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RESEARCH ARTICLE

Unlocking novel sources of resistance in brinjal (*Solanum melongena* Linn.) germplasm against the shoot and fruit borer (*Leucinodes orbonalis* Guenee)

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Abstract

Brinjal (*Solanum melongena* Linn.) is a significant fruit vegetable cultivated primarily in tropical and subtropical regions, with India being a major producer excluding high-altitude areas. This crop faces substantial biotic stresses, notably from over 140 species of insect and non-insect pests, which significantly reduce yields. The major pests include the shoot and fruit sborer, *Leucinodes orbonalis* Guenee (Lepidoptera: Crambidae); whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae); jassids, *Amarasca biguttula* (Ishida) (Hemiptera: Cicadellidae); aphids, *Aphis gossypii* (Glover) (Hemiptera: Aphididae); brinjal mite, *Tetranychus cinnabarinus* (Boisduval) (Acarina: Tetranychidae); and root-knot nematodes, *Meloidogyne* spp. (Tylenchida: Heteroderidae). The extent of damage varies seasonally and is influenced by environmental conditions. Farmers predominantly resort to chemical pesticides for pest management, which can lead to adverse effects such as pesticide residues, increased production costs, environmental degradation and resurgence of pests. To mitigate these issues, resistant cultivars are recommended as a sustainable pest management strategy. Resistant varieties can help control pests in an economically and environmentally sound manner. Recent studies have identified the genotype NDB-23-16 as strongly resistant to *L. orbonalis*, exhibiting only 9.23 % shoot damage and 9.53 % fruit damage. This genotype is valuable for breeding programs, being compatible with eggplant and has available introgression lines (ILs) for further development. The pest rating was assessed using a standardized rating scale, highlighting the potential of NDB-23-16 as a valuable source of resistance in brinjal improvement programs.

Keywords: brinjal; breeding; genotype; resistance; shoot and fruit borer

Introduction

Common eggplant (*Solanum melongena* Linn.), a member of the Solanaceae family, is a vital crop globally, with over 58 million tons produced in 2020-21 across 1.96 million hectares (1). It thrives in tropical and subtropical regions, particularly in Asia and the Mediterranean, with China, India, Egypt, Türkiye and Iran being the top producers (1). The unripe fruits are consumed as a low-calorie vegetable, rich in potassium, which contributes to antidiabetic and anti-obesity effects. Eggplant is also a significant source of carbohydrates, proteins, dietary fibre, vitamins (such as thiamine and niacin) and essential minerals (2). Breeding programs for eggplant primarily focus on developing F_1 hybrids. The traditional methods like pure line selection and backcrossing used to enhance fruit yield and quality while improving pest and disease resistance (3). However, eggplant production faces challenges from approximately 140 species of pests, notably the shoot and fruit borer (*Leucinodes orbonalis*), which can cause yield losses of up to 92 % (4). Effective pest management remains critical as pests vary seasonally based on environmental factors like temperature, relative humidity, rainfall, sunshine hours and wind speed. (5). Innovative breeding tools and understanding genetic and biochemical traits such as chlorophyll content, total reducing sugars, proteins, phenols and morphological characteristics are essential for developing pest-resistant cultivars. These traits can deter pests by interfering with their feeding and reproductive behaviours.

However, assessing resistance mechanisms is complicated by genotype-environment interactions, necessitating extensive lab research (6). Despite previous screenings revealing partial resistance traits within cultivated eggplant gene pools, their low efficacy limits their application in breeding programs (7-9). Enhanced breeding efforts are necessary to develop more effective resistant cultivars against major pests like *L. orbonalis*. While some resistant cultivars have been identified in India, comprehensive testing across a broader range of varieties is required to improve resistance strategies effectively. Based on this background, the present study was undertaken.

Materials and Methods

The site of the experiment is located at 26.54° N latitude and 81.84° E longitude. Twenty brinjal genotypes were used, as listed in Table 1. These genotypes were collected from the Department of Vegetable Science and Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya. Brinjal genotypes were transplanted in Randomized Block Design (RBD) replicated thrice with plot size 3.0 × 2.5 m and spacing 50 cm between rows and 50 cm between plants row and plant. All recommended agronomic practices were followed in raising brinjal crops.

Incidence of fruit and shoot borer (*L. orbonalis)* was recorded based on the percentage of damaged shoots per plot. Incidence in fruits was assessed by calculating the percentage of infested fruits at different pickings and the picking was done from the first appearance of mature fruit then succeeding picking four to six days interval till maturity of the crop and data was subjected to statistical analysis. Pest rating was done as per the scale described earlier (Table 2) (10).

$$\text{Percentage of shoots infested} = \frac{\text{Number of shoots showing damage}}{\text{Total no: of Shoots}} \times 100 \quad \text{(Eqn. 1)}$$

Estimation of biophysical parameters

The estimation of biophysical parameters involved the assessment of various plant, leaf and fruit characteristics across different genotypes and replications to compute the averages. Plant height was measured in cm from 10 randomly selected plants per replication. Shoot thickness was determined by measuring the diameter 2.5 cm below the shoot tip using a digital vernier caliper. The number of primary and secondary branches was counted at the peak harvest stage. For leaf characteristics, the length and width were measured from three representative leaves (upper, middle and lower) of 10 plants. Trichome density was evaluated on both the upper and lower surfaces of the leaves within a 25 mm^2 area using a stereomicroscope. Fruit characteristics were also thoroughly documented. Calyx length was measured from 10 mature fruits using a digital vernier caliper, while the total number of fruits per plant was counted to the final harvest. Fruit length and width were recorded from 10 mature fruits. Additionally, fruit shape and colour were visually assessed at the marketable maturity stage. All these observations were systematically recorded and analyzed to provide an accurate estimation of the biophysical parameters.

Table 1. Genotypes used in the experimental material consisted of 20 brinjal genotypes

Sr. No.	Genotypes	Sr. No.	Genotypes
1	NDB-23-1	11	NDB-23-11
2	NDB-23-2	12	NDB-23-12
3	NDB-23-3	13	NDB-23-13
4	NDB-23-4	14	NDB-23-14
5	NDB-23-5	15	NDB-23-15
6	NDB-23-6	16	NDB-23-16
7	NDB-23-7	17	NDB-23-17
8	NDB-23-8	18	NDB-23-18
9	NDB-23-9	19	NDB-23-19
10	NDB-23-10	20	NDB-23-20

Table 2. Percentage of infested shoot or fruit rating scale

Percentage of shoot infestation	Grade
0	Immune (I)
1-10	Highly resistant (HR)
11-20	Moderately resistant (MR)
21-30	Tolerant (T)
31-40	Susceptible (S)
>40	Highly susceptible (HS)

Estimation of biochemical parameters

The biochemical parameters were estimated using standard procedures to assess various physiological and biochemical traits. Chlorophyll content was estimated using the acetone extraction method (11). Reducing sugars were estimated using the dinitrosalicylic acid (DNS) method, which is suitable for high-throughput sample handling (12, 13). Total phenols were estimated using the Folin-Ciocalteu reagent (14). Total protein content was estimated using the Lowry method (15). Peroxidase activity was assayed using guaiacol as a substrate, following the method described previously (16).

Statistical analysis

The statistical analysis was carried out as per the method suggested previously (17). Critical difference for examining treatment means for their significance was calculated at 5 % level of significance. All the recorded insect pest populations were subjected to statistical analysis as per RBD.

Results

Identification of resistant sources of brinjal against *L. orbonalis*

Shoot damage

Among the different brinjal genotypes assessed against the shoot borer, the per cent shoot damage ranged between 9.23 % to 21.02 %. (Table 3 and 4). The lowest percentage of shoot damage by *L. orbonalis* was observed in the genotype NDB-23-16 (9.23 %), followed by NDB-23-4.

Fruit damage

Among the different brinjal genotypes assessed against the fruit and shoot borer, the per cent fruit damage ranged from 9.53 % to 51.80 % (Table 3 and 4). The lowest per cent fruit damage by *L. orbonalis* was observed in the genotype NDB-23-16 (9.53 %), followed by NDB-23-2 (11.93 %).

Morphological basis of resistance in brinjal genotypes

Significant variation in plant height was observed among genotypes (Table 5). The genotype NDB-23-7 recorded a maximum height of 74.29±3.71 cm, followed by NDB-23-10 (73.09±5.85 cm), NDB-23-5 (72.14±2.16 cm), while NDB-23-16 recorded the minimum height of 45.74±2.74 cm. The genotype

Table 3. Categorization of brinjal genotypes based on mean per cent shoot damage and fruit damage

Percentage of shoot infestation	Grade	Genotypes
0	Immune (I)	0
1-10	Highly resistant (HR)	NDB-23-16, NDB-23-4
10-20	Moderately resistant (MR)	NDB-23-19, NDB-23-15, NDB-23-13, NDB-23-2, NDB-23-3, NDB-23-5, NDB-23-8, NDB-23-10, NDB-23-11, NDB-23-14, NDB-23-17, NDB-23-18, NDB-23-20, NDB-23-6, NDB-23-1, NDB-23-13NDB-23-12, NDB-23-9
21-30	Tolerant (T)	NDB-23-7
31-40	Susceptible (S)	0
>40	Highly susceptible (HS)	0
Percentage of fruit infestation	**Grade**	
0	Immune (I)	0
1-10	Highly resistant (HR)	NDB-23-16
10-20	Moderately resistant (MR)	NDB-23-19, NDB-23-15, NDB-23-13, NDB-23-4, NDB-23-2, NDB-23-1
21-30	Tolerant (T)	NDB-23-3, NDB-23-5, NDB-23-8, NDB-23-10, NDB-23-11, NDB-23-14, NDB-23-17, NDB-23-18, NDB-23-20
31-40	Susceptible (S)	NDB-23-6, NDB-23-13, NDB-23-12
40-100	Highly susceptible (HS)	NDB-23-7, NDB-23-13

Table 4. Percent fruit and shoot infestation and biochemical bases of resistance in brinjal genotypes against major pests of brinjal

Genotypes	Fruit infestation (%)	Shoot infestation (%)	Total chlorophyll content (mg/g)	Reducing sugar (g/100g)	Protein content (mg/g)	Peroxidase activity (Units min^{-1} g^{-1})	Total phenol (mg/g)
NDB-23-1	15.05±0.75	11.96±0.60	2.34±0.44	2.12±0.1060	1.25±0.02	709.17±8.65	3.47±1.01
NDB-23-2	11.93±0.48	13.12±0.52	1.59±0.22	1.93±0.5405	2.44±0.29	700.85±25.13	3.00±0.57
NDB-23-3	29.21±1.75	12.31±0.74	3.19±0.29	2.40±0.0849	0.69±0.16	683.18±37.68	4.05±1.00
NDB-23-4	19.19±1.54	10.72±0.86	2.90±0.27	1.56±0.1905	1.06±0.08	594.31±77.36	2.01±0.13
NDB-23-5	28.43±0.85	12.79±0.38	2.56±1.97	1.72±0.0301	1.12±0.01	567.47±117.07	5.91±.50
NDB-23-6	31.11±1.24	13.65±0.55	3.69±1.74	2.39±0.0561	0.95±0.03	630.42±60.01	4.58±0.71
NDB-23-7	52.65±2.63	21.06±1.05	4.04±0.13	2.87±0.1435	1.01±0.02	638.93±143.79	3.74±0.73
NDB-23-8	22.52±1.35	11.01±0.66	4.30±0.43	2.16±0.0766	0.75±0.01	641.30±47.67	6.63±0.44
NDB-23-9	13.66±0.96	11.21±0.78	2.70±0.05	1.85±0.1295	2.43±0.02	629.39±52.79	3.16±0.66
NDB-23-10	27.33±2.19	12.73±1.02	2.63±0.46	2.40±0.0520	1.56±0.02	659.95±60.89	1.27±0.02
NDB-23-11	21.97±0.88	15.20±0.61	4.55±0.25	1.94±0.1443	0.96±0.01	615.53±97.27	1.34±0.04
NDB-23-12	30.21±2.42	12.28±0.98	4.28±0.34	2.25±0.1072	1.33±0.03	708.48±61.45	2.32±0.26
NDB-23-13	45.83±4.13	15.07±1.36	5.19±0.05	1.63±0.1467	1.13±0.37	647.00±42.19	3.20±0.23
NDB-23-14	25.00±1.50	16.41±0.98	4.79±2.36	1.98±0.5600	0.95±0.03	668.70±103.45	5.21±0.25
NDB-23-15	19.49±0.97	11.25±0.56	3.20±2.56	2.15±0.1563	0.91±0.02	642.32±81.25	3.26±0.18
NDB-23-16	9.53±0.57	9.23±0.55	3.90±0.37	1.23±0.1085	2.58±0.01	623.76±70.38	4.66±0.36
NDB-23-17	28.78±1.73	11.13±0.67	4.14±1.09	2.19±0.0776	1.65±0.04	597.44±166.37	5.30±0.58
NDB-23-18	22.02±1.32	13.06±0.78	3.45±0.55	2.21±0.1326	0.94±0.02	621.91±59.96	6.24±0.42
NDB-23-19	17.71±1.06	11.89±0.71	5.06±0.57	2.16±0.1473	0.85±0.03	646.66±55.39	4.21±0.21
NDB-23-20	23.61±1.42	19.47±1.17	5.13±0.72	1.83±0.0648	0.96±0.02	703.27±47.94	3.51±0.40
C.D	2.86	1.36	1.8	0.308	0.19	134.08	0.85
C.V	6.98	6.21	29.51	9.05	8.82	12.55	13.42
SEM±	1	0.48	0.63	0.107	0.06	46.84	0.3
p-VALUE	S	S	S	S	S	NS	S
D.F	59	59	59	59	59	59	59

S- Significant; NS- Non-significant

NDB-23-7 recorded the maximum leaf length of 13.99±0.70 followed by NDB-23-5(12.29±0.37) NDB-23-13(12.66±1.14) and NDB-23-15(12.69±0.63) while NDB-23-16 recorded the minimum leaf length (11.29±0.68). Leaf width ranged from (7.81±1.65) to NDB-23-13 (12.66±1.14) and NDB-23-15 (12.69±0.63), while NDB-23-16 recorded the minimum leaf length (11.29±0.68). Leaf width ranged from (7.81±1.65) to (11.32±1.08) cm. Leaf width ranged from 7.81±1.65 cm (NDB-23-6) to 11.32±1.08 cm (NDB-23-16).

Considerable variation was observed concerning the primary branch, which ranged from NDB-23-7 (10.33±0.52) to NDB-23-16 (3.11±0.19) cm. There was significant variation among genotypes for the secondary branch, ranging from 15.79±0.95 to 21.07±1.05. The genotype NDB-23-7 recorded the maximum secondary branch (21.07±1.05) while NDB- NDB-23-16 recorded the minimum secondary branches (15.79±0.95). The genotype NDB-23-7 recorded the maximum stem diameter of (2.56±0.13) cm, while NDB-23-16 recorded the minimum diameter of (0.56±0.03) cm. The genotype NDB-23-7 recorded the maximum calyx length (10.02±0.50) while NDB-23-16 recorded the minimum calyx length (7.95±0.48). The genotype NDB-23- 7recorded the maximum no. of fruit per plant of (42.33±2.12), while NDB-23-16 recorded the minimum no. of fruit per plant of (18.81±1.13). The genotype NDB-23-7 recorded the maximum fruit length (21.31±1.07) cm and NDB-23-11 (8.88±0.36) recorded the minimum fruit length. The genotype NDB-23-7 recorded the maximum fruit width (7.45±0.37) cm and NDB-23-13 (4.06±0.36) recorded the minimum fruit width. Trichome density ranged from 3.50±0.17 (NDB-23-7) to 15.20±0.91 (NDB-23-16) (Table 5).

Table 5. Morphological bases of resistance in brinjal genotypes against significant pests of brinjal

Genotypes	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	No. of primary branch	No. of secondary branch	Stem diameter (cm)	Calyx length (cm)	No. of fruits	Fruit length (cm)	Fruit width (cm)	Trichome density on leaf (No./25 mm^2)
NDB-23-1	61.82±3.09	13.50±0.67	39.42±1.97	6.78±0.34	19.57±0.98	1.39±0.07	9.13±0.46	33.04±1.65	11.77±0.59	5.21±0.26	8.48 ± 0.42
NDB-23-2	71.73±2.87	13.80±0.55	35.46±1.42	5.89±0.24	21.02±0.84	2.36±0.09	9.54±0.38	22.33±0.89	14.34±0.57	4.74±0.19	9.25 ±0.37
NDB-23-3	58.47±3.51	13.84±0.83	38.73±2.32	6.33±0.38	21.03±1.26	1.47±0.09	9.55±0.57	31.74±1.90	10.05±0.60	5.38±0.32	12.42±0.74
NDB-23-4	70.99±5.68	13.61±1.09	37.29±2.98	4.45±0.36	20.76±1.66	2.43±0.19	9.54±0.76	22.41±1.79	12.29±0.98	5.76±0.46	7.48 ±0.59
NDB-23-5	72.14±2.16	12.29±0.37	41.12±1.23	8.44±0.25	16.89±0.51	1.53±0.05	8.08±0.24	10.07±0.30	15.34±0.46	7.41±0.22	6.91 ±0.20
NDB-23-6	64.58±2.58	13.37±0.53	39.12±1.56	6.22±0.25	19.41±0.78	1.40±0.06	8.98±0.36	20.59±0.82	19.93±0.80	7.03±0.28	7.14 ±0.28
NDB-23-7	74.29±3.71	13.99±0.70	43.45±2.17	10.33±0.52	21.07±1.05	2.56±0.13	10.02±0.50	42.33±2.12	21.31±1.07	7.45±0.37	3.50±0.17
NDB-23-8	48.74±2.92	12.87±0.77	33.61±2.02	5.89 ±0.35	17.97±1.08	1.49±0.09	8.52±0.51	21.56±1.29	12.92±0.78	5.43±0.32	7.34±0.44
NDB-23-9	65.97±4.62	13.52±0.95	39.45±2.76	5.44 ±0.38	19.69±1.38	1.48±0.10	9.46±0.66	10.96±0.77	9.57±0.67	5.21±0.36	8.33±0.58
NDB-23-10	73.09±5.85	13.85±1.11	43.35±3.47	9.22 ±0.74	21.06±1.68	1.65±0.13	9.99±0.80	60.44±4.84	14.67±1.17	6.34±0.51	8.24±0.65
NDB-23-11	65.89±2.64	13.32±0.53	38.24±1.53	6.11 ±0.24	19.38±0.78	1.51±0.06	8.61±0.34	40.22±1.61	8.88±0.36	5.43±0.22	10.00±0.40
NDB-23-12	67.93±5.43	13.58±1.09	40.62±3.25	7.45 ±0.60	20.12±1.61	1.44±0.12	9.27±0.74	31.48±2.52	16.16± 1.29	7.12±0.57	8.12±0.64
NDB-23-13	53.24±4.79	12.66±1.14	32.38±2.91	6.56 ±0.59	17.00±1.53	2.51±0.23	8.98±0.81	51.78±4.66	19.89±1.79	4.06±0.36	5.08±0.45
NDB-23-14	62.28±3.74	13.18±0.79	37.90±2.27	7.22±0.43	18.92±1.14	1.73±0.10	8.61±0.52	31.67±1.90	10.25±0.62	7.34±0.44	9.57±0.57
NDB-23-15	53.38±2.67	12.69±0.63	33.37±1.67	7.52±0.38	17.70±0.88	1.56±0.08	8.08±0.40	22.04±1.10	15.28±0.76	4.39±0.22	7.56±0.37
NDB-23-16	45.74±2.74	11.29±0.68	28.52±1.71	3.45±0.21	15.79±0.95	0.56±0.03	7.95±0.48	18.81±1.13	13.61±0.82	4.58±0.27	15.20±0.91
NDB-23-17	65.52±3.93	13.61±0.82	41.84±2.51	3.11±0.19	20.71±1.24	2.44±0.15	9.32±0.56	23.41±1.40	13.34±0.80	6.34±0.38	8.13±0.48
NDB-23-18	58.45±3.51	13.15±0.79	35.57±2.13	6.11±0.37	18.49± 1.11	1.52±0.09	8.44±0.51	12.26±0.74	15.12±0.91	5.23±0.31	7.78±0.46
NDB-23-19	67.53±4.05	13.57±0.81	40.34±2.42	7.33±0.44	20.00±1.20	1.78±0.11	9.27±0.56	38.81±2.33	14.79±0.89	4.21±0.25	13.80±0.82
NDB-23-20	68.09±4.09	13.59±0.82	40.67±2.44	7.44±0.45	18.92±1.14	1.60±0.10	9.29±0.56	23.11±1.39	11.82±0.71	5.31±0.31	6.87±0.41
C.D	6.47	1.35	3.87	0.68	1.97	0.19	0.93	3.49	2.28	0.60	0.89
C.V	6.16	6.16	6.16	6.31	6.18	6.60	6.22	7.43	9.84	6.32	6.29
SEM ±	2.26	0.47	1.35	0.24	0.69	0.07	0.32	1.22	0.80	0.21	0.31
p-Value	S	NS	S	S	S	S	S	S	S	S	S
D.F	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00

S- Significant; NS- Non-significant

Biochemical basis of resistance in brinjal genotypes

The genotype NDB-23-2 recorded the lowest total chlorophyll content of 1.59±0.22 mg/g and the highest in NDB-23-20 (5.13±0.72mg/g). Genotype NDB-23-3 recorded the lowest protein content of 0.69±0.16 mg/g, highest in NDB-23-16 (1.275 mg/g). The genotype NDB-23-16 recorded the lowest reducing sugar content of (1.23±0.108) mg/100 g and the maximum in NDB-23-7 (2.87±0.1435) mg/100 g. The genotype NDB-23-5 (567.47±117) units' $min^{-1}g^{-1}$ recorded the lowest peroxidase content and highest in NDB-23-1 (709.17±8.65) units' $min^{-1}g^{-1}$). NDB-23-10 recorded the minimum phenol content (1.27±0.02 mg/g), while NDB-23-8 had the maximum (6.63±0.44 mg/g) (Table 4).

Correlation of *L. orbonalis* with morphological and biochemical parameters

Fruit damage by fruit borer showed a non-significant positive correlation with plant height (r=0.202), leaf length (r=0.229), fruit length (r=0.278), fruit width (r=0.347) and leaf width (r=0.351), significantly positively correlated with no. of the primary branch (r=0.513*), stem diameter (r=0.512*), No. of fruit (r=0.476*), peroxidase activity (r=0.445*). Non-significant positively correlated with calyx length (r=0.315), reducing sugar (r=0.367) and no. of secondary branch (r=0.129). Significant highly negatively correlated with trichomes density on leaves (r=-0.640**) and significantly highly positively correlated with total protein content (r=0.866**) and chlorophyll content (r=0.608**) and non-significantly negative correlated with total phenol (r=-0.313) (Table 6).

Shoot damage showed non-significant positive correlation with plant height (r=0.394), leaf length (r=0.358), leaf width (r=0.399), number of secondary branch (r=0.178), stem diameter (r=0.371), calyx length (r=0.308) and No. of fruit (r=0.334).Significantly highly positively correlated with no. of primary branch (r=0.611**) and fruit length (r=0.656**) and significantly negatively correlated with trichomes density on leaves (r=-0.516*) and significantly positive correlated with total protein content (r=0.476*) fruit width (r=0.452*) and reducing sugar (r=0.499*)and non-significantly negative correlated with total phenol (r=-0.343), non-significantly positive correlated with total chlorophyll content (r=0.370) and non-significantly positive correlated with peroxidase activity (r=0.441) (Table 6).

Discussion

Immunity to *L. orbonalis* has been reported only in wild brinjal species such as *Solanum khasianum* (18) and *S. anomalum* and *S. incanum* (19) and in their derivatives like Arka Mahima and Arka Sanjivans (20). In the present study, none of the genotypes tested was immune to *L. orbonalis*. The resistance in the above genotypes to *L. orbonalis* might be due to the presence of tough fruit skin, narrow pericarp, extra longish fruits with light purple colour, less seedless area and less peripheral ring, as reported earlier (21). Pusa Purple Cluster and Black Beauty were reported as resistant and they had purple-coloured leaves (22). As previously reported, the presence of a heavily lignified sclerenchyma hypodermis and compact vascular bundles in brinjal hybrids may contribute to their moderate resistance or tolerance (23). The range of shoot damage caused by *L. orbonalis* was recorded in different genotypes from 9.25 % to 18.60 % (24). The tolerance nature of brinjal genotypes might be attributed to the hardness of the fruit skin and flesh (25), hard-to-semi-hard shoot and medium-to-dense pubescence. Tolerant entries of brinjal are highly useful in Integrated Pest Management (IPM) to augment the natural enemies rather than resistant and relatively resistant entries. These moderately resistant and tolerant brinjal genotypes can be used as a resistance source in breeding programs to develop resistant/tolerant brinjal varieties of *L. orbonalis*. One genotype *viz.,* NDB-23-7 present study screened and found some genotypes were susceptible to shoot and fruit borer, which might be due to the softness of the shoot, sparse pubescence and spherical and oblong fruit with soft rind and loosely arranged seeds. The possible reasons for the high susceptibility of genotypes may be the round-shaped fruit with fewer seeds and soft and smooth surfaces, as reported previously (26-29).

Conclusion

A study screened 20 brinjal genotypes for resistance to insect pests, identifying NDB-23-10 and NDB-23-7 as promising with lower infestation rates, while NDB-23-16 and NDB-23-9 showed higher infestations. The study conducted during *Rabi* 2023-24 indicated that none of the genotypes exhibited complete immunity; rather, they were classified as resistant, moderately susceptible, or highly susceptible. Key anatomical traits such as plant height, leaf dimensions, stem diameter and fruit

Table 6. Correlation between biophysical and biochemical parameters genotypes of brinjal with *L. orbonalis*

Biophysical and biochemical parameters	Shoot infestation (%)	Fruit infestation (%)
Plant height (cm)	0.394	0.202
Leaf length (cm)	0.358	0.229
Leaf width (cm)	0.399	0.351
No. of primary branch	.611**	.513*
No. of secondary branch	0.178	0.129
Stem diameter (cm)	0.371	.512*
Calyx length (cm)	0.308	0.315
No. of fruit	0.334	.476*
Fruit length (cm)	.656**	0.278
Fruit width (cm)	.452*	0.347
Trichome density on leaf (No./25 mm^2)	-.516*	-.640**
Total protein content (mg/g)	.476*	.866**
Total carbohydrates (mg/ml)	.287	.410
Total phenol (mg/g)	-.343	-.313
Total chlorophyll content(mg/g)	.370	.608**
Peroxidase (units' $min^{-1}g^{-1}$)	.441	.445*
Reducing sugar (g/100 g)	499*	0.367

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level.

characteristics contributed to resistance against the *L. orbonalis*. Ovipositional preference studies revealed that biophysical (for instance trichome density) and biochemical factors significantly influenced resistance. Biochemical analyses indicated that phenols negatively affected larval survival and weight, whereas proteins and sugars positively impacted them. The findings suggest that genotypes NDB-23-7 and NDB-23-10, characterized by dense trichomes and higher phenol content with lower reducing sugars and proteins, could be valuable for hybridization programs to develop pest-resistant brinjal cultivars.

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Authors' contributions

Writing the original draft, methodology, investigation, formal analysis and conceptualization was done by PB and SKS. Writing review and editing, supervision and conceptualization was performed by KRS. SKT, VKD and AKS have done the review and editing. Writing reviews, editing and supervision was done by AJ. Writing reviews, editing and supervision was performed by UC. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

1. FAOSTAT. https://www.fao.org/faostat/en/#data/QCL
2. Narayana S, Chander S, Doddachowdappa S, Sabtharishi S, Divekar P. Seasonal variation in population and biochemical contents of brown planthopper, *Nilaparvata lugens*. J Environ Biol. 2022;43(1):52-8. http://doi.org/10.22438/jeb/43/1/MRN-198
3. Rakha M, Prohens J, Taher D, Wu TH, Solberg SO. Eggplant (*Solanum melongena*, *S. aethiopicum* and *S. macrocarpon*) breeding. In: Advances in plant breeding strategies: Vegetable crops. Springer Nature, Switzerland; 2021. p. 163-203. http://doi.org/10.1007/978-3-030-66961-4_5
4. Chakraborti S, Sarkar P. Management of *Leucinodes orbonalis* Guenee on eggplants during the rainy season in India. J Plant Prot Res. 2011;51(4):325-8. http://doi.org/10.2478/v10045-011-0053-5
5. Anjali M, Singh NP, Mahesh M, Swaroop S. Seasonal incidence and effect of abiotic factors on population dynamics of major insect pests on brinjal crop. J Environ Res Develop. 2012;7(1A):431-5. http://www.jerad.org/dispabstract.php?vID=835
6. Kasting R, Mc Ginnis AJ. Comparison of tissue from solid and hollow stemmed spring wheat during growth. Can J Zool. 1961;39:273-80. https://doi.org/10.1139/z61-030
7. Choudhary B. Vegetables. National Book Trust, India, New Delhi; 1970. p. 25-50.
8. Kishore P. Current status of host plant resistance in sorghum in India. J Entomol Res. 2001;25(1):1-20.
9. Rotino GL, Sala T, Toppino L. Eggplant. In: Alien Gene Transfer in Crop Plants. Springer Nature, Switzerland; 2014. p. 381-409. https://doi.org/10.1007/978-1-4614-9572-7_16
10. Mishra PN, Singh YV, Nautiyal MC. Screening of brinjal varieties for resistance to shoot and fruit borer (*Leucinodes orbonalis* Guen.) (Lepidoptera: Pyralidae). South Indian Horticult. 1988;36(4):188-92.
11. Arnon DI. Copper enzymes in isolated chloroplasts: polyphenol oxidases in *Beta vulgaris*. Plant Physiology. Springer Nature, Switzerland; 1949;24:1-14. https://doi.org/10.1104/pp.24.1.1
12. Krishnaveni S, Balasubramanian T, Sadasivam S. Sugar distribution in sweet stalk sorghum. Food Chem. 1984;15:229-32. https://doi.org/10.1016/0308-8146(84)90007-4
13. Miller GL. Use of dinitrosalicylic acid reagent for determination of reducing sugars. Anal Chem. 1972;31:426-8. https://doi.org/10.1021/ac60147a030
14. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with folin-phenol reagent. J Biol Chem. 1951;193:265-75. https://doi.org/10.1016/S0021-9258(19)52451-6
15. Malik CP, Singh MB. Plant enzymology and histoenzymology. Kalyani Publishers, New Delhi; 1980. p. 53.
16. Putter J. Peroxidase. In: Bergmeyer HU, editor. Methods of Enzymatic Analysis. Verlag Chemie, Weinhan; 1974. p. 685-90.
17. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. John Wiley and Sons, New York; 1984. p. 680.
18. Lal OP, Sharma RK, Verma TS, Bhagchandani PM, Chandra J. Resistance in brinjal to shoot and fruit borer (*L. orbonalis*). Veg Sci. 1976;3:111-6.
19. Behera TK, Singh N, Kalda TS. Genetic variability studies in eggplant in relation to fruit and shoot borer infestation. Orissa J Horticult. 1999;27:1-3.
20. Kale BP, Mohod UV, Dod VN, Thakare HS. Screening of brinjal germplasm (*Solanum* spp.) for resistance to shoot and fruit borer (*Leucinodes orbonalis*) under field conditions. Veg Sci. 1986;13(2):376-82.
21. Grewal RS, Singh D. Relationship of plant characters and level of infestation by shoot and fruit borer in brinjal. Trop Res J Punjab Agricult Univ. 1992;29:367-73.
22. Ghosh SK, Senapati SK. Evaluation of brinjal varieties commonly grown in Tarai region of West Bengal against pest complex. Crop Res Hissar. 2001;21(2):157-63.
23. Panda N, Mahapatra A, Sahoo M. Field evaluation of some brinjal varieties for resistance to shoot and fruit borer (*Leucinodes orbonalis* Guenee). Indian J Agricult Sci. 1971;41:597-601.
24. Khan A, Bhatnagar P, Rolania K, Parkash J, Kamboj R, Maanju S. Field screening of some brinjal genotypes for resistance to major insect pests. Int J Plant Soil Sci. 2023;35(21):462-9. https://doi.org/10.9734/ijpss/2023/v35i213997
25. Krishnaiah K, Vijay OP. Evaluation of brinjal varieties for resistance to shoot and fruit borer, *Leucinodes orbonalis* Guen. Indian J Horticult. 1975;32:84-5.
26. Sharma VK, Singh R, Arora RK, Gupta A. Field response of brinjal cultivars against shoot and fruit borer, *Leucinodes orbonalis*. Ann Biol. 1985;14:99-201.
27. Sunil V, Majeed W, Chowdhury S, Riaz A, Shakoori FR, Tahir M, et al.

Insect population dynamics and climate change. In: Climate Change and Insect Biodiversity. CRC Press; 2023. p. 121-46. https://doi.org/10.1201/9781003382089

28. Das A, Choudhury S, Gopinath V, Majeed W, Chakraborty S, Bhairavi KS, et al. Functions of flavonoids in plant, pathogen and opportunistic fungal interactions. In: Opportunistic Fungi, Nematode and Plant Interactions: Interplay and Mechanisms. Springer Nature Singapore, Singapore; 2024. p. 91-123. https://doi.org/10.1007/978-981-97-2045-3_6

29. Das A, Kadawla K, Nath H, Chakraborty S, Ali H, Singh S, et al. Drone-based intelligent spraying of pesticides: current challenges and its future prospects. In: Applications of Computer Vision and Drone Technology in Agriculture 4.0. Springer Nature Singapore, Singapore; 2024. p. 199-223. https://doi.org/10.1007/978-981-99-8684-2_12

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