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Heterosis for fruit yield and its quality characters in brinjal (*Solanum melongena* L.)

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Abstract
Ten genetically diverse parental lines, their 45 hybrids of brinjal obtained through half diallel and one standard check GABH 3 were studied to investigate extent of heterosis over better parent and standard check for fruit yield and its quality characters. The analysis of variance revealed hybrids differed significantly among themselves for all the characters under study. Appreciable heterosis was recorded over better parent and standard check for all the traits studied. In order of merit, significantly the highest heterobeltiosis and standard heterosis for fruit yield per plant was recorded with hybrid Doli 5 × Kashi Taru (63.54%) and GBL 1 × Doli 5 (48.28%), respectively. For the quality traits, the estimates of heterotic effects were low to moderate for all the characters except total phenol. The greater magnitude of heterobeltiosis for various characters indicated the differences in the performance between the parental lines and the hybrids. The moderate estimates of heterosis also suggested evidence for unidirectional dominance. Also, significant desirable heterotic effects for ascorbic acid and total anthocyanin (higher *per se* performance and standard heterosis) were also registered in the hybrid GBL 1 × Doli 5. The other top ranking hybrids were JBL 10-08-07 × AB 13-03, JBL 10-08-07 × GP-BRJ-216, JBL 10-08-07 x Kashi Taru and GAOB 2 × JBL 10-08-01 depicted higher and significant estimates of heterobeltiosis as well as standard heterosis for fruit yield per plant and desirable heterosis for different two to three quality traits. These crosses may be exploited for commercial cultivation and may also be advanced as those would likely to yield superior transgressive segregants for the improvements nutraceutical traits**.**

Keywords: Dialle cross, brinjal, fruit yield, quality traits, heterosis

Introduction
Brinjal or eggplant (*Solanum melongena* L.) is an important commercial vegetable in India. India is considered as the primary centre of origin of brinjal (Vavilov, 1931) [16]. It is the most consumed crop in India where it accounts for about 13.558 million tonnes production of brinjal from an area of 0.711 million hectares under cultivation with a productivity of 19.06 MT/ha (Anon., 2014) [1]. Major brinjal producing states are West Bengal, Orissa, Bihar and Gujarat. Although it is a self- compatible and highly self -pollinating crop, yet cross pollination to the extent of 30 to 40% has also been reported in Bulgaria. To obtain high fruit yield per unit area, exploitation of hybrid vigour is one of good way in this crop. There is prerequisite to bread genotypes with improved nutritional quality. The present investigation therefore was under taken to identify the best hybrid combination for exploitation of superior hybrids or isolate desirable segregants in subsequent generations for developing pure line variety/hybrid with good quality in brinjal.

Materials and Methods
Ten diverse parents *viz.*, GAOB 2, GBL 1, Doli 5, Punjab Sadabahar, JBL 10-08-07, JBL 10-08-01, AB 13-03, Kashi Taru, GP-BRJ-215 and GP-BRJ-216 were selected and crossed with all possible combinations (45 F_1) excluding reciprocals during *Kharif – Rabi* 2015-16. The experimental material consisted of 56 genotypes comprising of ten parents, their 45 hybrids and one standard check GABH 3. The experimental material was evaluated under randomized complete block design (RCBD) with two replications at Main Vegetable Research Station, Anand Agricultural University, Anand during *Kharif – Rabi* 2016-17. Each entry was grown in a single row of 4.80 m length keeping row to row 90 cm and plant to plant 60 cm distance. The recommended agronomic practices were followed to raise the experimental crop. The observations were recorded on five randomly selected plants for each treatment in each replication for fruit yield and random sample from plants for its eight quality characters *viz*., dry matter (Awasthi and Dixit, 1986) [2], total phenol (Malik and Singh, 1980) [10], ascorbic acid (Sadasivam and Manickam, 2008) [14], total soluble sugars (Dubois *et al*., 1956) [5], total anthocyanin (Ranganna, 1976) [13], acidity (Ranganna, 1976) [13] and total soluble solids (^{0}Brix)

by using hand refractometer (ERMA, Tokyo, Japan, Range 0-32%). The statistical analysis was done as per Panse and Sukhatme (1978) [9]. The magnitude of per cent heterosis of F_1 over better parent (BP) was estimated as per procedure suggested by Fonseca and Patterson (1968) [7], while magnitude of per cent heterosis of F_1 over standard check was estimated as per procedure suggested by Meredith and Bridge (1972) [11].

Results and Discussion

The analysis of variance revealed that mean squares due to genotypes were significant for all the characters indicating existence of considerable amount of variability among the genotypes for all the characters under study (Table 1). The further partitioning of the genotypic variance revealed that parents differed significantly among themselves for all the characters except total soluble solids (^{0}Brix), while hybrids differed statistically among themselves for all the characters. This indicated the existence of considerable amount of genetic variability among the parents for all the characters except total soluble solids and hybrids for all the characters under study. The parents *vs.* hybrids contrast comparisons were significant for all the attributes except dry matter and total phenol suggesting that parents and hybrids differed statistically for all the traits and consequently the evidence for the existence of hybrid vigour.

The range of heterosis for different traits are presented in Table 2. The *per se* performance, heterobeltiosis and standard heterosis of the top ranking three crosses for eight characters are given in Table 3.

The estimates of heterobeltiosis for fruit yield per plant ranged from -49.52 to 63.54 per cent. The hybrid Doli 5 × Kashi Taru (63.54%) exhibited the highest heterobeltiosis followed by JBL 10-08-07 × AB 13-03 (62.28%). With considering significant heterobeltiosis, other promising hybrids were GBL 1 × Doli 5 (62.22%), JBL 10-08-07 × GP-BRJ-216 (56.78%) and JBL 10-08-07 × Kashi Taru (46.07%). While, the standard heterosis ranged from -45.63 to 48.28 per cent. The hybrid GBL 1 × Doli 5 (48.28%) exhibited significant the highest standard heterosis followed by JBL 10-08-07 × GP-BRJ-216 (42.04%), GAOB 2 × JBL 10-08-01 (33.67%), GBL 1 × GP-BRJ-216 (30.50%) and GBL 1 × AB 13-03 (29.39%). The estimates of heterobeltiosis effects were moderate in negative direction while high in positive direction, where as the standard heterosis effects were moderate in both the directions. The results are congruent with the findings of Ramani *et al.* (2015) [12] for heterobeltiosis (HB) and standard heterosis (SH).

For processing purposes, the fruits should have high dry matter content. In case of this trait, the heterotic effect in respect to better parent varied from -28.75 to 36.41 per cent. The F_1 GAOB 2 × Punjab Sadabahar (36.41%) depicted the highest heterobeltiosis followed by JBL 10-08-07 × JBL 10-08-01 (13.57%) and JBL 10-08-01 × GP-BRJ-216 (10.33%). The estimates of standard heterosis ranged from -34.63 to 9.96 per cent. The F_1 JBL 10-08-01 × GP-BRJ-216 (9.96%) registered with the highest standard heterosis followed by JBL 10-08-07 × AB 13-03 (8.63%) and AB 13-03 × GP-BRJ-216 (0.95%). The estimates of heterobeltiosis were moderate in both the directions, while standard heterosis estimates were moderate in negative direction and low in positive direction. The results were akin to those of Suneetha *et al.*, 2008 [15] for HB and SH.

Phenols are the extremely abundant plant allelochemicals, often associated with feeding deterrence of growth inhibition of herbivores. For processing purposes, the fruit should have a low level of phenolics (Dhruve *et al*., 2014) [4]. For this trait, the negative heterosis depicting low phenol content is desirable. The magnitude of heterobeltiosis ranged between -1.63 to 7.97 per cent. The hybrid GAOB 2 × GBL 1 (-1.63%) manifested the least estimate of heterobeltiosis followed by GAOB 2 × JBL 10-08-07 (-1.11%) and GBL 1 x GP-BRJ-216 (0.67%). The spectrum of variation for total phenol was ranged between -3.83 to 10.49 per cent in standard heterosis. The hybrid GAOB 2 × JBL 10-08-07 (-3.83%) exerted the least estimate of standard heterosis followed by JBL 10-08-07 × JBL 10-08-01 (-3.59%) and GAOB 2 × JBL 10-08-01 (-3.32%). The results of present study revealed that the estimates of heterobeltiosis and standard heterosis were low in both the directions. The results are in disagreement with reports of Suneetha *et al*., 2008 [15].

Generally, the higher ascorbic acid content would increase the nutritive value of fruits. The heterobeltiosis was in the range of -42.37 to 22.39 per cent for the trait ascorbic acid. The hybrid JBL 10-08-07 × GP-BRJ-216 (22.39%) ranked first followed by GP-BRJ-215 × GP-BRJ-216 (9.71%) and AB 13-03 × GP-BRJ-216 (9.26%). The quantum of standard heterosis ranged from -41.27 to 24.74 per cent. The hybrid GAOB 2 × GBL 1 (24.74%) exerted the highest standard heterosis followed by, GBL 1 × Doli 5 (23.17%) and Doli 5 × JBL 10-08-07 (19.22%). The estimates of heterobeltiosis and standard heterosis were moderate in both the directions. The results are in accordance with the findings of Kumar *et al.*, 2012 [8] for HB and SH.

For the quality character total soluble sugars, the heterotic effect in respect to better parent varied from -30.37 to 22.50 per cent. The F_1 Kashi Taru × GP-BRJ-215 (22.50%) depicted the highest heterobeltiosis followed by JBL 10-08-07 × GP-BRJ-216 (17.84%) and JBL 10-08-07 × GP-BRJ-215 (17.30%). For standard heterosis, the estimates ranged from -26.00 to 27.73 per cent. The F_1 GAOB 2 × JBL 10-08-01 (27.73%) ranked first followed by JBL 10-08-01 × GP-BRJ-216 (21.32%) and JBL 10-08-07 × JBL 10-08-01 (13.86%). The estimates of heterobeltiosis and standard heterosis were moderate in both the directions. The findings are in conformity with report of Biswas *et al.* (2013) [3] for BH and SH.

The ability of anthocyanins to scavenge free radicals has been primarily related to the catechol functionof *B*– ring (Eva *et al*., 2006) [6]. The estimates of heterobeltiosis ranged from -99.28 to 8.56 per cent for the total anthocyanin content. The hybrid Punjab Sadabahar × GP-BRJ-215 (8.56%) registered the highest heterobeltiosis, followed by Punjab Sadabahar × JBL 10-08-01 (-1.64%) and GAOB 2 × GBL 1 (-2.24%). The minimum and maximum estimates of standard heterosis were -99.92 and 17.76 per cent, respectively. The highest standard heterosis was exerted by Doli 5 × Punjab Sadabahar (17.76%) followed by GBL 1 × Doli 5 (13.22%) and Punjab Sadabahar × GP-BRJ-215 (8.36%). The results of present investigation revealed that the estimates of heterobeltiosis were high in negative direction and low in positive direction. For standard heterosis, those were high in negative direction and moderate in positive direction.

For acidity content, low value is desirable. The heterobeltiosis was in the range of -45.65 to 139.13 per cent. The hybrid Punjab Sadabahar × GP-BRJ-216 (-45.65%) manifested the least estimate of heterobeltiosis followed by Punjab Sadabahar × AB 13-03 (-40.35%) and GP-BRJ-215 × GP-BRJ-216 (-39.13%). The quantum of standard heterosis ranged from 0.01 to 204.00 per cent. The hybrid Punjab

Sadabahar × GP-BRJ-216 (0.01%) had least estimate of standard heterosis followed by GP-BRJ-215 × GP-BRJ-216 (12.00%) and GAOB 2 × GBL 1 (16.00%).

In case of total soluble solids, the minimum and maximum estimates of heterobeltiosis were -11.27 and 16.18 per cent, respectively. The hybrid GAOB 2 × JBL 10-08-07 (16.18%) exhibited the highest heterobeltiosis followed by GAOB 2 × JBL 10-08-01 (16.09%) and Doli 5 × GP-BRJ-216 (10.95%). The estimates of standard heterosis for total soluble solids ranged from -10.00 to 18.99 per cent. The hybrid Doli 5 × GP-BRJ-216 (18.99%) exhibited the highest standard heterosis followed by GAOB 2 × JBL 10-08-01 (16.09%) and GAOB 2 × JBL 10-08-07 (14.49%). The estimates of heterobeltiosis and standard heterosis were low in negative direction and moderate in positive direction. The findings are in conformity with reports of Ramani *et al.*, 2015 [12] for SH.

Table 1: Analysis of variance (mean squares) for various characters in brinjal

Source of variations / Characters	d.f.	Fruit yield per plant	Dry matter	Total phenol	Ascorbic acid	Total soluble sugars	Total anthocyanin	Acidity	Total soluble solids
Replication	1	0.47	0.13	1.00	0.26	0.01	0.61	0.009	0.04
Genotypes	55	1.61**	2.27**	25.29**	7.76**	0.24**	1380.72**	0.007*	0.13**
Parents	9	1.18**	3.17**	37.63**	9.57**	0.17**	2563.89**	0.00955*	0.06
Hybrids	44	1.54**	2.09**	23.68**	7.61**	0.26**	1139.04**	0.00586*	0.15**
Parents *Vs.* Hybrids	1	10.18**	0.02	0.19	3.17**	0.14**	626.66**	0.00796*	0.22*
Check *Vs.* Hybrids	1	0.38	3.96**	10.77	3.04**	0.02	2258.87**	0.016*	0.001
Error	55	0.41	0.09	3.86	0.19	0.01	1.12	0.001	0.03

*, ** significant at 5% and 1% levels of probability, respectively.

Table 2: Range of heterosis for various characters in brinjal

Sr. No.	Characters	Range of heterosis (%)		No. of crosses which displayed significant heterosis			
		Heterobeltiosis (HB)	Standard heterosis (SH)	HB		SH	
				+Ve	-Ve	+Ve	-Ve
1	Fruit yield per plant (kg)	-49.52 to 63.54	-45.63 to 48.28	9	1	5	2
2	Dry matter (mg/100mg)	-28.75 to 36.41	-34.63 to 9.96	5	22	2	38
3	Total phenol (mg/100g)	-1.63 to 7.97	-3.83 to 10.49	13	0	20	2
4	Ascorbic acid (mg/100g)	-42.37 to 22.39	-41.27 to 24.74	2	28	8	27
5	Total soluble sugars (%)	-30.37 to 22.50	-26.00 to 27.73	12	18	9	17
6	Total Anthocyanin (mg/100g)	-99.28 to 8.56	-99.92 to 17.76	1	40	4	38
7	Acidity (%)	-45.65 to 139.13	0.01 to 204.00	19	17	43	0
8	Total soluble solids (^{0} Brix)	-11.27 to 16.18	-10.00 to 18.99	3	2	6	0

Table 3: Best three heterotic crosses for different traits in brinjal.

Characters	Top ranking hybrids		
	Per se	**HB**	**SH**
Fruit yield per plant (kg)	GBL 1 × Doli 5 (6.73)	Doli 5 × Kashi Taru (63.54)	GBL 1 × Doli 5 (48.28)
	JBL 10-08-07 × GP-BRJ-216 (6.44)	JBL 10-08-07 × AB 13-03 (62.28)	JBL 10-08-07 × GP-BRJ-216 (42.04)
	GAOB 2 × JBL 10-08-01 (6.06)	GBL 1 × Doli 5 (62.22)	GAOB 2 × JBL 10-08-01 (33.67)
Dry matter (mg/100mg)	JBL 10-08-01 × GP-BRJ-216 (11.59)	GAOB 2 × Punjab Sadabahar (36.41)	JBL 10-08-01 × GP-BRJ-216 (9.96)
	JBL 10-08-07 × AB 13-03 (11.45)	JBL 10-08-07 × JBL 10-08-01 (13.57)	JBL 10-08-07 × AB 13-03 (8.63)
	AB 13-03× GP-BRJ-216 (10.64)	JBL 10-08-01 × GP-BRJ-216 (10.33)	AB 13-03× GP-BRJ-216 (0.95)
Total phenol (mg/100g)	GAOB 2 × JBL 10-08-07 (91.17)	GAOB 2 × GBL 1 (-1.63)	GAOB 2 × JBL 10-08-07 (-3.83)
	JBL 10-08-07 × JBL 10-08-01 (91.39)	GAOB 2 × JBL 10-08-07 (-1.11)	JBL 10-08-07 × JBL 10-08-01 (-3.59)
	GAOB 2 × JBL 10-08-01 (91.65)	GBL 1 × GP-BRJ-216 (0.67)	GAOB 2 × JBL 10-08-01 (-3.32)
Ascorbic acid (mg/100g)	GAOB 2 × GBL 1 (13.43)	JBL 10-08-07 × GP-BRJ-216 (22.39)	GAOB 2 × GBL 1 (24.74)
	GBL 1 × Doli 5 (13.26)	GP-BRJ-215× GP-BRJ-216 (9.71)	GBL 1 × Doli 5 (23.17)
	Doli 5 × JBL 10-08-07 (12.84)	AB 13-03× GP-BRJ-216 (9.26)	Doli 5 × JBL 10-08-07 (19.22)
Total soluble sugars (%)	GAOB 2 × JBL 10-08-01 (3.68)	KashiTaru × GP-BRJ-215 (22.50)	GAOB 2 × JBL 10-08-01 (27.73)
	JBL 10-08-01 × GP-BRJ-216 (3.50)	JBL 10-08-07 × GP-BRJ-216 (17.84)	JBL 10-08-01 × GP-BRJ-216 (21.32)
	JBL 10-08-07 × JBL 10-08-01 (3.28)	JBL 10-08-07 × GP-BRJ-215 (17.30)	JBL 10-08-07 × JBL 10-08-01 (13.86)
Total Anthocyanin (mg/100g)	Doli 5 × Punjab Sadabahar (89.44)	Punjab Sadabahar × GP-BRJ-215 (8.56)	Doli 5 × Punjab Sadabahar (17.76)
	GBL 1 × Doli 5 (85.99)	Punjab Sadabahar × JBL 10-08-01 (-1.64)	GBL 1 × Doli 5 (13.22)
	Punjab Sadabahar × GP-BRJ-215 (82.30)	GAOB 2 × GBL 1 (-2.24)	Punjab Sadabahar × GP-BRJ-215 (8.36)
Acidity (%)	Punjab Sadabahar × GP-BRJ-216 (0.12)	Punjab Sadabahar × GP-BRJ-216 (-45.65)	Punjab Sadabahar × GP-BRJ-216 (0.01)

	GP-BRJ-215× GP-BRJ-216 (0.14)	Punjab Sadabahar × AB 13-03 (-40.35)	GP-BRJ-215× GP-BRJ-216 (12.00)
	GAOB 2 × GBL 1 (0.15)	GP-BRJ-215× GP-BRJ-216 (-39.13)	GAOB 2 × GBL 1 (16.00)
Total soluble solids (^{0} Brix)	Doli 5 × GP-BRJ-216 (4.11)	GAOB 2 × JBL 10-08-07 (16.18)	Doli 5 × GP-BRJ-216 (18.99)
	GAOB 2 × JBL 10-08-01 (4.01)	GAOB 2 × JBL 10-08-01 (16.09)	GAOB 2 × JBL 10-08-01 (16.09)
	GAOB 2 × JBL 10-08-07 (3.95)	Doli 5 × GP-BRJ-216 (10.95)	GAOB 2 × JBL 10-08-07 (14.49)

Conclusion

In present investigation, significant and moderate estimates of heterobeltiosis and standard heterosis were observed for fruit yield. For the quality characters, the estimates of heterotic effects were low to moderate for all the characters except total phenol. The greater magnitude of heterobeltiosis for various characters indicated the differences in the performance between the parental lines and the hybrids. The moderate estimates of heterosis also suggested evidence for unidirectional dominance.

The perusal of the values of heterotic crosses for various characters revealed that the expression of heterosis for fruit yield could primarily be attributed to combined effect of heterosis for its major component characters**.** The promising hybrids Doli 5 x Kashi Taru (63.54%), JBL 10-08-07 x AB 13-03 (62.28%), GBL 1 × Doli 5 (62.22%), JBL 10-08-07 × GP-BRJ-216 (56.78%), JBL 10-08-07 x Kashi Taru (46.07%) and GAOB 2 x JBL 10-08-01 (33.67%) exerted significant heterotic effect for fruits yield per plant and desirable heterosis for different two to three quality traits. Therefore, it can be concluded that improvement in brinjal for fruit yield, dry matter, total phenol, ascorbic acid, total soluble sugars, total anthocyanin, acidity and total soluble solids may be brought out through hybridization followed by recurrent selection and specific hybrid for fruit yield would be useful to researcher and need confirmation. Thus, genetic improvement of quality can be achieved through mass selection or single plant selection targeting desirable traits or through intra specific or interspecific hybridization to produce new genotypes with enhanced nutraceutical quality.

References

1. Anonymous. National Horticulture Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, 2014: www.nhb.gov.in.
2. Awasthi CP, Dixit J. Effect of varietal variation on nutritional attributes of fruits of eggplant. (*Solanum melongena* L.). *Prog. Hort*., 1986; 18(3-4):288-289.
3. Biswas L, Mehta N, Ansari SF. Hybrid vigour studies in brinjal (*Solanum melongena* L.). Global J. of Science Frontier Research Agriculture and Veterinary. 2013; 13(9):7-11.
4. Dhruve JJ, Shah Rutika, Gandhi Swati, Talati JG. Biochemical and morphological traits of different cultivars of brinjal fruits growing in Anand (Gujarat). Indian J Agric. Biochem. 2014; 27(2):211-214.
5. Dubois M, Giller KA, Rebers PA, Smith, F. Colorimetric method for determination of sugars & related substances. *Anal. Chem.* 1956; 28:350-356.
6. Eva S, Florian C, Stintzing, Reinhold Carle. Peel extract. Z. Naturforsch. 2006; 61C:527.
7. Fonseca S, Peterson FL. Hybrid vigour in a seven parent diallel cross in common winter wheat (*Triticum aestivum* L.). Crop Sci. 1968; 1:85-88.
8. Kumar SR, Arumugam T, Anandakumar CR, Balakrishnan S, Rajavel DS. Estimation of heterosis and specific combining ability for yield, quality, pest and disease incidence in eggplant (*Solanum melongena* L.). Bull. Env. Pharmacol. Life Sci. 2012; 2(1):3-15.
9. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Indian Council of Agricultural Research, Publication 3rd ed., New Delhi, 1978.
10. Malik CP, Singh MB. Extraction and estimation of total phenols. In Plant enzymology and Histoenzymology. Kalyani Publishers, New Delhi, 1980, 286.
11. Meredith WR Jr, Bridge RR. Heterosis and gene action in cotton (*Gossipium hirsutum* L.). Crop sci. 1972; 12:304-310.
12. Ramani PS, Vaddoria MA, Patel JB. Heterosis for fruit yield and its component traits in brinjal (*Solanum melongena* L.). *Agres.* - An International e – Journal. 2015; 2(3):249-254.
13. Ranganna S. Total Anthocyanin content. In Analysis of fruit & vegetable products. Mc Graw Hill Book Company, New Delhi, 1976, 87.
14. Sadasivam S, Manickam A. Biochemical methods Publication 3rd ed.. New Age International (P) Ltd., New Delhi, 2008,
15. Suneetha Y, Kathiria KB, Patel JS, Srinivas T. Studies on heterosis & combining ability in late summer brinjal (*Solanum melongena* L.). Indian J. Agric. Res. 2008; 42(3):171-176.
16. Vavilaov NI. The role of central Asia in the origin of cultivated plants. Bulletin of Applied Botany, Genetics and Plant Breeding. 1931; 26(3):3-44.