International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1369-1374

Received: 17-01-2019
Accepted: 20-02-2019

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Heterobeltiosis and standard heterosis for fruit yield and its attributing traits in brinjal (*Solanum melongena* L.)

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Abstract
A study was conducted to estimate the magnitude of heterosis for fruit yield and yield contributing components in brinjal using 45 F_1 hybrids generated by half-diallel mating design. Ten pure and diverse parents along with its F_1s were evaluated in a Randomized Block Design with three replications at Vegetable Research Station, Junagadh Agricultural University, Junagadh during *Rabi* 2016-17 (E_1), Late *kharif* 2017-18 (E_2) and *Rabi* 2017-18 (E_3). Appreciable magnitude of heterosis was found over better and standard parent for all the traits studied in desirable direction. In order of merit, F_1 hybrid PLR 1 x S.M.B. (73.81%) in E_1, Pant Rituraj x GJB-3 (66.13%) in E_2, GJB-3 x JBGR-06-08 (52.58%) in E_3 were observed significant and positive heterosis over better parent. Likewise, significant and positive heterosis over standard check (GBH-1) for fruit yield per plant was observed in hybrid PLR 1 x S.M.B. (125.07%) in E_1, GJB-2 x JBL-08-08 (101.20%) in E_2 and GJB-3 x JB-12-06 (93.89%) in E_3. The present study reveals good scope for isolation of pure lines from the progenies of segregating materials as well as commercial exploitation of heterosis in brinjal.

Keywords: Heterosis, fruit yield, yield attributes, brinjal

Introduction
Brinjal (*Solanum melongena* L.), also known as eggplant, is an important vegetable crop of India grown throughout the year. However, it is widely cultivated in both temperate and tropical regions of the globe mainly for its immature fruits as vegetables (Rai *et al*., 1995) [11], but in the temperate regions it is cultivated mainly during warm season. India is regarded as the primary centre of origin/diversity of brinjal (Vavilov, 1931; Bhaduri, 1951 and Genabus, 1963) [16, 3, 5]. Heterosis breeding has become the widely used breeding method for increasing productivity of the important solanaceous vegetable crops including brinjal. Exploitation of hybrid vigor in brinjal is commercially possible due to manifestation of high heterosis for fruit yield and other important characters, ease of handling the flowers during artificial emasculation and pollination and realization of higher number of hybrid seeds per effective pollination. The heterosis provides information about the right choice of parents for development of hybrids and also to determine the nature of gene action involved in the expression of desirable traits. Therefore, the present investigation was undertaken to find out suitable cross combinations on the basis of mean performance and heterosis in brinjal.

Materials and Methods
The experiment was conducted in randomized block design with three replication during *Rabi* 2016-17 (E_1), Late *kharif* 2017-18 (E_2) and *Rabi* 2017-18 (E_3) at Vegetable Research Station, Junagadh Agricultural University, Junagadh, India. The experimental material comprised of 10 homozygous lines *viz*., Pant Rituraj, PLR 1, KS 224, GJB 2, GJB 3, Swarna Mani Black, JBGR 06-08, JBL-08-08, AB-08-14 and JB 12-06. These ten parents were crossed with half-diallel mating design to derive 45 F_1 hybrids. Each entry was sown in a single row plot of 4.8 m length keeping row-to-row and plant-to-plant distance of 75 cm, and 60 cm, respectively. The recommended package of practices and necessary plant protection measures were followed timely to raise a healthy crop of brinjal. Observations were recorded from five randomly selected plants in each replication for all the characters *viz*., fruit length (cm), fruit girth (cm), number of fruits per plant, average fruit weight (g), number of primary branches per plant and fruit yield per plant (kg).

The magnitude of heterosis in hybrids was expressed as percentage increase or decrease of a character over better parent and standard check variety (GBH-1) using standard formula.

Results and discussion

The results of all the studied characters for heterobeltiosis and standard heterosis are given in Table 1. The heterobeltiosis for fruit length ranged from -36.48% (GJB-3 x S.M.B.) to 21.76% (PLR 1 x S.M.B.), -33.20% (GJB 2 x GJB-3) to 21.58% (GJB-3 x JB-12-06) and -33.16% (GJB-3 x S.M.B.) to 17.87% (GJB-2 x JBL-08-08) in E_1, E_2 and E_3, respectively. PLR 1 x S.M.B. (21.76%), PLR 1 x GJB-2 (17.11%), GJB-2 x JBL-08-08 (15.35%) in E_1; GJB-3 x JB-12-06 (21.58%), GJB-2 x JB-12-06 (20.31%) and GJB-2 x JBL-08-08 (20.30%) in E_2; and GJB-2 x JBL-08-08(-17.58%), JBGR-06-08 x JB-12-06 (16.50%) and PLR 1 x S.M.B. (16.39%) in E_3 were the best, significant and positive heterobeltiotic crosses for fruit length. Total nine, nine and seven crosses manifested significant and desired heterobeltiosis in E_1, E_2 and E_3, respectively. The magnitude of standard heterosis for this trait varied from -27.14% (S.M.B. x JB-12-06) to 38.89% (GJB-3 x JBGR-06-08), -27.79% (KS 224 x JB-12-06) to 40.87% (GJB-3 x JBGR-06-08); -23.71% (Pant Rituraj x JB-12-06) to 45.72% (JBGR-06-08 x JB-12-06) in E_1, E_2 and E_3, respectively. Three crosses *viz*., GJB-3 x JBGR-06-08 (38.89%), Pant Rituraj x JBGR-06-08 (38.25%) and JBGR-06-08 x JB-12-06 (38.25%) in E_1; three crosses namely, GJB-3 x JBGR-06-08 (40.87%), Pant Rituraj x JBGR-06-08 (40.07%) and JBGR-06-08 x JB-12-06 (38.80%) in E_2 and three crosses i.e. JBGR-06-08 x JB-12-06 (45.72%), GJB-3 x JBGR-06-08 (44.20%) and Pant Rituraj x JBGR-06-08 (43.29%) in E_3 were the top most significant and desirable standard heterotic crosses for fruit length. Total 10, 11 and 11 crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively. These results are akin to Makani, (2013) [8]; Ansari and Singh, (2016) [4]; Biswas *et al*. (2016) [4]; Sharma *et al*. (2016) [14]; Sivakumar *et al*. (2017) [15] and Modh *et al*. (2018) [9].

For fruit girth, out of 45 crosses, nine, eight and nine crosses manifested significant and positive heterobeltiotic crosses in E_1, E_2 and E_3, respectively. The heterosis over better parent for varied from -36.33% (Pant Rituraj x AB-08-14) to 22.24% (GJB-3 x JBGR-06-08); -29.87% (Pant Rituraj x AB-08-14) to 30.03% (GJB-2 x JBL-08-08), -35.02% (Pant Rituraj x AB-08-14) to 42.62% (GJB-2 x JBGR-06-08)in E_1, E_2 and E_3, respectively. GJB-3 x JBGR-06-08 (22.14%), JBGR-06-08 x JB-12-06 (21.29%) and GJB-3 x JB-12-06 (20.34%) in E_1; GJB-2 x JBL-08-08 (30.03%), GJB-3 x JBGR-06-08 (19.25%) and PLR 1 x SMB (17.78%) in E_2; and GJB-2 x JBGR-06-08 (42.62%), GJB-2 x JBL-08-08 (18.63%) and GJB-3 x JBGR-06-08 (17.28%) in E_3 were the top significant and positive heterobeltiotic crosses for fruit girth. The magnitude of standard heterosis for this trait ranged between -25.49% (Pant Rituraj x AB-08-14) and 29.04% (PLR 1 x S.M.B.); -35.18% (KS 224 x GJB-3) and 23.58% (Pant Rituraj x GJB-3) and -29.54% (KS 224 x GJB-3) to 30.39% (Pant Rituraj x JBGR-06-08) in E_1, E_2 and E_3, respectively. Crosses PLR 1 x S.M.B. (29.04%), Pant Rituraj x JBGR-06-08 (28.90%) and GJB-3 x AB-08-14 (27.19%) in E_1; Pant Rituraj x GJB-3 (23.58%), GJB-3 x AB-08-14 (22.14%) and PLR 1 x S.M.B. (21.75%) in E_2; and Pant Rituraj x JBGR-06-08 (30.39%), Pant Rituraj x GJB-3 (30.35%) and GJB-3 x AB-08-14 (26.39%) in E_3 were the best significant and desirable standard heterotic crosses for fruit girth. Total 16, 13 and 10 crosses manifested significant and desirable standard heterotic in E_1, E_2 and E_3, respectively. These findings are in line with Makani *et al*. (2013) [8], Paramappa *et al*. (2014) [10], Ansari and Singh (2016) [1], Balwani *et al*. (2017) [2].

In case of number of fruits per plant, the heterobeltiosis over better parent varied from -19.42% (S.M.B. x JB-12-06) to 24.72% (PLR 1 x S.M.B.); -23.00% (PLR 1 x JB-12-06) to 21.21% (Pant Rituraj x GJB-3); and -26.04% (Pant Rituraj x KS 224) to 23.96% (GJB-3 x JBGR-06-08) in E_1, E_2 and E_3, respectively. Out of 45, ten crosses in each environment manifested significant and positive heterobeltiosis for number of fruits per plant. The best three hybrids namely, PLR 1 x S.M.B. (24.72%), Pant Rituraj x JBGR-06-08 and GJB-2 x JBL-08-08 (17.82%) and KS 224 x S.M.B. (16.85%) in E_1; Pant Rituraj x GJB-3 (21.21%), GJB-3 x JB-12-06 (21.00%) and Pant Rituraj x PLR 1 (20.00%) in E_2; and GJB-3 x JBGR-06-08 (23.96%), PLR 1 x S.M.B. (23.91%) and Pant Rituraj x GJB-3 (20.83%) in E_3 were registered significant and positive heterosis over better parent. Total 35, 14 and 25 crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively. Similarly, the standard heterosis varied from 2.53% (Pant Rituraj x KS 224) to 50.63% (Pant Rituraj x JBGR-06-08); -21.43% (PLR 1 x JB-12-06) to 23.47% (GJB-3 x JB-12-06); and -17.44% (Pant Rituraj x KS 224) to 38.37% (GJB-3 x JBGR-06-08) in E_1, E_2 and E_3, respectively. The best three hybrids *viz*., Pant Rituraj x JBGR-06-08 and GJB-2 x JBL-08-08 (50.63%), JBL-08-08 x JB-12-06 (48.10%) and Pant Rituraj x GJB-3, GJB-3 x JB-12-06 and JBGR-06-08 x JB-12-06 (46.84%) in E_1; GJB 3 x JB-12-06 (23.47%), Pant Rituraj x GJB-3 (22.45%) and Pant Rituraj x AB-08-14 and GJB-2 x AB-08-14 (19.39%) in E_2; and GJB-3 x JBGR-06-08 (38.17%), GJB-3 x JB-12-06, GJB-3 x AB-08-14 (36.05%) and Pant Rituraj x GJB-3 (34.88%) in E_3 were the top most significant and desirable standard heterotic crosses for number of fruits per plant. The results are conformity with Makani *et al*. (2013) [8], Paramappa *et al*. (2014) [10], Ansari and Singh (2016) [1], Sivakumar *et al*. (2017) [15], Modh *et al*. (2018) [9].

For average fruit weight, the heterosis over better parent varied from -31.41% (KS 224 x JB-12-06) to 31.11% (PLR 1 x S.M.B.); -25.37% (Pant Rituraj x KS 224) to 34.42% (GJB-3 x JBGR-06-08); and -52.56% (Pant Rituraj x KS 224) to 25.58% (Pant Rituraj x JBGR-06-08) in E_1, E_2 and E_3, respectively. Total nine, nine and seven crosses manifested significant and positive heterobeltiosis in E_1, E_2 and E_3, respectively. Crosses, PLR 1 x S.M.B. (31.11%), GJB-3 x JBGR-06-08 (30.97%) and Pant Rituraj x GJB-3 (27.21%) in E_1; GJB-3 x JBGR-06-08 (34.42%), PLR 1 x S.M.B. (30.78%) and Pant Rituraj x GJB-3 (21.18%) in E_2; and Pant Rituraj x JBGR-06-08 (25.58%), Pant Rituraj x GJB-3 (23.67%) and GJB-3 x JBGR-06-08 (27.17%) in E_3 were the best significant and positive heterobeltiotic crosses for average fruit weight. On the other hand, out of 45 crosses, total 25, 41 and 23 crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively. The magnitude of standard heterosis for this trait varied from -6.78% (GJB-3 x S.M.B.) to 51.01% (PLR 1 x S.M.B.); 2.60% (GJB-3 x S.M.B.) to 61.95% (GJB-2 x JBL-08-08); and -31.31% (Pant Rituraj x KS 224) to 52.04% (GJB-2 x JBL-08-08) in E_1, E_2 and E_3, respectively. Crosses PLR 1 x S.M.B. (51.01%), S.M.B. x JBL-08-08 (47.25%) and GJB-2 x JBL-08-08 (45.99%) in E_1; GJB-2 x JBL-08-08 (61.95%), PLR 1 x S.M.B. (60.72%) and S.M.B. x JBL-08-08 (59.58%) in E_2; and GJB-2 x JBL-08-08 (52.04%), JBGR-06-08 x JB-12-06

(42.81%) and PLR 1 x S.M.B. (42.42%) in E_3 were the top most significant and desirable standard heterotic crosses for average fruit weight. Similar results were reported by Makani *et al*. (2013) [8], Paramappa *et al*. (2014) [10], Ansari and Singh (2016) [1], Kalaiyarasi *et al*. (2018) [7].

With respect to number of primary branches per plant, heterobeltiosis ranged from -46.15% (JBL-08-08 x AB-08-14) to 75.00% (JBGR-06-08 x JBL-08-08); -22.22% (Pant Rituraj x JB-12-06) to 62.50% (KS 224 x JB-12-06); and -11.11% (KS 224 x GJB-3) to 75.00% (JBGR-06-08 x AB-08-14, PLR 1 x JBL-08-08 and S.M.B. x JBL-08-08) in E_1, E_2 and E_3, respectively. Total 13, 9 and 16 crosses manifested significant and positive heterobeltiosis in E_1, E_2 and E_3, respectively. Three cross combinations *viz*., JBGR-06-08 x JBL-08-08 (75.00%), Pant Rituraj x JBGR-06-08 (66.67%) and GJB-2 x JBL-08-08 (62.50%) in E_1; GJB-2 x JBL-08-08, JBGR-06-08 x JB-12-06 (62.50%), PLR 1 x JBL-08-08 (55.56%); and KS 224 x AB-08-14 (50.00%) in E_2; and PLR 1 x JBL-08-08, S.M.B. x JBL-08-08, JBGR-06-08 x AB-08-14 (75.00%), JBGR-06-08 x JBL-08-08, JBGR-06-08 x JB-12-06 and GJB-3 x JBGR-06-08 (55.56%) in E_3 were the best significant and positive heterobeltiotic crosses for number of primary branches per plant. The magnitude of standard heterosis for this trait ranged from -33.33% (GJB-3 xJBL-08-08) to 77.78% (JBGR-06-08 x AB-08-14); -12.50% (PLR 1 x GJB-3) to 75.00% (PLR 1 x JBL-08-08); and zero percent (KS 224 x GJB-3, KS 224 x AB-08-14) to 75.00% (PLR 1 x JBL-08-08, KS 224 x JB-12-06, S.M.B. x JBL-08-08 and JBGR-06-08 x AB-08-14) in E_1, E_2 and E_3, respectively. Total 17, 19 and 18 crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively. The cross combinations namely, GJB-3 x JBGR-06-08, JBGR-06-08 x AB-08-14 (77.78%), AB-08-14 x JB-12-06, Pant Rituraj x JBGR-06-08 (66.67%) and PLR 1 x S.M.B., PLR 1 x JBL-08-08, GJB-3 x JB-12-06, JBGR-06-08 x JBL-08-08, JBGR-06-08 x JB-12-06 (55.56%) in E_1; Pant Rituraj x JBGR-06-08 (75.00%), Pant Rituraj x GJB-2, Pant Rituraj x GJB-3, PLR 1 x S.M.B., KS 224 x S.M.B., KS 224 xJB-12-06, GJB-2 x JBGR-06-08, GJB-2 x JBL-08-08, GJB-3 x JBGR-06-08, S.M.B. x JB-12-06, JBGR-06-08 x JB-12-06 (62.50%) and KS 224 x AB-08-14 (50.00%) in E_2; and PLR 1 x S.M.B., PLR 1 x JBL-08-08, KS 224 x JB-12-06, GJB-3 x JBGR-06-08, S.M.B. x JBL-08-08 and JBGR-06-08 x AB-08-14 (75.00%); Pant Rituraj x GJB-3, Pant Rituraj x JBGR-06-08, GJB-2 x GJB-3, JBGR-06-08 x JBL-08-08, JBGR-06-08 x JB-12-06 and AB-08-14 x JB-12-06 (62.50%) in E_3 were the top most significant and desirable standard heterotic crosses for number of primary branches per plant. Similar findings were also observed by Shanmugapriya *et al*. (2009) [13], Ram and Sigh (2012) [12], Sivakumar *et al*. (2017) [15].

Out of 45 crosses, total 10, 11 and 9 crosses manifested significant and positive heterobeltiosis in E_1, E_2 and E_3, respectively for fruit yield per plant. The heterosis over better parent for fruit yield per plant ranged from -31.65% (S.M.B. x JB-12-06) to 73.81% (PLR 1 x S.M.B.); -29.36% (KS 224 x JB-12-06) to 66.13% (Pant Rituraj x GJB-3); and -63.48% (Pant Rituraj x KS 224) to 52.48% (GJB-3 x JBGR-06-08) in E_1, E_2 and E_3, respectively. PLR 1 x S.M.B. (73.81%) followed by Pant Rituraj x JBGR-06-08 (63.38%) and Pant Rituraj x GJB-3 (58.10%) in E_1; Pant Rituraj x GJB-3 (66.13%) followed by Pant Rituraj x JBGR-06-08 (63.53%) and PLR 1 x S.M.B. (59.35%) in E_2; and GJB-3 x JBGR-06-08 (52.58%) followed by Pant Rituraj x GJB-3 (49.10%) and PLR 1 x S.M.B. (47.20%) in E_3 were the top most significant and positive heterobeltiotic crosses for fruit yield per plant. Likewise, total 38, 35 and 25 crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively. The magnitude of standard heterosis for this trait varied from 6.06% (S.M.B. x JB-12-06) to 125.07% (PLR 1 x S.M.B.); -3.99% (PLR 1 x GJB-3) to 101.20% (GJB-2 x JBL-08-08); and -42.81% (Pant Rituraj x KS 224) to 93.89% (GJB-3 x JB-12-06) in E_1, E_2 and E_3, respectively. PLR 1 x S.M.B. (125.07%) followed by GJB-2 x JBL-08-08 (124.87%) and JBGR-06-08 x JB-12-06 (124.46%) in E_1; GJB-2 x JBL-08-08 (101.20%) followed by GJB-3 x JB-12-06 (96.75%) and Pant Rituraj x GJB-3 (89.59%) in E_2; and GJB-3 x JB-12-06 (93.89%) followed by GJB-2 x JBL-08-08 (92.91%) and JBGR-06-08 x JB-12-06 (89.38%) in E_3 were the top most significant and desirable standard heterotic crosses for fruit yield per plant. One cross combination i.e. GJB-2 x JBL-08-08 was common in all the three environments for fruit yield per plant. Similar results were also reported by Makani *et al*. (2013) [8]; Paramappa *et al*. (2014) [10]; Ansari and Singh (2016) [1]; Shivakumar *et al*. (2017) [15]; Kalaiyarasi *et al*. (2018) [7] and Modh (2018) [9].

It is of profound interest to know the cause of heterosis for fruit yield. Whitehouse *et al*. (1958) [17] and Grafius (1959) [6] suggested that there may not be any gene system for fruit yield *per se*, as fruit yield is an end product of the multiplicative interaction among the yield components. This would indicate that the heterosis for fruit yield should be through heterosis for the individual yield components or alternatively due to the multiplicative effect of partial dominance of component characters. Williams and Gilbert (1960) [18] reported that even simple dominance in respect of yield components may lead to expression of heterosis for fruit yield.

Highly significant and positive heterobeltiosis for fruit yield per plant (Table 2) also showed significant and positive heterosis for fruit length, fruit girth, number of fruits per plant and average fruit weight in all the six crosses in all the three environments except average fruit weight for JBGR-06-08 x JB-12-06 in E_1 and fruit length and average fruit weight for GJB-3 x AB-08-14 in E_3. This indicated that apart from some common traits in different crosses, pathway for releasing hererotic effects varied from cross to cross and also from environment to environment. Thus, in above mentioned crosses, which had significant and desirable heterobeltiosis for different yield contributing attributes may release high performing transgressive segregants also in advanced generations as well as commercial exploitation of heterosis in brinjal is feasible.

The correlation coefficients had been worked out with a view to know the relationship between different statistical parameters used in the present investigation. *Per se* performance of crosses was compared with heterobeltiosis revealed significant and positive correlation between both the parameters for all the characters in E_1, E_2 and E_3. Similarly, there was also significant and positive correlation between heterobeltiosis and standard heterosis in all the three individual environments for all the traits (Table 3).

Table 1: Range and number of significant crosses for heterobeltiosis (H) and standard heterosis (SH) for various characters in brinjal for individual environments

S.N.	Character	Env	Range						Number of crosses with significant heterosis			
									H (%)		SH (%)	
			H (%)	Crosses	H (%)	SH (%)	Crosses	SH (%)	+ve	-ve	+ve	-ve
1.	Fruit length (cm)	E_1	-36.48 to 21.76	PLR 1 x S.M.B.	21.76**	-27.14 to 38.89	GJB-3 x JBGR-06-08	38.89**	09	22	10	15
				PLR 1 x GJB-2	17.11*		Pant Rituraj x JBGR-06-08	38.25**				
				GJB-2 x JBL-08-08	15.35*		PLR 1 x S.M.B.	21.34**				
		E_2	-33.20 to 21.58	GJB-3 x JB-12-06	21.58**	-27.97 to 40.87	GJB-3 x JBGR-06-08	40.87**	09	16	11	12
				GJB-2 x JB-12-06	20.32**		Pant Rituraj x JBGR-06-08	40.07**				
				GJB-2 x JBL-08-08	20.30**		JBGR-06-08 x JB-12-06	38.80**				
		E_3	-33.16 to 17.87	GJB-2 x JBL-08-08	17.87**	-23.71 to 45.72	JBGR-06-08 x JB-12-06	45.72**	07	23	13	12
				JBGR-06-08 x JB-12-06	16.50*		GJB-3 x JBGR-06-08	44.20**				
				PLR 1 x S.M.B.	16.39*		Pant Rituraj x JBGR-06-08	43.29**				
2.	Fruit girth (cm)	E1	-36.33 to 22.24	GJB-3 x JBGR-06-08	22.24**	-25.49 to 29.04	PLR 1 x S.M.B.	29.04**	09	15	15	12
				JBGR-06-08 x JB-12-06	21.29**		Pant Rituraj x JBGR-06-08	28.90**				
				GJB-3 x JB-12-06	20.34**		GJB-3 x AB-08-14	27.91**				
		E_2	-29.87 to 30.03	GJB-2 x JBL-08-08	30.03**	-35.18 to 23.58	Pant Rituraj x GJB-3	23.58**	08	09	11	10
				GJB-3 x JBGR-06-08	19.25**		GJB-3 x AB-08-14	22.14**				
				PLR 1 x SMB	17.78**		PLR 1 x S.M.B.	21.75**				
		E_3	-35.02 to 42.62	GJB-2 x JBGR-06-08	42.62**	-29.24 to 30.39	Pant Rituraj x JBGR-06-08	30.39**	09	13	10	13
				GJB-2 x JBL-08-08	18.63**		Pant Rituraj x GJB-3	30.35**				
				GJB-3 x JBGR-06-08	17.28*		GJB-3 x AB-08-14	26.39**				
3.	Number of fruits	E_1	-19.42 to 24.72	PLR 1 x S.M.B.	24.72**	2.53 to 50.63	Pant Rituraj x JBGR-06-08	50.63**	10	3	33	-
	per plant			GJB-2 x JBL-08-08	17.82**		JBL-08-08 x JB-12-06	48.10**				
				KS 224 x S.M.B.	16.85*		GJB-3 x JB-12-06	46.84**				
		E_2	-23.00 to 21.21	Pant Rituraj x GJB-3	21.21**	-21.43 to 23.47	GJB 3 x JB-12-06	23.47**	10	05	13	04
				GJB-3 x JB-12-06	21.00**		Pant Rituraj x GJB-3	22.45**				
				Pant Rituraj x PLR 1	20.00**		GJB-2 x AB-08-14	19.39**				
		E_3	-26.04 to 23.96	GJB-3 x JBGR-06-08	23.96**	-17.44 to 38.37	GJB-3 x JBGR-06-08	38.37**	10	06	25	03
				PLR 1 x S.M.B.	23.91**		GJB-3 x JB-12-06	36.05**				
				Pant Rituraj x GJB-3	20.83**		Pant Rituraj x GJB-3	34.88**				
4.	Average fruit	E_1	-31.41 to 31.11	PLR 1 x S.M.B.	31.11**	-6.78 to 51.01	PLR 1 x S.M.B.	51.01**	08	14	26	-
	weight (g)			GJB-3 x JBGR-06-08	30.97**		S.M.B. x JBL-08-08	47.25**				
				Pant Rituraj x GJB-3	27.21**		GJB-2 x JBL-08-08	45.99**				
		E_2	-25.37 to 34.42	GJB-3 x JBGR-06-08	34.42**	2.60 to 61.95	GJB-2 x JBL-08-08	61.95**	08	10	41	-
				PLR 1 x S.M.B.	30.78**		PLR 1 x S.M.B.	60.72**				
				Pant Rituraj x GJB-3	21.18**		S.M.B. x JBL-08-08	59.58**				
		E_3	-34.97 to 25.58	Pant Rituraj x JBGR-06-08	25.58*	-9.81 to 52.04	GJB-2 x JBL-08-08	52.04**	07	12	22	01
				Pant Rituraj x GJB-3	23.67*		JBGR-06-08 x JB-12-06	42.81**				
				GJB-3 x JBGR-06-08	23.17*		PLR 1 x S.M.B.	42.42**				
5.	Number of primar	E_1	-46.15 to 75.00	JBGR-06-08 x JBL-08-08	75.00**	-33.33 to 77.78	GJB-3 x JBGR-06-08		77.78**	13	11	19
	branches per plant			Pant Rituraj x JBGR-06-08	66.67**		Pant Rituraj x JBGR-06-08	66.67**				
				GJB-2 x JBL-08-08	62.50**		PLR 1 x S.M.B.	55.56**				
		E_2	-22.22 to 62.50	GJB-2 x JBL-08-08	62.50**	-12.50 to 75.00	Pant Rituraj x GJB-2	75.00**	09	-	13	-
				PLR 1 x JBL-08-08	55.56**		JBGR-06-08 x JB-12-06	62.50**				
				KS 224 x AB-08-14	50.00**		KS 224 x AB-08-14	50.00**				
		E3	-11.11 to 75.00	PLR 1 x JBL-08-08	75.00**	0.00 to 75.00	PLR 1 x S.M.B.	75.00**	16	-	16	-
				JBGR-06-08 x JBL-08-08	62.50**		Pant Rituraj x GJB-3	62.50**				

				GJB-3 x JBGR-06-08	55.56**		AB-08-14 x JB-12-06	50.00**				
6.	Fruit yield per	E_1	-31.65 to 73.81	PLR 1 x S.M.B	73.81**	6.06 to 125.07	PLR 1 x S.M.B.	125.07**	10	09	38	-
	plant			Pant Rituraj x JBGR-06-08	63.38**		GJB-2 x JBL-08-08	124.87**				
				Pant Rituraj x GJB-3	58.10**		JBGR-06-08 x JB-12-06	124.46**				
		E_2	-29.36 to 66.13	Pant Rituraj x GJB-3	66.13**	-3.99 to 101.20	GJB-2 x JBL-08-08	101.20**	11	06	35	-
				Pant Rituraj x JBGR-06-08	63.53**		GJB-3 x JB-12-06	96.75**				
				PLR 1 x S.M.B.	59.35**		Pant Rituraj x GJB-3	89.59**				
		E_3	-63.48 to 52.58	GJB-3 x JBGR-06-08	52.58**	-42.81 to 93.89	GJB-3 x JB-12-06	93.89**	09	11	25	04
				Pant Rituraj x GJB-3	49.10**		GJB-2 x JBL-08-08	92.91**				
				PLR 1 x S.M.B.	47.20**		JBGR-06-08 x JB-12-06	89.38**				

*, ** significant at 5% and 1% levels, respectively

Table 2: Comparative study of six most heterobrltiotic crosses and *per se* performances for fruit yield per plant and its component characters in brinjal for all three environment

S.N.	Env	Crosses	Mean fruit yield/ plant (kg)	Heterosis for fruit yield per plant		Components showing significant and desirable heterosis over	
				BP (%)	SH (%)	Better parent	Standard check
1.	E_1	PLR 1 x S.M.B.	3.11	73.81**	125.07**	FL, FG,NFP, AFW, NBP	FG,NFP, AFW, NBP
2.		GJB-2 x JBL-08-08	3.11	33.60**	124.87**	FL, FG,NFP, AFW, NBP	FL, FG, NFP, AFW, NBP
3.		JBGR-06-08 x JB-12-06	3.10	44.65**	124.46**	FL, FG, NFP, NBP	FL, FG,NFP, NBP
4.		GJB-3 x JB-12-06	3.03	41.19**	119.10**	FL, FG,NFP, AFW	FL, FG,NFP, AFW
5.		Pant Rituraj x JBGR-06-08	2.89	63.38**	108.89**	FL, FG, NFP, AFW, NBP	FL, FG,NFP, AFW, NBP
6.		Pant Rituraj x GJB-3	2.79	58.10**	101.6**	FL, FG,NFP, AFW, NBP	FL, FG,NFP, AFW, NBP
1.	E_2	GJB-2 x JBL-08-08	3.17	54.86**	101.2**	FL, FG, NFP, AFW	FL, FG, NFP, AFW, NBP
2.		GJB-3 x JB-12-06	3.10	44.40**	96.75**	FL, FG, NFP, AFW	FL, FG, NFP, AFW
3.		Pant Rituraj x GJB-3	2.98	66.13**	89.59**	FL, FG, NFP, AFW	FL, FG, NFP, AFW, NBP
4.		PLR 1 x S.M.B.	2.98	59.35**	89.36**	FL, FG, NFP, AFW, NBP	FL, FG, NFP, AFW, NBP
5.		Pant Rituraj x JBGR-06-08	2.84	63.53**	80.37**	FL, FG, NFP, AFW, NBP	FL, FG, NFP, AFW, NBP
6.		GJB-3 x JBGR-06-08	2.82	57.02**	79.19**	FL, FG, NFP, AFW	FL, FG, NFP, AFW
1.	E_3	GJB-3 x JB-12-06	2.88	47.11**	93.89**	FL, FG,NFP, AFW	FL, FG, NFP, AFW
2.		GJB-2 x JBL-08-08	2.86	36.18**	92.91**	FL, FG,NFP, AFW, NBP	FL, FG, NFP, AFW, NBP
3.		JBGR-06-08 x JB-12-06	2.81	43.69**	89.38**	FL, FG,NFP, AFW, NBP	FL, FG, NFP, AFW, NBP
4.		PLR 1 x S.M.B.	2.79	47.20**	88.13**	FL, FG,NFP, AFW, NBP	FL, FG, NFP, AFW, NBP
5.		GJB-3 x AB-08-14	2.69	24.73*	81.24**	FG, NFP	FG, NFP, AFW
6.		GJB-3 x JBGR-06-08	2.64	52.58**	77.63**	FL, FG,NFP, AFW	FL, FG, NFP,AFW

*, ** significance at 5% and 1% levels, respectively

Table 3: Correlation coefficient between *per se* performance and heterobeltiosis as well as heterobeltiosis and standard heterosis in brinjal

	S.N. Characters	***per se* performance and heterobeltiosis**			**Heterobeltiosis and standard heterosis**		
		E_1	**E_2**	**E_3**	**E_1**	**E_2**	**E_3**
1.	Fruit length (cm)	0.86**	0.87**	0.91**	0.86**	0.87**	0.91**
2.	Fruit girth (cm)	0.63**	0.55**	0.74**	0.63**	0.55**	0.74**
3.	Number of fruits per plant	0.87**	0.85**	0.98**	0.87**	0.85**	0.98**
4.	Average fruit weight (g)	0.57**	0.76**	0.66**	0.57**	0.76**	0.69**
5.	Number of primary branches per plant	0.79**	0.83**	0.95**	0.79**	0.83**	0.95**
6.	Fruit yield per plant (kg)	0.82**	0.83**	0.87**	0.82**	0.86**	0.88**

*, ** Significant at 5% and 1% levels, respectively

Conclusion

The present study reveals ample variability exist among the parents and better scope for the exploitation of heterosis for advancement of fruit yield in brinjal. Heterobeltiosis for various yield contributing characters might be resulted in better expression of heterobeltiosis for fruit yield. It was also noted that the expression of heterobeltiosis was highly influenced by the variable environments for almost all the characters, because of significant G x E interaction. Thus, six crosses, which had significant and desirable heterobeltiosis for different yield contributing traits may release high performing transgressive segregants in advanced generations. It can be concluded that highest heterobeltiosis was recorded by cross PLR 1 x S.M.B. (125.07%) followed by GJB-2 x JBL-08-08 (124.87%) and JBGR-06-08 x JB-12-06 (124.46%) in E_1; GJB-2 x JBL-08-08 (101.20%) followed by GJB-3 x JB-12-06 (96.75%) and Pant Rituraj x GJB-3 (89.59%) in E_2; and GJB-3 x JB-12-06 (93.89%) followed by GJB-2 x JBL-08-08 (92.91%) and JBGR-06-08 x JB-12-06 (89.38%) in E_3 were the top most significant and desirable standard heterotic crosses for fruit yield per plant.

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