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

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Abstract
A study was undertaken to estimate the magnitude of heterosis for fruit yield and yield contributing components in brinjal using twenty-eight brinjal hybrids obtained from half-diallel of eight elite genotypes were evaluated along with their parents and standard check GJBH-4 during Late *kharif* 2022-23 (E_1), *Rabi* 2022-23 (E_2) and Early *Rabi* 2023-24 (E_3) at the Instructional Farm, Jambuvadi, College of Horticulture, J.A.U, Junagadh. Appreciable magnitude of heterosis was observed for heterobeltiosis and standard heterosis for number of primary branches, fruit length (cm), fruit diameter (cm), fruit weight (g), number of fruits per plant and fruit yield per plant (kg) studied in desirable direction. Among all the 28 crosses, thirteen and nine crosses manifested significant and positive heterobeltiosis in E_2 and E_3, respectively. The top most heterobeltiosis was exhibited by JBR-20-01 x JBR-20-11 (22.78%) in E_1; JBR-21-14 x JBL-21-09 (67.70%) in E_2 and JBL-21-12 x JBL-21-09 (65.10%) in E_3. The significant and positive standard heterosis for fruit yield per plant was recorded in eight and four crosses in E_2 and E_3, respectively. The highest economic heterosis was exhibited up to 4.37% by cross JBL-21-12 x JBL-21-10 in E_1; 56.02% by cross JBL-21-09 x JBL-21-10 in E_2; and 54.15% by cross JBL-21-09 x JBL-21-10 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, heterobeltiosis, 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) [1], 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) [2, 3, 4]. 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 experimental material comprised of eight homozygous lines namely, JBR-20-01, JBR-20-11, JBR-21-06, JBR-21-14, JBR-20-06, JBL-21-12, JBL-21-09 and JBL-21-10. These eight parents were crossed with half-diallel mating design to derive 28 F_1 hybrids. The experiment was conducted in randomized block design with three replication during Late *kharif* 2022-23 (E_1), *Rabi* 2022-23 (E_2) and Early *Rabi* 2023-24 (E_3) at the Instructional Farm, Jambuvadi, College of Horticulture, J.A.U, Junagadh, India. Each entry was sown in a single row plot of 5.4 m length keeping row-to-row and plant-to-plant distance of 90 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.

For late *kharif*-2022-23 season, the nursery was raised during first week of July 2022; For *Rabi*-2022-23, the seeds were sown in nursery during last week of Septebmber 2022, while for early *Rabi*- 2023-24 season, the seeds were sown during last week of August 2023. Seedlings were transplanted in the field after 55 days of sowing in the nursery for both *rabi* and late *kharif* planting. Observations were recorded from five randomly selected plants in each replication for 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 (GJBH-4) 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 -24.17% (JBR-20-11 x JBR-20-06) to 17.37% (JBL-21-12 x JBL-21-09), -27.49% (JBR-20-06 x JBL-21-12) to 14.30% (JBR-21-06 x JBL-21-09) and -29.52% (JBR-20-06 x JBL-21-12) to 12.94% (JBR-21-06 x JBL-21-09) in E_1, E_2 and E_3, respectively. JBL-21-12 x JBL-21-09 (17.37%) in E_1; JBR-21-06 x JBL-21-09 (14.30%) in E_2 and JBR-21-06 x JBL-21-09 (12.94%) and JBL-21-12 x JBL-21-09 (12.88%) in E_3 was significant heterobeltiotic cross in desired direction for fruit length. The magnitude of standard heterosis for this trait varied from -33.38% (JBR-20-11 x JBR-21-06) to 14.64% (JBL-21-12 x JBL-21-09), -35.98% (JBR-20-01 x JBR-21-06) to 6.59% (JBL-21-12 x JBL-21-09) and -38.04% (JBR-20-01 x JBR-21-06) to 10.93% (JBL-21-12 x JBL-21-09) in E_1, E_2 and E_3, respectively. JBL-21-12 x JBL-21-09 (14.64%) in E_1 and JBR-21-06 x JBL-21-09 (10.93%) in E_3 was significant and desirable standard heterotic cross for fruit length. These results are similar to Makani *et al*. (2013) [5]; Ansari and Singh (2016) [6]; Biswas *et al*. (2016) [7]; Sharma *et al*. (2016) [8]; Sivakumar *et al*. (2017) [9]; Modh *et al*. (2018) [10]; Zarna *et al*. (2019) [11]; Makasare *et al.* (2020) [12] and Timmareddygari *et al.* (2021) [13].

For fruit girth, the heterosis over better parent varied from -22.50% (JBR-20-11 x JBL-21-12) to 12.93% (JBR-21-14 x JBR-20-06) in E_1; -35.29% (JBR-20-11 x JBL-21-12) to 21.78% (JBR-21-14 x JBR-20-06) in E_2 and -23.41% (JBR-20-01 x JBR-21-06) to 19.78% (JBR-21-14 x JBR-20-06) in E_3. All the crosses were found non-significant for desirable direction in E_1. Three heterobeltiotic crosses were found significant *viz.*, JBR-21-14 x JBR-20-06 (21.78%), JBR-20-06 x JBL-21-10 (13.04%) and JBR-20-06 x JBL-21-12 (12.87%) in E_2 and one cross JBR-21-14 x JBR-20-06 (19.78%) in E_3 for fruit diameter. The magnitude of standard heterosis for this trait ranged between -16.40% (JBL-21-12 x JBL-21-09) and 21.02% (JBR-21-14 x JBR-20-06); -10.41% (JBR-20-11 x JBL-21-12) and 32.63% (JBR-20-11 x JBR-21-06) and -19.20% (JBR-21-06 x JBL-21-12) to 29.12% (JBR-20-11 x JBR-20-06) in E_1, E_2 and E_3, respectively. Crosses JBR-21-14 x JBR-20-06 (21.02%), JBR-20-11 x JBR-20-06 (18.95%) and JBR-20-11 x JBR-21-06 (17.99%) in E_1; JBR-20-11 x JBR-21-06 (32.63%), JBR-20-01 x JBR-20-11 (30.86%) and JBR-21-14 x JBR-20-06 (30.16%) in E_2; and JBR-20-11 x JBR-20-06 (29.12%), JBR-21-14 x JBR-20-06 (21.12%) and JBR-20-11 x JBR-21-06 (13.92%) in E_3 were significant and desirable standard heterotic crosses for fruit diameter. Total three, 12 and four crosses manifested significant and desirable standard heterotic in E_1, E_2 and E_3, respectively (Table 1). These findings are in line with Makani *et al*. (2013) [5], Paramappa *et al*. (2014) [14], Ansari and Singh (2016) [6], Balwani *et al*. (2017) [15] Zarna *et al*. (2019) [11] and Makasare *et al.* (2020) [12] for fruit girth.

For number of fruits per plant, The heterobeltiosis varied from -39.23% (JBR-20-01 x JBL-21-10) to 35.26% (JBR-20-11 x JBL-21-10); -52.20% (JBR-20-11 x JBR-21-06) to 69.05% (JBR-20-06 x JBL-21-12) and -53.19% (JBR-20-11 x JBR-21-06) to 55.56% (JBR-20-06 x JBL-21-12) in E_1, E_2 and E_3, respectively. The best three hybrids namely, JBR-20-11 x JBL-21-10 (35.26%), JBR-21-06 x JBL-21-12 (25.99%) and JBR-20-06 x JBL-21-12 (24.45%) in E_1; JBR-20-06 x JBL-21-12 (69.05%), JBR-21-06 x JBL-21-10 (44.47%) and JBR-20-06 x JBL-21-09 (39.73%) in E_2; and JBR-20-06 x JBL-21-12 (55.56%), JBL-21-12 x JBL-21-09 (48.12%) and JBR-20-11 x JBL-21-10 (38.02%) in E_3 were registered significant heterosis over better parent in desirable direction. Total seven, eight and five crosses manifested significant and positive heterobeltiosis in E_1, E_2 and E_3, respectively for number of fruits per plant. Likewise, the standard heterosis varied from -37.42% (JBR-20-01 x JBL-21-10) to 38.79% (JBR-21-14 x JBR-20-06) in E_1; -53.29% (JBR-20-11 x JBR-21-06) to 58.09% (JBR-20-01 x JBR-21-14) in E_2 and -44.97% (JBR-20-11 x JBR-21-06) to 44.28% (JBR-21-06 x JBL-21-10) in E_3. The best three hybrids *viz*., JBR-21-14 x JBR-20-06 (38.79%), JBR-21-14 x JBL-21-12 (18.00%) and JBR-20-11 x JBL-21-10 (16.22%) in E_1; JBR-20-01 x JBR-21-14 (58.09%), JBR-21-14 x JBL-21-09 (56.07%) and JBR-21-06 x JBL-21-10 (46.67%) in E_2; and JBR-21-06 x JBL-21-10 (44.28%), JBR-20-11 x JBL-21-10 (40.86%) and JBR-20-01 x JBR-21-14 (39.73%) in E_3 were the top most significant and desirable standard heterotic crosses for number of fruits per plant. Total five, 11 and 11 crosses manifested significant and positive standard heterotic in E_1, E_2 and E_3, respectively for this trait (Table 1). The results are conformity with Makani *et al*. (2013) [5], Paramappa *et al*. (2014) [14], Ansari and Singh (2016) [6], Sivakumar *et al*. (2017) [9], Modh *et al*. (2018) [10]; Zarna *et al*. (2019) [11]; Makasare *et al.* (2020) [12] and Timmareddygari *et al.* (2021) [13].

In case of average fruit weight, the heterosis over better parent ranged from -40.54% (JBR-20-06 x JBL-21-12) to 32.20% (JBR-20-01 x JBR-20-06); -39.56% (JBR-20-11 x JBL-21-10) to 40.31% (JBR-20-01 x JBR-21-06) and -49.71% (JBR-20-11 x JBL-21-09) to 44.35% (JBR-20-01 x JBR-21-06) in E_1, E_2 and E_3, respectively. Three crosses, *i.e.*, JBR-20-01 x JBR-20-06 (32.20%), JBL-21-09 x JBL-21-10 (29.19%) and JBR-20-01 x JBR-21-06 (27.62%) in E_1; Three crosses, *i.e.*, JBR-20-01 x JBR-21-06 (40.31%), JBR-21-06 x JBR-21-14 (32.56%) and JBL-21-09 x JBL-21-10 (32.42%) in E_2 and Three crosses, *i.e.*, JBR-20-01 x JBR-21-06 (44.35%), JBR-21-06 x JBR-21-14 (40.82%) and JBR-20-01 x JBL-21-10 (28.93%) in E_3 were the best significant heterobeltiotic crosses for average fruit weight. Total five, five and six crosses manifested significant and positive heterobeltiosis in E_1, E_2 and E_3, respectively. Similarly, the magnitude of standard heterosis for this trait varied from -51.96% (JBR-21-14 x JBR-20-06) to 35.19% (JBL-21-09 x JBL-21-10); -26.97% (JBR-20-11 x JBL-21-10) to 41.27% (JBL-21-09 x JBL-21-10) and -55.64% (JBR-

21-14 x JBR-20-06) to 38.58% (JBR-20-01 x JBL-21-10) in E_1, E_2 and E_3, respectively. Crosses JBL-21-09 x JBL-21-10 (35.19%), JBR-20-01 x JBL-21-10 (30.93%) and JBR-20-01 x JBR-20-11 (23.97%) in E_1; JBL-21-09 x JBL-21-10 (41.27%), JBR-20-01 x JBL-21-10 (39.34%) and JBR-20-11 x JBR-21-06 (28.14%) in E_2; and JBR-20-01 x JBL-21-10 (38.58%), JBL-21-09 x JBL-21-10 (33.06%) and JBR-20-01 x JBR-20-11 (23.26%) in E_3 were the top most significant and desirable standard heterotic crosses for fruit weight. Total four, five and four crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively (Table 1). Similar results were reported by Makani *et al*. (2013) [5]; Paramappa *et al*. (2014) [14]; Ansari and Singh (2016) [6]; Kalaiyarasi *et al*. (2018) [16]; Zarna *et al*. (2019) [11]; Makasare *et al.* (2020) [12] and Timmareddygari *et al.* (2021) [13] for average fruit weight.

The heterobeltiosis for number of primary branches per plant was between -58.19% (JBR-20-11 x JBR-21-06) and -6.14% (JBR-20-01 x JBL-21-10 and JBL-21-09 x JBL-21-10) in E_1; -64.71% (JBR-21-06 x JBR-20-06) and 16.56% (JBL-21-09 x JBL-21-10) in E_2 and -55.56% (JBR-21-06 x JBR-20-06) and 4.62% (JBR-21-06 x JBL-21-10) in E_3. Cross combination JBL-21-09 x JBL-21-10 (16.56%) in E_2 was the only cross found significant and positive for number of primary branches per plant. The magnitude of standard heterosis for this trait ranged from -28.16% (JBR-20-11 x JBR-21-06) to 61.32% (JBR-20-06 x JBL-21-10); -32.01% (JBR-21-06 x JBR-20-06) to 50.99% (JBR-20-06 x JBL-21-10) and -28.57% (JBR-20-01 x JBL-21-09) to 54.05% (JBR-20-06 x JBL-21-10) in E_1, E_2 and E_3, respectively. The cross combinations namely, JBR-20-06 x JBL-21-10 (61.32%), JBL-21-12 x JBL-21-09 (52.63%) and JBR-21-14 x JBL-21-12 (49.21%) in E_1; JBR-20-06 x JBL-21-10 (50.99%), JBR-20-11 x JBR-21-14 (35.98%) and JBR-20-06 x JBL-21-12 (32.29%) in E_2 and JBR-20-06 x JBL-21-10 (54.05%); JBR-21-14 x JBR-20-06 (28.57%) and JBR-20-06 x JBL-21-12 (26.90%) in E_3 were the top most significant and desirable standard heterotic crosses for number of primary branches per plant. Total ten, eight and seven crosses manifested significant and positive standard heterosis in E_1, E_2 and E_3, respectively (Table 1). The results were in conformity with Makani *et al*. (2013) [5]; Paramappa *et al*. (2014) [14]; Ansari and Singh (2016) [6]; Zarna *et al*. (2019) [11]; Makasare *et al.* (2020) [12] and Timmareddygari *et al.* (2021) [13].

The heterosis over better parent for fruit yield per plant ranged from -17.49% (JBR-21-14 x JBR-20-06) to 22.78% (JBR-20-01 x JBR-20-11) in E_1; -37.02% (JBR-20-11 x JBL-21-10) to 67.70% (JBR-21-14 x JBL-21-09) in E_2 and -46.47% (JBR-20-11 x JBL-21-09) to 65.10% (JBL-21-12 x JBL-21-09) in E_3. Among all the 28 crosses, none of the cross combination reported significant and positive heterobeltiosis in E_1. However, JBR-21-14 x JBL-21-09 (67.70%) followed by JBR-21-06 x JBR-21-14 (62.11%) and JBR-20-01 x JBR-21-06 (49.03%) in E_2 as well as JBL-21-12 x JBL-21-09 (65.10%) followed by JBR-21-06 x JBR-21-14 (55.80%) and JBR-20-06 x JBL-21-09 (53.69%) in E_3 were the top most significant and positive heterobeltiotic crosses for fruit yield per plant. Total thirteen and nine crosses manifested significant and positive heterobeltiosis in E_2 and E_3, respectively. Likewise, the magnitude of standard heterosis for this trait varied from -34.06% (JBR-21-14 x JBR-20-06) to 4.37% (JBL-21-12 x JBL-21-10); -43.46% (JBR-21-06 x JBR-20-06) to 56.02% (JBL-21-09 x JBL-21-10) and -55.61% (JBR-20-11 x JBL-21-09) to 54.15% (JBL-21-09 x JBL-21-10) in E_1, E_2 and E_3, respectively. Among all 28 crosses, none of cross was found significant and positive over check in E_1. The cross JBL-21-09 x JBL-21-10 (56.02%) followed by JBR-21-06 x JBL-21-10 (52.36%) and JBR-21-14 x JBL-21-09 (41.36%) in E_2 as well as JBL-21-09 x JBL-21-10 (54.15%) followed by JBR-21-06 x JBL-21-10 (46.83%) and JBR-21-06 x JBR-21-14 (37.56%) in E_3 were the top most significant and desirable standard heterotic crosses for fruit yield per plant. Total eight and four crosses manifested significant and positive standard heterosis in E_2 and E_3, respectively (Table 1). Similar results were reported by Makani *et al*. (2013) [5]; Paramappa *et al*. (2014) [14]; Ansari and Singh (2016) [6]; Kalaiyarasi *et al*. (2018) [16]; Modh *et al*. (2018) [10]; Zarna *et al*. (2019) [11]; Makasare *et al.* (2020) [12] and Timmareddygari *et al.* (2021) [13] for fruit yield per plant.

It is of profound interest to know the cause of heterosis for fruit yield. Whitehouse *et al*. (1958) and Grafius (1959) 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 yield. Hagberg (1952) [20] observed similar effects and termed it "combinational heterosis". In order to see whether similar situation exist in brinjal or not, a comparison of six most heterotic crosses over better parrent for fruit yield was made with other yield related characters along with average fruit yield per plant in all the three environments (Table 2).

Six crosses *viz.*, JBL-21-12 x JBL-21-10, JBL-21-09 x JBL-21-10, JBR-21-14 x JBL-21-10, JBR-20-01 x JBR-20-11, JBR-20-01 x JBL-21-12 and JBR-21-14 x JBL-21-12 manifested significant and desirable heterobeltiosis only for fruit weight in 2 cases in E_1 as well as for standard heterosis for fruit weight in 3 cases; for number of primary branches in 3 cases and for number of fruits per plant in one case in E_1. On the other hand, six crosses *viz.*, JBL-21-09 x JBL-21-10, JBR-21-06 x JBL-21-10, JBR-21-14 x JBL-21-09, JBR-21-06 x JBR-21-14, JBR-21-14 x JBL-21-10 and JBR-20-01 x JBR-21-14 12 manifested significant and desirable heterobeltiosis for fruit yield per plant (all the six cases), number of fruits per plant (4 cases), fruit weight (2 cases) and number of primary branches and fruit diameter (1 case) in E_2. However, for standard heterosis fruit yield per plant (all the six cases), number of fruits per plant (5 cases) and number of primary branches (1 case) in E_2. Similarly, six crosses *viz.*, JBL-21-09 x JBL-21-10, JBR-21-06 x JBL-21-10, JBR-21-06 x JBR-21-14, JBR-20-01 x JBR-21-06, JBL-21-12 x JBL-21-09 and JBR-21-14 x JBL-21-10 manifested significant and desirable heterobeltiosis for fruit yield per plant (5 cases), fruit weight (3 cases), number of fruits per plant (2 cases) and fruit length (1 case) in E_3. However, for standard heterosis number of fruits per plant and fruit yield per plant (4 cases), number of primary branches (2 cases) and fruit weight and fruit length (1 case) in E_3. This indicated that heterobeltiosis for various yield contributing characters might be result in the expression of heterobeltiosis for fruit yield. However, some crosses showing heterotic expression for fruit yield per plant were not heterotic for all the yield attributing characters. It was also noted that the expression of heterobeltiosis was highly influenced by the variable environments for almost all the characters. This could be due to precense of G x E interaction. Thus, the above mentioned crosses, which had significant and desirable values of heterobeltiosis for different yield contributing attributes may release high performing transgressive segregants in advanced generations. Further, the parents involved in these crosses were higher yielding and may possess better genetic profile for higher fruit yield. In this context, such high heterotic crosses and the parents involved in these crosses may be used in future breeding programme in order to isolate desirable types and to improve fruit yield levels in brinjal. The similar results have been reported in brinjal by Makani *et al*. (2013) [5]; Ansari and Singh (2016) [6]; Sharma *et al.* (2016) [8]; Sivakumar *et al.* (2017) [9]; Kalaiyarasi *et al.* (2018) [16]; Zarna *et al*. (2019) [11]; Makasare *et al.* (2020) [12] and Timmareddygari *et al.* (2021) [13].

The correlation coefficients had been worked out with a view to know the relationship between *Per se* performance and heterobeltiosis 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 except number of primary branches in E_2 (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 and three best crosses						Number of crosses with significant heterosis			
									H (%)		SH (%)	
			H (%)	Crosses	H (%)	SH (%)	Crosses	SH (%)	+ve	-ve	+ve	-ve
1	Fruit length (cm)	E_1	-24.17 to 17.37	JBL-21-12 x JBL-21-09	17.37**	-33.38 to 14.64	JBL-21-12 x JBL-21-09	14.64**	01	10	01	21
				JBR-21-06 x JBL-21-09	11.02		JBR-20-11 x JBL-21-12	0.70				
				JBR-20-11 x JBL-21-10	6.57		JBR-21-14 x JBL-21-12	0.31				
		E_2	-27.49 to 14.30	JBR-21-06 x JBL-21-09	14.30**	-35.98 to 6.59	JBL-21-12 x JBL-21-09	6.59	01	10	0	21
				JBL-21-12 x JBL-21-09	8.24		JBR-21-06 x JBL-21-09	-1.77				
				JBR-20-01 x JBR-20-11	3.24		JBR-20-11 x JBL-21-12	-4.42				
		E_3	-29.52 to 12.94	JBR-21-06 x JBL-21-09	12.94**	-38.04 to 10.93	JBL-21-12 x JBL-21-09	10.93*	02	09	01	22
				JBL-21-12 x JBL-21-09	12.88**		JBR-21-06 x JBL-21-09	-2.47				
				JBR-20-01 x JBR-20-11	9.25		JBR-21-06 x JBL-21-12	-3.78				
2	Fruit girth (cm)	E_1	-22.50 to 12.93	JBR-21-14 x JBR-20-06	12.93	-16.40 to 21.02	JBR-21-14 x JBR-20-06	21.02**	0	10	03	01
				JBR-21-14 x JBL-21-12	1.56		JBR-20-11 x JBR-20-06	18.95*				
				JBR-20-06 x JBL-21-12	0.59		JBR-20-11 x JBR-21-06	17.99*				
		E_2	-35.29 to 21.78	JBR-21-14 x JBR-20-06	21.78**	-10.41 to 32.63	JBR-20-11 x JBR-21-06	32.63**	03	17	12	0
				JBR-20-06 x JBL-21-10	13.04*		JBR-20-01 x JBR-20-11	30.86**				
				JBR-20-06 x JBL-21-12	12.87*		JBR-21-14 x JBR-20-06	30.16**				
		E_3	-23.41 to 19.78	JBR-21-14 x JBR-20-06	19.78**	-19.20 to 29.12	JBR-20-11 x JBR-20-06	29.12**	01	14	04	03
				JBR-20-11 x JBR-20-06	7.89		JBR-21-14 x JBR-20-06	21.12**				
				JBR-21-06 x JBR-20-06	1.74		JBR-20-11 x JBR-21-06	13.92*				
3	Number of fruits per plant	E_1	-39.23 to 35.26	JBR-20-11 x JBL-21-10	35.26**	-37.42 to 38.79	JBR-21-14 x JBR-20-06	38.79**	07	09	05	09
				JBR-21-06 x JBL-21-12	25.99**		JBR-21-14 x JBL-21-12	18.00**				
				JBR-20-06 x JBL-21-12	24.45**		JBR-20-11 x JBL-21-10	16.22**				
		E_2	-52.20 to 69.05	JBR-20-06 x JBL-21-12	69.05**	-53.29 to 58.09	JBR-20-01 x JBR-21-14	58.09**	08	10	11	10
				JBR-21-06 x JBL-21-10	44.47**		JBR-21-14 x JBL-21-09	56.07**				
				JBR-20-06 x JBL-21-09	39.73**		JBR-21-06 x JBL-21-10	46.67**				

		E3	-53.19 to 55.56	JBR-20-06 x JBL-21-12	55.56**	-44.97 to 44.28	JBR-21-06 x JBL-21-10	44.28**	05	09	11	08
				JBL-21-12 x JBL-21-09	48.12**		JBR-20-11 x JBL-21-10	40.86**				
				JBR-20-11 x JBL-21-10	38.02**		JBR-20-01 x JBR-21-14	39.73**				
4	Fruit weight (g)	E1	-40.54 to 32.20	JBR-20-01 x JBR-20-06	32.20**	-51.96 to 35.19	JBL-21-09 x JBL-21-10	35.19**	05	11	04	08
				JBL-21-09 x JBL-21-10	29.19**		JBR-20-01 x JBL-21-10	30.93**				
				JBR-20-01 x JBR-21-06	27.62*		JBR-20-01 x JBR-20-11	23.97**				
		E2	-39.56 to 40.31	JBR-20-01 x JBR-21-06	40.31**	-26.97 to 41.27	JBL-21-09 x JBL-21-10	41.27**	05	10	05	06
				JBR-21-06 x JBR-21-14	32.56**		JBR-20-01 x JBL-21-10	39.34**				
				JBL-21-09 x JBL-21-10	32.42**		JBR-20-11 x JBR-21-06	28.14**				
		E3	-49.71 to 44.35	JBR-20-01 x JBR-21-06	44.35**	-55.64 to 38.58	JBR-20-01 x JBL-21-10	38.58**	06	14	04	11
				JBR-21-06 x JBR-21-14	40.82**		JBL-21-09 x JBL-21-10	33.06**				
				JBR-20-01 x JBL-21-10	28.93**		JBR-20-01 x JBR-20-11	23.26**				
5	Number of primary branches per plant	E1	-58.19 to -6.14	JBL-21-09 x JBL-21-10	-6.14	-28.16 to 61.32	JBR-20-06 x JBL-21-10	61.32**	0	22	10	01
				JBR-20-06 x JBL-21-10	-8.10		JBL-21-12 x JBL-21-09	52.63**				
				JBR-21-14 x JBL-21-10	-8.29		JBR-21-14 x JBL-21-12	49.21**				
		E2	-64.71 to 16.56	JBL-21-09 x JBL-21-10	16.56*	-32.01 to 50.99	JBR-20-06 x JBL-21-10	50.99**	01	23	08	05
				JBR-21-06 x JBL-21-09	11.53		JBR-20-11 x JBR-21-14	35.98**				
				JBR-20-01 x JBR-21-06	5.36		JBR-20-06 x JBL-21-12	32.29**				
		E3	-55.56 to 4.62	JBR-21-06 x JBL-21-10	4.62	-28.57 to 54.05	JBR-20-06 x JBL-21-10	54.05**	0	23	07	05
				JBR-20-01 x JBR-21-06	-4.84		JBR-21-14 x JBR-20-06	28.57**				
				JBR-21-06 x JBL-21-09	-4.84		JBR-20-06 x JBL-21-12	26.90**				
6	Fruit yield per plant (kg)	E1	-17.49 to 22.78	JBR-20-01 x JBR-20-11	22.78	-34.06 to 4.37	JBL-21-12 x JBL-21-10	4.37	0	0	0	09
				JBL-21-12 x JBL-21-10	16.02		JBL-21-09 x JBL-21-10	3.06				
				JBL-21-09 x JBL-21-10	15.69		JBR-21-14 x JBL-21-10	-0.44				
		E2	-37.02 to 67.70	JBR-21-14 x JBL-21-09	67.70**	-43.46 to 56.02	JBL-21-09 x JBL-21-10	56.02**	13	07	08	09
				JBR-21-06 x JBR-21-14	62.11**		JBR-21-06 x JBL-21-10	52.36**				
				JBR-20-01 x JBR-21-06	49.03**		JBR-21-14 x JBL-21-09	41.36**				
		E3	-46.47 to 65.10	JBL-21-12 x JBL-21-09	65.10**	55.61 to 54.15	JBL-21-09 x JBL-21-10	54.15**	09	04	04	08
				JBR-21-06 x JBR-21-14	55.80**		JBR-21-06 x JBL-21-10	46.83**				
				JBR-20-06 x JBL-21-09	53.69**		JBR-21-06 x JBR-21-14	37.56**				

*, ** 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	
				H (%)	SH (%)	Better parent	Standard check
1	E_1	JBL-21-12 x JBL-21-10	2.39	16.02	4.37	-	NPB, FW
2		JBL-21-09 x JBL-21-10	2.36	15.69	3.06	FW	FW
3		JBR-21-14 x JBL-21-10	2.28	11.76	-0.44	-	-
4		JBR-20-01 x JBR-20-11	2.21	22.78	-3.49	FW	NPB, FW
5		JBR-20-01 x JBL-21-12	2.19	6.31	-4.37	-	
6		JBR-21-14 x JBL-21-12	2.19	6.31	-4.37	-	NPB, NFP
1	E_2	JBL-21-09 x JBL-21-10	2.98	43.27**	56.02**	NPB, FW, FYP	FW, FYP
2		JBR-21-06 x JBL-21-10	2.91	39.90**	52.36**	NFP, FYP	NFP, FYP
3		JBR-21-14 x JBL-21-09	2.70	67.70**	41.36**	NFP, FYP	NFP, FYP
4		JBR-21-06 x JBR-21-14	2.61	62.11**	36.65**	FW, NFP, FYP	NFP, FYP
5		JBR-21-14 x JBL-21-10	2.42	16.35*	26.70**	FYP	NPB, NFP, FYP
6		JBR-20-01 x JBR-21-14	2.36	46.58**	23.56**	FG, NFP, FYP	NFP, FYP
1	E_3	JBL-21-09 x JBL-21-10	3.16	40.44**	54.15**	FW, FYP	FW, FYP
2		JBR-21-06 x JBL-21-10	3.01	33.78**	46.83**	NFP, FYP	NFP, FYP
3		JBR-21-06 x JBR-21-14	2.82	55.80**	37.56**	FW, FYP	NFP, FYP
4		JBR-20-01 x JBR-21-06	2.49	46.47**	21.46*	FW, FYP	FYP
5		JBL-21-12 x JBL-21-09	2.46	65.10**	20.00	FL, NFP, FYP	NPB, FL, NFP
6		JBR-21-14 x JBL-21-10	2.46	9.33	20.00	-	NPB, NFP

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

FW - Fruit weight	NPB - Number of primary branches per plant	NFP - Number fruits per plant	FL - Fruit Length
FG - Fruit girth	FYP - Fruits yield per plant		

Table 3: Correlation coefficient between *per se* performance and heterobeltiosis in brinjal

S. N.	Characters	Per se performance and Heterobeltiosis		
		E_1	E_2	E_3
1	Number of primary branches	0.80**	0.36	0.41*
2	Fruit length (cm)	0.88**	0.81**	0.76**
3	Fruit girth (cm)	0.65**	0.60**	0.72**
4	Fruit weight (g)	0.71**	0.70**	0.59**
5	Number of fruits per plant	0.82**	0.81**	0.64**
6	Fruit yield per plant (kg)	0.84**	0.87**	0.84**

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 presence of 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 the top most heterobeltiosis was exhibited by crosses *viz.*, JBR-20-01 x JBR-20-11 (22.78%) in E_1; JBR-21-14 x JBL-21-09 (67.70%) in E_2 and JBL-21-12 x JBL-21-09 (65.10%) in E_3 and the highest economic heterosis was exhibited up to 4.37% by cross JBL-21-12 x JBL-21-10 in E_1; 56.02% by cross JBL-21-09 x JBL-21-10 in E_2; and 54.15% by cross (JBL-21-09 x JBL-21-10) in E_3 for fruit yield per plant. Clould tested in multilocation trials to boost high fruit yield through exploitation of heterosis in brinjal.

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