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Biophysical and biochemical characteristics of Green Fruited Brinjal genotypes for resistance to Shoot and Fruit Borer (*Leucinodes orbonalis* guenee)

N. Nirmala[1] and P. Irene Vethamoni[2]

[1]Ph D scholar, Department of vegetable crops, Tamil Nadu Agricultural University, Coimbatore – 641 003
[2]Professor, Department of vegetable crops, Tamil Nadu Agricultural University, Coimbatore – 641 003

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Abstract
An experiment was carried out with thirty green fruited brinjal genotypes at Tamil Nadu Agricultural University, Coimbatore to find the influence of biophysical and biochemical characters of brinjal genotypes on the infestation to shoot and fruit borer. Among the genotypes, ABSR-2 was found least attacked by the borers recording minimum percentage of fruit infestation (14.51 percent) with maximum marketable yield of 2.29 kg per plant. Fruit infestation was positively but not significantly correlated with length of pedicel (r = 0.059) and calyx (r = 0.057) whereas, marketable yield (r= -0.87), polyphenol oxidase (r = -0.68), solasodine (r = -0.43) and phenol (r = -0.49) showed significantly negative correlation with fruit infestation and positive correlation with shoot infestation (r = 0.64) and total sugars (r = 0.74). The genotype ABSR-2 recording maximum yield, less shoot and fruit infestation, lowest pedicel and calyx length, low sugar, high polyphenol oxidase and high phenol could be used as resistant cultivar for further shoot and fruit borer resistance breeding programme.

Key words: green fruited brinjal, biophysical, biochemical, *Leucinodes orbonalis*, resistance

Introduction

Brinjal (*Solanum melongena* L.) is widely cultivated as one of the most important vegetables in both subtropical and tropical regions of India. It is grown almost in all the districts of Tamil Nadu and extensively in Dindigul, Theni and Madurai districts. In these districts consumers prefer only green coloured fruits than other coloured fruits. To meet the consumers preference of these districts, it is necessary to develop green fruited variety or hybrids coupled with borer resistance. Among the major pests infesting the crop, shoot and fruit borer is the most limiting factor distributed all over India, causing heavy yield loss upto 70 per cent (Jat and Pareek, 2003). Chemical control is widely used means of managing the pest. Repeated use of broad spectrum synthetic chemicals results in environmental contamination, pesticide residue in the produce and destruction of beneficial insects. Heavily sprayed and freshly harvested brinjal can be dangerous to our health. Hence, there is an urgent need to look alternate and safer method. Host plant resistance (HPR) is the economically sound technique for effective pest management. Developing brinjal hybrids/varieties with natural resistance to BSFB is one of the effective and eco friendly alternate methods for combating the pest. The morphological and biophysical characteristics of shoot and fruits are associated with attraction, feeding and oviposition of the pest. Therefore, the identification of biophysical characteristics from insect resistant genotypes is most practical significance. Previous research findings was revealed that biochemical characters, such as total Sugars and free amino acids, were positively correlated with fruit infestation, whereas, polyphenol oxidase and glycoalkaloids are negatively correlated with fruit borer attack. With this background, an experiment was made for collection and evaluation of genotypes with resistance against BFSB based on biophysical and biochemical basis of resistance.

Materials and Methods

The present investigation on influence of biophysical and biochemical characteristics of green fruited brinjal for shoot and fruit borer resistance was carried out in the college orchard, Department of vegetable crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2015 which is situated at 11° N latitude and 77° E longitude and at an elevation of 426.6 m above MSL. The experimental materials for the present study consisted of thirty genotypes. Out of thirty genotypes, twelve (IC 261786, IC 354546, IC 111033, IC 090907, EC 316201, EC 315014, IC

249344, IC 354721, IC 383345, IC 454561, IC 310889 and IC 111013) from NBPGR, New Delhi, one (ABSR -2) were received from IIVR, Varanasi, fifteen were collected from local areas (Notchidaipatti, Namakkal, Karur, Patteswaram, Mathukadipattu, Sathirampatti, Kumbakonam, Kurumbapatti, Devachinnampatti, Swamimalai, Ottanchathiram, Andipatti, Thirchy, Mettupalayam and Musuri) and two (Arka Kusumakar and Arka Shirish) from IIHR, Bangalore and evaluated in a randomized block design with two replications. Forty five days old seedlings were transplanted on the ridges adopting a spacing of 60 x 60 cm. Twenty five plants were maintained for each hybrid in each replication. Cultural practices were followed as per the package of practices recommended for Tamil Nadu. Five matured fruits per plant were randomly selected to measure the length of pedicel and calyx with the help of a scale. The Marketable yield per plant was measured by deducting the yield of infested fruits from the total yield per plant. The per cent infestation of fruits on number basis was calculated by counting the infested and healthy fruits separately from all the plants in each accession. The weight of both healthy and infested fruits was taken separately and level of percent infestation was calculated. Polyphenol oxidase activity was assayed as per the method described by Srivastava (1987). Folin ciocalteau reagent method was followed for estimating the total phenols (Bray and Thrope, 1954). The total sugar was carried out based on the method by Hedge and Horreiter (1962). The solasodine content was estimated based on the method by Bakshi and Hamied (1972). The statistical analysis for mean performance as suggested by Panse and Sukhetme (1989) and correlation analysis for all the characters was given by Miller *et al.* (1958).

Results and Discussion

The analysis of variance showed significant difference among the genotypes for all the characters (data not given). The genotypic variance for all the characters was highly significant indicating wide variability for all the characters studied.

Biophysical characters of brinjal genotypes in relation to shoot and fruit borer

Plants defend themselves against herbivores using their biophysical and structural features. In many cases, it is obvious that the biophysical characters of the host plant play an important role in conferring resistance to fruit borer. Major biophysical characters of eggplant fruits in relation to BFSB infestation is given in Table 2. Calyx and pedicel are the most important morphological component which has strong association with pest infestation. The results revealed that the lowest pedicel length (1.55 cm) and calyx length (1.80 cm) were observed in the genotype ABSR-2. The highest pedicel length (5.35 cm) was recorded in IC 261786 and calyx length in mettupalayam local (4.10 cm). The genotypes with fruits having short pedicel and calyx were more resistant than those with long pedicel and calyx. The correlation analysis showed that fruit infestation was positively but not significantly correlated with length of pedicel (r = 0.059) and calyx (r = 0.057) of fruit. It clearly demonstrated that genotypes consisting of long fruits pedicel and calyx were more susceptible than those with short pedicel and calyx helping the neonate larvae to hide and get easily into the fruit through the soft tissue below the calyx. The present findings are in agreement with Wagh *et al.* (2012) and Niranjana *et al.* (2015), they also observed that the pedicel and calyx length had positive correlation with susceptibility to fruit borer.

The marketable fruit yield per plant which is free of infection by the fruit borer is the most important parameter in brinjal. It describes the profit of the grower and it is decided mainly by the percentage of infestation by fruit and shoot borer. Lesser the fruit infestation better would be the marketable yield per plant. The highest marketable yield per plant was recorded in the genotype ABSR-2 (2.29 kg) followed by EC 316201 (2.19 kg) and the lowest marketable yield was recorded by IC 249344 (0.37 kg). The highest yield is due to less infection by the borer. The genotype IC 249344 is highly affected by the borer and highly susceptible to the pest. Brinjal genotypes with higher marketable yield possess relatively higher genetic tolerance to shoot and fruit infestation. The similar results were recorded by Praneetha (2002). The results showed significantly negative correlation with marketable yield per plant (r= -0.87). This indicated decrease in yield with low infestation.

The shoot borer infestation affects the growth of the plant as well as yield. The genotype EC 316201 showed less shoot infestation percentage (8.15 percent) followed by ABSR -2 (8.40 percent) and the genotype IC 249344 recorded higher shoot infestation of 16.45 percent. The very low shoot infestation attributed due to genetic and environmental effect. The results of the present study are in confirmation with the findings of Humayun Javed *et al.* (2011) and Navqi *et al.* (2009). Shoot infestation had significantly positive correlation (r = 0.64) with fruit infestation. The highest shoot infestation led to more fruit infestation leading to decrease in the crop yield.

The infestation of shoot and fruit borer was less in ABSR-2 on weight basis and on number basis with 13.12 and 14.51 percent respectively. The genotype

IC 249344 was highly susceptible against BSFB and the infestation was more with 33.82 percent on weight basis. IC 354721 had high level of infestation with 30.12 percent on number basis. The similar results were reported by Asati *et al.* (2002), Wagh *et al.* (2012) and Prasad *et al.* (2014). The fruit infestation on weight basis had significant positive correlation (r = 0.94) with fruit infestation. The more number of infested fruits attributed to the production of more unmarketable fruit yield.

Biochemical characters of brinjal genotypes in relation to shoot and fruit borer

Many biochemical factors are known to be associated with insect pest resistance in crop plants. In many cases, it is obvious that the biochemical constituents like, total phenols, flavonols and enzymes are more important than other morphological and physiological factors, in conferring non-preference and antibiosis. Some biochemical constituents may also act as feeding stimuli for insects.

The highest total sugars content (18.3 g g^{-1} FW) was recorded in highly susceptible genotype IC 354721, while lowest (6.5 g g^{-1} FW) was recorded in resistant genotype ABSR-2. BFSB infestation had significant positive correlation with total sugars (r = 0.73). Since sugar is considered one of the vital nutrients in plants, the difference in the relative amount of sugars between different genotypes with differential susceptibilities to fruit borer indicate that these compound might act as phago-stimulants to BFSB feeding on eggplant. The present results are in agreement with the findings of Jat and Pareek (2003), Elanchezhyan *et al.* (2009) and Prasad *et al.* (2014), who reported that total sugars were positively correlated with fruit infestation. Higher concentration of sugars in eggplant fruits may act as feeding stimulant in the susceptible varieties.

The discolouration in brinjal fruit is attributed to high polyphenol oxidase activity. The highest PPO activity was recorded in the resistant genotype ABSR -2 (1.231 Changes in OD min^{-1} g^{-1}) and the lowest was recorded in the susceptible genotype IC 249344 (0.213 Changes in OD min^{-1} g^{-1}). The result of present study suggested that the genotype having high PPO activity showed resistant reaction to borer attack with significant negative correlation with PPO activity (r = -0.68). These findings are in agreement with the findings of Doshi *et al.* (1998) and Khorsheduzzaman *et al.* (2010).

The glycoalkaloid contents in the Indian commercial cultivars vary from 0.37 to 4.83 mg/100 g fresh weight. Generally, a bitter taste and off flavour of brinjal fruits may be produced by higher content of glycoalkaloids. The lowest solasodine content was found in IC 249344 (0.020 %) and the highest solasodine content was measured in Thirchy local (0.054 %). Similar trend was observed by Dhruve *et al.* (2014). The fruit infestation had significantly negative correlation with solasodine content (r = -0.43). Similar correlation for glycoalkaloid content was observed by Doshi *et al.* (1998).

The lowest phenol content (1.32 mg g^{-1}) was recorded in the genotype Sathirampatti local and it was high in resistant genotype, ABSR -2 (1.59 mg g^{-1}), which recorded lowest infestation on number and weight basis. Phenols are the extremely abundant plant allelochemicals, often associated with feeding deterrence or growth inhibition of herbivores. Phenols in fairly large concentration could ward off insects pests because of their direct toxicity. The genotype with high phenols content showed low percentage infestation, indicating its role in imparting resistance against this pest. Total phenols showed a significantly negative correlation with per cent fruit borer infestation (r = -0.49). The present results are in agreement with Asati *et al.* (2002), Jat and Parrek (2003), Chandrashekhar *et al.* (2009), Elanchezhyan *et al.* (2009) and Prasad *et al.* (2014) who reported higher phenol contents with increased resistance to fruit borer.

Green fruit colour of brinjal was associated with resistance to *L. orbonalis*, while purple fruit colour was associated with susceptibility to this insect. Less susceptibility of of green fruited genotype to BFSB was reported by Jat and Parrek (2003), Wagh *et al.* (2012), Dar *et al.* (2014) and Prasad *et al.* (2014). Hence, the combination of biophysical and biochemical traits can be used as an effective and reliable selection criteria to select resistant genotype. In general, the green fruited genotype with high yield, low sugar and high phenols and polyphenol oxidase activity may be used in hybridization programme to develop cultivars with resistance to *L. orbonalis*. The genotype ABSR-2, identified as resistant genotype can be utilized in the breeding programme for development of resistant cultivars or hybrids

Conclusion

The brinjal genotype (ABSR-2) with low fruit and shoot infestation, short pedicel and calyx of fruit, high yield, low sugar and high polyphenols and PPO activity was resistant to the infestation of *L. orbonalis.* This resistant genotype can be used as a male parent in developing resistant varieties or hybrids for *L. orbonalis* in breeding programmes.

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Table 1. Biophysical characters of brinjal genotypes in relation to fruit and shoot borer

S. NO	Genotypes	Pedicel length (cm)	Calyx length (cm)	Marketable yield per plant (kg)	Shoot infestation (%)	Fruit infestation (%) (Wt. basis)	Fruit infestation (%) (No. Basis)
1.	Notchidaipatti local	4.70	3.10	1.75	10.20	19.08	19.69
2.	ABSR -2	1.55	1.80	2.29	8.40	13.12	14.51
3.	Namakkal local	3.40	2.30	1.62	9.25	20.80	20.02
4.	IC 261786	5.35	2.05	0.85	14.20	27.25	29.20
5.	Karur local	2.55	2.10	1.52	13.45	22.30	21.08
6.	Patteswaram local	1.95	2.45	1.25	14.00	23.03	22.80
7.	Arka Shirish	2.45	3.10	1.21	15.95	25.03	23.56
8.	Mathukadipattu local	2.65	2.10	0.96	14.80	21.26	24.87
9.	Sathirampatti local	3.15	2.75	1.28	11.05	24.77	24.89
10.	Kumbakonam local	1.65	2.25	1.35	14.60	25.64	26.37
11.	Kurumbapatti local	3.25	2.40	0.80	13.75	25.28	24.04
12.	Devachinnampatti local	3.30	2.35	2.09	9.50	16.96	16.01
13.	IC 354546	2.70	2.55	0.89	12.60	31.72	29.99
14.	IC 111033	4.25	3.45	0.80	13.00	23.26	25.01
15.	Swamimalai local	3.35	3.10	1.26	11.45	23.75	22.70
16.	Ottanchathiram local	3.60	2.20	1.70	8.55	19.45	19.32
17.	IC 090907	4.10	3.35	2.09	9.25	17.71	18.00
18.	Andipatti local	4.40	3.45	1.78	11.70	19.88	19.00
19.	EC 316201	3.35	1.90	2.19	8.15	16.42	17.01
20.	EC 315014	4.25	2.15	1.32	12.55	25.88	25.94
21.	Arka Kusumakar	3.40	2.50	1.60	13.50	22.45	21.85
22.	Thirchy local	3.65	2.25	1.18	14.70	26.34	24.11
23.	Mettupalayam local	4.25	4.10	1.58	10.95	25.95	25.95
24.	Musuri local	2.25	2.10	0.97	10.95	23.51	21.90
25.	IC 249344	2.05	2.45	0.37	16.45	33.82	29.15
26.	IC 354721	3.55	2.40	0.61	13.25	32.13	30.12
27.	IC 383345	3.10	1.93	1.57	10.70	22.14	22.14

28.	IC 454561	4.05	2.80	1.41	12.50	23.89	25.03
29.	IC 310889	2.80	2.65	0.88	12.45	24.68	25.77
30.	IC 111013	3.25	2.35	0.39	14.40	28.67	30.10
	Mean	3.28	2.54	1.33	12.28	23.53	23.39
	SEd	0.955	0.430	0.528	2.292	1.839	1.944
	CD (0.5%)	1.953	0.879	1.080	4.688	3.762	3.976
	Correlation coefficient (r)	0.059	0.057	-0.87**	0.64**	0.94**	

Table2. Biochemical characters in relation to shoot and fruit borer infestation

S. NO	Genotypes	Total sugars (mg/g) (FW)	Polyphenol Oxidase (Changes in OD/min/ g of sample)	Solasodine (%)	Total phenol (mg g^{-1})	Fruit infestation (%) (No. basis)
1.	Notchidaipatti local	11.6	0.911	0.042	1.47	19.69
2.	ABSR -2	6.5	1.231	0.031	1.59	14.51
3.	Namakkal local	8.2	0.521	0.037	1.58	20.02
4.	IC 261786	15.3	0.322	0.021	1.37	29.20
5.	Karur local	12.1	0.551	0.036	1.42	21.08
6.	Patteswaram local	11.3	0.425	0.052	1.49	22.80
7.	Arka Shirish	10.2	0.462	0.048	1.56	23.56
8.	Mathukadipattu local	14.6	0.653	0.041	1.45	24.87
9.	Sathirampatti local	15.3	0.901	0.046	1.32	24.89
10.	Kumbakonam local	12.4	0.820	0.032	1.48	26.37
11.	Kurumbapatti local	16.2	0.594	0.035	1.38	24.04
12.	Devachinnampatti local	7.3	1.013	0.028	1.58	16.01
13.	IC 354546	10.7	0.534	0.023	1.53	29.99
14.	IC 111033	9.6	0.217	0.041	1.44	25.01
15.	Swamimalai local	9.1	0.325	0.033	1.56	22.70
16.	Ottanchathiram local	10.7	0.724	0.042	1.39	19.32
17.	IC 090907	7.3	1.002	0.035	1.55	18.00

18.	Andipatti local	10.2	0.625	0.046	1.48	19.00
19.	EC 316201	8.7	0.812	0.040	1.50	17.01
20.	EC 315014	10.3	0.516	0.032	1.42	25.94
21.	Arka Kusumakar	9.5	0.936	0.040	1.53	21.85
22.	Thirchy local	11.4	0.625	0.054	1.47	24.11
23.	Mettupalayam local	12.6	0.418	0.042	1.56	25.95
24.	Musuri local	12.4	0.845	0.034	1.40	21.90
25.	IC 249344	14.8	0.337	0.020	1.43	29.15
26.	IC 354721	18.3	0.213	0.037	1.39	30.12
27.	IC 383345	13.6	0.695	0.041	1.42	22.14
28.	IC 454561	14.7	0.746	0.036	1.42	25.03
29.	IC 310889	15.4	0.539	0.033	1.54	25.77
30.	IC 111013	17.2	0.572	0.021	1.36	30.10
	Mean	11.98	0.636	0.037	1.47	23.39
	SEd	2.218	0.145	0.007	0.048	1.944
	CD (0.5%)	4.537	0.297	0.015	0.099	3.976
	Correlation coefficient (r)	0.73**	-0.68**	-0.43**	-0.49**	