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Heterosis for yield and shoot and fruit borer incidence in brinjal (*Solanum melongena* L.)

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ABSTRACT

A field study was carried out in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamilnadu, India, during January 2016. With a view to estimate heterosis in brinjal 60 genotypes were collected from various eco-geographical regions. They were subjected to genetic divergent study using Mahalanobis D^2 statistics. Six genotypes were selected as parents who showed greater divergence. They were then subjected to full diallel design of mating. The heterosis was studied for the following fifteen economic characters viz., plant height, primary branches/ plant, secondary branches/ plant, long styled flowers/ plant, medium styled flowers/ plant, short styled flowers/ plant, flowers/ plant, days to first flower, number of flowers/ plant, fruit set percentage, shoot and fruit borer incidence, fruit length, fruit girth, fruit weight and fruit yield/ plant. It was observed that the maximum heterosis for fruit yield per plant was exhibited by P_1 x P_3 (214.53 %) followed by P_1 x P_6 (190.10 %), P_4 x P_5 (129.38 %) and P_2 x P_4 (104.51 %). The cross P_1 x P_3 showed maximum positive and significant heterosis of 11.80 per cent over the standard check while for fruit length desirable, negative heterosis was recorded for the crosses P_1 x P_2 (-27.81 %) and P_1 x P_4 (-17.74 %). Significant and desirable negative heterosis was recorded in two hybrids for shoot and fruit borer infestation, the highest desirable heterosis was recorded for the characters viz., primary branches/ plant, secondary branches/ plant, long styled flowers/ plant, medium styled flowers/ plant, short styled flowers/ plant, flowers/ plant, days to first flower, fruits/ plant, fruit set percentage, shoot and fruit borer incidence, fruit girth, fruit weight and fruit yield/ plant in the cross P_1 x P_3 (-14.36 %) followed by the cross P_1 x P_6 (-10.64) for the characters viz., secondary branches/ plant, long styled flowers/ plant, short styled flowers/ plant, fruits/ plant, fruit set percentage, shoot and fruit borer incidence, fruit girth, fruit weight and fruit yield/ plant. There was high heterosis response in most of the hybrids which supports the role of non-additive gene effects.

Key words: Brinjal, heterosis breeding, yield, shoot and fruit borer incidence

INTRODUCTION

Eggplant, brinjal or aubergine (*Solanum melongena* L.) is a very important common man's vegetable in India. Due to its versatility use in India food, brinjal is often described as the "*King of vegetables*'. The area under its cultivation is 6.80 lakh hectares with a production of 118 lakh tones contributing 8.4 per cent of total area and production. Brinjal was one of the first vegetable crops adopted by farmers as hybrids, which occupied more than 50 per cent area under F1 hybrids in different parts of the country and is a significant source of income approximately 14 lakh small and marginal farmers. Eggplant continues to be a choice of breeders for exploitation of heterosis due to hardy nature of crop, comparatively large size of flowers and large number of seeds in a single act of pollination. Highly varied consumer acceptance from region to region also demands for development of a large number of high yielding F_1 hybrids. Exploitation of hybrid vigor has become a potential tool for improvement in eggplant (Bavage *et al*, 2005; Dharwad *et al* 2011 and Prabhu *et al* 2005). Among the biotic stresses hamper 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 of crop growth. It causes damage to the plant by feeding into tender shoots, flower buds and fruit and makes the fruits to unfit for human consumption and leads to loss in production as well as profit. The percentage of fruit damage due to this pest was reported to vary from 25.82 to as high as 92.50 (Gangwar and Sachan, 1981). Use of some chemical pesticide make the environment polluted as well it effect the human health. Productivity of F_1 hybrid in brinjal is very high as compared to varieties. The growers and consumers are demanding to evolve high yielding hybrids with low incidence of pest. Exploitation of hybrids vigor in brinjal is

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economical as fruit contains a large amount of seeds (Varghes and Vanab, 1994). In view of this requirement, the present study was undertaken to identify the brinjal hybrids with high yielding potential and low incidence of shoot and fruit borer pest. Brinjal offers much scope for improvement through heterosis breeding.

MATERIALS AND METHODS

The experimental material comprised of six pure diverse parents including a commercial check variety (Annamalai 1) *viz*., Thovalai local – (P_1), Pechiparai local –(P_2), Pechiparai-Mothiramalai local - (P_3), IC 127063 – (P_4), IC 316291 – (P_5), Annamalai – 1 – (P_6). Crossings were initiated in Diallel fashion including the reciprocals during March 2015. The resulting 30 F_1 hybrids along with their parents were evaluated during Jan 2016, in a randomized block design with three replications in vegetable area, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai nagar. Each plot had 15 plants spaced at 60 x 45 cm. The observations were recorded on five randomly selected plants from each treatment and replication for fifteen characters viz., plant height, number of primary branches per plant, number of secondary branches per plant, number of long styled flowers per plant, number of medium styled flowers per plant, number of short styled flowers per plant, number of flowers per plant, number of days to 1^{st} flowering, fruit set percentage, number of fruits per plant, shoot and fruit borer incidence (%), fruit length (cm), fruit girth (cm), fruit weight (g) and fruit yield per plant (g). Relative heterosis (RH) expressed as per cent increase or decrease in hybrid (F_1) over its mid parental value, better parent (BP) and standard heterosis (SV) values in the desirable direction was calculated using the following formula.

Per cent of Relative hetetosis (RH) =

$$\frac{\overline{F} - \overline{MP}}{\overline{MP}} \times 100$$

Mid parent (MP) value $= \frac{P1+P2}{2}$

Per cent of Heterobeltiosis (HB) =

$$\frac{\overline{F} - \overline{BP}}{\overline{BP}} \times 100$$

Standard heterosis (SH) = $\frac{\overline{F} - \overline{SV}}{\overline{SV}} \times 100$

Where, $\overline{BP}$ = Mean performance of better parent, $\overline{F_1}$ = Mean performance of F_1 hybrid and $\overline{SV}$ = Standard variety

RESULTS AND DISCUSSION

The magnitude of heterosis over commercial check for different quantitative characters are depicted in Table 1. For plant height, 8 crosses exhibited significant heterosis in desirable direction over standard check. The maximum standard heterosis was recorded by crosses viz., P_3 x P_4 (16.32 %) and P_3 x P_6 (15.41 %). The results are in agreement with Reddy and Patel (2014).Out of 15 crosses, one cross P_1 x P_3 (19.53%) showed significant positive standard heterosis for number of primary branches per plant indicating the predominance of non-additive gene action (Table 1). These results are in conformation with the results of Nalini Dharwad *et al.* (2011) and Reddy and Patel (2014). Number of secondary branches per plant is an important character. Of the 15 crosses, three crosses showed significant and positive standard heterosis for the trait indicating the predominance of non-additive gene action. The cross P_1 x P_3 (33.62 %) showed highest standard heterosis for this trait followed by P_1 x P_6 (22.60 %) and P_4 x P_5 (22.23 %). These results are in conformation with the findings of Nalini Dharwad *et al.* (2011) and Reddy and Patel (2014). More number of flowers per plant among crosses was evident from the recorded positive heterosis in six crosses. The cross P_1 x P_3 showed maximum positive and significant heterosis of 11.80 per cent over the standard check (Table 1). The findings are on line with those of Bavage (2002), Shafeeq (2005), Nalini Dharwad *et al.* (2011) and Reddy *et al.* (2011). Earliness for days to first flower is an important trait which fetches economic importance in the farmers point of view. Earliness is manifested in F1 hybrids and preferred for commercial cultivation when the high yield is coupled with earliness. Based on this, the cross P_1 x P_3 registered less number of days to first flower when compared to both the parents. Hence, this genotype could be selected for further improvement for hybrid breeding programme. Significant negative heterosis was registered by the cross P_1 x P_3 for this trait. These results are in agreement with the findings of Das *et al.*, (2009) and Murthy *et al.*, (2011) in brinjal.

Table 1: Estimates of heterosis over standard check (Annamalai-1) for fifteen characters in brinjal

Crosses	Plant height	Primary branches/ plant	Secondary branches / plant	Long styled flowers/plant	Medium styled flowers/ plant	Short styled flowers / plant	Flowers / plant	Days to I[st] flower
P_1 x P_2	-6.34	15.80	18.59	10.88	1.29	-8.20	2.83	6.59
P_1 x P_3	-8.88	19.53*	33.62**	31.13**	22.95*	-31.93**	11.80*	-9.74*
P_1 x P_4	-5.91	15.89	18.72	13.29*	4.37	-16.26	4.16	-1.95
P_1 x P_5	-6.75	15.71	18.45	13.70*	4.31	-11.69	4.08	1.83
P_1 x P_6	-7.49	17.17	22.60**	26.48**	17.85	-27.59*	9.41	-9.62
P_2 x P_3	7.42**	5.90	-4.60**	11.57	-12.79	-4.91	-0.36	21.79*
P_2 x P_4	8.98	16.17	19.00	13.86	5.08	-18.90	4.10	-3.74
P_2 x P_5	8.88*	0.36	-16.36	1.03	-11.83	-3.26	-4.09	17.83**
P_2 x P_6	6.76**	7.36	6.20	11.57	-12.69	-4.91	-0.33	36.72**
P_3 x P_4	16.32**	-30.88	-30.11	4.63*	-1.84	-16.71*	-4.72	6.11
P_3 x P_5	15.27**	-22.71	-27.02	7.28*	0.14	-14.86	-2.61	6.32
P_3 x P_6	15.41**	-26.16	-23.51**	5.62	0.08	-15.52	-3.47	6.27
P_4 x P_5	-1.67	16.53	21.23**	26.08**	14.15	-26.68	8.16	-4.88
P_4 x P_6	3.09*	5.36	-4.74	11.44	-13.64	-14.91	-4.23	-0.12
P_5 x P_6	7.77**	4.36	-7.33	8.42	-5.16	-10.75	-0.89	14.74

Significant at 5% level* * Significant at 1% level*

Out of fifteen crosses 13 crosses viz., P_1xP_3, P_1xP_4, P_1xP_5, P_1xP_6, P_2xP_3, P_2xP_4, P_2xP_6, P_3xP_4, P_3xP_5, P_3xP_6, P_4xP_5, P_4xP_6 and P_5xP_6 showed positive significant heterosis for number of fruits per plant over the commercial check, thus showing the role of non-additive gene action and wide range of heterosis. The cross P_1 x P_3 showed maximum positive heterosis of 52.53 per cent over the commercial check. Similar findings were also reported by Prabhu *et al.*, (2005), Chowdhury *et al.* (2010) and Reddy and Patil (2014). Of 15 crosses, ten crosses viz., P_1xP_3, P_1xP_4, P_1xP_6, P_2xP_3, P_2xP_4, P_3xP_4, P_3xP_5, P_3xP_6, P_4xP_5 and P_4xP_6 exhibited positively significant heterosis over the standard check. The data suggest that dominant gene action had its influence on fruit set percentage. The cross P_1 x P_3 showed maximum positive heterosis of 36.39 per cent over the standard check (Table 2). All heterotic crosses had both or either of the parent's superior over standard check. Similar findings have also been reported by Nalini Dharwad *et al.* (2011), Reddy *et al* (2011) and Reddy and Patil (2014).

Negative heterosis was considered desirable for identifying resistant hybrids against shoot and fruit borer infestation. Significant and desirable heterosis was recorded in two hybrids. The highest desirable heterosis was recorded in the cross P_1 x P_3 (-14.36 %) followed by the cross P_1 x P_6 (-10.64) (Table 2). These results are akin to the findings of Prabhu *et al.* (2005), Kamalakkannan *et al.* (2007), Vaddoria *et al.* (2009) and Ramani *et al.* (2015). Fruit length and fruit girth are important parameters for deciding consumer preference. In South India, high fruit length is not preferred. Therefore, the crosses showing negative heterosis are useful. For fruit length desirable negative heterosis was recorded for the crosses P_1 x P_2 (-27.81 %) and P_1 x P_4 (-17.74 %). Majority of the crosses showed negative heterosis over standard check. These are in conformity with the studies of Shafeeq (2005), Timmapur *et al.* (2008) and Chowdhury *et al.* (2010). For fruit girth crosses showing positive heterosis are useful. All the crosses showed positive significant heterosis for this trait. Maximum desirable positive heterosis was recorded for the cross P_1 x P_3 (79.49 %) followed by the cross P_1 x P_6 (75.21 %) (Table2). Similar reports have been made by Nalini Dharwad *et al.* (2011) and Reddy and Patel. (2014). For fruit weight per plant, out of fifteen crosses, thirteen crosses viz., P_1xP_2, P_1xP_3, P_1xP_4, P_1xP_5, P_1xP_6, P_2xP_3, P_2xP_4, P_2xP_5, P_2xP_6, P_3xP_5, P_4xP_5, P_4xP_6 and P_5xP_6 showed positive and significant heterosis over the standard check. The cross P_1 x P_3 (108.24 %)

Table 2: Estimates of heterosis over standard check (Annamalai-1) for fifteen characters in brinjal

Crosses	Number of fruits / plant	Fruit set percentage	Shoot and fruit borer incidence	Fruit length	Fruit girth	Fruit weight	Fruit yield / plant
P_1 x P_2	17.90	14.51	8.36**	-27.81**	68.96**	49.17**	73.95**
P_1 x P_3	52.53**	36.39**	-14.36**	3.26	79.49**	108.24**	214.53**
P_1 x P_4	26.09**	21.08*	5.24	-17.74*	31.04**	49.34**	88.58**
P_1 x P_5	22.70**	17.96	6.93**	-11.46	64.58**	53.94**	87.30**
P_1 x P_6	47.97**	34.98**	-10.64*	-2.46	75.21**	98.09**	190.10**
P_2 x P_3	12.31**	12.48**	16.47**	-32.19	69.55**	36.28**	51.67**
P_2 x P_4	31.46**	26.32*	-3.32	-4.09	70.70**	55.42**	104.51**
P_2 x P_5	2.56	7.66	53.16**	-26.80	70.38**	49.91**	52.35**
P_2 x P_6	14.10*	15.17	16.27**	-21.26	69.32**	53.40**	73.57**
P_3 x P_4	16.65**	22.70**	81.21**	-13.21	40.88**	-12.75**	0.63**
P_3 x P_5	16.54**	20.04**	78.48**	-12.38	43.98**	15.41**	33.67**
P_3 x P_6	24.24**	28.57**	78.95**	-12.47	43.58**	-12.08	8.48*
P_4 x P_5	40.11**	29.86**	-10.45	-3.55	71.43**	68.21**	129.38**
P_4 x P_6	8.87**	14.44**	12.07**	-21.23	14.22**	47.12**	58.93**
P_5 x P_6	8.74*	9.58	37.53**	-13.21	62.57**	45.34**	56.56**

**Significant at 5% level   ** Significant at 1% level*

recorded maximum positive significant heterosis followed by the cross P_1 x P_6 (98.09 %). Similar views were also put forth by Suneetha *et al.* (2008), Timmapur *et al.* (2008) and Chowdhuary *et al.* (2010).

Fruit yield per plant cannot be taken as a single entry; since it is associated with many yield attributing characters. For fruit yield per plant all the crosses exhibited significant and positive heterosis over the standard check. The hybrids with high *per se* performance also registered high heterotic effect. The maximum heterosis for fruit yield per plant was exhibited by P_1 x P_3 (214.53 %) followed by P_1 x P_6 (190.10 %), P_4 x P_5 (129.38 %) and P_2 x P_4 (104.51 %). These hybrids could be considered for exploitation of heterosis. These results are in conformation of the findings of Prabhu *et al.* (2005), Suneetha *et al.* (2008), Nalini Dharwad *et al.* (2011), Reddy *et al.* (2011), Pachiyappan *et al.* (2012) and Sivakumar *et al.* (2017). The high heterotic response observed in most of the hybrids further supported the predominant role of non-additive component in the characters studied.

From the present investigation, it may be concluded that the hybrids viz., P_1 x P_3 and P_1 x P_6 which showed high heterosis for most of the yield component characters have been selected for commercial utilization based on its standard heterosis performance.

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