Full Length Research Article

© 2024, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 15; Issue 04 (Jul–Aug 2024); pp 982–987

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Evolution of Hybrids for Heterosis Breeding in Brinjal (*Solanum melongena* L.)

S. Ranjith Raja Ram*[1] and R. Elakkiya[2]

[1-2] Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar - 608 002, Tamil Nadu, India

Received: 03 May 2024; Revised accepted: 24 Jul 2024

Abstract

Brinjal is an important vegetable crop and a good source of dietary minerals, vitamins, iron and anthocyanin based on the economic and nutritional value of brinjals, breeding efforts focus on developing high yielding promising hybrids with resistant to many pests and diseases. Heterosis or Hybrid vigour is a hybrid which is phenotypically superior over its parents for quantitative and qualitative characters. Heterosis breeding is one of the efficient tools to exploit the heterotic response for various useful traits. The Line x Tester crossing was undertaken with seven lines and three testers were evaluated along with twenty-one hybrids in RBD design to estimate the magnitude of heterosis for yield and its yield contributing characters. The best way to utilize heterosis breeding in crop is to generate F_1 hybrids having maximum heterozygosity, thereby facilitating the identification and selection of hybrid vigour. The positive significant standard heterosis for fruit yield per plant was maximum with Sevanthipatti brinjal x Arka harshita (12.33%) followed by Arka keshav x Arka harshita (11.72%) and Kulasai brinjal x Arka harshita (8.62%) respectively. Some of the promising hybrids have showed desirable heterosis for days to 50% flowering, plant height, number of flowers per cluster, number of fruits per cluster, number of fruits per plant, fruit length, fruit breadth, fruit weight and fruit yield per plant. The Hybrids Sevanthipatti Brinjal X Arka harshita and Kulasai brinjal X Arka harshita recorded with high *per se* performance, highly significance SCA effects and high standard heterosis for fruit yield and its component character were found to be suitable for heterosis breeding.

***Key words*:** Heterosis, F_1 hybrids, Line X Tester, Gene action

Brinjal (*Solanum melongena* L.) is very popular vegetable crop belongs to the family of *Solanaceae* and has diploid chromosome number (2n = 2x = 24). The evolution of hybrids for heterosis breeding in brinjal (Solanum melongena L.) has been a significant focus in horticultural science, aimed at improving yield, quality, and resistance to pests and diseases. Heterosis, or hybrid vigor, refers to the phenomenon where hybrid offspring exhibit superior qualities compared to their parents. The evolution of hybrids for heterosis breeding in brinjal represents a dynamic and ongoing process aimed at addressing the challenges and opportunities in brinjal cultivation. Through continued research and innovation, hybrid breeding will remain a cornerstone of efforts to enhance the productivity and sustainability of this important vegetable crop. This approach has been instrumental in the advancement of brinjal breeding programs.

It thrives in tropical and subtropical regions and holds the distinction of being a primary center of origin in India, where it is affectionately termed the "king of vegetables" due to its widespread culinary use [1]. Revered across all social strata, it is aptly called the "vegetable of masses" due to its accessibility and affordability [2]. Though primarily cultivated in tropical areas, brinjal also grows in temperate regions, primarily for its immature fruits [3]. Brinjal is often referred as the poor man's vegetable crop [4] because of its low cost of production and easily availability throughout the year. It is celebrated not only for its culinary versatility but also for its medicinal properties, including benefits for diabetic patients and liver health [5]. It has also been recommended as an excellent remedy for people suffering from liver complaints [6]. In India brinjal is grown in an area of 0.753 m ha with total production of 13.023 mt having an average productivity of 17.3 t/ha (3rd advance estimate 2021-2022, GOI). India is the second largest producer of brinjal next to China. The major brinjal producing states in India are West Bengal, Odisha, Gujarat, Bihar and Madhya Pradesh. In the present investigation, a study was conducted to study on heterosis in various crosses.

MATERIALS AND METHODS

The Line x Tester experimental study was carried out in Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Chidambaram, Tamil Nadu. The set of crosses were attempted involving genetically diversified seven lines such as Violet brinjal (L_1), Arka keshav (L_2), Bhavani brinjal (L_3), Sevanthipatti brinjal (L_4), Kollampatti brinjal (L_5), Manaparai brinjal (L_6), Kulasai brinjal (L_7) and genetically diversified three testers such as White brinjal (T_1), Large bhavani brinjal (T_2), Arka harshita (T_3) collected from

***Correspondence to:** S. Ranjith Raja Ram, E-mail: ranjithplantbreeder@gmail.com

Citation: Ram SRR, Elakkiya R. 2024. Evolution of hybrids for heterosis breeding in brinjal (*Solanum melongena* L.). *Res. Jr. Agril. Sci.* 15(4): 982-987.

Namakkal, Tamil Nadu and IIHR, Bangalore were used for this studies. These Seven lines and three testers were crossed in line x tester mating design to generate 21 F_1 hybrids. These 21 hybrids along with 10 parents were grown in kharif and summer season of 2020-22 in randomized block design with three replications. The observation data was recorded on ten selected plants of each hybrid and parents for all ten characters viz., days to 50% flowering, plant height, number of branches per plant, number of flowers per cluster, number of fruits per cluster, number of fruits per plant, fruit length, fruit weight, fruit breadth and fruit yield per plant.

RESULTS AND DISCUSSION

Analysis of variance for experimental design

The analysis of variance on biometrical traits revealed that significant differences among lines and testers in respect of gca for all the characters. The significance of gca variances thus reflected the importance of non-additive gene action for these traits. Similar results were also reported by Das and Barua [7] and Rai and Asati [8]. The differences among hybrids due to interaction between lines and testers in respect of sca were also found significant for all the characters in F_1 generation indicating the importance of non-additive gene action. Similar results of gene action for these traits were also reported by Reddy and Patel [9]. The predominant role of non-additive gene action in F_1 generation was observed for all the traits. For all the ten characters the ratio (GCA/SCA) value less than unity indicated the predominance of non-additive gene action in the inheritance of these traits and its good for heterosis breeding to improve yield (Table 1). Heterosis was estimated for ten characters and expressed as percentage. The first two cross of each character for over mid parent (di-relative heterosis), better parent (dii-heterobeltiosis) and standard parent (diii-standard heterosis) has been mentioned below in (Table 2).

Table 1 Analysis of variance for ten characters in brinjal

Source	df	Days to 50% flowering	Plant height	No. of branches per plant	No. of flowers per cluster	No. of fruits per cluster	No. of fruits per plant	Fruit length	Fruit weight	Fruit breath	Fruit yield per plant
Replication	2	0.9227	0.0609	0.1202	0.0864	0.0452**	1.9429	0.6146	0.6468	0.5486	0.5323
Lines	6	220.79**	138.18**	4.21**	4.8666**	5.2272**	158.89**	25.68**	1870.37**	13.049**	78658.98**
Testers	2	22.518**	115.07**	1.21**	0.2155**	0.8031**	110.7859**	53.61**	2482.61**	4.7971**	71719.46**
L × T	12	62.28**	130.78**	0.60**	0.4819**	0.2389**	16.9682**	1.2292**	221.0879**	0.7419**	8285.21**
Error	60	0.3027	0.2464	0.0997	0.0493	0.00646	0.3633	0.2000	0.4285	0.2331	430.269**
GCA	-	0.9075	0.7955	0.0229	0.0311	0.0254	1.3365	0.4787	20.1099	0.1110	615.8576
SCA	-	20.6629	43.4973	0.1664	0.1422	0.0526	5.5221	0.3369	73.5263	0.1641	2623.1813
GCA/ SCA	-	0.04391	0.01828	0.1376	0.21870	0.4828	0.2420	1.4208	0.2735	0.6764	0.2347

Table 2 Analysis of variance for combining ability for ten characters

Source	Days to 50% flowering	Plant height	No. of branches per plant	No. of flowers per cluster	No. of fruits per cluster	No. of fruits per plant	Fruit length	Fruit weight	Fruit breadth	Fruit yield per plant
GCA	0.9075	0.7955	0.0229	0.0311	0.0254	1.3365	0.4787	20.1099	0.1110	615.8576
SCA	20.6629	43.4973	0.1664	0.1422	0.0526	5.5221	0.3369	73.5263	0.1641	2623.1813
GCA/ SCA	0.04391	0.01828	0.1376	0.21870	0.4828	0.2420	1.4208	0.2735	0.6764	0.2347

Fruit yield per plant being the most important attribute exhibited non -additive gene action at the ratio between gca and sca variance is less than one. Similar results in fruit yield per plant in brinjal also reported by Gangadharan *et al*. [10], Timmareddygari *et al*. [11] and Rajan *et al*. [12] for the trait exhibited additive gene action, simple selective would be desirable for improvement of these character as it is flexible. In the traits where non- additive gene action is present, it is advocated for heterosis breeding. Nagai and Kida [13] were the first to observe hybrid vigour in brinjal. The commercial exploitation of this crop is possible due to the low cost of F_1 seed production and the low seed requirement / unit area [14].

Days to 50% flowering

The cross (Kollampatti brinjal x Arka harshitha) L_5 x T_3recorded maximum significant negative relative heterosis of (-10.19 per cent) followed by (Manapaari brinjal x White brinjal) L_6 x T_1 recorded (-7.92 per cent) and (Bhavani brinjal x Arka harshitha) L_3 x T_3 (-7.79 per cent) and the crosses)(Kollampatti brinjal x Arka harshitha) L_5 x T_3 (-18.88 percent followed by (Manaparai brinjal x White brinjal) L_6 x T_1 (-15.70 per cent) and (Bhavani brinjal x Arka harshitha) L_3 x T_3 (-15.54 per cent) recorded negative and significant heterobeltiosis. The standard heterosis ranged from -1.68 per cent for (Kulasai brinjal x Arka harshitha) L_7 x T_3 to (Violet brinjal x Large bhavani brinjal) L_1 x T_2 (-7.52 per cent) and the crosses (Violet brinjal x Large bhavani brinjal) L_1 x T_2 recorded maximum negative standard heterosis (-7.52 per cent) followed by (Violet brinjal x Arka harshita) L_1 x T_3 (-6.04 per cent) and (Violet brinjal x White brinjal) L_1 xT_1 (-4.09 per cent) for this trait.

Plant height (cm)

Eleven out of twenty-one crosses recorded negative significant relative heterosis for this trait. The maximum negative relative heterosis was observed in (Kollampatti brinjal x Large bhavani brinjal) L_5 x T_2 (-15.68 per cent) followed by (Kulasai brinjal x Large bhavani brinjal) L_7 x T_2 (-12.51 per cent). All cross combinations recorded negative and significant heterobeltiosis for this trait. Fourteen out of twenty-one cross combinations recorded maximum negative significant standard heterosis for this trait. The crosses (Kollampatti brinjal x Large bhavani brinjal) L_5 x T_2 (Kollampatti brinjal x Large white brinjal) recorded maximum negative standard heterosis of (-23.73 percent) followed by (Kollampatti brinjal x Arka harshitha) L_5 x T_3 (-20.30 per cent).

Number of branches per plant

The cross (Arka keshav x White brinjal) L_2 x T_1 (15.51 per cent) recorded significant positive relative heterosis for this trait. One cross out of twenty-one crosses recorded significant positive heterobeltiosis with (Sevanthipatti brinjal x White brinjal) L_4 x T_1 (16.30 per cent). The standard heterosis ranged from (Violet brinjal x White brinjal) L_1 x T_1 (14.43 per cent) to (Sevanthipatti brinjal x Large bhavani brinjal) L_4 x T_2 (29.30 per cent) and the crosses of (Sevanthipatti brinjal x Large bhavani brinjal) L_4 x T_2 recorded maximum significant positive standard heterosis of (29.30 per cent) followed by (Sevabthipatti brinjal x White brinjal) L_4 x T_1 (21.17 per cent) and (Violet brinjal x Arka harshitha) L_1 x T_3 (19.05 per cent) for this trait.

Table 3 Heterosis over mid parent, better parent and standard heterosis in 21 F_1's crosses for ten traits in brinjal

Hybrids	Days to 50% flowering			Plant height			Number of branches per plant			Number of flowers per cluster		
	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)
$L_1 \times T_1$	-0.78	-5.59**	-4.09**	-7.09**	-15.39**	-1.85**	-7.3	-8.28**	14.43*	-11.31**	-19.81**	-6.20
$L_1 \times T_2$	-0.40	-1.57*	-7.52**	0.82	-3.69**	0.77	-15.44**	-25.07**	-6.52	-3.07	-8.52**	7.01*
$L_1 \times T_3$	-1.99**	-6.04**	-6.04**	-1.75**	-4.08**	-4.08**	5.93	-4.58**	19.05**	3.98	-3.57	12.80**
$L_2 \times T_1$	-2.96**	-6.79**	2.81**	7.34**	-4.66**	10.60**	15.51**	-5.58**	15.38**	-15.94**	-27.17**	-6.03
$L_2 \times T_2$	-2.39**	-9.62**	-0.32	3.50**	-3.71**	0.76	-11.12	-19.77**	-22.71**	-4.95**	-14.23**	10.66**
$L_2 \times T_3$	-1.34*	-5.95**	3.74**	-1.89**	-6.76**	-6.76**	-10.31	-20.37**	-20.37**	10.19**	-2.20	26.19**
$L_3 \times T_1$	5.94**	-2.26**	17.49**	12.83**	-1.70**	14.03**	3.12	-13.79**	5.35	-11.13**	-21.45**	-25.72**
$L_3 \times T_2$	-1.41**	-12.18**	5.57**	-7.08**	-15.30**	-11.37**	-11.58*	-18.10**	-21.10**	21.71**	3.40	7.36*
$L_3 \times T_3$	-7.79**	-15.54**	1.53*	0.21	-6.74**	-6.74**	-4.26	-12.82*	-12.82*	8.69**	-6.20	-6.20
$L_4 \times T_1$	-0.89**	-1.45*	1.26	-10.33**	-19.35**	-6.45**	-9.22*	16.30**	21.17**	-11.34**	-19.53**	-6.66*
$L_4 \times T_2$	-1.07	-5.31**	-2.71**	3.21**	-2.69**	1.82**	7.26	-10.68**	29.30**	-1.05	-6.24*	8.75**
$L_4 \times T_3$	-0.86	-2.18**	-1.78**	0.22	-3.46**	-3.46**	-11.70*	-25.35**	8.06	3.70	-3.45	11.99**
$L_5 \times T_1$	3.06**	-6.25**	16.24**	18.66**	-1.66**	14.08**	2.82	-10.25*	9.67	-1.75	-3.68	-8.92**
$L_5 \times T_2$	10.69**	-2.71**	20.62**	-15.68**	-27.11**	-23.73**	-8.64	-11.10	-14.36*	-6.07*	-11.94**	-8.57**
$L_5 \times T_3$	-10.19**	-18.88**	0.57	-9.58**	-20.30**	-20.30**	-6.25	-10.40	-10.40	-5.59	-9.91**	-9.91**
$L_6 \times T_1$	-7.92**	-15.70**	3.05**	-0.15	-16.48**	-3.12**	-5.18	-9.95	10.04	-12.00**	-21.38**	25.67**
$L_6 \times T_2$	-2.19**	-13.51**	5.73**	-7.31**	-19.09**	-15.34**	0.96	-5.27	4.10	14.24**	-1.95	1.80
$L_6 \times T_3$	8.60**	-1.28*	20.67**	3.25**	-8.09**	-8.09**	-5.34	-9.60	-0.66	9.10**	-4.87	-4.87
$L_7 \times T_1$	-0.51	-1.77**	-0.20	-6.05**	-12.09**	1.98**	9.35	-10.25*	9.67	-7.47**	-13.45**	-6.03
$L_7 \times T_2$	-0.51	-3.05**	-4.00**	-12.51**	-13.99**	-10.00**	-3.56	-12.55*	-15.75**	5.35*	3.04	11.88**
$7_7 \times T_3$	-1.19*	1.68*	-1.68**	-2.26**	-2.78**	-1.73**	0.45	-10.40	-10.40	7.72**	3.47	12.34**

Table 4 Heterosis over mid parent, better parent and standard heterosis in 21 F_1's crosses for ten traits in brinjal

Hybrids	Number of fruits per cluster			Number of fruits per plant (%)			Fruit length (per cent)		
	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)
$L_1 \times T_1$	2.84	-14.06**	63.68**	-1.88	-3.55*	28.12**	-12.31	-21.59**	-64.91**
$L_1 \times T_2$	-4.34	-20.83**	50.79**	-0.69	-20.35**	2.21	-6.91	-13.93*	-54.63**
$L_1 \times T_3$	-14.27**	-34.63**	24.51**	3.70*	-7.74**	18.39**	9.45**	-20.78**	-20.78**
$L_2 \times T_1$	-3.59	-16.24**	7.09	-3.77*	-8.10**	22.08**	-11.29**	-40.78**	-37.66**
$L_2 \times T_2$	0.09	-12.15*	9.65	-13.31**	-28.86**	-13.99**	-6.27	-29.67**	-25.96**
$L_2 \times T_3$	11.25**	8.07	8.07	0.73	-7.98**	11.25**	-12.71**	-14.90**	-10.40**
$L_3 \times T_1$	6.05	-16.40**	6.89	-26.77**	-47.11**	-29.74**	-1.11	16.08**	-57.54**
$L_3 \times T_2$	7.88	-14.20**	7.09	-11.61**	-22.15**	-39.65**	-18.46**	-20.09**	-57.88**
$L_3 \times T_3$	11.05**	3.54**	-3.54	15.26**	-8.35**	-8.35**	4.47	-21.34**	-21.34**
$L_4 \times T_1$	0.69	-0.30	30.02**	-1.00	-17.82**	9.17**	-9.26	-17.26**	-64.56**
$L_4 \times T_2$	7.52	5.12	37.20**	-4.17	-9.73**	-20.83**	-4.31	-13.28*	-54.29**
$L_4 \times T_3$	8.42	-4.23	24.90**	-1.24	-7.31**	-7.31**	23.24**	11.99**	11.99**
$L_5 \times T_1$	5.74	-5.26	52.95**	-20.16**	-46.54**	-28.98**	-11.91	-14.92	-67.78**
$L_5 \times T_2$	-0.76	-12.02**	42.03**	13.52**	-10.24**	-30.41**	-5.25	-18.59**	-57.09**
$L_5 \times T_3$	5.04	-14.95**	37.30**	-29.21**	-48.65**	-48.65**	7.76*	-25.72**	-25.72**
$L_6 \times T_1$	4.01	1.31	36.61**	18.85**	-16.52**	10.90**	-4.52	-13.67*	-62.32**
$L_6 \times T_2$	3.49	-0.36	34.35**	3.53	-12.32**	-32.03**	-0.41	-8.97	-52.02**
$L_6 \times T_3$	-5.03	-17.30**	11.52	17.02**	-10.03**	-10.03**	18.49**	-14.89**	-14.89**
$L_7 \times T_1$	-17.08**	-17.24**	5.81	8.55**	-19.47**	6.97**	-10.58	-24.86**	-61.05**
$L_7 \times T_2$	-0.55	-1.55	25.39**	3.58	-5.28	-26.57**	-7.45	-8.22	-51.62**
$7_7 \times T_3$	-7.97	-17.85**	4.63	24.34**	2.12	7.87**	4.66	-20.54**	-20.54**

Number of flowers per cluster

The cross (Bhavani brinjal x Large bhavani brinjal) L_3 x T_2 recorded significant positive relative heterosis of (21.71per cent) followed by (Manaparai brinjal x Large bhavani brinjal) L_6 x T_2 (14.24 per cent) and) (Arka keshv X Arka harshitha) L_2 x T_3 (10.19 per cent. All cross combinations recorded negative and significant heterobeltiosis for this trait. Eight out of twenty-one crosses recorded positive commercial heterosis and it ranged from (Violet brinjal x Large bhavani brinjal) L_1 x T_2 (7.01 per cent) to (Arka keshav x Arka harshitha) L_2 x T_3 (26.19 per cent) and the cross of L_2 x T_3 (Arka keshav x Arka harshitha) recorded maximum significant positive standard heterosis (26.19 per cent) followed by (Manaparai brinjal x White binjal) L_6 x T_1 (25.67 per cent) (Violet brinjal x Arka harshitha) L_1 x T_3 (12.80 per cent) for this trait.

Number of fruits per cluster

The cross (Arka kesav x Arka harshitha) L_2 x T_3 recorded significant positive relative heterosis of (11.25 per cent) followed by (Bhavani brinjal x Arka harshitha) L_3 x T_3 (11.05per cent). One crosses have recorded significant positive heterobeltiosis (Bhavani brinjal x Arka harshitha) L_3 x T_3 (3.54 per cent for this trait. The standard heterosis ranged from (Violet brinjal x Arka harshitha) L_1 x T_3 (24.51 per cent) to (Violet brinjal x White brinja) L_1 x T_1 (63.68 per cent) and the cross of L_1 x T_1 (recorded maximum significant positive standard heterosis (63.68 per cent) followed by (Kollampatti brinjal x White brinjal) L_5 x T_1 (52.95 per cent) and (Violet brinjal x Large bhavani brinjal) L_1 x T_2 (50.79 per cent) for this trait.

Number of fruits per plant

The cross (Kulasai brinjal x Arka harshitha) L_7 x T_3 recorded significant positive relative heterosis of (24.34 per cent) followed by (Manaparai brinjal x Violet brinjal) L_6 x T_1 (18.85 per cent) and (Manaparai brinjal x Arka harshitha) L_6 x T_3 (17.02 per cent). All cross combinations recorded negative and significant heterobeltiosis for this trait. The standard heterosis ranged from (Violet brinjal x White brinjal) L_1 x T_1 (28.12 per cent) to (Kulasai brinjal xWhite brinjal) L_7 x T_1 (6.97 per cent) and the cross of (Violet brinjal x White brinjal) L_1 x T_1 recorded maximum significant positive standard heterosis (28.12 per cent) followed by (Arka keshav x Violet brinjal) L_2 x T_1 (22.08 per cent) and (Violet brinjal x Arka harshitha) L_1 x T_3 (18.39 per cent) for this trait.

Fruit length (cm)

The cross (Kollampatti brinjal x Arka harshitha) L_4 x T_3 (23.24 per cent) followed by (Manaparai brinjal x Arka harsitha) L_6 x T_3 (18.49 per cent) and (Violeet brinjal x Arka harshitha) L_1 x T_3 (9.45 per cent) respectively. Two out of twenty-one crosses recorded positive significant hetetobeltiosis with (Bhavani brinjal x White brinjal) L_3 x T_1 (16.08 per cent) followed by (Sevanthipatti brinjal x Arka harshitha) L_4 x T_3 (11.99 per cent). One out of twenty-one cross combinations recorded maximum significant positive standard heterosis with (Sevanthipatti brinjal x Arka harsitha) L_4 x T_3 (11.99 per cent) for this trait.

Fruit weight (g)

The cross (Kulasai brinjal x Arka harshitha) L_7 x T_3 exhibited significant positive relative heterosis (13.35 per cent) followed by (Arka keshav x Arka harshitha) L_2 x T_3 (8.82 per cent) and (Violet brinjal x White brinjal) L_1 x T_1 (4.84 per cent) respectively. All cross combinations recorded negative and significant heterobeltiosis for this trait. The standard heterosis ranged from (Sevanthipatti brinjal x Arka harshitha) L_4 x T_3 (2.19 per cent) to (Manaparai brinjal x Large bhavani brinjal) L_6 x T_2 (36.88 per cent) and the cross (Manaparai brinjal x Large bhavani brinjal) L_6 x T_2 recorded maximum significant positive Standard heterosis (36.88 per cent) followed by (Manaparai brinjal x White brinjal) L_6 x T_1 (30.38 per cent) (Manaparai brinjal x Arka harshitha) L_6 x T_3 (28.39 per cent) for this trait.

Table 5 Heterosis over mid parent, better parent and standard heterosis in 21 F_1's crosses for ten traits in brinjal

Hybrids	Fruit weight (per cent)			Fruit breadth (per cent)			Number of fruits per plant (%)		
	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)	RH (di)	HB (dii)	SH (diii)
$L_1 \times T_1$	4.84**	-4.04**	-23.69**						
$L_1 \times T_2$	-3.84**	-9.18**	-40.02**	4.36	-9.22	117.92**	-1.76	-3.64	-32.69**
$L_1 \times T_3$	-2.24**	-18.84**	-18.84**	-4.72	-32.52**	62.00**	-8.84**	-22.58**	-22.58**
$L_2 \times T_1$	-8.87**	-22.95**	-38.73**	-15.14	-29.13**	4.22	-13.70**	-29.52**	-37.84**
$L_2 \times T_2$	-1.32*	-4.48**	-43.92**	10.33	-14.21*	52.32**	2.25	-6.36*	-37.08**
$L_2 \times T_3$	8.82**	-15.69**	-15.69**	-3.22	-3.91	-3.91	13.27**	-11.72**	11.72**
$L_3 \times T_1$	-0.15	-1.47**	-21.65**	8.80**	-29.19**	88.36**	-2.76	-5.47**	-16.64**
$L_3 \times T_2$	-5.80**	-17.18**	-35.88**	2.67	14.40**	127.70**	-5.73**	-14.83**	-29.08**
$L_3 \times T_3$	-6.14**	-16.74**	-16.74**	1.63	-30.08**	85.99**	-8.53**	-16.18**	-16.18**
$L_4 \times T_1$	-1.85**	-14.63**	-8.21**	-2.35	-12.44	62.31**	-7.00*	-1528**	-9.09**
$L_4 \times T_2$	-17.83**	-36.49**	-31.71**	-9.99	-11.89	63.34**	12.51**	-28.86**	-23.67**
$L_4 \times T_3$	-1.52**	-4.96**	2.19**	5.74	-18.16**	50.88**	-0.89	4.27**	12.33**
$L_5 \times T_1$	-3.80**	-7.80**	-20.03**	-4.31	-12.53	55.30**	-0.20	-0.42	-11.79**
$L_5 \times T_2$	0.95*	-15.36**	-26.59**	-8.99	-8.99	61.59**	-7.65**	-18.80**	-28.07**
$L_5 \times T_3$	1.62**	-5.12**	-5.12**	-16.81*	-34.98**	15.45	-2.74	-8.30**	-8.30**
$L_6 \times T_1$	-4.88**	-12.45**	30.38**	3.71	-20.92**	121.52**	-11.15**	-20.14**	-29.58**
$L_6 \times T_2$	0.53	-5.60**	36.88**	-0.14	-18.42**	128.53**	-2.61	-4.79	-33.03**
$L_6 \times T_3$	-14.17**	-28.39**	28.39**	-21.43**	-46.69**	49.33**	-8.69**	-22.24**	-22.24**
$L_7 \times T_1$	-10.03**	-20.15**	-36.50**	-6.56	-10.56	43.87**	-3.87	-17.35**	-27.11**
$L_7 \times T_2$	-0.92	-3.26**	-40.39**	-3.90	-8.41	62.62**	0.40	-2.39	-34.41**
$7_7 \times T_3$	13.35**	-8.41**	8.41**	-10.94	-27.78**	16.17	11.81**	-8.62**	8.62**

Table 6 Heterosis for the first two best hybrids in relative heterosis, heterobeltiosis and standard heterosis

Characters	1	2	3	4	5	6	7	8	9	10
Relative heterosis (di)	$L_5 \times T_3$ (-10.19%)	$L_5 \times T_1$ (18.66%)	$L_2 \times T_1$ (15.51%)	$L_3 \times T_2$ (21.71%)	$L_2 \times T_3$ (11.25%)	$L_7 \times T_3$ (24.34%)	$L_4 \times T_3$ (23.24%)	$L_7 \times T_3$ (13.35%)	$L_1 \times T_1$ (10.77%)	$L_2 \times T_3$ (13.27%)
	$L_6 \times T_1$ (-7.92%)	$L_3 \times T_1$ (12.83%)	-	$L_6 \times T_2$ (14.24%)	$L_3 \times T_3$ (11.05%)	$L_6 \times T_1$ (18.85%)	$L_6 \times T_3$ (18.49%)	$L_2 \times T_3$ (8.82%)	$L_3 \times T_1$ (8.80%)	$L_4 \times T_2$ (12.51%)
Heterobeltiosis (dii)	$L_5 \times T_3$ (-18.88%)	-	$L_4 \times T_1$ (16.30%)	-	$L_3 \times T_3$ (3.54%)	-	$L_3 \times T_1$ (16.08%)	-	$L_3 \times T_2$ (14.40%)	$L_4 \times T_3$ (4.27%)
	$L_6 \times T_1$ (-15.70%)	-	-	-	-	-	$L_4 \times T_3$ (11.99%)	-	-	-
Standard heterosis (diii)	$L_1 \times T_2$ (-7.52%)	$L_5 \times T_1$ (14.08%)	$L_4 \times T_2$ (29.30%)	$L_2 \times T_3$ (26.19%)	$L_1 \times T_1$ (63.68%)	$L_1 \times T_1$ (28.12%)	$L_4 \times T_3$ (11.99%)	$L_6 \times T_2$ (36.88%)	$L_3 \times T_2$ (127.70%)	$L_4 \times T_3$ (12.33%)
	$L_1 \times T_3$ (-6.04%)	$L_3 \times T_1$ (14.03%)	$L_4 \times T_1$ (21.17%)	$L_6 \times T_1$ (25.67%)	$L_5 \times T_1$ (52.95%)	$L_2 \times T_1$ (22.08%)	-	$L_6 \times T_1$ (30.38%)	$L_6 \times T_1$ (121.52%)	$L_2 \times T_3$ (11.72%)

Fruit breadth (cm)

The cross (Violet brinjal x White brinjal) L_1 x T_1 recorded maximum significant positive relative heterosis (10.77 per cent) followed by (Bhavani brinjal x Violet brinjal) L_3 x T_1 (8.80 per cent). One cross out of twenty-one cross recorded maximum significant positive heterobeltiosis with (Bhavani brinjal x Long bhavani brinjal) L_3 x T_2 (14.40 per cent). The standard heterosis ranged from (Kulasai brinjal x Violet brinjal) L_7 x T_1 (43.87 per cent) to (Manaparai brinjal x Large bhavani brinjal) L_6 x T_2 (128.53 per cent) and the cross (Manaparai brinjal x Large bhavani brinjal) L_6 x T_2 recorded maximum significant positive standard heterosis of (128.53 per cent) followed by (Bhavani brinjal x Large bhavani brinjal) L_3 x T_2 (127.70 per cent) followed by (Manaparai brinjal x White brinjal) L_6 x T_1 (121.52 per cent) and (Violet brinjal x White brinjal) L_1 x T_1 (117.92 per cent) for this trait.

Fruit yield per plant (g)

The cross (Arka keshav x Arka harshitha) L_2 x T_3 recorded maximum significant positive relative heteosis (13.27 per cent) followed by (Sevanthipatti brinjal x Large bhavani brinjal) L_4 x T_2 (12.51 per cent) and (Kulasai brinjal x Arka harshitha) L_7 x T_3 (11.81 per cent). One out of twenty-one cross recorded maximum positive significant heterobeltiosis with (Sevanthipatti brinjal x Arka harshitha) L_4 x T_3 (4.27 per cent). The standard heterosis ranged from (Kulasai brinjal x Arka harshitha) L_7 x T_3 (8.62 per cent) to (Sevanthipatti brinjal x Arka harshitha) L_4 x T_3 (12.33 per cent) and it was maximum with the cross L_4 x T_3 (12.33 per cent) followed by (Arka keshav x Large bhavani brinjal) L_2 x T_3 (11.72 per cent) and (Kulasai brinjal x Arka harshitha) L_7 x T_3 (8.62 per cent) for this trait.

Considering all the growth parameters, the results showed relatively higher in the crosses viz: Thus, the study indicates that (Sevanthipatti brinjal x Arka harshitha) (L_4 x T_3) should be considered for exploitation of hybrid vigour in brinjal for vegetable traits [15-18]. The result of fruit yield attributes viz. fruit length, fruit girth, average fruit weight and fruit per plant showed significant variations ranging from (22-21) to (25-31). The crosses viz. show relatively higher positive HB. So, these crosses can be exploited for fruit yield attributing traits as the performed superior than their better parent [19-20].

CONCLUSION

The hybrids Sevanthipatti brinjal x Arka harshitha, Arka keshav x Arka harshitha and Kulasai brinjal x Arka harshitha recorded as superior hybrids based on the magnitude of standard heterosis for fruit yield per plant. The hybrids Violet brinjal x Large bhavani brinjal recorded for days to 50% flowering based on the magnitude of standard heterosis. Hybrids such as Kollampatti brinjal x White brinjal and Bhavani brinjal x White brinjal identified as tall plant, the crosses Sevanthipatti brinjal x Large bhavani brinjal and Sevanthipatti brinjal x White brinjal score more number of branches per plant. The hybrid Sevanthipatti brinjal x Arka harshitha was identified as the best hybrid since it had significant standard heterosis for most of the traits. The next best hybrids were Kulasai brinjal x Arka harshitha possessed desirable standard heterosis for some traits. It can be concluded from the above results that hybrid Sevanthipatti brinjal x Arka harshitha is the most promisinh hybrid and may be exploited in practical plant breeding program.

LITERATURE CITED

1. Vavilov NI. 1931. The role of Central Asia in the origin of cultivated plants. *Bulletin of Applied Botany-Genetics and Plant Breeding* 26(3): 3-44.
2. Patel KK, Sarnaik DA. 2003. Performance study of long fruited genotypes of brinjal under Raipur condition. *The Orissa Journal of Horticulture* 31(1): 74-77.
3. Rai M, Gupta PN, Agarwal RC. 1995. Catalogue on eggplant (*Solanum melongena L.*) germplasm Part-1. *National Bureau of Plant Genetic Resources,* Pusa Campus, New Delhi. pp 1-3.
4. Sharma B, Parthania NK, Gautham V. 2004. Combining ability studies in brinjal (*Solanum melongena* L.). *Himachal Journal of Agricultural Research* 30(1): 54-59.
5. Gangadhara K, Abraham M, Selvakumar R. 2021. Combining ability and gene action for structural and economical traits in brinjal (*Solanum melongena* L.). *Indian Journal of Agricultural Sciences* 91(7): 32-36.
6. Shukla V, Naik LB. 1993. Agro-techniques of solanaceous vegetables. *Advances in Horticulture* Volume 5, Veg Crops, part 1, pp 365. (Eds) Chadha, K. L., Kalloo, G. Malhotra publishing House, New Delhi.
7. Das G. Barua NS. 2001. Heterosis and combining ability for yield and its components in brinjal. *Annuals of Agricultural Research* 23: 399-403.
8. Rai N, Asati BS. 2011. Combining ability and gene action studies for fruit yield and yield contributing traits in brinjal. *Indian Journal of Horticulture* 68: 212-215.

9. Reddy EEP, Patel AI. 2014. Heterosis studies in yield and yield attributing characters in brinjal (*Solanum melongena* L.) *Sch. Journal of Agricultural Sciences* 4: 109-112.
10. Liu Z, Jiang J, Ren A, Xu X, Zhang H, Zhao T, Jiang X, Sun Y, Li J, Yang H. 2021. Heterosis and combining ability analysis of fruit yield, early maturity, and quality in tomato. *Agronomy* 11(4): 807.
11. Abhinav, Nandan. 2010. Studies on heterosis in relation to combining ability for yield and quality attributes in brinjal (*Solanum melongena* L.). *Electronic Journal of Plant Breeding* 1(4): 783-788.
12. Das S, Mandal AB, Hazra P. 2010. Combining ability for shoot and fruit borer and other quantitative traits in brinjal (*Solanum melongena* L.). *International Journal of Plant Science* 5(2): 561-565.
13. Dishri M, Mishra HN. 2017. Estimation of combining ability and gene action studies in round brinjal (*Solanum melongena* L.). *International Journal of Current Microbiology and Applied Science* 6(10): 3584-3591.
14. Chaudhari BN, Patel AI, Vashi JM. 2020. Study on heterosis over environments in brinjal (*Solanum melongena* L.). *International Journal of Current Microbiology and Applied Sciences* 9(7): 3358-3367.
15. Deshmukh SB, Narkhede GW, Gabale LK, Dod VN. 2015. Hybrid vigour in brinjal (*Solanum melongena* L.). *The Bioscan* 10(2): 869-876.
16. Shahjahan M, Kabir K, Zomo SA, Sarkar MD, Fazlullah MU. 2016. Evaluation of heterosis in exotic eggplant. *International Research Journal of Agriculture and Food Sciences* 1(2): 23-32.
17. Bagade AB, Deshmukh JD, Kalyankar SV. 2020. Heterosis studies for yield and yield traits in brinjal. *The Pharma Innovation Journal* 9(11): 205-208.
18. Rameshkumar D, Vethamonai IP. 2020. Heterosis for quantitative and qualitative traits in brinjal (*Solanum melongena* L.). *Vegetable Science* 47(1): 55-61.
19. Farooq, Filza, Delvadiya IR. 2023. Blossoming heterosis: Unveiling the potential of hybridization in eggplant (*Solanum Melongena* L.). *International Journal of Plant and Soil Science* 35(18): 2162-2168.
20. Singh S, Sharma HD, Dogra RK, Verma V, Aditika, Shilpa. 2021. Study of heterosis for vegetative and quantitative traits in brinjal (*Solanum melongena* L.). *The Pharma Innovation Journal* 10(12): 335-338.