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Heterosis for earliness and yield contributing traits in brinjal (*Solanum melongena* L.)

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Abstract
The present investigation was conducted to found out the magnitude of the heterosis in brinjal. Eight parents were crossed in diallel excluding reciprocal to developed 28 crosses. The hybrids al song with parents were evaluated in 2 consecutive years. The data were recorded on plant height, number of primary branches per plant, days to 50% flowering, days to first fruit harvest, harvest duration, average fruit weight, marketable fruit yield, which are contributing earliness and yield. For days to 50% flowering, and days to first fruit harvest maximum negative standard heterosis, and heterobeltiosis, were shown by cross combination P_5 x P_7 and P_3 x P_8, respectively. For days to first fruit harvest, high magnitude of standard heterosis and heterobeltiosis were shown by P_5 x P_7. For marketable fruit yield, high magnitude of standard heterosis and heterobeltiosis were shown by P_1 x P_8. The cross combination of P_5 x P_7 and P_2 x P_7 were found promising for earliness and yield. The cross combination utilizing inbred P_1, P_2, P_6, and P_8 were prosing, therefore these parental lines could be used for development hybrids for early and high yield.

Keywords: Heterosis, heterobeltiosis, brinjal, earliness, yield

Introduction
Eggplant (*Solanum melongena* L. 2n=24) or brinjal is a important solanaceous vegetable, which is known by various name in India *viz.*, Baigan (Hindi), Badanekai (kannada), Vangi (Marathi), Kathirikai (Tamil), Vankai (Telugu) and worldwide known as aubergine (France) or guinea squash. Brinjal is one of the most popular and major vegetable crop in India and some other parts of the world. It is a self-pollinated and annual herbaceous crop, probably originated in India and shows secondary diversity in South East Asia. It is being grown extensively in India, Bangladesh, Pakistan, China, Japan, Philippines, France, Italy and U.S.A. In India, brinjal occupies an area of 6.62 lakh ha with annual production of 125.88 lakh metric tonnes & productivity stand at 18.9 metric tons per hectares. In Uttar Pradesh, Agra, Meerut, Lucknow, Kanpur, Aligarh, Chitrakoot and Gorakhpur districts having maximum area and production (Annonymous, 2016) [1].

The heterosis breeding programme mainly depends on the choice of superior parents for hybridization and the knowledge of combining ability and magnitude of gene action involved in the expression of component traits. Among the various mating designs diallel cross techniques has been most frequently used to determine general and specific combining ability variances and their effects in brinjal (Bavage *et al.* 2005; Panda *et al.* 2005; Suneetha *et al.* 2006 & Hazra *et al.* 2010) [4, 11, 13, 7]. Hence this study was conducted to develop brinjal hybrid with early and higher yield.

Materials and Methods
Field experiment was conducted at (MES) Department of Vegetable Science, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) India. The materials for the present investigation comprised of 8 divers genotype of brinjal viz.; Siliguri (P_1), Mukta Kesi (P_2), Pant Rituraj (P_3), NDW-White-1 (P_4), Punjab Sadabahar (P_5), NDB-S-1-1 (P_6), KS-224 (P_7) and NDB-3 (P_8). The genotypes were crossed in the all possible combinations, excluding reciprocals to develop 28 hybrid combinations. The 28 Hybrids along with parents were evaluated for two successive years in 2016-17 and 2017-18 *kharif* season in Randomized Block Design with three replications. The crop was planted in rows spaced at 1.5 x 3.0 meters apart with a plant to plant spacing of 75 x 50 (cm). The analysis of heterosis was done over better parent and standard variety for days to 50% flowering, plant height (cm), number of

primary branches per plant, 50% flowering, days to first fruit harvest, average fruit weight (g) and marketable fruit yield per plant (kg).

Results and Discussion

The analysis of variance showed significant differences due to treatments for all the characters except days to 50% flowering, number of primary branches, days to first fruit harvest for parent vs their F_1 hybrids (Table 1) indicating that materials used in this study have good amount of variation. The range of heterosis over better parent varied between -35.48% to 34.81% for plant height, -45.90% to 59.34% for number of primary branches per plant, -11.16 to 39.49% for days to 50% flowering, -19.55% to 55.20% for days to first fruit harvest, -39.24% to 62.36% for average fruit weight and -47.23% to 109.20 marketable fruit per yield. The heterosis over standard variety ranged between -35.48% to 34.81% for plant height, -25.17% to 36.46% for number of primary branches per plant, -54.11% to 50.15% for days to 50% flowering, -19.56% to 51.75% for days to first fruit harvest, -22.63% to 45.56% for average fruit weight and -46.23% to 85.74 marketable fruit per yield (Table 2). For plant height, the highest magnitude of heterosis over better parent was recorded in cross combination $P_2 \times P_7$ (34.81%) followed by $P_3 \times P_3$ (31.74%), and P_3 x P_8 (30.83%). Whereas, cross combination P_4 x P_5 (60%) was had maximum heterosis followed by P_4 x P_6 (47.26%) and P_3 x P_8 (47.03 %) over standard variety in Y1. In Y2, for plant height, the highest magnitude of heterosis over better parent was recorded in cross combination $P_2 \times P_7$ (37.32%) followed by $P_1 \times P_2$ (34.68%), and P_1 x P_5 (33.66%). In Y_1, for number of primary branches per plant, out of 28 crosses, best three significant positive and desirable heterosis possessed by crosses P_4 x P_7 (59.34%) followed by P_6 x P_7 (43.94%) and P_5 x P_7 (30.20) over better parent and P_4 x P_7 (36.46%) followed by P_5 x P_7 (30.20%) and P_3 x P_4 (29.25%) over standard variety. In Y_2, for number of primary branches per plant, among the cross combinations best three crosses were P_5 x P_8 (50.15%) followed by P_2 x P_5 (45.07%) and P_2 x P_8 (24.27%) over better parent and P_3 x P_4 (85.58%) followed P_2 x P_5 (82.48%) and P_2 x P_7 (70.80%) over standard variet (Das *et al*. 2009) [5].

In Y_1 for days of 50% flowering, best three significant positive and desirable heterosis possessed by crosses P_2 x P_5 (-11.16%) followed by P_5 x P_8 (-2.93%) and P_1 x P_3 (-1.95%) over better parent and P_2 x P_5 followed by P_1 x P_3 and P_1 x P_2 over standard variety. While in Y_2, best three crosses were P_2 x P_5 (-21.22%) followed by P_3 x P_6 (-8.84%) and P_4 x P_7 (-5.44%) over better parent and P_1 x P_3 (-18.23%), P_4 x P_7 (-13.09%) and P_2 x P_8 (-12.90%) over standard variety. The maximum heterosis in Y1 recorded for days to first fruit harvest in the cross combination P_5 x P_7 (-19.55%) followed by P_5 x P_8 (-12.26%) and P_3 x P_8 (-8.28%) over better parent and P_5 x P_7 (-19.56%) followed by P_5 x P_8 -(-8.70%) and P_5 x P_6 (-6.53%) for over standard variety, whereas in Y2, maximum heterosis was recorded in the cross combination P_6 x P_7 (-17.30%) followed by P_5 x P_8 (-9.77%) and P_5 x P7 (-9.99 %) over better parent and P_6 x P_8 (-6.51%) followed by P_5 x P_7 (-5.88%) and P_6 x P_7 (-1.90%) for over standard variety (Parmila *et al*. 2017). For average fruit weight, in Y1, the highest heterosis over better parent was recorded in P_4 x P_8 (62.36%) followed by P_6 x P_8 (55.27%) and P_1 x P_6 (48.46%) (Ansari *et. al*. (2017) [2], whereas, over standard variety cross combination P_3 x P_5 (45.56%), P_5 x P_7 (42.19%) and P_1 x P_6 (32.96%) exhibited the maximum heterosis. Highest magnitude of heterosis in Y2 for average fruit weight over better parent was recorded in P_1x P6 (74.67%) followed by P_6 x P_8 (59.48%) and P_4 x P_8 (49.63%), whereas, over standard variety cross combination P_1 x P_6 (42.42%), P_2 x P_7 (37.48%) and P_3 x P_5 (34.58%) exhibited the maximum heterosis

In Y1, for average marketable fruit yield, the highest heterosis over better parent was recorded in P_2 x P_7 (109.20%) followed by P_2 x P_6 (71.67%) and P_2 x P_4 (55.56%). Whereas, over standard variety cross combination P_1 x P_6 (85.74%), P_1 x P_8 (82.55%) and P_3 x P_4 (73.40%) exhibited the maximum heterosis. In Y2, the highest heterosis over better parent was recorded in P_2 x P_7 (135.04%) followed by P_3 x P_4 (100.0%) and P_2 x P_3 (75.56%). Whereas, over standard variety cross combination P_1 x P_8 (142.89%), P_1 x P6 (132.74%) and P_2 x P7 (132.74%) exhibited the maximum heterosis. The results are in conformity with those obtained by (Reddy and Patel 2014 and Baraskar *et al.* 2016) [3]. The present study revealed that the inbred P_1, P_2, P_6, and P_8 could be used as parental lines for development of hybrid for yield and earliness traits. The F_1 hybrids from the crosses P_5 x P_7 and P_2 x P_7 were found promising for earliness and yield. This hybrid may be tested further for earliness and high yielding traits under different agro-climatic conditions before commercialization.

Table 1: Analysis of variance of 8 x 8 diallel progenies for six characters in during Bothe the year

Source of variation	Year	DF	Plant height (cm)	Number of Primary branches per plant (cm)	Days to 50% flowering	Days to first fruit harvest	Average fruit weight	Marketable fruit yield per plant(kg)
Replications	Y_1	2	1.93**	0.17	1.91	6.28	14.57	1.65
	Y_2	2	3.73	0.20	2.60	12.95	22.76	0.88
Treatments	Y_1	35	352.60**	5.45**	32.93**	257.01**	2429.73**	7.70**
	Y_2	35	332.68**	9.75**	37.66**	142.21**	2901.65**	9.26**
Parents	Y_1	7	399.84**	8.29**	8.58**	10.30*	3304.84**	4.00**
	Y_2	7	439.48**	10.25**	23.58**	36.08**	5193.14**	4.63**
F_1s	Y_1	27	294.94**	4.81**	35.64**	299.10**	1845.42**	6.94**
	Y_2	27	244.10**	9.97**	40.05**	162.32**	2181.77**	7.69**
P v F_1	Y_1	1	1578.67**	2.98**	130.39**	847.48**	12080.04**	54.01**
	Y_2	1	1976.59**	0.64	71.70	342.19	6298.05**	83.886**
Error	Y_1	70	42.62	0.21	1.63	3.65	188.38	1.00
	Y_2	70	8.175	0.31	13.34	4.19	18.17	3.27

Y1= Kharif 2016-17, Y2= Kharif 2017-18;

Table 2: Best crosses selected on the basis of heterosis for six characters

Characters	Seasons	Best three croos combination over		Range over	
		BP	SV	BP	SV
Plant height (cm)	Y_1	P_2xP_7, P_3xP_7, P_3xP_8	P_4 x P_5, P_4 x P_6, P_3 x P_8	34.81	48.25
	Y_2	P_2xP_7, P_1xP_2, P_1xP_5	P_4 x P_5, P_3 x P_5, P_2 x P_7	47.16	53.02
Number of primary branches per plant	Y_1	P_4xP_7, P_6xP_7, P_5xP_7	P_4 x P_7, P_5 x P_7, P_3 x P_4	59.34	36.46
	Y_2	P_5xP_8, P_2xP_5, P_2xP_8	P_3x P_4, P_2 x P_5, P_2 x P_7	50.15	85.58
Days to 50% flowering	Y_1	P_2xP_5, P_5xP_8, P_1xP_3	P_2 x P_5, P_1 x P_3, P_1 x P_2	-11.16	-21.22
	Y_2	P_2xP_5, P_3xP_6, P_4xP_7,	P_1 x P_3, P_4 x P_7,P_2 x P_8	-13.55	-18.23
Days to first fruit harvest	Y_1	P_5xP_7, P_5xP_8, P_3xP_8	P_5 x P_7, P_5 x P_8, P_5 x P_6	-19.55	-19.56
	Y_2	P_6xP_7, P_5xP_8, P_5xP_7	P_6 x P_8, P_5 x P_7, P_6 x P_7	-17.30	-6.51
Average fruit weight	Y_1	P_4xP_8, P_6xP_8, P_1xP_6	P_3 x P_5, P_5 x P_7, P_1 x P_6	62.36	45.56
	Y_2	P_6xP_8, P_4xP_8, P_1xP_6	P_1 x P_6, P_2 x P_7, P_3 x P_5	59.48	42.42
Marketable fruit yield per plant(kg)	Y_1	P_2xP_7, P_2xP_6, P_2xP_4	P_1 x P_6, P_1 x P_8, P_3 x P_4	109.20	85.74
	Y_2	P_2xP_7, P_3xP_4, P_2xP_3	P_1 x P_8, P_1 x P_6, P_2 x P_7	135.0	142.89

Y_1= Kharif 2016-17, Y_2= Kharif 2017-18; BP=Better parent, SV= standard variety

Parent used in this study P_1 =Siliguri, P_2=Mukta Kesi, P_3= Pant Rituraj, P_4= NDW-White-1 (P_5) = Punjab Sadabahar, (P_6) = NDB-S-1-1, (P_7) = KS-224 and (P_8) =NDB-3

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