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Research Article

Per se performance and heterosis for shoot and fruit borer (*Leucinodes orbonalis* Gn) resistance and yeild in brinjal (*Solanum melongena* L.)

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Abstract
Nine parents involving full diallel mating design was used to obtain the hybrids. Heterosis effect on different characters along with fruit yield and shoot and fruit borer resistance in brinjal was estimated. The cross EP 12 x MDU 1 recorded the highest heterobeltiosis per cent followed by EP 65 x Pusa Uttam and the best parent heterosis was maximum in EP 65 x Pusa Uttam for marketable yield per plant. For shoot borer infestation the highest negative heterobeltiosis was recorded in the hybrid EP 5 x APAU Bagmathi. The hybrid EP 65 x MDU 1 registered negative significant best parent heterosis. The highest significant and negative best parent heterosis was measured by the hybrid EP 65 x Pusa Uttam (-18.40) for fruit borer infestation. Only one hybird viz., EP 65 x Pusa Uttam showed positive and significant heterosis as best parent heterosis. Hence, this hybrid can be suggested for commercial cultivation so as to get high marketable yield and also to exploit hybrid vigour for low shoot and fruit borer incidence.

Key words
Brinjal, heterosis, shoot and fruit borer resistance, marketable yield

Introduction

Brinjal is a common tropical vegetable grown commercially in almost all parts of the country. It is an often cross pollinated crop and possesses considerable diversity for plant stature, fruit yield and yield attributing characters. Thereby, it offers the chance to exploit the genetic diversity for development of hybrid varieties (Chadha *et al.*,1990 and Vijay and Prem Nath, 1975). Manifestation of hybrid vigour in brinjal for earliness, yield and other important characters suggested its commercial utilization either by manual hybridization or by use of self emasculating system (Kalloo, 1994). Hence, the present investigation on heterosis in brinjal was carried out to assess the extend of heterosis for commercial exploitation.

Material and methods

Nine parents *viz*., Surya, APAU Bagmathi, Pusa Uttam, EP 5, EP 12, EP 65, EP 104, EP 113 and MDU 1 were selected and crossed in a diallel fashion with reciprocals. A total of seventy two F_1s were developed and evaluated along with parents in a Randomised Block Design with two replications. Seedlings were planted at 60 cm x 60 cm spacing. The recommended cultural operations were carried out. The relative heterosis (di), heterobeltiosis (dii) and best parent heterosis (diii) were calculated as per the formula of Gowen (1952).

Results and discussion

Mean perforamance: The results on mean performance of shoot borer infestation, fruit borer infestation and marketable fruit yield per plant are given in Tables 1,2 and 3 respectively. The parent APAU Bagmathi recorded the highest yield of 2.98 kg per plant among parents and 3.03 kg in EP 65 x Pusa Uttam cross among the hybrids (Table 1). The parent EP 65 recorded the lowest shoot borer infestation (7.50 per cent). Among the hybrids EP 65 x MDU 1 recorded the least shoot borer infestation of 5.46 per cent (Table 2). The lowest of 17.77 percentage as fruit borer infestation was recorded in the parent EP 65 and 14.50 percentage in cross EP 65 x Pusa Uttam (Table 3).

Heterosis: The heterosis results for shoot borer infestation, fruit borer infestation and marketable yield are given in Tables 4,5 and 6. In case of shoot borer infestation the highest negative and significant relative heterosis was recorded by the cross EP 5 x APAU Bagmathi (-48.58). Sixteen hybirds showed negative and significant relative heterosis out of the 72 crosses. Negative heterobeltiosis ranged from -42.91 to -0.61 per cent in hybrids. However, three crosses alone registered negative and significant values with maximum in the hybrid EP 5 x APAU Bagmathi. Only one cross (EP 65 x MDU 1) recorded negative significant best parent heterosis of -27.20 shoot borer infestation.

For fruit borer infestation, the maximum relative heterosis of -32.26 per cent was measured by the cross EP 113 x EP 104. The value of negative heterobeltiosis estimates was significant in only one cross EP 113 x EP 104 (-29.90). Significant and negative best parent heterosis was recorded by the hybrid EP 65 x Pusa Uttam (-18.40) for fruit borer infestation. Prabhu (2004) and Kamal Deep *et al.* (2006) recorded significant negative

desirable heterosis over better parent for shoot and fruit borer infestation.

Seven hybirds registered significant and positive relative heterosis for marketable fruit yield per plant. It was maximum in the hybrid combination of EP 12 x MDU 1 (41.92). With respect to heterobeltiosis, four hybirds showed significant and positive values. The highest heterobeltiosis of 36.99 per cent was observed in the F_1 of EP 12 x MDU 1. Only one hybrid (EP 65 x Pusa Uttam) showed positive and significant best parent heterosis (7.02). High magnitude of heterosis for yield was also reported by Tiwari (1966), Singh (1980), Chadha *et al*. (1990) and Prasath *et al*. (2000) in brinjal. Rajaneesh Singh and Maurya (2005) also recorded high heterosis over better parent and over mid parent for yield.

As the cross EP 5 x APAU Bagmathi recorded desirable relative heterosis and heterobeltosis for shoot borer infestation this can be suggested as a hybrid to get reduced shoot borer infestation, thereby it would reduce the fruit borer infestation and also would increase the plant growth and yield. The hybrid EP 65 x Pusa Uttam registered desirable heterobeltiosis and best parent heterosis for fruit borer infestation and also best parent heterosis for marketable fruit yield. This hybrid can be suggested for commercial cultivation so as to get high marketable yield and also to exploit hybrid vigour for lower borer incidence thereby the total marketable produce would be the maximum.

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Table 1. *Per se* performance of parents (bold) and hybrids of brinjal for fruit yield per plant (kg)

Parents and Hybrids	Surya	APAU Bagmathi	Pusa Uttam	EP 5	EP 12	EP 65	EP 104	EP 113	MDU 1
Surya	**2.04**	2.16	1.45	1.39	1.62	2.43	1.53	2.14	2.05
APAU Bagmathi	2.13	**2.98**	1.63	1.46	2.56	1.58	1.69	1.66	1.79
Pusa Uttam	1.58	1.61	**2.32**	1.86	1.39	2.53	1.34	1.45	1.58
EP 5	1.62	1.74	1.85	**1.64**	1.46	1.72	1.29	1.92	1.53
EP 12	1.97	2.19	1.84	1.32	**2.18**	1.68	1.39	1.85	2.97
EP 65	2.04	2.06	3.03	1.49	1.56	**2.39**	1.30	2.10	1.80
EP 104	1.58	2.90	1.32	1.46	1.35	1.31	**1.87**	1.33	1.39
EP 113	2.08	2.14	2.15	1.35	1.62	2.10	1.85	**2.33**	2.17
MDU 1	2.45	1.97	2.08	1.97	1.54	1.69	1.53	2.10	**2.18**
			S.Ed = 0.062			C. D. (0.05) = 0.123			

Note: Direct and reciprocal crosses are presented at above and below diagonal respectively

Table 2. *Per se* performance of parents (bold) and hybrids of brinjal for shoot borer infestation (%)

Parents and Hybrids	Surya	APAU Bagmathi	Pusa Uttam	EP 5	EP 12	EP 65	EP 104	EP 113	MDU 1
Surya	**10.60**	15.52	11.95	14.12	8.50	11.42	10.27	13.62	15.50
APAU Bagmathi	15.20	**12.57**	12.86	8.85	11.15	9.55	9.61	12.88	9.72
Pusa Uttam	12.29	11.12	**7.68**	11.15	9.76	8.35	9.73	9.87	12.37
EP 5	9.94	5.88	8.52	**10.30**	7.35	6.25	9.72	6.81	10.50
EP 12	8.95	6.78	7.32	8.33	**9.72**	11.65	8.15	8.27	9.09
EP 65	8.73	6.76	7.14	10.42	7.67	**7.50**	8.33	6.25	5.46
EP 104	10.02	7.53	8.78	9.93	8.07	7.55	**8.70**	8.53	13.88
EP 113	7.55	6.16	6.88	6.57	8.67	9.14	12.36	**8.86**	15.72
MDU 1	9.97	11.44	8.42	6.83	8.20	7.75	7.03	9.15	**9.72**
		S.Ed= 1.456			C. D. (0.05) = 2.898			(0.01) = 3.845	

Note: Direct and reciprocal crosses are presented at above and below diagonal respectively

Table 3. *Per se* performance of parents (bold) and hybrids of brinjal for fruit borer infestation (%)

Parents and Hybrids	Surya	APAU Bagmathi	Pusa Uttam	EP 5	EP 12	EP 65	EP 104	EP 113	MDU 1
Surya	**20.55**	17.85	21.23	24.91	29.76	19.38	20.24	32.50	28.62
APAU Bagmathi	25.15	**18.73**	22.84	35.62	18.57	19.53	30.16	28.64	27.65
Pusa Uttam	32.28	18.75	**19.80**	34.52	38.47	15.26	25.40	37.43	31.54
EP 5	33.33	35.29	36.00	**22.04**	30.47	21.78	27.65	32.84	42.28
EP 12	25.24	23.73	26.67	35.50	**26.18**	27.58	40.26	41.14	20.07
EP 65	18.60	17.22	14.50	31.54	30.06	**17.77**	32.67	28.72	23.61
EP 104	26.15	16.13	23.49	34.52	32.87	18.44	**26.44**	29.52	36.45
EP 113	23.54	24.80	19.86	40.17	31.86	22.15	18.52	**28.26**	43.36
MDU 1	18.34	20.11	26.58	34.28	30.20	15.25	28.85	39.84	**21.59**
		S.Ed= 2.253			C. D. (0.05) = 4.483				

Note: Direct and reciprocal crosses are presented at above and below diagonal respectively

Table 4. Heterosis (per cent) for shoot borer infestation (%)

Parents		Surya	APAU Bagmathi	Pusa Uttam	EP 5	EP 12	EP 65	EP104	EP113	MDU1
Surya	**di**	-	33.97**	30.74**	35.12**	16.34	26.19**	6.42	39.98**	52.56**
	dii	-	46.41**	55.60**	37.09*	-12.55	52.27**	18.05	53.72**	59.47**
	diii	-	106.93**	59.33**	88.27**	13.33	52.27**	36.93**	81.60**	106.67**
APAU Bagmathi	**di**	31.20**	-	27.01**	-22.61**	0.04	-4.83	-9.64	20.21*	-12.79
	dii	43.39**	-	67.45**	-14.08	14.71	27.33	10.46	45.37**	0.00
	diii	102.67**	-	71.47**	18.00	48.67**	27.33**	28.13**	71.73**	29.60**
Pusa Uttam	**di**	-34.46**	9.83	-	24.03*	12.18	10.01	18.80	19.35	42.18**
	dii	60.02**	44.79**	-	45.18*	27.08	11.33	26.69	28.52	61.07**
	diii	63.87**	48.27**	-	48.67**	30.13**	11.33	29.73*	31.60**	64.93**
EP 5	**di**	-4.88	-48.58**	-5.23	-	-26.57**	-29.78**	2.32	-28.91**	4.90
	dii	-3.50	-42.91**	10.94	-	-24.38	-16.67	11.72	-23.14	8.02
	diii	32.53**	-21.60	13.60	-	-2.00	-16.67	29.60*	-9.20	40.00**
EP 12	**di**	-11.91**	-39.17**	-15.86	-11.79	-	35.25**	-11.51	-10.98	-6.48
	dii	9.47	-30.24*	-4.69	-14.30	-	55.33	-6.32	-14.92	-0.06
	diii	19.33	-9.60	-2.40	17.73	-	55.27**	8.67	10.27	21.20
EP 65	**di**	-3.54	-32.64**	-5.93	17.08	-10.92	-	2.84	-23.59*	-36.59**
	dii	16.40	-9.86	-4.80	38.93*	2.27	-	11.07	-16.67	-27.20
	diii	16.40	-9.87	-4.80	38.93**	2.27	-	11.07	-16.67	-27.20*
EP 104	**di**	3.83	-29.20**	7.20	4.53	-12.38	-6.79	-	-2.85	50.71**
	dii	15.17	-13.45	14.32	14.14	-7.24	0.01	-	-1.95	59.54**
	diii	33.60	0.40	17.07	32.40**	7.60	0.67	-	-13.73	85.07**
EP 113	**di**	-22.40*	-42.51**	-16.81	31.42**	-6.67	11.74	40.77**	-	69.21**
	dii	-14.79	-30.47	-9.03	-25.85	-2.14	21.87	42.07*	-	77.42**
	diii	0.67	-17.87	-8.27	-12.40	15.60	21.87	64.80**	-	109.60**
MDU 1	**di**	-1.87	2.65	-3.22	-31.77**	-15.64	-9.99	-23.67*	-1.51	-
	dii	2.57	17.69	9.64	-29.73	-0.16	3.33	-19.20**	3.27	-
	diii	32.93**	52.53**	12.27	-8.93	9.33	3.33	-6.27	22.00	-

di= relative heterosis; dii= heterobeltiosis; diii= best parent heterosis
Note: Direct and reciprocal crosses are presented at above and below diagonal respectively
*,**Significant at 5 and 1 per cent level respectively

Table 5. Heterosis (per cent) for fruit borer infestation (%)

Parents		Surya	APAU Bagmathi	Pusa Uttam	EP 5	EP 12	EP 65	EP104	EP113	MDU1
Surya	**di**	-	-9.14	5.20	16.95*	27.34**	1.12	-13.84*	33.14**	35.80**
	dii	-	-4.70	7.224	21.22	44.82**	9.10	-1.50	58.15**	39.27**
	diii	-	0.45	19.47*	40.18**	67.47**	9.06	13.90	82.89**	61.06**
APAU	**di**	28.02**	-	18.56*	74.74**	-17.30**	7.01	33.60**	21.90**	37.15**
Bagmathi	**dii**	34.28**	-	21.94	90.18**	-0.01	9.90	61.03**	52.91**	47.62**
	diii	41.53**	-	28.53**	100.45**	4.50	9.90	69.72**	61.17**	55.60**
Pusa	**di**	59.96**	-2.67	-	65.01**	67.33**	-18.76*	9.91	55.76**	52.40**
Uttam	**dii**	63.03**	0.11	-	74.34**	94.29**	-14.12	28.28*	89.04**	59.29**
	diii	81.65**	5.51	-	94.26**	116.49**	-14.12	42.94**	110.64**	77.49**
EP 5	**di**	56.48**	73.12**	72.08**	-	26.38**	9.42	14.11*	30.58**	93.81**
	dii	62.19**	88.41**	81.81**	-	38.25**	22.57**	25.45**	49.00**	95.83**
	diii	87.56**	98.59**	102.59**	-	71.47**	22.57**	55.60**	84.81**	137.93**
EP 12	**di**	8.00	5.68	16.01**	47.24**	-	25.51**	53.08**	51.14**	-15.97**
	dii	22.82**	26.70**	34.70**	61.07**	-	55.21**	53.78**	57.14**	-7.04
	diii	42.04**	33.54**	50.08**	99.77**	-	55.21**	126.56**	131.51**	12.94
EP 65	**di**	-2.95	-5.64	-22.81**	58.45**	36.79**	-	47.86**	24.79**	19.97**
	dii	4.67	-3.09	-18.40	77.49**	69.16**	-	83.85**	61.62**	32.86*
	diii	4.67	-3.10	-18.40*	77.49**	69.16**	-	83.85**	61.62**	32.86**
EP 104	**di**	11.32	-28.55**	1.64	42.47**	24.98**	-16.54**	-	7.97	51.84**
	dii	27.25*	-13.88	18.64	56.62**	25.55	3.77	-	11.73	68.83**
	diii	47.16**	-9.23	32.19**	94.26**	84.97**	3.77	-	66.12**	105.12**
EP 113	**di**	-3.56	5.55	-17.35**	59.72**	17.05**	-3.76	-32.26**	-	73.96**
	dii	14.55	32.41**	0.00	82.26	21.70*	24.65	-29.90**	-	100.83**
	diii	32.47**	39.56**	11.76	126.06**	79.29**	24.65**	4.22	-	144.01**
MDU 1	**di**	-12.98	-0.25	28.44**	57.14**	26.44**	-22.51**	20.18**	593.84**	-
	dii	-10.75	7.37	34.24**	58.78**	39.88**	-14.18	33.63*	84.53**	-
	diii	3.21	13.17	49.58**	92.91**	69.95**	-14.18	62.35**	124.20**	-

di= relative heterosis; dii= heterobeltiosis; diii= best parent heterosis

Note: Direct and reciprocal crosses are presented at above and below diagonal respectively

*,**Significant at 5 and 1 per cent level respectively

Table 6. Heterosis (per cent) for marketable yield per plant (kg)

Parents		Surya	APAU Bagmathi	Pusa Uttam	EP 5	EP 12	EP 65	EP104	EP113	MDU1
Surya	**di**	-	-12.38**	-34.48**	-28.28**	-29.41**	9.19**	-18.67**	-12.46**	-12.84**
	dii	-	-26.86**	-38.71**	-35.80**	29.63*	-0.51	-24.69**	-13.77**	-15.61**
	diii	-	-26.86**	-52.89**	57.02**	-52.89**	-19.01**	-49.59**	-40.50**	-39.67**
APAU Bagmathi	**di**	-21.29**	-	-41.12**	-49.19**	3.23	-42.14**	-37.89**	-42.30**	-37.83**
	dii	-34.30**	-	-47.93**	-61.16**	-14.05**	-47.52**	-51.24**	-51.24**	-46.69**
	diii	-34.30**	-	-47.93**	-61.16**	-14.05**	-47.52**	-51.24**	51.24**	-46.69**
Pusa Uttam	**di**	-38.51**	-40.19**	-	-22.29**	-50.43**	11.75**	-38.27**	-49.29**	-39.83**
	dii	-42.47**	-47.11**	-	-34.41**	-53.76**	8.63**	-46.24**	-51.88**	-41.94**
	diii	-55.79**	-47.11**	-	-49.59**	-64.46**	11.57**	-58.68**	-63.02**	-55.37**
EP 5	**di**	-25.52**	-38.92**	-24.84**	-	-29.41**	-16.92**	-30.08**	-12.54**	-41.53**
	dii	-33.33**	-53.31**	-36.56**	-	36.65**	-31.47**	-32.61**	-22.75**	-49.13**
	diii	-55.37*	-53.31**	-51.24**	-	-57.85**	-44.21**	-61.57**	-46.69**	-63.64**
EP 12	**di**	-8.98**	-16.87**	-22.19**	-41.18**	-	-31.84**	-44.48**	-33.54**	41.92**
	dii	-9.26**	-30.79**	-27.42**	-47.20**	-	-38.07**	-48.45**	-34.73**	36.99**
	diii	-39.26**	-30.79**	-44.21**	-64.88**	-	-49.59**	-65.70**	-54.96**	-2.07
EP 65	**di**	-7.52**	-22.55**	35.25**	-37.23**	-39.11**	-	-47.46**	-17.58**	-25.41**
	dii	-15.74**	-29.75**	31.47**	-48.22**	-44.67**	-	-55.33**	-23.86**	-29.95**
	diii	-31.40**	-29.75**	7.02**	-57.85**	-54.96**	-	-63.64**	-38.02**	-42.98**
EP 104	**di**	-22.00**	27.89**	-37.65**	-27.82**	-39.13**	-36.12**	-	-38.36**	-43.41**
	dii	-27.78**	0.41	-45.70**	-30.43**	-43.48**	-45.69**	-	-43.71**	-49.13**
	diii	-51.65**	0.41	-58.26**	-60.33**	-62.40**	-55.79**	-	-61.16**	-63.64**
EP 113	**di**	-3.34*	-23.72**	-2.55	-45.08**	-32.93**	-10.44**	-0.98	-	-27.65**
	dii	-4.79**	-35.54**	-7.53**	-51.50**	34.13**	-17.26**	9.58**	-	-28.90**
	diii	-34.30**	-35.54**	-28.93**	-66.53**	-54.55**	-32.64**	-37.60**	-	-49.17**
MDU 1	**di**	19.40***	-24.34**	-14.76**	-14.29**	-35.93**	-22.70**	-30.55**	-25.88	-
	dii	15.61**	-35.12**	-17.74**	-25.43**	-38.15**	-27.41**	-37.57**	-27.17**	-
	diii	-17.36**	-35.12**	-36.78**	-46.69**	-55.79**	-40.91**	-55.37**	-47.93**	-

di= relative heterosis; dii= heterobeltiosis; diii= best parent heterosis

Note: Direct and reciprocal crosses are presented at above and below diagonal respectively

*,**Significant at 5 and 1 per cent level respectively