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Research Article

Utilizing wild relative ((*Solanum viarum*) as resistant source to shoot and fruit borer in brinjal (*Solanum melongena* Linn.)

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Abstract

Brinjal (*Solanum melongena* Linn.) has very important place in Indian curries and also in China, Japan and Southern Europian recipies. High yield combined with good quality as well as resistance to shoot and fruit borer in a brinjal variety is the ultimate aim in the most of the brinjal breeding programme. *Solanum viarum* is closely related to *Solanum melongena* and both are cross compatible. Therefore hybridization was undertaken in brinjal (*Solanum melongena* L.) with *Solanum viarum* to transfer the resistance trait of shoot and fruit borer and combine the resistance trait with high yield of brinjal.. Hybridization was made and F_1 hybrid plants were raised. Subsequently in each generation selfing was done followed by selection to obtain F_9 generation. In F_9 generation selection was done in the plants with high marketable yield along with very low or negligible shoot and fruit borer infestation. The direct derivatives of EP 65 x *Solanum viarum* were evaluated upto F_9 . Two recombinant progenies viz., 7 and 9 were selected in F_9 generation for carrying forward to the next generation based on their high marketable yield and the least infestation of shoot and fruit borer. Molecular study with RAPD primers also revealed the introgression of the genes from donor parent *Solanum viarum* to brinjal.

Key words : Brnjal variety - shoot and fruit bore infestation - *Solanum viarum*- Hybridization - HD 1 and HD 2

Introduction

Brinjal (*Solanum melongena* Linn.) is one of the most popular vegetable crops grown round the year in most of the parts of India and finds its place as the poor man's vegetable in Indian curries.. It holds a very important place in China, India and Japan. In Southern Europe, it is a staple vegetable. It is a favourite dish in South East of France. Due to its low calorie (24 kcal/100g) and high potassium content (200mg/100g) it is suitable for diabetes, hypertensive and obese patients.

India produces almost thirteen per cent of world's vegetable output occupying second position in brinjal production. In India, brinjal cultivation is estimated in an area of 5,12,800 ha with an annual production of 84,50,200 tonnes and productivity of 16,478.50 kg ha^{-1} during the year 2007 (FAO, 2007).

Among the biotic stress factors that hamper the production of brinjal the shoot and fruit borer (*Leucinodes orbonalis* Guen.) is the most serious one, which occurs throughout the year at all the stages ofcrop growth. Shoot and fruit borer, *Leucinodes orbonalis* Guen. is one of the major constraints in brinjal production. The percentage of fruit damage due to this pest was reported to vary from 25.82 to as high as 92.50 (Atwal and Verma, 1972; Gangwar and Sachan, 1981) and yield reduction was as high as 20.70 per cent (Peswani and Lal, 1964).

Varieties or hybrids that are inherently resistant to shoot and fruit borer has the potential to improve the marketable yield and enhance economic returns of the poor farmers. The major bottleneck in the resistance breeding programme for shoot and fruit borer is the lack of resistant source in the cultivated germplasm. This has necessitated brinjal breeders to search resistance for genes in wild species that are taxonomically related and compatible with brinjal.

The use of wild forms in breeding crop plants, particularly to obtain vigour and resistance has been well recognised (Sarvayya, 1936). In brinjal, several experiments involving wild species of *Solanum* to obtain shoot and fruit borer resistance have been carried out (Gowda *et al*., 1990b; Anis *et al*., 1994;

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Behera and Singh, 2002; Praneetha, 2002).Selection of a genotype with high yield and resistant nature reduces the yield loss in one hand and increases the availability of the produce to market which is fairly free from pesticide residue on the other hand.

An attempt to incorporate the resistance to shoot and fruit borer in the cultivated egg plant genotypes was made in interspecific hybrid progenies of the cross S.melongena x solanum viarum and evaluating the direct segregating progenies of such interspecific crosses so as to identify recombinant inbred plants with high yield and shoot and fruit borer resistance.

High heritability coupled with low genetic gain can be improved by development of hybrid varieties or selection of transgressive segregants in hybridization programme. This implied that the breeder can opt for selection, following hybridization to isolate desirable transgressive segregants (Mohanty and Prusti, 2002).

Materials and Methods

The wild relative of brinjal , *Solanum viarum* is found to be resistant for the shoot and fruit borer infestation. High yielding but susceptible brinjal variety, EP 65 was used as female parent and crossed with pollen grains of *Solanum viarum* and the interspecific hybrids were self fertile.

In this study, selfing was done to raise the next generation crop (right from F_1 to F_9 generation) In each generation selection of individual plants was made based on the mean performance of the hybrids, biometrical and quality traits, shoot and fruit borer resistance, and consumer preference. The present experiments were conducted with the breeding materials developed by hybridizing brinjal (*Solanum melongena* L.) and its wild relative *Solanum viarum* by Preneetha (2002) and continued by Prabhu (2004).

Right from F_4 generation single plant selection was done upto F_8 generation and the seeds of single plant the 08^{th} plant was denoted as 34-55-25-10-08 and used for raising F_9 generation. A total number of thirty F_9 progenies of a single plant namely 34-55-25-10-08 selected in the F_8 generation of EP 65 x *Solanum viarum* were studied for different biometric traits like plant height, branches plant^{-1}, fruit length, fruit girth, calyx length, single fruit weight, fruits plant^{-1}, shoot borer infestation, fruit borer infestation, total yield plant^{-1} and marketable yield plant^{-1}

The biochemical defense mechanism would certainly be helpful in selection of plants as source of resistance. With this aim, the biochemical constituents such as peroxidase, poly phenol oxidase, total phenol and solasodine content were estimated in selected derivatives in F_9 generation in comparison with susceptible variety CO 2.

Results and Discussion

The data recorded from direct F_9 generation derivatives of EP 65 x *Solanum viarum* were utilized to study thoroughly and three progenies each out of thirty in F_9 generations were selected for further studies. All these selected progenies have performed very well with respect to shoot and fruit borer resistance. From this evaluation study two hybrid derivatives were selected and designated as HD 1 and HD 2

Performance of HD 1 (F_9 progeny of EP 65 x *Solanum viarum* : 34-55-25-10-08-07)

Among the thirty F_9 progenies of EP 65x *Solanum viarum* evaluated the HD1 (34-55-25-10-08-07) recorded the mean plant height of 96.60 cm. The mean number of branches per plant was 13.00. It recorded the mean number of fruits /plant as 75.00 with an average fruit length of 8.60 cm, fruit girth of 15.90 cm, calyx length of 3.60 cm and single fruit weight of 57.40 g.

The progenies also recorded the mean shoot borer infestation of as low as 7.69% and fruit borer infestation as 6.67%. The average total yield /plant was 4.31 kg and marketable yield /plant was 4.07 kg

Performance of HD 2 (F_9 progeny of EP 65 x *Solanum viarum* : 34-55-25-10-08-09)

Among the thirty F_9 progenies of EP 65x *Solanum viarum* evaluated the HD1 (34-55-25-10-08-07) recorded the mean plant height of 101.30 cm. The mean number of branches per plant was 11.00. It recorded the mean number of fruits /plant as 73.00 with an average fruit length of 9.20 cm, fruit girth of 16.20 cm, calyx length of 3.80 cm and single fruit weight of 50.80 g.

The progenies also recorded the mean shoot borer infestation as 9.09 % and fruit borer infestation as 6.85 %. The average total yield /plant was 3.71 kg and marketable yield /plant was 3.46 kg

Finally based on the overall evaluation (Table 1) progeny number 7 and 9 recorded very low fruit borer infestation of 6.67 per cent and 6.85 per cent respectively along with very high marketable yield of 4.07 kg for progeny number 7 and 3.46 kg for progeny number 9 under **unprotected conditions**.

The two progenies have found to record (progeny number 7 and 9) low borer and high marketable yield .

The selected progenies viz., HD 1and HD 2 showed profuse flowering and fruiting and also cluster bearing habit. The colour of the fruit was bright purple while the fruit surface was smooth, glossy along with tightly packed seeds in its flesh which again act as physical barrier for mandibles of fruit borer to chew and bore into the flesh of fruits. All these traits including cluster bearing habit would have been derived from the wild parent namely *Solanum viarum* while the purple colour and other traits are imparted by the female parent EP 65 used in original cross and retained in the progenies due to recombination and by repeated selection from the segregating progenies right from F_2 to F_9.

The fruits of HD 1 and HD 2 were mediun in size (57-60 g). The shoot borer infestation ranged from 7.69 to 10.00 per cent, fruit borer infestation ranged from 6.67 to 8.57 per cent and marketable yield ranged from 3.49 to 4.07 kg plant^{-1}. The fruits sre oblong in shape and smooth surfaced. It was having compact or hard pulp and tightly arranged seeds. The colour of the fruit is dark purple with smooth and glossy skin.. The bearing habit of the plant was of clustering nature. These traits of this progeny conforms to resistant traits for shoot and fruit borer as described in findings given by Mishra *et al*. (1988), Ali (1994), Hossain *et al*. (2002) and Mannan *et al*. (2003)

Biochemical basis of resistance

Many biochemical factors are known to be associated with insect resistance in crop plants. In many cases it is obvious that the biochemical factors are more important than morphological and physiological factors in conferring non-preference and antibiosis. Some biochemical constituents may act as feeding stimuli for insects. Occurrence at lower concentration or total absence of such biochemicals leads to non preference, a form of insect resistance (Singh, 1983). The biochemical constituents like glycoalkaloid (solasodine), phenols, phenolic oxidase enzymes *viz.,* polyphenol oxidase and peroxidase are available in brinjal and these biochemical constituents possess insect resistant properties (Kalloo, 1988).

Biochemical constituents of intervarietal hybrids and their parents contributing resistance to shoot and fruit borer (Table 2)

The biochemical constituents *viz.,* peroxidase and polyphenol oxidase in the shoots and peroxidase, polyphenol oxidase and solasodine content in the fruits were estimated in the parents and hybrids of intervarietal crosses. Among the seven parents, EP 65 recorded the highest values for the activity of peroxidase (0.278 in shoot and 0.272 in fruit as changes in OD min^{-1} g^{-1} of sample), polyphenol oxidase (0.382 in shoot and 0.365 in fruit as changes in OD min^{-1} g^{-1} of sample) and total phenol content was highest in *Solanum viarum* (227.45 mg 100g^{-1} in shoot and 215.40 mg 100g^{-1} in fruit).

The F_9 hybrid recorded the highest peroxidase activity (0.335 in shoot, 0.290 in fruit as changes in OD min^{-1} g^{-1} of sample) than the parents . It also recorded the maximum polyphenol oxidase activityin fruit (0.388 in fruit as changes in OD min^{-1} g^{-1} of sample). This hybrid also recorded almost equalent quantity of total phenol content in the shoot (225.45 mg 100g^{-1}) and fruit (212.50 mg 100g^{-1}) and moderate quantity of solasodine content of 0.028 per cent in fruit.

The results clearly showed that the presence of biochemical constituents acted as stimulants of resistance mechanism against shoot and fruit borer. The study revealed that the genotypes with high or moderate level of these biochemical constituents suffered less for shoot and fruit borer infestation. These results indicated that all these biochemical constituents also contribute to confer resistance to shoot and fruit borer in brinjal as already refered by Kosuge (1969), Praneetha (2002) and Prabhu (2004).

Conclusion

In the F_9 generation of the cross EP65 x *Solanum viarum*, recombinant inbred progenies namely HD 1 (34-55-25-10-08-07) and HD 2 (34-55-25-10-08-09) were identified based on their high marketable yield (4.07 kg plant^{-1} and 3.46 kg plant^{-1} respectively) and the least infestation of shoot borer (7.69 per cent and 9.09 per cent respectively) and fruit borer (6.67 per cent and 6.85 per cent respectively).

By utilizing interspecific breeding technique and recombination, borer-free brinjal can be developed to protect the high yield and satisfy the preference of consumers. Selection based on fruit borer infestation and yield would be inadequate in brinjal breeding programme if the consumer preference is not addressed to.and given due importance, which decides the commercial cultivation of a particular genotype. As such improvement in all types of brinjal by incorporation of shoot and fruit borer resistance

to fulfill the consumer needs in different locations can be taken up. There is adequate opportunity to use **Host plant resistance** in breeding brinjal programme.

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Table 1. *Per se* **performance of F_9 interspecific hybrid progenies of EP 65 x** *Solanum viarum* **(34-55-25-10-08) in comparison with female parent EP 65 and check variety CO 2**

Progeny no.	Plant height (cm)	Branches plant^{-1}	Fruit length (cm)	Fruit girth (cm)	Calyx length (cm)	Single fruit weight (g)	Fruits plant^{-1}	Shoot borer (per cent)	Fruit borer (per cent)	Total yield plant^{-1} (kg)	Marketable Yield plant^{-1} (Kg)
01	101.30	12.00	9.20	11.80	3.80	50.00	52.00	8.33	15.38	2.60	2.18
02	105.40	11.00	10.30	12.60	4.30	51.00	61.00	9.09	11.48	3.11	2.79
03	94.00	12.00	8.50	11.90	4.10	52.80	65.00	16.67	18.46	3.43	2.82
04	91.20	11.00	9.20	14.80	4.40	56.40	58.00	18.18	8.62	3.27	3.03
05	93.00	10.00	8.60	13.70	4.70	45.60	74.00	20.00	8.11	3.37	3.06
06	92.30	12.00	9.10	14.00	4.90	54.20	65.00	8.33	10.77	3.52	3.14
07	**96.60**	**13.00**	**8.60**	**15.90**	**3.60**	**57.40**	**75.00**	**7.69**	**6.67**	**4.31**	**4.07**
08	94.80	12.00	8.20	15.40	4.80	52.60	63.00	8.33	15.87	3.31	2.80
09	**101.30**	**11.00**	**9.20**	**16.20**	**3.80**	**50.80**	**73.00**	**9.09**	**6.85**	**3.71**	**3.46**
10	98.00	10.00	8.80	11.90	4.20	54.60	54.00	10.00	9.26	2.95	2.70
11	105.20	12.00	7.90	12.20	4.30	57.20	57.00	16.67	17.54	3.26	2.78
12	101.40	14.00	8.30	11.90	5.10	54.80	63.00	7.14	22.22	3.45	2.74
13	92.00	14.00	9.20	12.70	4.20	46.70	75.00	7.14	21.33	3.50	2.74
14	93.20	12.00	8.80	15.60	4.40	53.10	51.00	16.67	23.53	2.71	2.08
15	91.00	14.00	8.50	12.30	4.10	56.10	54.00	14.29	11.11	3.03	2.69
16	101.30	10.00	8.20	11.90	4.30	52.80	55.00	20.00	14.55	2.90	2.53
17	102.70	15.00	8.60	10.80	4.70	54.10	58.00	20.00	13.79	3.14	2.71
18	94.00	10.00	9.30	11.50	3.80	54.00	70.00	10.00	8.57	3.78	3.49
19	102.40	10.00	8.60	12.70	4.20	55.70	57.00	10.00	8.77	3.17	2.92
20	98.30	11.00	8.50	14.30	3.70	50.20	64.00	9.09	9.38	3.21	2.93
21	96.10	14.00	9.00	13.60	4.50	52.40	60.00	7.14	8.33	3.14	2.91
22	98.60	11.00	8.50	14.30	3.90	51.80	58.00	9.09	8.62	3.00	2.78
23	91.20	12.00	8.80	12.70	4.20	48.60	63.00	8.33	7.94	3.06	2.84
24	97.00	11.00	8.50	14.80	4.50	54.60	66.00	9.09	16.67	3.60	3.08
25	97.20	14.00	8.20	12.40	4.80	51.30	58.00	7.14	8.62	2.98	2.75
26	103.20	12.00	8.60	15.30	5.10	52.60	67.00	16.67	11.94	3.52	3.12
27	94.20	11.00	8.80	11.40	4.20	50.40	61.00	9.09	8.20	3.07	2.81
28	93.10	13.00	8.20	15.80	4.10	55.80	59.00	15.38	8.47	3.29	3.02
29	92.50	11.00	8.30	14.20	4.80	47.60	62.00	9.09	9.68	2.95	2.69
30	98.40	10.00	8.20	13.70	4.50	52.40	58.00	10.00	8.62	3.04	2.80
Range	91.20-105.4	10.00-14.00	7.90-10.30	10.80-16.2	3.60-5.10	45.60-57.4	51.00-75.0	7.14-20.0	6.67-23.53	2.60-4.31	2.18-4.07
SEd	3.08	1.07	0.38	0.88	0.31	2.63	5.64	3.38	3.43	0.27	0.26
CD (0.05)	6.48	2.87	0.81	1.87	0.65	5.53	11.85	7.10	7.21	0.56	0.55
CV (%)	3.89	14.16	5.42	8.11	8.73	6.13	11.17	35.71	35.08	10.09	11.04
Mean	97.03	11.83	8.69	13.41	4.33	52.59	61.87	11.59	11.98	3.25	2.88
EP 65	88.20	11.00	9.30	12.20	3.50	46.00	45.20	18.18	22.12	2.08	1.66
CO 2	**85.24**	**8.60**	**12.80**	**18.70**	**4.70**	**67.00**	**41.50**	**23.26**	**50.60**	**2.78**	**1.84**

Table 2. Biochemical constituents in the best performed interspecific crosses (EP 65 x *Solanum viarum*) and parents of brinjal

Genotypes	Shoot			Fruit			
	Peroxidase (changes in OD $min^{-1}g^{-1}$ of sample)	Polyphenol Oxidase (changes in OD $min^{-1}g^{-1}$ of sample)	Total phenol content (mg $100g^{-1}$)	Peroxidase (changes in OD $min^{-1}g^{-1}$ of sample)	Polyphenol Oxidase (changes in OD $min^{-1}g^{-1}$ of sample)	Total phenol content (mg $100g^{-1}$)	Solasodine (%)
F_9	0.335	0.374	225.45	0.290	0.388	212.50	0.028
CO 2	0.205	0.320	130.85	0.201	0.308	125.50	0.023
Solanum *viarum* (♂)	0.248	0.353	227.45	0.243	0.352	215.40	1.910
EP 65 (♀)	0.278	0.382	160.80	0.272	0.365	152.60	0.037