.20	3.20	3.20	3.09	2.30	2.50	2.80	3.00	2.80	2.90	3.10	2.77[d]
Prapti	0.60	2.00	2.80	3.80	2.40	3.60	3.20	2.63	2.80	3.20	3.20	2.40	3.20	3.20	4.00	3.14	1.70	2.60	3.00	3.10	2.80	3.40	3.60	2.89[d]
Pusa Purple Cluster	0.40	1.00	2.00	2.80	2.20	2.40	2.40	1.89	2.20	1.80	2.40	1.60	2.00	2.60	3.00	2.23	1.30	1.40	2.20	2.20	2.10	2.50	2.70	2.06[c]
Pusa Purple Long	0.60	1.60	2.80	3.80	3.60	3.60	4.00	2.86	2.40	3.40	3.60	2.40	2.80	2.80	2.20	2.80	1.50	2.50	3.20	3.10	3.20	3.20	3.10	2.83[d]
Mean	0.45[a]	1.33[b]	2.28[cd]	2.85[e]	2.18[cd]	2.38[d]	2.48[de]	1.99[a]	2.48[de]	2.35[cd]	2.28[cd]	1.98[c]	2.20[cd]	2.43[d]	2.48[de]	2.31[b]	1.46[a]	1.84[b]	2.28[cd]	2.41[cd]	2.19[c]	2.40[cd]	2.48[d]	

$CD_{(P=0.05)}$: Cultivars (C)= 0.29
Months (M) = 0.14
Intervals (I) = 0.27
C×M = N/S
C×I = N/S
M×I = 0.39
C×M×I = N/S

Shoot infestation caused by brinjal shoot and fruit borer

The data presented in Table 3 reveal that the per cent shoot infestation ranged from 2.12% to 5.16% among different brinjal cultivars. The minimum shoot infestation was observed in 'Ganesh' (2.12%) whereas, maximum infestation was found in 'Prapti' (5.16%). The infestation in 'Prapti' was statistically at par with the infestation observed in 'Pusa Purple Long' (3.91%) and 'Neelkanth' (3.70%) whereas, the infestation in 'Ganesh' was statistically at par with the infestation in 'DS-407' (2.25%), 'Pusa Purple Cluster' (2.91%), 'Long Green' (3.20%) and 'Brinjal Long (F1)' (3.29%). The result of present studies are in agreement to those of Jat *et al*. (2003) [15] reported that shoot infestation varied from 3.28 to 12.71% in ten different cultivars of brinjal and whereas, Senapati (2003) [36] reported that the per cent shoot infestation ranged from 4 to 11.1%. Wagh *et al*. (2012) [42] reported per cent shoot infestation ranged from 1.38 to 9.96% in the different brinjal genotypes. A rating system for the shoot damage developed by Subbaratnam and Butani (1981) [40] was followed for estimating resistance and susceptibility of selected brinjal cultivars. The cultivars were categorized as 'Tolerant' (less than 2 or 2% shoot damage), 'Moderately Tolerant' (2.1-3.0% shoot damage), 'Susceptible' (3.1-5.0% shoot damage), 'Highly Susceptible' (above 5.0% shoot damage).

Among the eight cultivars screened, none of the cultivars was completely free from attack of the brinjal shoot and fruit borer

(Table 4). 'Prapti' cultivar was found to be highly susceptible having shoot infestation of > 5.0% whereas 'Pusa Purple Long', 'Neelkanth', 'Long Green' and 'Brinjal Long (F1)' were found to be susceptible with 3.1-5.0% shoot infestation while 'Ganesh', 'DS-407' and 'Pusa Purple Cluster' were categorized as 'Moderately tolerant' or less susceptible with shoot infestation ranging from 2.1-3.0% shoot damage. The variations in the level of infestation could be explained due to the presence of thin stem, more branches, lower third leaf length and width, more spines, rough leaf surface area, heavily lignified thick cuticle, broad and thick hypodermis, closely packed vascular bundle and small pith area which might have contributed for lower infestation and vice versa in case of higher infestation. Such phenomena have been reported by various workers (Mishra *et al.* 1988, Ali *et al.*, 1994 and Hossain *et al.*, 2002) [27, 3, 14].

Table 3: Per cent shoot infestation by brinjal shoot and fruit borer in different brinjal cultivars

S. No	Cultivars	Per cent shoot infestation
1	Brinjal Long (F1)	3.29^{abc}
2	DS-407	2.25^{ab}
3	Ganesh	2.12^{a}
4	Long Green	3.20^{abc}
5	Neelkanth	3.70^{bcd}
6	Prapti	5.16^{d}
7	Pusa Purple Cluster	2.91^{abc}
8	Pusa Purple Long	3.91^{cd}
	$CD_{(p=0.05)}$	1.52

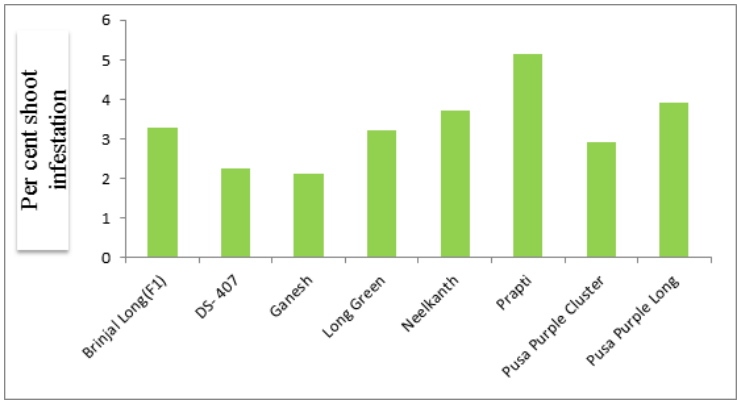

Fig 1: Per cent shoot infestation by brinjal shoot and fruit borer in different brinjal cultivars

Table 4: Shoot infestation index of different brinjal cultivars to brinjal shoot and fruit borer

S. No.	Cultivars	Infestation index (% damage)	Rating*
1.	Nil	< 2.0	Tolerant
2.	Ganesh, DS-407, Pusa Purple Cluster,	2.1-3.0	Moderately tolerant
3.	Pusa Purple Long, Long Green, Brinjal Long (F1), Neelkanth	3.1-5.0	Susceptible
4.	Prapti	> 5.0	Highly susceptible

***** As per the grade index of Subbaratnam and Butani (1981) [40]

Fruit borer infestation and fruit weight loss

The data presented in Table 5 reveal that the fruit infestation of brinjal shoot and fruit borer infestation varied significantly among different brinjal cultivars. It ranged from 6.66% (DS-407) to 46.63% (Prapti). The maximum infestation was found in 'Prapti' and it was statistically at par with the infestation as observed in 'Pusa Purple Long' (40.00%), whereas the minimum fruit infestation was found in 'Ganesh' and was statistically at par with the infestation observed in 'DS-407' with fruit infestation of 6.66%. Ashoke and Abhishek (2002) [5] reported 33.65% to 53.02% fruit infestation in different brinjal cultivars under field conditions. Kumar and Shukla (2002) [20] also reported 33% to 55% fruit infestation in different brinjal cultivars. Javed *et al.* (2011) [16] reported that infestation due to this borer among different cultivars ranged from 4.77% to 58.60%. Wagh *et al.* (2012) [42] reported that fruit infestation by the brinjal shoot and fruit borer ranged from 8.94% to 44.67%, while Ramesh *et al.* (2015) [33] reported the infestation to vary from 5.71 to 69.57%. These results are more or less in confirmity with the present studies on fruit borer infestation. Slight variations in fruit damage in the present studies and studies carried out by these workers might be due to differences in brinjal cultivars and their genetic potential that resisted the attack of the borer on some cultivars as observed in the present studies.

The data presented in Table 5 reveal the per cent fruit weight loss by brinjal shoot and fruit borer in eight brinjal cultivars *viz.* 'Brinjal Long (F1)', 'DS-407', 'Ganesh', 'Long Green', 'Neelkanth', 'Prapti', 'Pusa Purple Cluster' and 'Pusa Purple Long' which varied from 3.12% to 42.86%. 'Prapti' had significantly the highest fruit weight loss (42.86%) which was significantly at par with 'Pusa Purple Long' (40.97%), 'Neelkanth' (38.29%), 'Brinjal Long (F1)' (36.63%) and 'Long Green' (32.42%). The lowest fruit weight loss was observed in 'DS-407' (3.12%) and it was statistically at par with 'Ganesh' (4.21%). The result of the present studies are in agreement to those of Ahmed *et al.* (2008) [1] who reported 44.04% damage in susceptible cultivar (Bijoy) whereas it was only 3.07% damage in resistant cultivar (Thamba). Among the 52 brinjal cultivars screened by Ramesh *et al.* (2015) [33] one accession namely IC136347 was found to be resistant which had the lowest fruit damage of 5.62% as against 74.33% fruit damage in highly susceptible genotype (IC136564).

Comparable range of fruit infestation (20.23 to 45.61%) was

reported by Jat *et al*. (2003) [15] though they used different set of cultivars in their experiment. Similarly, Krishna *et al*. (2001) found 43% fruit infestation in 'Ramy Round Purple' of India which was comparatively the most susceptible cultivar while minimum fruit infestation was reported in SM-02. Kumar and Shukla (2002) [20] found 33 to 53% damage of fruits in 12 different cultivars of aubergine. Similarly, Ashoke and Abhishek (2002) [5] while evaluating 12 aubergine cultivar under field conditions reported 33.65% to 53.02% fruit infestation of brinjal shoot and fruit borer.

The reaction of different cultivars was to the infestation of the brinjal shoot and fruit borer has tabulated on basis of fruit damage by this pest as per the rating system of Subbaratnam and Butani (1981) [40] wherein the cultivars were categorized as susceptible and tolerant. These were categorized as 'Tolerant' (less than 15 or 15% fruit damaged), 'Moderately tolerant' (16-25% fruit damaged), 'Susceptible' (26-40% fruit damaged), 'Highly susceptible' (above 40% fruit damaged). Among the eight cultivars screened for fruit damage, none of the cultivar was completely resistant to attack of the borer. 'Prapti' was found to be highly susceptible having fruit infestation of more than 40% while 'Pusa Purple Long', 'Neelkanth', 'Long Green', 'Brinjal Long (F1)' and 'Pusa Purple Cluster' was found to be susceptible with 26-40% fruit damage, 'Ganesh' and 'DS-407' were categorized as tolerant or less susceptible with infestation rate ranging less than 15% fruit damage (Table 6).

In the present findings the entries of brinjal designated as resistant/ fairly resistant/ tolerant may be due to they have also low population of sucking pests as suggested by Muthukumar (2002) [28]. Gaikwad *et al*. (1991) [11] reported KB 9, Pusa Purple Long, KP 10, L 13 and BB1 as tolerant to *A. devastans*. PKM-1, KKM-1, Pootheri Local and Soorakundu Local were less susceptible to *B. tabaci*, recording a mean population of less than one per three leaves. Shunmugaraj (1995) [37] reported few resistant entries (EP 55, EP 78, EP 52) to *B. tabaci*. The reasons attributed to the less susceptibility of above entries to sucking pests of brinjal are due to the poor quality of host plants with purple coloured leaves, as reported by Kalra (2004) [17].

Rashid *et al*. (2013) [34] reported that 38 genotypes were tolerant to *L. orbonalis*. The tolerance nature of above entries of brinjal might be attributed by hardness of the fruit skin and flesh (Krishnaiah and Vijay, 1975) [19] and hard to semi-hard shoot and medium to dense pubescence (Raut and Sonone, 1980) [35]. Tolerant entries of brinjal are highly useful in IPM to augment the natural enemies rather than resistant and fairly resistant entries.

In the present study, the possible reasons for high susceptibility of 'Prapti' cultivar might be due to the round shaped fruit with less number of seeds and soft and smooth surface. Highly susceptible reaction was exhibited by the entries, Bejo Sheetal and Pusa Hybrid-6, due to the softness of the shoot, sparse pubescence and spherical and oblong fruit with soft rind and loosely arranged seeds which is in conformity with Yadav and Sharma (2005) [43].

Table 5: Fruit infestation and fruit weight loss by brinjal shoot and fruit borer larvae in different brinjal cultivars

S. No.	Cultivars	Fruit borer Infestation (%)	Fruit weight loss (%)
1	Brinjal Long (F1)	32.2^{bc} (34.55)	36.63^{bc} (36.46)
2	DS-407	6.66^{a} (14.62)	3.12^{a} (10.10)
3	Ganesh	6.66^{a} (14.62)	4.21^{a} (11.74)
4	Long Green	29.96^{b} (33.15)	32.42^{bc} (34.24)
5	Neelkanth	38.86^{cd} (38.41)	38.29^{c} (38.13)
6	Prapti	46.63^{e} (43.04)	42.86^{c} (40.87)
7	Pusa Purple Cluster	27.73^{b} (31.70)	26.65^{b} (30.62)
8	Pusa Purple Long	40.00^{de} (39.23)	40.97^{c} (39.78)
	$CD_{(p=0.05)}$	7.48	11.31

* Figures in parentheses are Angular transformed values.

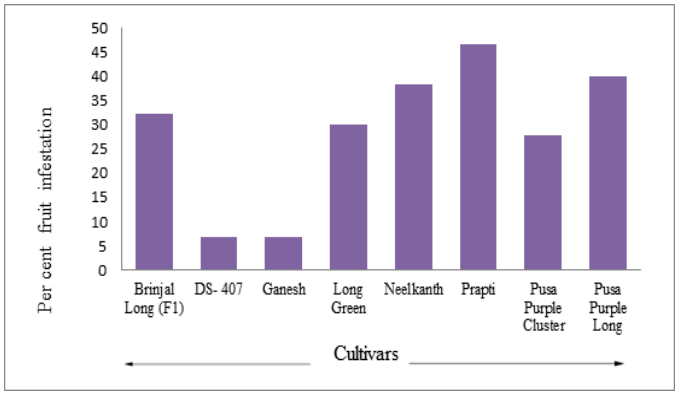

Fig 5: Fruit infestation of brinjal shoot and fruit borer in different brinjal cultivars

Table 6: Fruit infestation index of different brinjal cultivars to brinjal shoot and fruit borer

S. No	Cultivars	Infestation index (% damage)	Rating*
1.	DS-407, Ganesh	< 15	Tolerant
2.	None	16-25	Moderately tolerant
3.	Pusa Purple Long, Neelkanth, Brinjal Long (F1), Long Green and Pusa Purple Cluster	26-40	Susceptible
4.	Prapti	> 40	Highly susceptible

***** As per the grade index of Subbaratnam and Butani (1981) [40]

The fruit infestation of different cultivars was subjected to correlation analysis with egg count, larval and fruit weight loss of the brinjal shoot and fruit borer. It was found that the infestation was significantly positively correlated with egg count/plant (r = 0.978), larval count/plant (r = 0.967) and fruit weight loss (r = 0.984) revealing there by that more number of eggs and larvae resulted in higher fruit borer infestation which caused more weight loss in brinjal fruits.

Table 7: Correlation between brinjal shoot and fruit borer infestation with egg count, larval and fruit weight loss of brinjal shoot and fruit borer

Brinjal shoot and fruit borer infestation (%)	Egg population/plant	Larval population /plant	Per cent fruit weight loss
	0.978*	0.967*	0.984*

*Significant at 5% level of significance

4. Conclusion

On the basis of present studies, none of the cultivars was found to be free from the infestation of the brinjal shoot and fruit borer but considerable variation of infestation was recorded among different cultivars. Prapti was found to be highly susceptible while Pusa Purple Cluster, Ganesh and DS-407 were found to be moderately tolerant. The total phenol content was the maximum in 'DS-407' cultivar followed by 'Ganesh', 'Brinjal Long (F1)', 'Long Green', 'Pusa Purple Cluster', 'Pusa Purple Long' and 'Neelkanth' while, it was minimum on 'Prapti' cultivar.

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