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Heterosis Studies for Growth, Flower and Yield Characters in Brinjal (*Solanum melongena* L.)

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ABSTRACT: Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine, is an easily cultivated plant belongs to the family Solanaceae. India is regarded as the primary centre of origin. Whereas, China as the secondary centre of origin. Despite the crop potential, economic and its medicinal use the present study was undertaken using twelve lines and three testers to develop 36 F_1 hybrids in L × T (Line × Tester) pattern. Evaluation of hybrids along with their parents revealed that the cross combinations KRCCH-11 × GL, KRCCH-12 × GL and KRCCH-10 × GL showed highest positive heterosis, which were supercilious for earliness, yield parameters and KRCCH-11 × BL and KRCCH-11 × GL expressed superior for quality parameters resulting as best hybrids. Based on its yield potential and favoured earliness characteristics, the KRCCH-11 × GL hybrid was chosen as the best hybrid out of 36 cross combinations, with a yield of 73.34 t/ha. Hence the best hybrids are recommended for commercial exploitation of heterosis.

Keywords: Eggplant, hybrids, *per se* performance, Heterosis, Best parent heterosis, Standard heterosis.

INTRODUCTION

Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine, is an easily cultivated plant belongs to the family Solanaceae. India is regarded as the primary centre of origin. Whereas, China as the secondary centre of origin (Bhaduri, 1951; Vavilov, 1931). India is the second largest producer of brinjal in the world next to China. It is highly popular as the poor man's crop (Gargi and Kalita 2012). The unripe fruits are mainly consumed as cooked vegetable and dried stalks are used as fuel in villages. It has high nutritive value having high dietary fiber and low in fat. It is a good source of vitamin A and vitamin C and rich in minerals like Ca, Mg, P, K and Fe. It is an excellent remedy for those suffering from liver complaints and can be used to cure toothache. Green leaves are good appetizers and cardiotonic (Singh *et al.*, 1963). Brinjal is beneficial for diabetes individuals and contains several ayurvedic medicinal benefits. It has also been touted as a fantastic treatment for people with liver issues (Shukla and Naik 1993). The average concentration of free reducing sugars, anthocyanin, phenols, glycoalkaloids (such solosodine) and dry matter is higher in oblong-fruited aubergine cultivars (Bajaj *et al.*, 1979).

The consumer preferences for brinjal vary from region to region. For instance, in Northern Karnataka, purple colored fruits with glossiness and spines are preferred; in the Dharwad district, Malapur local is very popular; in the Kuduchi area, green fruits are popular; in North and South Canara, white fruits are popular; and in Bangalore and Mysore, green long-type fruits are preferred. Similarly, local preferences for color, size and shape vary. Therefore, it is crucial to produce high yielding brinjal types or hybrids that suit regional tastes.

Numerous reports on the hybrid vigour of brinjal are available in India. In an effort to gain some commercial recognition in crosses between various Japanese types, Nagai and Kida (1926) were likely the first to observe hybrid vigour. Utilising hybrid vigour in brinjal has therefore been acknowledged as a useful strategy for breeders looking to improve yield and other economic traits. In no scientifically based genetic improvement initiative have the majority of local varieties raised by Indian farmers been fully utilised. Crop improvement through heterosis breeding is effective and choosing the right parental lines is crucial for creating hybrids for commercial use. Understanding combining ability facilitates selecting the best combiners, facilitates heterosis breeding or accumulates. Studying the impacts of specific combining ability (SCA) and general combining ability (GCA) can help in the selection of superior hybrids and lines, respectively. Keeping in view of the above discussed aspects, the present investigation was carried out with an objective of studying the performance of hybrids for yield and yield related traits in field conditions.

MATERIAL AND METHODS

The present experiment was conducted at Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district, Karnataka. The genotypes used in the present study comprised of twelve lines namely KRCCH-1, KRCCH-2, KRCCH-3, KRCCH-4, KRCCH-5, KRCCH-6, KRCCH-7, KRCCH-8, KRCCH-9, KRCCH-10, KRCCH-11, KRCCH-12 and three testers namely Banglore Local, Arabhavi Local and Gangavathi Local which are of broad genetic base and all these genotypes were collected from various parts of Karnataka, Maharashtra and New Delhi which were choosen based on their *per se* performance for yield attributes. These genotypes were crossed in line × tester pattern to obtain 36 hybrids and the obtained F_1's were grown in randomized block design with two replications along with two commercial checks (MAHY Super – 10 and Arjun). During experimentation all the necessary cultural practices were followed and plant protection measures were taken. The data on various earliness, flowering, yield and quality parameters were recorded from five randomly selected plants. The mean data was subjected to analysis in INDOSTAT 2.0 software to obtain heterosis percentage for various parameters. The heterosis was estimated from mean values, and its significance was tested using t-test.

RESULTS AND DISCUSSION

Positive or negative heterosis refers to the F_1 hybrids superiority or inferiority to their parents, respectively. Growth and yield factors can be manifested *via* positive heterosis. The earliest parameters are shown by the negative heterosis. Among the parents, the maximum and minimum values for the trait plant height were observed in 69.36 cm (KRCCH-2) to 78.87cm (KRCCH-11) among lines, 76.10 cm (Gangavathi Local) to 79.93 cm (Bangalore Local) among testers. Among the hybrids, 70.07 cm (KRCCH-2 × AL) to 143.85 cm (KRCCH-11 × BL). The cross KRCCH-11 x BL showed the highest levels of heterosis over the best parent (79.98%) and commercial check-1 (63.46%). *i.e.*, Standard heterosis for plant height. Out of 36 crosses, 18 crosses over best parent and six crosses over commercial check-1 (MAHY Super - 10) showed positive significant heterosis, which were found to be similar with the results of Pramila *et al*. (2017); Sharma *et al*. (2016); Pandey and Yadav (2018); Dharmendra *et al*. (2017), Dhaka *et al*. (2017); Dubey *et al*. (2014); Suneetha *et al*. (2008); dissimilar with Desai *et al*. (2017). Different responses for plant height may be caused by the genotype vigour, genetic makeup and intrinsic traits.

Among the parents, the highest and the lowest number of secondary branches per plant were observed in KRCCH-11 (12.53) and KRCCH-5 (7.97) for lines. For testers maximum number of secondary branches was observed in Bangalore Local (9.91) and lowest was observed in Arabhavi Local (8.32). Among the hybrids, the cross KRCCH-11 × BL recorded maximum value of 13.38 and minimum number of secondary branches in cross KRCCH-5 × AL (10.13). Cross KRCCH-11 × BL showed the highest levels of heterosis over the best parent (6.78%), commercial check-1 (19.89%) for number of secondary branches. Out of 36 crosses three crosses over best parent and 13 crosses over commercial check -1 showed positive significant heterosis. These results are in confirmation of the results of earlier workers Deshmukh *et al*. (2020). Pramila *et al*. (2017), Sao and Mehta (2010), Choudhary *et al*. (2010), Mistry *et al*. (2018); Hussain *et al*. (2018); Ansari (2017). The results are dissimilar with Patidar *et al*. (2017). Different responses for number of branches per plant may be caused by the genotype vigour, genetic makeup and intrinsic traits.

Vegetable crops should take the earliness feature into account in order to maximise their potential economic yield. When determining earliness, characteristics like the days to first flowering and days to the first fruit harvest are highly helpful. Negative heterosis is preferred for these traits. Lines exhibited a range of 48.66 (KRCCH-12) to 55.27 days (KRCCH-2) for days to first flowering. Among testers, it was ranged from 48.75 (Gangavathi Local) to 54.58 days (Arabhavi Local). In hybrids, this character was ranged from 45.05 (KRCCH-12 × BL and KRCCH-12 × GL) to 52.74 days (KRCCH-2 × AL). The cross KRCCH-11 × BL exhibited significant negative heterosis over best parent (-11.27%), commercial check-1 (-13.00%) for days to first flowering. Among 36 crosses, four crosses over best parent and five cross over commercial check-1 exhibited significant heterosis in the desirable direction (negative). Similar results were also reported by Kalaiyarasi *et al*. (2018); Dharmendra *et al*. (2017); Kumar *et al*. (2017); Hussain *et al.* (2018); Akiyonde *et al*. (2018); Desai *et al*. (2017). Dissimilar result was reported by Abhinav and Nandan (2010). The usage of several lines and testers is responsible for days to first flowering.

The mean values for days to first harvest among lines were ranged from 61.02 (KRCCH-11) to 73.08 days (KRCCH-3). In tester, the character was varied from 62.87 (Gangavathi Local) to 64.52 days (Arabhavi Local). Days to first harvest among hybrids recorded a range of 57.65 (KRCCH-11 × GL) to 72.94 days (KRCCH-2 × AL).

Table 1: ***Per se*** **performance of parents for growth and flowering parameters in brinjal.**

Sr. No.	Genotypes	Plant height at final harvest (cm)	No. of secondary branches at final harvest	Days to first flowering	Days to first fruit harvest	Fruit diameter (cm)	Fruit length (cm)
	Lines						
1.	KRCCH-1	75.69	9.74	53.74	69.50	4.77	7.60
2.	KRCCH-2	69.36	8.21	55.27	72.66	4.51	6.68
3.	KRCCH-3	74.93	8.53	50.78	73.08	4.67	7.03
4.	KRCCH-4	75.85	9.07	54.24	63.81	4.58	7.52
5.	KRCCH-5	71.57	7.97	54.47	69.82	4.55	7.66
6.	KRCCH-6	76.13	8.35	53.32	65.26	4.66	8.18
7.	KRCCH-7	75.65	10.78	53.07	65.16	4.83	7.48
8.	KRCCH-8	72.81	10.31	54.70	65.83	4.82	7.43
9.	KRCCH-9	73.36	10.57	51.52	67.48	4.83	7.80
10.	KRCCH-10	76.33	10.95	50.12	66.52	4.95	8.23
11.	KRCCH-11	78.87	12.53	50.02	61.02	4.90	8.27
12.	KRCCH-12	78.78	11.87	48.66	61.48	4.83	9.53
	Testers						
1	Bangalore Local (BL)	79.93	9.91	50.53	63.75	4.77	7.81
2	Arabhavi Local (AL)	77.45	8.32	54.58	64.52	4.58	7.33
3	Gangavathi Local (GL)	76.10	9.76	48.75	62.87	4.81	8.05
	Commercial checks						
1	MAHY Super - 10	88.01	11.16	49.63	63.21	4.85	8.94
2	Arjun	80.13	10.72	51.28	63.86	4.90	7.20
	S.Em±	3.79	0.51	2.03	2.33	0.26	0.34
	CD at 5%	10.75	1.45	5.76	6.62	0.74	0.95
	CD at 1%	14.32	1.93	7.68	8.82	0.99	1.27

Table 2: ***Per se*** **performance of crosses for growth and flowering parameters in brinjal.**

Sr. No.	Genotypes	Plant height at final harvest (cm)	No. of secondary branches at final harvest	Days to first flowering	Days to first fruit harvest	Fruit diameter (cm)	Fruit length (cm)
	Crosses						
1.	KRCCH-1 × BL	85.04	10.80	52.05	63.53	5.23	7.62
2.	KRCCH-1 × AL	91.30	10.76	52.11	59.99	5.12	7.66
3.	KRCCH-1 × GL	79.96	11.12	52.71	62.17	5.03	7.82
4.	KRCCH-2 × BL	83.04	11.18	50.71	65.95	4.58	7.69
5.	KRCCH-2 × AL	70.07	10.19	52.74	72.94	4.23	7.67
6.	KRCCH-2 × GL	92.72	10.66	48.73	62.74	5.17	7.83
7.	KRCCH-3 × BL	82.43	11.55	50.69	63.55	4.99	7.62
8.	KRCCH-3 × AL	71.73	10.20	50.73	69.29	5.12	7.33
9.	KRCCH-3 × GL	85.10	11.83	51.78	63.22	4.97	7.83
10.	KRCCH-4 × BL	79.80	11.38	52.33	64.22	5.14	8.17
11.	KRCCH-4 × AL	76.18	10.16	50.33	67.80	5.15	7.71
12.	KRCCH-4 × GL	86.92	11.49	51.29	61.21	5.38	7.61
13.	KRCCH-5 × BL	88.63	10.91	48.38	68.47	4.92	7.81
14.	KRCCH-5 × AL	76.12	10.13	52.00	69.63	5.13	7.80
15.	KRCCH-5 × GL	94.29	10.32	48.08	63.61	5.06	7.84
16.	KRCCH-6 × BL	95.69	10.50	50.70	68.52	5.24	8.17
17.	KRCCH-6 × AL	90.05	10.32	50.16	64.94	5.26	7.61
18.	KRCCH-6 × GL	96.26	11.19	48.34	61.78	5.37	7.89
19.	KRCCH-7 × BL	77.82	11.82	49.76	64.16	5.29	8.16
20.	KRCCH-7 × AL	78.80	10.29	48.45	64.60	5.42	7.33
21.	KRCCH-7 × GL	94.33	10.83	45.62	66.49	5.32	7.50
22.	KRCCH-8 × BL	78.30	10.75	49.03	63.54	4.90	8.20
23.	KRCCH-8 × AL	86.18	11.80	48.19	61.77	5.90	7.33
24.	KRCCH-8 × GL	94.78	10.36	48.48	66.05	4.91	7.50
25.	KRCCH-9 × BL	88.31	10.81	49.90	60.81	4.89	7.67
26.	KRCCH-9 × AL	87.58	10.88	48.79	69.25	5.25	8.15
27.	KRCCH-9 × GL	97.88	11.02	47.03	61.93	5.51	8.82
28.	KRCCH-10 × BL	98.50	11.49	46.54	59.40	5.71	8.45
29.	KRCCH-10 × AL	97.87	11.12	44.72	61.27	5.46	9.77
30.	KRCCH-10 × GL	103.29	11.34	48.31	57.92	5.91	9.44
31.	KRCCH-11 × BL	143.85	13.38	43.18	57.89	5.86	10.12
32.	KRCCH-11 × AL	91.72	12.98	51.13	58.71	5.66	9.14
33.	KRCCH-11 × GL	93.20	13.08	46.04	57.65	5.69	10.20
34.	KRCCH-12 × BL	90.88	12.14	45.05	58.90	5.60	10.15
35.	KRCCH-12 × AL	95.96	12.22	47.78	60.21	5.71	9.68
36.	KRCCH-12 × GL	105.15	12.32	45.05	58.42	5.81	10.45

Table 3: Per cent heterosis over best parent (BTP) and commercial checks (CC) for growth and flowering parameters in brinjal.

Sr. No.	Crosses	Plant height		No. of secondary branches		Days to first flowering		Days to first fruit harvest		Fruit diameter		Fruit length	
		BTP	SH	BTP	SH	BTP	SH	BTP	SH	BTP	SH	BTP	SH
1.	KRCCH-1 × BL	6.40	-3.36	-13.78**	-3.18**	6.96*	4.88	4.12	0.50	5.73**	8.05**	-20.09**	-14.82 **
2.	KRCCH-1 × AL	14.23*	3.74	-14.17**	-3.63**	7.09*	5.00	-1.69	-5.11	3.52**	5.68**	-19.62**	-14.32 **
3.	KRCCH-1 × GL	0.05	-9.14	-11.23**	-0.36	8.31**	6.21*	1.89	-1.65	1.61**	3.82**	-17.91**	-12.47 **
4.	KRCCH-2 × BL	3.89	-5.65	-10.81**	0.18	4.21	2.17	8.09**	4.33	-7.38**	-5.37**	-19.31**	-13.98 **
5.	KRCCH-2 × AL	-12.34*	-20.39 **	-18.67**	-8.69**	8.38**	6.27*	19.54**	15.39 **	-14.61**	-12.80**	-19.55**	-14.26 **
6.	KRCCH-2 × GL	16.00**	5.35	-14.94**	-4.48**	0.14	-1.81	2.83	-0.74	4.50**	6.81**	-17.80**	-12.36 **
7.	KRCCH-3 × BL	3.13	-6.33	-7.80**	3.49**	4.18	2.14	4.14	0.53	0.77*	2.89**	-20.09**	-14.82 **
8.	KRCCH-3 × AL	-10.26	-18.50 **	-18.60**	-8.60**	4.26	2.23	13.56**	9.61**	3.49**	5.78**	-23.05**	-17.95 **
9.	KRCCH-3 × GL	6.47	-3.30	-5.61**	5.96**	6.42*	4.34	3.61	0.01	0.43	2.58**	-17.89**	-12.47 **
10.	KRCCH-4 × BL	-0.16	-9.32	-9.21**	1.93*	7.55*	5.45*	5.24	1.59	3.82**	5.99**	-14.31**	-8.61**
11.	KRCCH-4 × AL	-4.69	-13.44 *	-18.89**	-8.96**	3.43	1.41	11.11**	7.25*	3.95**	6.19**	-19.10**	-13.76 **
12.	KRCCH-4 × GL	8.75	-1.23	-8.34**	2.91**	5.40	3.34	0.31	-3.17	8.71**	11.15**	-20.11**	-14.82 **
13.	KRCCH-5 × BL	10.90	0.72	-12.97**	-2.28**	-0.58	-2.52	12.20**	8.30*	-0.52	1.65**	-18.05**	-12.64 **
14.	KRCCH-5 × AL	-4.77	-13.51 *	-19.18**	-9.27**	6.87	4.78	14.11**	10.16**	3.54**	5.78**	-18.12**	-12.70 **
15.	KRCCH-5 × GL	17.97**	7.14	-17.64**	-7.53**	-1.20	-3.12	4.24	0.62	2.13**	4.33**	-17.79**	-12.36 **
16.	KRCCH-6 × BL	19.72**	8.73	-16.22**	-5.91**	4.20	2.17	12.29**	8.39*	5.81**	8.05**	-14.31**	-8.67**
17.	KRCCH-6 × AL	12.67*	2.33	-17.60**	-7.48**	3.09	1.07	6.43	2.74	6.19**	8.46**	-20.13**	-14.88 **
18.	KRCCH-6 × GL	20.44**	9.38	-10.71**	0.27	-0.66	-2.60	1.24	-2.28	8.51**	10.84**	-17.17**	-11.69 **
19.	KRCCH-7 × BL	-2.64	-11.58*	-5.68**	5.91**	2.25	0.25	5.15	1.50	6.90**	9.29**	-14.41**	-8.78**
20.	KRCCH-7 × AL	-1.41	-10.47	-17.86**	-7.75**	-0.43	-2.38	5.87	2.20	9.45**	11.76**	-23.05**	-17.95 **
21.	KRCCH-7 × GL	18.02**	7.19	-13.56**	-2.96**	-6.24	-8.07**	8.97*	5.19	7.45**	9.80**	-21.30**	-16.11 **
22.	KRCCH-8 × BL	-2.03	-11.03	-14.20**	-3.63**	0.76	-1.21	4.13	0.51	-1.00*	1.14**	-13.97**	-8.28**
23.	KRCCH-8 × AL	7.82	-2.07	-5.86**	5.69**	-0.97	-2.91	1.23	-2.29	19.18**	21.78 **	-23.05**	-18.01 **
24.	KRCCH-8 × GL	18.59**	7.70	-17.33**	-7.17**	-0.38	-2.32	8.24*	4.48	-0.75	1.44**	-21.28**	-16.11 **
25.	KRCCH-9 × BL	10.49	0.35	-13.74**	-3.14**	2.54	0.54	-0.34	-3.80	-1.18**	1.03**	-19.55**	-14.26 **
26.	KRCCH-9 × AL	9.57	-0.48	-13.17**	-2.55**	0.27	-1.69	13.49**	9.55**	6.09**	8.46**	-14.45**	-8.78**
27.	KRCCH-9 × GL	22.46**	11.22*	-12.05**	-1.25	-3.35	-5.24*	1.49	-2.03	11.37**	13.73**	-7.50**	-1.40**
28.	KRCCH-10 × BL	23.24**	11.93*	-8.34**	2.91**	-4.36	-6.23*	-2.65	-6.03	15.33**	17.85 **	-11.33**	-5.48**
29.	KRCCH-10 × AL	22.45**	11.21*	-11.29**	-0.40	-8.11**	-9.90**	0.40	-3.08	10.40**	12.80**	2.52**	9.28**
30.	KRCCH-10 × GL	29.23**	17.36 **	-9.53**	1.57*	-0.72	-2.65	-5.08	-8.38*	19.48**	22.08 **	-0.94	5.59**
31.	KRCCH-11 × BL	79.98**	63.46 **	6.78**	19.89 **	-11.27**	-13.00 *	-5.14	-8.43*	18.39**	20.95 **	6.14**	13.14 **
32.	KRCCH-11 × AL	14.75*	4.22	3.59**	16.31 **	5.09	3.03	-3.78	-7.13*	14.42**	16.92 **	-4.09**	2.24**
33.	KRCCH-11 × GL	16.61**	5.90	4.37**	17.20 **	-5.38	-7.22*	-5.52	-8.80*	14.90**	17.44 **	7.03**	14.09 **
34.	KRCCH-12 × BL	13.70*	3.27	-3.12**	8.78**	-7.42*	-9.23**	-3.47	-6.82*	13.08**	15.48**	6.51**	13.53 **
35.	KRCCH-12 × AL	20.06**	9.04	-2.47**	9.50**	-1.81	-3.73	-1.32	-4.75	15.29**	17.85 **	1.57**	8.28**
36.	KRCCH-12 × GL	31.56**	19.49 **	-1.68*	10.39**	-7.42*	-9.24**	-4.27	-7.59*	17.44**	19.92 **	9.65**	16.89 **
	CD @ 5%	5.46	5.46	0.73	0.73	2.90	2.90	3.32	3.32	0.37	0.37	0.48	0.48
	CD @ 1%	11.08	11.08	1.49	1.49	5.90	5.90	6.73	6.73	0.76	0.76	0.97	0.97
	S.Em ±	14.87	14.87	2.01	2.01	7.92	7.92	9.05	9.05	1.02	1.02	1.30	1.30

Note:* and** indicate significance at values at p=0.05 and p=0.01, respectively
BTP= Best parent; SH = Heterosis over commercial check (MAHY Super-10)

KRCCH-11 × GL cross showed the highest significant magnitude of heterosis over commercial check-1(-8.80%), for days to first fruit harvest. Out of 36 crosses, six crosses exhibited negative heterosis over commercial. Check-1 and none of the crosses over best parent for days to first fruit harvest, although the range of heterosis was slightly higher than that of Pandey and Yadav (2018); Dharmendra *et al*. (2017); Aswani *et al*. (2016); Rameshkumar and Vethamonai (2020); Balwani *et al*. (2017); Pramila *et al*. (2017). Range of heterosis was dissimilar with Choudhary *et al*. (2010). The usage of several lines and testers is responsible for days to first fruit harvest.

According to Aswani *et al*. (2016), the length and diameter of the fruit vary depending on genetic makeup and environmental factors, have an direct effect on the number of fruits produced per plant. For fruit diameter, the genotypes varied greatly among one another. It varied from 4.51 (KRCCH-2) to 4.95 cm (KRCCH-10) among lines, 4.58 (Arabhavi Local) to 4.81cm (Gangavathi Local) among testers and 4.23 (KRCCH-2 × AL) to 5.91 cm (KRCCH-10 × GL) among crosses. KRCCH-10 × GL showed the highest and significant heterosis over best parent (19.48%), over commercial check-1 (22.08%) for fruit diameter. Among 36 cross combinations, the fruit diameter exhibited a significant positive heterosis in 34 crosses over commercial check-1, 28 crosses over best parent and it was found similar with Dubey *et al*. (2014); Dhaka *et al*. (2017); Kumar *et al*. (1999); Mankar *et al.* (1995); Shafeeq (2005). Different responses for fruit diameter may be caused by the genotype vigour, genetic makeup and intrinsic traits.

Fruit length varied significantly among the genotypes and which ranged from 6.68 (KRCCH-2) to 9.53 cm (KRCCH-12) among lines, 7.33 (Arabhavi Local) to 8.05 cm (Gangavathi Local) among testers and 7.33 (KRCCH-3 × AL and KRCCH-8 x AL) to 10.45 cm (KRCCH-12 × AL) among crosses. Cross KRCCH-12 × GL showed considerable positive heterosis over best parent (9.65%), commercial check-1 (16.89%) for fruit length. Six crosses over best parent, eight crosses over commercial check-1 were found among the 36 cross combinations. Which is similar to the findings of Dharmendra *et al*. (2017); Dubey *et al*. (2014); Dhaka *et al.* (2017); Kumar *et al.* (1999), Mankar *et al.* (1995); Shafeeq (2005). These both parameters directly decides the number of fruits per plant and in turn fruit yield per plant (Ansari, 2017). Different responses for fruit diameter may be caused by the genotype vigour, genetic makeup and intrinsic traits.

The ultimate goal of any breeding programme is target to achieve maximization of marketable yield. Since yield is a complex and polygenically inherent trait, number of fruits per plant and average fruit weight are directly contributing to yield in brinjal breeding. Lines exhibited a range of 18.82 (KRCCH-5) to 31.23 (KRCCH-11) for number of fruits per plant. In testers, this character was varied between 18.88 (Arabhavi Local) to 31.89 (Gangavathi Local). Number of fruits per plant among hybrids shown variation between 20.04 (KRCCH-5 × AL) to 40.86 (KRCCH-11 × GL). The cross KRCCH-11 × GL showed the highest levels of heterosis over best parent (28.11%), commercial check-1 (51.93%) for number of fruits per plant. Nine cross over best parent, 21 crosses over commercial check-1 showed significant heterosis for the number of fruits per plant among 36 crosses. The present results are in agreement with the earlier findings of Pandey and Yadav (2018), Al-Hubaity and Teli (2013), Reddy and Patel (2015); Kalaiyarasi *et al*. (2018); Ponnuswami *et al*. (1994); Aswani *et al*. (2016); Kumar *et al*. (2017). The usage of several lines and testers is responsible for number of fruits per plant.

In lines, the general mean of average fruit weight was 51.80 (KRCCH-5) and 58.35 g (KRCCH-11). Among testers, it was ranged from 54.46 (Arabhavi Local) and 57.35 g (Gangavathi Local). Average fruit weight among hybrids was varied between 60.27 (KRCCH-4 × BL) and 81.76 g (KRCCH-11 × GL). Cross KRCCH-11 × GL has the highest and most significant heterosis over best parent (40.11%), KRCCH-12 × BL exhibited significant positive heterosis over commercial check-1 (45.64%). Out of 36 cross combinations 35 crosses over best parent, 36 crosses over commercial check-1 showed positive and significant heterosis for average fruit weight, which was consistent with Patel *et al*. (2017); Singh *et al.* (2004); Pramila *et al*. (2017); Aswani *et al*. (2016); Reddy and Patel (2015). The usage of several lines and testers is responsible for the fluctuating average fruit weight.

Yield in any crop is the final product of different yield components. This ultimate produce in the plant is expressed through mutual balancing of characters. Fruit yield per plant varied greatly across genotypes, ranging from 0.98 (KRCCH-5) to 1.82 kg (KRCCH-11) among lines, 1.03 (Arabhavi Local) to 1.83 kg (Gangavathi Local) among testers and 1.23 (KRCCH-5 × AL) to 3.34 kg (KRCCH-11 × GL) among crosses. significant and positive heterosis was exhibited by cross KRCCH-11 × GL over best parent (82.57%), commercial check 1(123.41%). Among the 36 crosses, 16 crosses over best parent and 32 crosses over commercial check-1 exhibited positive and significant heterosis. Similar results were also reported by Reddy and Patel (2015), Kalaiyarasi *et al*. (2018); Dharmendra *et al*. (2017); Bugali *et al*. (2007); Bavage (2002); Hussain *et al*. (2018); Mistry *et al*. (2018); Ansari (2017). Varied magnitude of heterosis for yield parameters is attributed to use of different lines and genetic stocks in different studies.

Fruit yield per plot varied greatly among genotypes and ranged from 9.92 (KRCCH-5) to 16.26 kg (KRCCH-11) among lines, 10.68 (Arabhavi Local) to 15.16 kg (Gangavathi Local) among testers and 12.76 (KRCCH-5 × AL) to 19.91 kg (KRCCH-11 × GL) among crosses. KRCCH-11 × GL exhibited significant positive heterosis over best parent (22.45%), over commercial check-1 (16.16%) A significant positive heterosis for fruit yield per plot was seen in 22 of the 36 cross combinations over best parent, 13 over commercial check-1. Similar results were also reported by Reddy and Patel (2015); Kalaiyarasi *et al*. (2018), Dharmendra *et al*. (2017); Bugali *et al*. (2007); Bavage (2002), Hussain *et al*. (2018); Mistry *et al*. (2018); Ansari (2017). Varied magnitude of heterosis for yield parameters is attributed to use of different lines and genetic stocks in different studies.

Fruit yield per hectare varied greatly among genotypes ranging from 36.74 (KRCCH-5) to 60.20 tonnes (KRCCH-11) among lines, 39.54 (Arabhavi Local) to 56.15 tonnes (Gangavathi Local) among testers and 47.24 (KRCCH-5 × AL) to 73.34 tonnes (KRCCH-11 × GL) among crosses. The cross KRCCH-11 × GL exhibited significant heterosis over best parent (22.49%), over commercial check-1 (16.16%). Out of 36 crosses, 15 crosses over best parent, five crosses over commercial check-1 exhibited significant positive heterosis. These results were within range observed by Ansari (2017); Singh *et al.* (2004); Pramila *et al*. (2017); Aswani *et al*. (2016); Reddy and Patel (2015).

Table 4: ***Per se*** **performance of parents for yield and quality parameters in brinjal.**

Sr. No.	Genotypes	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield per ha (tonnes)
	Lines					
1.	KRCCH-1	19.36	53.75	1.04	11.17	41.37
2.	KRCCH-2	21.83	52.31	1.14	11.24	41.63
3.	KRCCH-3	23.88	52.80	1.26	12.10	44.82
4.	KRCCH-4	21.29	52.67	1.12	11.06	40.98
5.	KRCCH-5	18.82	51.80	0.98	9.92	36.74
6.	KRCCH-6	23.46	53.40	1.25	10.85	40.19
7.	KRCCH-7	21.21	54.14	1.15	11.43	42.31
8.	KRCCH-8	21.46	53.34	1.15	11.95	44.24
9.	KRCCH-9	24.87	55.65	1.39	14.44	53.46
10.	KRCCH-10	28.73	56.08	1.61	15.32	56.72
11.	KRCCH-11	31.23	58.35	1.82	16.26	60.20
12.	KRCCH-12	29.62	56.82	1.68	15.79	58.48
	Testers					
1	Bangalore Local (BL)	24.71	55.32	1.36	13.25	49.06
2	Arabhavi Local (AL)	18.88	54.46	1.03	10.68	39.54
3	Gangavathi Local (GL)	31.89	57.35	1.83	15.16	56.15
	Commercial checks					
1	MAHY Super - 10	26.89	55.49	1.50	17.14	63.48
2	Arjun	26.06	55.36	1.44	14.65	54.25
	S.Em±	1.23	2.71	0.11	0.66	2.44
	CD at 5%	3.48	7.69	0.31	1.87	6.93
	CD at 1%	4.64	10.24	0.42	2.49	9.24

Table 5: ***Per se*** **performance of crosses for yield and quality parameters in brinjal.**

Sr. No.	Genotypes	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (kg)	Fruit yield per plot (kg)	Fruit yield per ha (tonnes)
	Crosses					
1.	KRCCH-1 × BL	26.28	61.20	1.61	13.91	51.50
2.	KRCCH-1 × AL	24.47	66.73	1.64	15.56	57.63
3.	KRCCH-1 × GL	27.44	64.66	1.78	15.77	58.41
4.	KRCCH-2 × BL	25.85	66.27	1.71	15.50	57.39
5.	KRCCH-2 × AL	24.59	62.01	1.52	15.43	57.13
6.	KRCCH-2 × GL	27.94	65.32	1.82	18.02	66.72
7.	KRCCH-3 × BL	23.06	62.91	1.45	14.95	55.37
8.	KRCCH-3 × AL	22.91	64.91	1.49	14.76	54.67
9.	KRCCH-3 × GL	24.83	62.37	1.55	14.95	55.35
10.	KRCCH-4 × BL	27.29	60.27	1.65	16.04	59.40
11.	KRCCH-4 × AL	25.45	64.11	1.63	16.53	61.23
12.	KRCCH-4 × GL	26.69	65.07	1.74	16.65	61.67
13.	KRCCH-5 × BL	20.53	64.49	1.33	14.11	52.24
14.	KRCCH-5 × AL	20.04	61.90	1.23	12.76	47.24
15.	KRCCH-5 × GL	22.92	66.11	1.52	14.99	55.50
16.	KRCCH-6 × BL	30.49	67.98	2.07	18.15	67.22
17.	KRCCH-6 × AL	24.57	64.77	1.59	16.49	61.07
18.	KRCCH-6 × GL	30.34	63.77	1.94	17.46	64.65
19.	KRCCH-7 × BL	27.93	64.40	1.80	18.25	67.59
20.	KRCCH-7 × AL	24.35	64.52	1.57	16.10	59.63
21.	KRCCH-7 × GL	31.45	63.61	2.00	17.66	65.41
22.	KRCCH-8 × BL	28.00	63.94	1.79	16.86	62.44
23.	KRCCH-8 × AL	25.64	63.74	1.63	15.26	56.52
24.	KRCCH-8 × GL	28.26	65.77	1.86	16.85	62.41
25.	KRCCH-9 × BL	31.54	65.97	2.08	17.09	63.30
26.	KRCCH-9 × AL	30.43	65.10	1.98	16.69	61.81
27.	KRCCH-9 × GL	33.87	63.61	2.16	17.43	64.54
28.	KRCCH-10 × BL	34.68	67.26	2.33	18.65	69.07
29.	KRCCH-10 × AL	31.64	69.12	2.18	18.35	67.96
30.	KRCCH-10 × GL	35.31	76.78	2.71	18.96	70.20
31.	KRCCH-11 × BL	37.89	71.82	2.73	18.26	67.63
32.	KRCCH-11 × AL	35.25	69.15	2.44	17.67	65.43
33.	KRCCH-11 × GL	40.86	81.76	3.34	19.91	73.74
34.	KRCCH-12 × BL	36.83	73.84	2.72	18.82	69.69
35.	KRCCH-12 × AL	37.11	75.46	2.80	18.29	67.74
36.	KRCCH-12 × GL	38.27	78.90	3.02	19.07	70.63

Table 6: Per cent heterosis over best parent (BTP) and commercial checks (CC) for yield and quality parameters in brinjal.

Sr. No.	Crosses	Number of fruits per plant		Average fruit weight		Fruit yield per plant		Fruit yield per plot		Fruit yield per ha	
		BTP	SH	BTP	SH	BTP	SH	BTP	SH	BTP	SH
1.	KRCCH-1 × BL	-17.60**	-2.29*	4.89*	10.28**	-12.09**	7.36**	-14.48**	-18.87 **	-14.45**	-18.87 **
2.	KRCCH-1 × AL	-23.27**	2.65*	14.37**	20.25 **	-10.20**	10.03**	-4.31**	-9.22**	-4.27	-9.22*
3.	KRCCH-1 × GL	-13.97**	2.03*	10.81**	16.51 **	-3.00**	18.73**	-3.01**	-7.99**	-2.98	-7.99*
4.	KRCCH-2 × BL	-18.94**	-3.89**	13.58**	19.43 **	-6.31**	14.72**	-4.70**	-9.60**	-4.67	-9.60**
5.	KRCCH-2 × AL	-22.90**	-8.55**	6.27*	11.74**	-17.03**	1.67**	-5.14**	-10.01**	-5.10	-10.00**
6.	KRCCH-2 × GL	-12.38**	3.92**	11.94**	17.70 **	-0.32*	22.07 **	10.80**	5.11**	10.84**	5.11
7.	KRCCH-3 × BL	-27.69**	-14.24 **	7.81*	13.35**	-20.73**	-3.01**	-8.05**	-12.78 **	-8.02*	-12.78 **
8.	KRCCH-3 × AL	-28.17**	-14.80 **	11.25**	11.27**	-18.73**	-0.67**	-9.23**	-13.89 **	-9.19*	-13.89 **
9.	KRCCH-3 × GL	-22.14**	-7.66**	6.89*	12.39**	-15.16**	4.01**	-8.09**	-12.81 **	-8.05*	-12.81 **
10.	KRCCH-4 × BL	-14.41**	1.51	3.29	8.60*	-10.08**	10.03**	-1.36	-6.42**	-1.32	-6.42
11.	KRCCH-4 × AL	-20.21**	-5.37**	9.87*	15.51**	-10.97**	9.03**	1.67*	-3.56**	1.71	-3.55
12.	KRCCH-4 × GL	-16.30**	-0.73	11.51**	17.25 **	-5.10**	16.05**	2.40*	-2.86**	2.44	-2.86
13.	KRCCH-5 × BL	-35.61**	-23.63 **	10.52**	16.20 **	-27.56**	-11.37**	-13.25**	-17.71 **	-13.22**	-17.71 **
14.	KRCCH-5 × AL	-37.15**	-25.46 **	6.08*	19.21 **	-32.59**	-17.39**	-21.55**	-25.58 **	-21.53**	-25.58 **
15.	KRCCH-5 × GL	-28.11**	-14.76 **	13.30**	19.13 **	-17.13**	1.34**	-7.83**	-12.57 **	-7.80*	-12.56 **
16.	KRCCH-6 × BL	-4.39**	13.39 **	16.50**	22.50 **	13.13**	38.46 **	11.62**	5.89**	11.66**	5.89
17.	KRCCH-6 × AL	-22.97**	-8.65**	11.01**	16.71 **	-12.96**	6.35**	1.40	-3.79**	1.44	-3.80
18.	KRCCH-6 × GL	-4.85**	12.85**	9.29**	14.92**	5.77**	29.43 **	7.35**	1.84**	7.39*	1.84
19.	KRCCH-7 × BL	-12.42**	3.87**	10.37**	16.06 **	-1.59**	20.40**	12.24**	6.48**	12.28**	6.47
20.	KRCCH-7 × AL	-23.64**	-9.45**	10.58**	16.27 **	-14.24**	5.02**	-0.98	-6.07**	-0.95	-6.06
21.	KRCCH-7 × GL	-1.38	16.96 **	9.01**	14.61**	9.33**	33.78 **	8.61**	3.03**	8.65*	3.03
22.	KRCCH-8 × BL	-12.21**	4.13**	9.58**	15.22**	-2.20**	19.73**	3.69**	-1.63**	3.73	-1.63
23.	KRCCH-8 × AL	-19.59**	-4.65**	9.23**	14.85**	-10.69**	9.03**	-6.15**	-10.97**	-6.12	-10.96**
24.	KRCCH-8 × GL	-11.40**	5.08**	12.71**	18.51 **	1.55**	24.41 **	3.63**	-1.69	3.67	-1.69
25.	KRCCH-9 × BL	-1.11	17.27 **	13.06**	18.88 **	13.50**	39.13 **	5.10**	-0.29	5.14	-0.29
26.	KRCCH-9 × AL	-4.57**	13.18 **	11.58**	17.32 **	8.31**	32.44 **	2.64**	-2.63**	2.68	-2.62
27.	KRCCH-9 × GL	6.21**	25.96 **	9.02**	14.63**	17.85**	44.48 **	7.16**	1.66	7.20*	1.67
28.	KRCCH-10 × BL	8.76**	28.97 **	15.28**	21.21 **	27.43**	55.85 **	14.70**	8.81**	14.74**	8.81*
29.	KRCCH-10 × AL	-0.78	17.66 **	18.45**	24.55 **	19.17**	45.82 **	12.85**	7.06**	12.90**	7.06
30.	KRCCH-10 × GL	10.73**	31.33 **	31.58**	44.04 **	48.19**	81.27 **	16.57**	10.59**	16.62**	10.59**
31.	KRCCH-11 × BL	18.81**	40.91 **	23.08**	29.42 **	48.99**	82.27 **	12.30**	6.53**	12.34**	6.54
32.	KRCCH-11 × AL	10.53**	31.09 **	18.51**	35.99 **	33.18**	62.88 **	8.64**	3.06**	8.68*	3.06
33.	KRCCH-11 × GL	28.11**	51.93 **	40.11**	45.57 **	82.57**	123.41 **	22.45**	16.16 **	22.49**	16.16 **
34.	KRCCH-12 × BL	15.50**	36.98 **	26.54**	45.64 **	48.46**	81.61 **	15.71**	9.77**	15.76**	9.77**
35.	KRCCH-12 × AL	16.36**	37.99 **	29.32**	40.47 **	53.05**	87.29 **	12.48**	6.71**	12.53**	6.71
36.	KRCCH-12 × GL	20.01**	42.32 **	35.22**	39.32 **	65.04**	102.01 **	17.28**	11.26 **	17.32**	11.26 **
	CD @ 5%	4.69	4.69	11.68	11.68	0.15	0.15	0.94	0.94	3.49	3.49
	CD @ 1%	1.72	1.72	4.29	4.29	0.31	0.31	1.91	1.91	7.08	7.08
	S.Em ±	3.50	3.50	8.71	8.71	0.42	0.42	2.56	2.56	9.50	9.50

Note: * and** indicate significance at values at p=0.05 and p=0.01, respectively ; BTP= Best parent heterosis ; SH = Heterosis over commercial check (MAHY Super-10)

CONCLUSIONS

Based on mean performance, the top five promising crosses for marketable yield per plant were KRCCH-11 × GL (3.34 kg), KRCCH-12 × GL (3.02 kg), KRCCH-11 × BL (2.73 kg), KRCCH-12 × BL (2.72 kg) and KRCCH-10 × GL (2.71 kg). The hybrids namely, KRCCH-11 × GL, KRCCH-11 × BL, KRCCH-12 × GL, KRCCH-12 × BL were best for earliness and yield parameters, the hybrids namely KRCCH-10 × GL, KRCCH-10 × BL, KRCCH-9 × GL were best for quality parameters and also expressed significant and desirable best parent heterosis and standard heterosis for the major traits. Thus, these hybrids can be exploited in practical plan breeding for selection of better transgressive segregants and they may also be exploited through heterosis breeding programme in order to achieve hybrids with high fruit yield.

FUTURE SCOPE

The crosses KRCCH-11 × GL, KRCCH-11 × BL, KRCCH-12 × GL, KRCCH-12 × BL and KRCCH-10 × GL were the superior hybrids selected for yield These crosses can be further assessed for their yield to confirm their potentiality and also their adaptability to different areas before exploiting them on commercial scale. The parents KRCCH-11, KRCCH-12, KRCCH-10, Gangavathi Local and Bangalore Local are produced good yield per plant and they can be used in identifying superior new heterotic combinations.

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