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SCREENING OF F_3 PROGENY FAMILIES OF BRINJAL THREE-WAY CROSS HYBRIDS FOR RESISTANCE TO SHOOT AND FRUIT BORER

Sandhra Maria Denny[1], Jiji Joseph[1*], P.P. Thirumalaisamy[2], Berin Pathrose[3] and Deepu Mathew[4]

[1]Department of Plant Breeding and Genetics, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur - 680 656, Kerala, India.

[2]ICAR-National Bureau of Plant Genetic Resources, Regional Station, Thrissur - 680 656, Kerala, India.

[3]Department of Entomology, College of Agriculture, Vellanikkara, Kerala Agricultural University, Thrissur - 680 656, Kerala, India.

[4]Centre for Molecular Biology and Plant Biotechnology, Kerala Agricultural University, Thrissur - 680 656, Kerala, India.

*Corresponding author E-mail : jiji.joseph@kau.in

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ABSTRACT

Brinjal (*Solanum melongena* L.) belongs to the Solanaceae family and is a prominent vegetable in India and Southeast Asia. Its production is severely constrained by shoot and fruit borer (*Leucinodes orbonalis*). Development of varieties with resistance to this stress along with desirable yield attributes is therefore an important breeding objective. The current study focused on screening 44 segregating F_3 family derived from three- way cross hybrids to identify superior segregants having resistance to brinjal shoot and fruit borer (BSFB). Shoot and fruit borer infestation was ensured by by planting the susceptible check Surya. Considerable variation was recorded for shoot and fruit borer tolerance and marketable fruit yield. 46 transgressive segregants were identified based on the cumulative performance for resistance to (BSFB and marketable yield. The identified segregants provide valuable breeding materials for developing high yielding varieties with resistance to shoot and fruit borer.

Key words : Brinjal, Shoot and fruit borer, *Leucinodes orbonalis* Three-way cross, Segregating population.

Introduction

Brinjal is one of the most widely cultivated solanaceous crops grown worldwide in an area of 1.96 million hectares and having a productivity of29336.6kg/ha(FAOSTAT, 2024). It is one of the major vegetable crop cultivated widely in India contributing significantly to the nation's vegetable production. The crop is valued not only for its economic importance but also for its nutritional and medicinal properties. It contain significant amounts of phenolics, phenylpropanoid derivatives, antioxidants such as chlorogenic acid, caffeic acid and hydroxycinnamic acid (Sivasankarreddy *et al*., 2024).

Despite its economic and nutritional importance, brinjal production is severely constrained by the crop's vulnerability to diseases and pests, as well as to abiotic stresses like drought and high temperature (Subramanian *et al*., 2023). Brinjal is found to be infested by thirteen major insect species, of which the shoot and fruit borer (*Leucinodes orbonalis* Guenée) is the most destructive, causing a yield loss exceeding 70 per cent (Yadav, 2026; Akanksha *et al*., 2023). Adult female moths lay eggs on the abaxial surface of young leaves and tender shoots; on hatching, the larvae bore into tender shoots, petioles, developing buds, fruits and fill the entry holes with frass (Panwar *et al*., 2021; Udikeri *et al*., 2024). The overreliance on insecticides for the management of pests has resulted in pesticide resistance, phytotoxicity and bioaccumulation; furthermore, these practices cause environmental contamination and a decline in the population of natural enemies.

Considering the economic importance of brinjal and the substantial losses caused by shoot and fruit borer, breeding brinjal varieties with resistance to these biotic stresses along with high yields and acceptable quality is of paramount importance. The existing studies are mainly focused on simple crosses; however complex crosses

like three way crosses allow an additional round of segregation, resulting in the formation of segregants with a broad genetic base. The present study undertakes the screening of 44 F_3 progeny families derived from three way cross hybrids (Sivasankarreddy, 2025) for their resistance to shoot and fruit borer along with their parents and checks.

Materials and Methods

Plant material : The experiment was conducted at ICAR-NBPGR Regional Station, Thrissur from September 2025 to February 2026. Fourty-four three way cross hybrids from the F_2 generation were advanced to the F_3 generation for further evaluation of yield and screening of shoot and fruit borer. Fourty-four F_3 progeny families, along with the five parental lines (Ponni, Vengeri, IC618016, IC636521, IC624240) and four checks (Neelima, Haritha, Pusa purple long, Surya), as detailed in Table 1 were evaluated.

Field Experiment : The seeds were treated with Indofil M45, a contact fungicideto prevent seed borne diseases. Polybags filled with soil, with the top layer covered with cocopeat and vermicompost, were used for sowing seeds. Healthy and uniformly grown seedlings were transplanted to the field 45 days after sowing, maintaining a spacing of 100 cm × 75 cm. Twenty plants from each family, along with the parents and checks, were transplanted. This resulted in a total plant population of 960 plants for the experiment. The shoot and fruit borer susceptible variety Surya was planted intermittently between the segregating lines so as to facilitate natural infestation of shoot and fruit borer. Standard agronomic practices as recommended in the Package of Practices of Kerala Agricultural University (2024) were followed.

Observation and analysis : Observations were recorded on an individual plant basis, as the experimental material consisted of a segregating F_3 population. The total number of shoots and the number of infested shoots were measured for each plant, and from that, per cent fruit infestation was calculated. Per cent fruit infestation was calculated using the observations of the number of fruits and the number of infested fruits.

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

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

The plants were scored for shoot and fruit borer on a modified scale from that proposed by Mishra *et al.* (1988) from immune (0) to highly susceptible (5) (Table 2).

Quantitative traits like plant height(cm), total number of shoots per plant, total number of fruits per plant, fruit length (cm), fruit breadth (cm), average fruit weight (g) and marketable fruit yield per plant (g) were recorded. Selection was carried out on a plant-by-plant basis considering marketable fruit yield per plant, shoot and fruit borer score for a period of four and a half months after transplanting. Correlation between the traits were estimated using the software Grapes (Gopinathan *et al.*, 2021)

Table 1 : Experimental material including parents, checks and segregating F_3 families evaluated for combined resistance to bacterial wilt and shoot and fruit borer.

Genotypes	Genotype code	Genotypes	Genotype code	No. of family
5 Parents		**Selected three-way cross hybrids**		
Ponny	1	(Ponny×Vengeri) × IC618016	(1×2)×3 = 123	4
Vengeri	2	(Ponny×Vengeri) × IC636521	(1×2)×4 =124	11
IC618016	3	(Ponny× IC618016) × IC624240	(1×3)×5 =135	1
IC636521	4	(Vengeri× IC618016) × IC624240	(2×3) ×5=235	2
IC624240	5	(Vengeri× IC636521) ×Ponny	(2×4)×1 =241	10
Checks		(Vengeri× IC636521) × IC618016	(2×4)×3 =243	6
Haritha	Neelima	(Vengeri× IC624240) ×IC636521	(2×5)×4=254	9
Pusa Purple Long	Surya	(IC618016 × IC636521) ×Ponny	(3×4)×1 =341	1

Table 2 : Classification of genotypes based on per cent infestation of shoot and fruit borer in brinjal as per the modified scale of Mishra *et al.* (1988).

Score	Reaction type	Infestation range (%)
0	Immune	0
1	Highly resistant	1-10
2	Moderately resistant	11-20
3	Tolerant	21-30
4	Susceptible	31-40
5	Highly susceptible	Above 40

Results and Discussion

Performance of F_3 segregants : Considerable



Fig. 1 : Morphological variation in fruits of the segregating F_3 plants.

phenotypic variation was observed among the genotypes for all the traits, as represented in Table 3 and Fig. 1, indicating extensive recombination and segregation of genes governing these traits. This reflects the effectiveness of the three-way cross in generating a broad genetic base. The surviving plants were further evaluated for tolerance to shoot and fruit borer and for yield and associated traits. The maximum number of infested shoots per plant was observed in the line 254-11-16-2(2 shoots). The maximum per cent shoot infestation (100%) was recorded in ten lines, including 254-11-16-2, indicating high susceptibility to the pest, and 418 plants exhibited no shoot infestation (0%). The per cent fruit infestation ranged from 0 to 100%. The maximum number of infested fruits was recorded to be 5 in line 123-1-5-3 and 10 plants, including 123-1-5-3, exhibited 100% fruit infestation. 289 plants exhibited no fruit infestation (0%). 2-3 infested fruits per plant were observed in the susceptible check Surya. Compared with the F_2 generation, where per cent shoot infestation ranged from 4.5% to 60% and per cent fruit infestation varied from 0% to 75% (Aftab, 2026), the F_3 segregants exhibited a wider range of variation, reflecting further segregation and recombination for tolerance to shoot and fruit borer.

Table 3 : Variability in the observed traits.

S. no.	Character	Minimum	Maximum
1	Total shoots	1	9
2	Infested shoots	0	2
3	PSI(%)	0	100
4	Total fruits	0	12
5	Infested fruits	0	5
6	PFI (%)	0	100
7	Plant height (cm)	20	100
8	Fruit length (cm)	4	25.75
9	Fruit breadth (cm)	1.2	9.2
10	Average fruit weight (g)	10	260
11	Yield (g)	0	1234
12	FSB Score	0	5

Correlation studies : The correlation coefficients among the observed traits are presented in Table 4 Marketable fruit yield was positively and strongly correlated with plant height (r= 0.683), total number of shoots (r=0.426), total number of fruits (r= 0.721), fruit length (r=0.481), fruit breadth (r= 0.396) and average fruit weight (r=0.683), indicating that vigorous plants with greater vegetative growth had enhanced fruit bearing potential, resulting in higher yield. This positive association with number of fruits and fruit weight is of high breeding importance as it can increase productivity. Fruit yield exhibited a negative correlation with percent shoot infestation (r=-0.114) and percent fruit infestation (r=-0.242), suggesting that increased borer infestation

Table 4 : Correlation matrix among shoot and fruit borer and yield attributing traits in brinjal.

	TS	IS	PSI (%)	TF	IF	PFI (%)	PH (cm)	FL (cm)	FB (cm)	FW (g)	MY (g)
TS	1										
IS	-0.107*	1									
PSI (%)	-0.166***	0.89***	1								
TF	0.683***	-0.145**	-0.15**	1							
IF	0.305***	-0.021	-0.033	0.289***	1						
PFI (%)	-0.076	0.123*	0.122*	-0.199***	0.747***	1					
PH (cm)	0.625***	-0.103*	-0.139**	0.698***	0.27***	-0.119*	1				
FL (cm)	0.208***	-0.079	-0.069	0.304***	-0.048	-0.202***	0.421***	1			
FB (cm)	0.082	-0.028	-0.085	0.078	-0.046	-0.116*	0.321***	0.126*	1		
FW (g)	0.139**	-0.03	-0.078	0.128*	-0.099	-0.159**	0.484***	0.54***	0.585***	1	
MY (g)	0.426***	-0.092	-0.114*	0.721***	0.012	-0.242***	0.683***	0.481***	0.396***	0.683***	1

*** Correlation is significant at 0.001 level, ** Correlation is significant at 0.01 level, * Correlation is significant at 0.05 level TS-Total shoots, IS-Infested shoots, PSI-percent shootinfestation , TF-total fruits, IF-infested fruits, PFI-percent fruit infestation, PH-Plant height, FL-Fruit length, FB-Fruit breadth,FW- Fruit weight, MY-Marketable yield.

Table 5 : Morphological observation of the transgressive segregants along with parents and checks.

Genotype	TS	IS	PSI (%)	TF	IF	PFI (%)	PH (cm)	FL (cm)	FB (cm)	FW (g)	MY (g)	FSB SCORE
124-7-19-9	5	0	0	8	0	0	86	11.1	4.7	176.3	1234	0
241-4-20-4	3	0	0	4	0	0	44	20	4.5	245	980	0
124-1-16-4	5	0	0	8	1	12.5	66	16	5.7	137.5	1100	1
241-4-20-5	4	0	0	3	0	0	43	18.5	6.3	260	780	0
241-4-15-6	3	0	0	6	0	0	64	12.5	5.8	124.5	746.5	0
135-12-7-8	6	0	0	9	0	0	65	14	47	78.5	706	0
124-7-19-10	5	0	0	8	0	0	75	13.5	3.9	82	656	0
254-11-6-9	4	0	0	4	0	0	70	9.4	5.6	155	620	0
124-1-16-10	6	0	0	10	2	20	100	14	4.4	69.5	695	0
243-14-2-8	5	0	0	7	0	0	50	8.9	4.5	81.2	568	2
241-4-15-5	2	0	0	4	0	0	65	15.1	5.3	141	564	0
254-11-2-5	6	0	0	7	0	0	66	10.9	4.8	92.8	650	0
241-4-8-9	3	0	0	5	0	0	60	14	4.1	89	178	0
241-4-15-7	3	0	0	5	1	20	60	12.2	5.1	106	530	0
241-4-8-4	6	0	0	6	0	0	70	14.5	4.1	87.5	525	0
241-4-8-1	3	0	0	6	0	0	50	14.5	4.1	85.5	513	0
124-1-16-9	5	0	0	4	1	25	60	12.7	4.1	148.2	592.5	2
254-11-6-5	3	0	0	5	0	0	55	9.8	4.5	98	490	0
241-4-15-1	4	0	0	4	0	0	50	15.2	5.2	117.3	469.3	0
241-4-20-3	4	0	0	3	0	0	44	15.5	5.2	152.6	458	0
135-12-7-10	5	0	0	6	0	0	48	12.8	4.1	74.6	448	0
341-7-10-7	5	1	20	3	0	0	67	107	8.1	143	429	0
124-7-2-5	4	0	0	6	0	0	46	16.6	3.3	70.2	421	0
254-11-1-6	2	0	0	3	0	0	53	10	7.4	139	417	0
124-7-2-9	2	0	0	7	2	28.6	62	12.5	4.2	80.3	562	2
135-12-7-9	4	0	0	4	0	0	65	14.6	4.2	102.7	411	0
254-11-9-8	3	0	0	3	0	0	50	6	6	135.7	407	0
243-14-11-7	4	0	0	7	0	0	50	7.7	4.3	56.4	394.6	0
241-4-10-9	5	0	0	6	0	0	55	10	4.9	79.8	479	0
123-1-5-5	4	0	0	6	0	0	40	13.6	4.5	64.5	387	0
124-7-19-4	6	0	0	5	0	0	40	12.6	3.9	76.8	384	0
124-7-2-7	5	0	0	12	0	0	42	9.4	3.5	31	372	0
124-7-2-8	3	0	0	3	0	0	54	18.7	4.6	151	453	0
124-1-4-7	5	0	0	4	0	0	76	11.5	4.7	90.7	363	0
135-12-7-2	4	0	0	6	0	0	52	12.7	4.8	75	450	0
135-12-7-6	4	0	0	6	0	0	57	11.6	4.2	59.3	356	0
254-11-11-9	3	0	0	3	0	0	60	14.3	5.2	117	351	0
124-5-20-7	6	0	0	5	0	0	52	17.7	3.2	70	350	0
124-1-16-2	3	0	0	3	0	0	37	13.2	3.9	91.6	550	1
124-1-16-6	5	0	0	5	0	0	50	10.2	4.8	135.9	679.5	0
243-14-20-10	2	0	0	3	1	33.3	55	9	5.6	107.6	323	0
124-5-20-9	4	0	0	5	0	0	56	14.3	4.1	64.4	322	0
241-4-8-2	4	0	0	4	0	0	34	14	3.8	80.5	322	0
241-4-8-5	8	0	0	4	1	25	74	12	4.9	103	412	2

Table 5 continued...

Table 5 continued...

Genotype	TS	IS	PSI (%)	TF	IF	PFI (%)	PH (cm)	FL (cm)	FB (cm)	FW (g)	MY (g)	FSB SCORE
241-4-15-10	4	0	0	4	1	25	80	12.2	5.4	115	461	2
124-7-2-3	3	0	0	7	0	0	36	15.6	3.1	56.4	394.8	0
Ponny	5	0	0	5	3	60	65.4	15.5	3.4	60.1	284	4
Vengeri	3	0	0	3	0	0	53	21.8	3.5	80.8	201.8	0
IC618016	3	0	0	4	1	25	40.6	12.2	4.6	93.7	187.4	1
IC636521	5	0	0	3	1	33.3	52.6	9.8	4.6	73.3	123.3	3
IC624240	3	0	0	4	1	25	30.2	10.1	3.2	49.42	70.1	0
Surya	3	1	33.3	3	2	66.6	30.5	8.08	4.1	44.64	100	5
Pusa purple long	1	0	0	0	0	NA	20	NA	NA	NA	NA	0
Haritha	3	0	0	3	1	33.3	32.8	12.6	3.9	67.14	156.6	2
Neelima	3	0	0	3	0	0	38.4	10.65	4.1	119	330	0

TS-Total shoots, IS-Infested shoots, PSI-percent shootinfestation , TF-total fruits, IF-infested fruits, PFI-percent fruit infestation, PH-Plant height, FL-Fruit length, FB-Fruit breadth,FW- Fruit weight, MY-Marketable yield

adversely affected yield. Similar associations between yield and borer infestation were reported by Thangamani and Jhansirani (2012), Gangadhara *et al*. (2023) and Rameshkumar *et al*. (2026).

Per cent fruit infestation was positively correlated with infested shoots (r=0.123), percent shoot infestation (r=0.122) and infested fruits(r=0.747), while a negative correlation was observed with total fruits (r=-0.199), plant height (r=-0.119), fruit length (r=-0.202), fruit breadth (r=-0.116), fruit weight (r=-0.159) and yield (r=-0.242) similar to the findings of Aftab *et al*. (2025). Percent shoot infestation showed a positive correlation with infested shoots (r=0.89) and per cent fruit infestation (r=0.122), and a negative correlation with total shoot (r=-0.166), total fruit (r=-0.15), plant height (r=-0.139), and yield (r=-0.114). The observed correlations were consistent with those in the early segregating generation; this consistency suggests the potential to use these traits for indirect selection for shoot and fruit borer tolerance among the segregating lines.

Selection of superior segregants : Selection was carried out on a plant-to-plant basis considering marketable fruit yield per plant, and shoot and fruit borer score. Based on these cumulative scores, plants were ranked, andsuperior segregants having high marketable yield and resistance to shoot and fruit borer were identified. Progenies exhibited higher fruit yield than the yield check while maintaining low shoot and fruit borer scores were selected. The genotype 124-7-19-9 was highly promising, recoding a yield of 1234g along with shoot and fruit borer score of 0. Other promising genotypes 241-4-20-4 (980g), 124-1-16-4 (1100), 241-4-20-5 (780g) and 241-4-15-6 (746.5g)also recorded comparatively high yield with low shoot and fruit borer scores. Among the 44 F_3 progeny families, 46 lines were identified as superior segregants exhibiting better performance compared to the parental linesas presented in Table 5. These genotypes can be advanced to further generation for stabilisation of the resistance to shoot and fruit borer.

The present study evaluated the segregating population of brinjal derived from three- way cross hybrids for resistance to shoot and fruit borer. Substantial variation was observed among the segregants for all the observed traits, providing opportunity for effective selection. The observed positive correlation of yield with fruit number, plant height, fruit weight and negative association with shoot and fruit borer infestation, highlighted the potential of these traits in indirect selection. The study identified superior segregants with combined resistance to shoot and fruit borer along with desirable yield. These selected lines can serve as valuable breeding materials for developing high yielding varieties with combined resistance to bacterial wilt and shoot and fruit borer.

Conflict of interest

The authors declare no conflict of interest.

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