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ESTIMATION OF HETEROSIS IN OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH] FOR FRUIT YIELD AND ITS COMPONENTS THROUGH LINE × TESTER MATING DESIGN

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Abstract

Estimation the magnitude of heterosis for yield and yield contributing parameters of Okra was conducted. Fifty-four F_1 hybrids were generated by line x tester mating design. These F_1s along with 21 parents and commercial check (Mhyco-10) were evaluated in a randomized block design with two replications. Analysis of variance with respect to yield and quality characters in parents and hybrids were highly significant. This indicates the existence of high variation in parents and hybrids for different characters studied. Out of 54 cross combinations, seven crosses revealed the significant and positive heterosis over better parent. While 11 crosses showed positive and significant heterosis over economic parent. It is pertinent to mention that the crop has potential to produce the heterotic cross combinations and such crosses can be used for further improvement of this crop. Five crosses, namely L43 × T44, L22 × T36, L22 × T44, L53 × T36 and L31 × T23 were found to be potential for the production of fruit yield per plant and other desired characters. The high heterosis and *per se* performance was found in hybrid L43 × T44 over both better parents and standard check for fruit yield per plant. This indicates that the cross can be exploited commercially**.**

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] belonging to *Malvaceae* is an important vegetable crop of the tropics and subtropics. It is specially valued for its tender, delicious green fruits which are cooked, canned and consumed in various forms in different parts of the country. India is the largest producer of okra covering an area of 0.50 million hectares with an annual production of 5.85 million tonnes (Anon. 2016a). It is a potential export earner accounting for 13% of export of fresh vegetables. The ease in emasculation, very high per cent of fruit set and large number of seeds per fruit makes commercial exploitation of hybrid vigour easy in okra. Being an often cross-pollinated crop, out crossing to an extent of 5-9% by insects is reported which renders considerable genetic diversity Duggi *et al.* (2013). India is the leading country in okra production, but the yield potential is very low attributing to poor yielding varieties and incidence of various pests and diseases. The low cost of production and high nutritional value have enhanced the usefulness of this crop (Aykroyd 1963). Hybrid breeding has helped in overcoming the yield barriers by accelerating increase in productivity. Hybrid vigour in okra has been first reported by Vijayaraghavan and Warier (1946). Despite high cost of hybrid seeds, there has been an increasing interest among farmers on cultivation of hybrids of this crop. This is mainly because under optimum crop production and protection management, the crops raised from F_1 hybrids show higher yield due to large size and increased number of fruits per plant.

To initiate an effective breeding programme, it is imperative to have information on various genetic parameters. Since yield potential of okra is generally low the productivity of okra

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presumably be increased by improving the genetic architecture through hybridization and recombination. Indeed, knowledge of heterosis of yield and its component characters should be placed on greater emphasis. Hence, the first step in okra improvement should involve evaluation of the germplasm for genetic variability. As a second step, it is required to generate crosses employing a suitable mating design to know the extent of heterosis for various economic traits and inheritance pattern of desired characters, which in turn, would help in deciding the breeding strategies as well as identifying potential parents and crosses for further use in breeding programme (Singh and Singh 2012). The present study was, therefore, aimed to estimate the magnitude of heterosis for yield and yield components of okra through line × tester mating design.

Material and Methods

The investigation on heterosis studies in okra was carried out at the Department of Vegetable Science, K.R.C. College of Horticulture, Arabhavi, Gokak Taluk, Belgavi district of Karnataka state during 2016-2017. The experimental material comprised of 18 lines (L-4, L-5, L-6, L-14, L-16, L-17, L-22, L-24, L-31, L-37, L-38, L-39, L-42, L-43, L-47, L-50, L-53 and L-65) and three testers (T23, T36 and T44) which were collected from different sources and their 54 F_1 hybrids along with one commercial check (MHY-10). Each of the 18 lines were crossed with each of the three testers to derive 54 F_1 hybrids. The experiment was laid out in randomized block design with two replications and sowing was done on 24-08-2018. Each treatment or a genotype in each replication was represented by one row each accommodating 15 plants at a row to row spacing of 60 cm and 30 cm from plant to plant. Recommended package of practices were *i.e.*, about 25 tonnes of FYM per hectare and the recommended basal dose of fertilizers (62.5 : 75 : 62.5 kg NPK/ha) were incorporated into the soil just before sowing. The remaining 62.5 kg of nitrogen was applied as a top dress at 45 days after sowing. To raise a good crop and harvesting of fruit was started on 11-10-2018 and up to one and half month of harvesting was done at alternate day .Observations were made on five randomly selected plants in parents, F_1s and check in each replication for characters, *viz.*, fruit length, fruit diameter, average fruit weight, number of fruits per plant, fruit yield per plant, fruit yield per plot, fruit yield per hectare, number of ridges on fruit surface, number of seeds per fruit and vitamin C content. Five plants were randomly selected for each genotype from each replication and evaluated for the quantitative characters and the replicated mean values of various characters of parents and hybrids were subjected to line × tester (l × t) with the method suggested by Kempthorne (1957).

Results and Discussion

Analysis of variance with respect to ten characters in parents and hybrids revealed that mean sum of squares due to characters in hybrids were highly significant for different characters (Table 1). The variance due to genotypes, crosses and line × tester showed significant differences for all the characters. Heterosis for yield and quality parameters are presented in Table 2. For fruit length the cross L22 × T36 showed maximum and positive significant heterosis over mid parent (32.09%), better parent (29.19%) and over the commercial check (53.41%). Out of 54 crosses, 15 crosses over mid parent, 11 crosses over better parent and 46 crosses over commercial check recorded positive and significant heterosis (Table 2). The findings were at par with the expectation because the significant relative heterosis for these characters have direct influence on yield as also reported earlier by Thippeswamy (2001), Shoba and Mariappan (2005), Kishor *et al.* (2013), Ashwani *et al.* (2013) and Neetu *et al.* (2015) in okra.

For fruit diameter the maximum positive and significant heterosis over mid parent (40.85%) and better parent (35.12%) was exhibited by the cross L47 × T36 and the cross L22 × T44 (22.12%) over commercial check. Among 54 crosses, 36 crosses over mid parent, 23 crosses over

Table 1. Analysis of variance (ANOVA) of line x tester analysis for various characters in okra.

Sl. No.	Character	Replications	Genotypes	Parents	Parents vs crosses	Crosses	Lines	Testers	Line x Tester	Error
	Degrees of freedom	1	74	20	1	53	17	2	34	74
A.	Yield parameters									
1	Fruit length	3.26	3.00**	0.88NS	1.42	3.83**	0.56	1.20	3.96**	0.51
2	Fruit diameter	0.16	15.86**	2.61**	9.02**	20.99**	2.50	2.24	18.80**	1.21
3	Average fruit weight	0.49	13.51**	4.22*	53.37**	16.26**	2.83	3.65	16.75**	2.33
4	Number of fruits per plant	0.91	12.83**	579**	0.89	15.71**	5.38**	1.22	19.15**	1.26
5	Total yield per plant	2688.16	3707.72**	1838.75**	3836.97**	4410.55**	1501.44**	118.89	5062.46**	330.28
6	Total yield per plot	0.13	0.88**	0.57**	0.30**	1.01**	0.48**	0.03	1.09**	0.03
7	Total yield per hectare	1.19	12.16**	7.79**	4.73**	13.96**	6.59**	0.45	15.25**	0.51
B.	Quality parameters									
8	Number of ridges per fruit	0.49	0.54**	0.23*	0.02	0.67**	0.15	0.11	0.77**	0.11
9	Number of seeds per fruit	96.66	262.67**	116.33**	204.87**	318.98**	99.70**	100.64**	304.04**	14.37
10	Vitamin C	0.26	25.49**	18.55**	5.88**	28.48**	21.77**	0.16	14.03**	0.35

*,** Indicate significance of values at $p = 0.05$ and $p = 0.01$, respectively. NS: Non significant, DAS: Days after sowing.

Table 2. Heterosis (%) over mid parent, better parent and commercial check for fruit length, fruit diameter and average fruit weight.

Sl. No.	Crosses	Fruit length			Fruit diameter			Average fruit weight		
		MP	BP	CC	MP	BP	CC	MP	BP	CC
1	L4 x T23	-28.05**	-34.79**	-11.08**	3.30**	2.96**	0.41	-1.69	-10.23**	-15.45**
2	L4 x T36	2.48**	-0.96	17.61**	14.71**	6.76**	3.43**	8.95**	-6.67**	1.82
3	L4 x T44	-25.24**	-30.22**	-10.80**	10.40**	8.16**	4.78**	-29.01**	-40.00**	-32.36**
4	L5 x T23	-24.26**	-31.12**	-6.08**	5.22**	1.96	6.00**	-32.31**	-32.95**	-35.64**
5	L5 x T36	8.51**	5.26**	25.00**	10.81**	-0.13	3.83**	0.00	-6.00**	2.55
6	L5 x T44	-4.82**	-10.84**	13.98**	-5.08**	-10.11**	-6.55**	-25.61**	-31.13**	-22.36**
7	L6 x T23	-16.67**	-22.92**	5.11**	8.89**	8.70**	6.00**	13.06**	11.97**	5.45**
8	L6 x T36	-34.48**	-35.26**	-23.13**	10.46**	2.65*	-0.24	-39.53**	-44.17**	-39.09**
9	L6 x T44	4.90**	0.00	27.84**	17.75**	15.18**	11.94**	24.11**	12.90**	27.27**
10	L14 x T23	-10.98**	-16.54**	13.81**	2.27*	0.23	1.80	21.17**	11.58**	5.09**
11	L14 x T36	2.63**	2.38**	22.16**	0.48	-8.48**	-7.06**	11.20**	-4.00*	4.73**
12	L14 x T44	19.03**	15.07**	47.10**	25.25**	19.94**	21.81**	30.68**	11.29**	25.45**
13	L16 x T23	-14.94**	-23.75**	3.98**	3.34**	-0.64	4.99**	-25.45**	-28.19**	-32.36**
14	L16 x T36	-6.34**	-10.53**	6.25**	3.32**	-7.54**	-2.31*	8.15**	-2.67	6.18**
15	L16 x T44	15.58**	6.67**	36.36**	13.20**	6.39**	12.42**	23.64*	9.68**	23.64**
16	L17 x T23	-14.69**	-18.96**	10.51**	4.27**	-0.13	6.38**	2.24	-1.08	-0.36
17	L17 x T36	-11.29**	-12.73**	7.10**	-30.36**	-37.90**	-33.85**	3.29*	-0.67	8.36**
18	L17 x T44	-6.67**	-8.53**	16.93**	8.44**	1.53	8.14**	-2.21	-7.42**	4.36**
19	L22 x T23	-2.23**	-10.42**	22.16**	-42.77**	-43.60**	-43.35**	18.36**	16.99**	10.18**
20	L22 x T36	32.09**	29.19**	53.41**	19.90**	9.76**	10.24**	19.35**	10.00**	20.00**
21	L22 x T44	8.29**	2.22**	30.68**	26.29**	21.58**	22.12**	24.33**	12.90**	27.27**
22	L24 x T23	-2.22**	-8.33**	25.00**	-43.39**	-43.82**	-44.37**	-1.66	-8.49**	-13.82**
23	L24 x T36	-9.88**	-10.10**	7.27**	-39.39**	-44.16**	-44.71**	3.63**	-9.67**	-1.45
24	L24 x T44	-8.97**	-12.00**	12.50**	-1.93*	-4.93**	-5.87**	-20.45**	-31.61**	-22.91**
25	L31 x T23	12.08**	4.58**	42.61**	13.56**	12.49**	11.80**	20.64**	17.86**	16.36**
26	L31 x T36	0.74	0.48	19.32**	11.54**	2.59*	1.97	-0.61	-5.33**	3.27**
27	L31 x T44	-2.98**	-6.67**	19.32**	-37.92**	-39.93**	-40.30**	7.31**	0.65	13.45**
28	L37 x T23	-2.84**	-10.83**	21.59**	5.90**	3.34**	5.90**	10.56**	3.09*	-2.91
29	L37 x T36	6.47**	4.31**	23.86**	10.82**	0.53	3.02**	8.40**	-5.33**	3.27*

Contd.

Sl. No.	Crosses	Fruit length			Fruit diameter			Average fruit weight		
		MP	BP	CC	MP	BP	CC	MP	BP	CC
30	L37 x T44	-13.00*	-17.73**	5.17**	7.13**	2.15	4.68**	-26.22**	-36.45**	-28.36**
31	L38 x T23	-0.23	-8.33**	25.00**	3.90**	0.92	4.41**	-9.64**	-13.13**	-18.18**
32	L38 x T36	-1.85**	-3.73**	14.32**	8.06**	-2.39*	0.98	-3.90**	-13.67**	-5.82**
33	L38 x T44	-13.24**	-17.87**	5.00**	9.15**	3.61**	7.19**	-29.33**	-37.42**	-29.45**
34	L39 x T23	-9.76**	-14.46**	16.65**	9.16**	8.32**	7.29**	42.97**	42.69**	34.91**
35	L39 x T36	-26.23**	-27.26**	-11.14**	6.47**	-1.92	-2.85**	-36.79**	-41.00**	-35.64**
36	L39 x T44	-22.50**	-24.22**	-3.13**	10.35**	6.95**	5.94**	-15.79**	-22.58**	-12.73**
37	L42 x T23	10.63**	-4.58**	30.11**	21.12**	16.17**	13.30**	57.78**	42.86**	34.55**
38	L42 x T36	-4.96**	-12.92**	3.41**	-25.49**	-28.03**	-35.55**	-5.88**	-20.00**	-12.73**
39	L42 x T44	5.06**	-6.84**	19.09**	18.74**	16.57**	8.34**	20.38**	0.97	13.82**
40	L43 x T23	-15.78**	-21.04**	7.67**	-48.21**	-48.52**	-49.80**	28.23**	13.13**	6.55**
41	L43 x T36	-5.73**	-5.95**	12.22**	-2.64**	-9.15**	-12.48**	15.26**	-4.33**	4.36**
42	L43 x T44	8.51**	4.89**	34.09**	18.92**	16.83**	12.55**	49.61**	22.58**	38.18**
43	L47 x T23	-11.11**	-16.67**	13.64**	-38.85**	-45.39**	-46.74**	-13.09**	-14.55**	-16.73**
44	L47 x T36	14.32**	14.05**	36.08**	40.85**	35.12**	12.75**	23.94**	17.33**	28.00**
45	L47 x T44	-37.66**	-39.73**	-22.95**	-48.00**	-52.55**	-55.90**	-42.56**	-46.45**	-39.64**
46	L50 x T23	-9.91**	-14.04**	17.22**	-26.41**	-28.52**	-26.05**	1.71	0.38	-2.91
47	L50 x T36	-2.48**	-4.50**	18.30**	-39.38**	-45.25**	-43.35**	13.78**	7.33**	17.09**
48	L50 x T44	-3.16**	-4.67**	21.88**	-48.19**	-50.82**	-49.12**	12.50**	4.52**	17.82**
49	L53 x T23	-10.80**	-16.38**	14.03**	-42.33**	-46.09**	-47.42**	1.43	-4.25**	-9.82**
50	L53 x T36	5.97**	5.71**	26.14**	30.56**	29.52**	9.84**	32.08**	16.67**	27.27**
51	L53 x T44	-6.21**	-9.33**	15.91**	18.63*	13.43**	5.43**	17.04**	1.94	14.91**
52	L65 x T23	-1.81**	-9.79**	23.01**	-1.01	-2.27*	-2.20	18.66**	16.60**	9.82**
53	L65 x T36	1.61*	-0.33	18.35*	15.45**	5.86**	5.94**	4.73**	-4.00*	4.73**
54	L65 x T44	-24.32**	-28.36**	-8.41	4.75**	1.02	1.09	-20.71*	-28.39**	-19.27**
	SEm ±	0.62	0.71	0.71	0.95	1.10	1.10	1.32	1.52	1.52
	CD @ 5%	1.24	1.44	1.44	1.91	2.20	2.20	2.65	3.06	3.06
	CD @ 1%	1.66	1.91	1.91	2.54	2.94	2.94	3.53	4.08	4.08

better parent and 28 crosses over commercial check exhibited significant and positive heterosis. For average fruit weight among 54 crosses, 30 crosses over mid parent, 19 crosses over better parent and 28 crosses over commercial check. These findings are in agreement with the findings of Jindal *et al.* 2009, Ashwani *et al.* (2013), Verma and Sood (2015) and Sabesan *et al.* (2016) in okra. Magnitude of heterosis was significant in both the directions over mid parent, better parent and commercial check.

For number of fruits per plant the maximum and positive significant heterosis was observed in the cross L43 x T44 over mid parent (71.72%) and over better parent (47.83%) and the cross L22 x T36 over commercial check (75.00%) (Table 3). Among 54 crosses, 13 crosses over mid parent, 11 crosses over better parent and 24 crosses over commercial check exhibited significant and positive heterosis. Plausibly the involvement of non-additive (dominance) gene action was very important for expression of these traits, as also revealed in the reports of Thippeswamy (2001) and Khanapara *et al.* 2009 in okra.

Table 3. Heterosis (%) over mid parent, better parent and commercial check for number of fruits/plant and yield /plant.

Sl. No.	Crosses	Number of fruits per plant			Fruit yield per plant		
		MP	BP	CC	MP	BP	CC
1	L4 x T23	-8.37**	-20.90**	1.25	2.65	-9.24*	-10.34*
2	L4 x T36	-3.60**	-17.05**	7.00**	-4.29	-16.24**	-15.28**
3	L4 x T44	-16.35**	-24.35**	-13.00**	-27.03**	-37.26**	-33.83**
4	L5 x T23	-29.55**	-39.45**	-22.50**	-20.18**	-26.36**	-27.24**
5	L5 x T36	-6.33**	-19.77**	3.50**	6.22	-3.04	-1.93
6	L5 x T44	16.91**	5.22**	21.00**	8.04	-3.21	2.09
7	L6 x T23	-12.02**	-12.69**	13.50**	-4.59	-5.63	-4.70
8	L6 x T36	-41.31**	-41.54**	-24.00**	-54.06**	-54.09**	-53.57**
9	L6 x T44	26.53**	19.23**	55.00**	10.59**	8.24	14.16**
10	L14 x T23	-19.64**	-30.47**	-11.00**	-4.25	-15.56**	-16.58**
11	L14 x T36	-51.91**	-58.53**	-46.50**	-38.19**	-46.04**	-45.42**
12	L14 x T44	34.29**	21.74**	40.00**	23.77**	6.16	11.96**
13	L16 x T23	-9.47**	-14.06**	10.00**	1.72	-7.58	-8.69
14	L16 x T36	-26.64**	-30.62**	-10.50**	-1.01	-11.00*	-9.99*
15	L16 x T44	17.39**	17.39**	35.00**	27.34**	12.41**	18.55**
16	L17 x T23	-3.46**	-18.36**	4.50**	11.99**	3.56	2.31
17	L17 x T36	-0.69	-16.28**	8.00**	18.59**	8.49	9.73*
18	L17 x T44	6.63**	-5.65**	8.50**	8.97**	-2.16	3.18
19	L22 x T23	-33.19**	-40.63**	-24.00**	-24.69**	-27.91**	-28.78**
20	L22 x T36	53.17**	35.66**	75.00**	33.00**	25.90**	27.33**
21	L22 x T44	49.18**	39.13**	60.00**	25.57**	16.57**	22.94**
22	L24 x T23	-34.71**	-41.21**	-24.75**	-19.26**	-25.00**	-25.91**
23	L24 x T36	-14.04**	-22.87**	-0.50	-15.44**	-22.29**	-21.41**
24	L24 x T44	-10.80**	-15.65**	-3.00*	-11.87**	-20.52**	-16.18**
25	L31 x T23	24.51**	24.03**	60.00**	25.30**	23.33**	21.84**
26	L31 x T36	-17.44**	-17.44**	6.50**	1.65	-1.09	0.04
27	L31 x T44	-28.28**	-32.17**	-12.50**	-22.45**	-26.04**	-22.00**

Contd.

Sl. No.	Crosses	Number of fruits per plant			Fruit yield per plant		
		MP	BP	CC	MP	BP	CC
28	L37 x T23	-22.92**	-23.83**	-2.50*	15.87**	-12.53**	-13.59**
29	L37 x T36	-25.59**	-26.74**	-5.50**	2.28	-23.40**	-22.52**
30	L37 x T44	-23.75**	-26.80**	-8.50**	-0.90	-26.79**	-22.79**
31	L38 x T23	14.01**	-7.81**	18.00**	7.93	4.44	3.18
32	L38 x T36	-25.96**	-40.31**	-23.00**	-34.73**	-37.55**	-36.84**
33	L38 x T44	-31.96**	-42.61**	-34.00**	-26.13**	-30.70**	-26.92**
34	L39 x T23	-18.42**	-27.34**	-7.00**	11.02**	-0.02	-1.23
35	L39 x T36	-30.57**	-38.37**	-20.50**	-25.52**	-33.62**	-32.86**
36	L39 x T44	-1.86	-8.26**	5.50**	9.41**	-4.25	0.99
37	L42 x T23	43.48**	28.91**	65.00**	41.96**	20.00*	18.55**
38	L42 x T36	-30.74**	-37.98**	-20.00**	-41.80**	-51.27**	-50.71**
39	L42 x T44	-13.82**	-18.70**	-6.50**	-10.67**	-26.44**	-22.41**
40	L43 x T23	-7.58**	-23.83**	-2.50*	5.32	-8.93*	-10.03*
41	L43 x T36	-35.85**	-47.29**	-32.00**	-6.12	-19.62**	-18.70**
42	L43 x T44	71.72**	47.83**	70.00**	52.61**	28.43**	35.46**
43	L47 x T23	-23.33**	-35.16**	-17.00**	-25.01**	-29.96**	-30.80**
44	L47 x T36	33.33**	12.40**	45.00**	17.47**	8.53	9.77*
45	L47 x T44	-14.50**	-24.35*	-13.00**	-23.74**	-30.87**	-27.09**
46	L50 x T23	-38.31**	-40.23**	-23.50**	-41.86**	-44.42**	-45.09**
47	L50 x T36	-14.06**	-17.05**	7.00**	3.32	-2.32	-1.21
48	L50 x T44	-8.94**	-10.83**	7.00**	-5.19	-12.09**	-7.29
49	L53 x T23	-4.93**	-17.19**	6.00**	17.63**	-0.93	-2.13
50	L53 x T36	25.00**	8.53**	40.00**	45.18**	21.12**	22.50**
51	L53 x T44	-9.52**	-17.39**	-5.00**	-6.75*	-23.48**	-19.30**
52	L65 x T23	-20.79**	-21.88**	0.00	-16.23**	-20.07**	-21.03**
53	L65 x T36	-24.26**	-25.58**	-4.00**	-17.01**	-21.68**	-20.79**
54	L65 x T44	-24.01**	-26.91**	-9.00**	-23.73**	-29.41**	-25.55**
	SEm ±	0.97	1.12	1.12	4.6	5.12	5.12
	CD @ 5%	1.95	2.25	2.25	8.4	8.80	8.80
	CD @ 1%	2.60	3.00	3.00	9.2	11.00	11.00

Maximum and positive significant heterosis was observed over mid parent (52.61%), over better parent (28.43%) and over commercial check (35.46%) as exhibited by the cross L43 x T44. Maximum heterosis over commercial check for fruit yield per plant was exhibited by the cross L22 × T36 (27.33%) followed by L22 × T44 (22.94%), L53 × T36 (22.50%), L31 × T23 (21.84%), L42 × T23 (18.55%), L6 × T44 (14.16%), L14 × T44 (11.96%), L47 × T36 (9.77%) and L17 × T36 (9.73%). Among 54 crosses, 16 crosses over mid parent, seven crosses over better parent and 11 crosses over commercial check exhibited positive and significant heterosis. It is pertinent to mention that the crop has potential to produce desired heterotic cross combination which can be further used for yield improvement of this crop. It also indicates that these hybrids may be used for further exploiting heterosis for the improvement of this character. Five crosses, namely, L43 × T44 followed by L22 × T36 (27.33%), L22 × T44 (22.94%), L53 × T36 (22.50%)

and L31 × T23 (21.84%) were found to be significant for fruit yield per plant (Table 3). On the basis of the findings of this study, and *per se* performance over both the parents (better parent and economic check) the hybrid L43 x T44 could be exploited commercially for hihger fruit yield. More speiically, in case of fruit yield per hectare among 54 crosses, 23 crosses over mid parent, 12 crosses over better parent and 18 crosses over commercial check showed positive and significant heterosis (Table 4). The finding was expected on in line of significant heterobeltiosis for yield contributing characters as also reported earlier by Chauhan and Singh 2002, Senthil *et al.* 2005, Ashwani *et al.* 2013, Kumar *et al.* 2015, Verma and Sood 2015, More *et al.* 2015 and Sabesan *et al.* 2016 in okra.

Table 4. Heterosis (%) over mid parent, better parent and commercial check for yield/plot and yield per hectare.

Sl. No.	Crosses	Fruit yield per plot			Fruit yield per hectare		
		MP	BP	CC	MP	BP	CC
1	L4 x T23	1.32**	-16.30**	-9.41**	1.36*	-16.29**	-9.41**
2	L4 x T36	-5.08**	-20.00**	-17.65**	-5.08**	-20.02**	-17.67**
3	L4 x T44	-21.95**	-36.00**	-29.41**	-21.99**	-36.05**	-29.47**
4	L5 x T23	-36.60**	-42.93**	-38.24**	-36.65**	-42.97**	-38.28**
5	L5 x T36	-16.21**	-22.86**	-20.59**	-16.24**	-22.88**	-20.61**
6	L5 x T44	4.56**	-6.67**	2.94**	4.56**	-6.66**	2.94**
7	L6 x T23	-1.11**	-3.53**	4.41**	-1.11	-3.52**	4.41**
8	L6 x T36	-45.71**	-45.71**	-44.12**	-45.76**	-45.76**	-44.16**
9	L6 x T44	4.97**	1.33**	11.76**	4.84**	1.36**	11.75**
10	L14 x T23	2.42**	-16.58**	-9.71**	2.43**	-16.59**	-9.73**
11	L14 x T36	-27.77**	-40.00**	-38.24**	-27.80**	-40.05**	-38.28**
12	L14 x T44	4.97**	1.33**	11.76**	4.84**	1.36**	11.75**
13	L16 x T23	0.31	-13.04**	-5.88**	0.34	-13.03**	-5.88**
14	L16 x T36	-6.45**	-17.14**	-14.71**	-6.43**	-17.13**	-14.69**
15	L16 x T44	23.26**	6.00**	16.91**	23.28**	6.01**	16.92**
16	L17 x T23	3.11**	-7.61**	0.00	3.11**	-7.60**	0.00
17	L17 x T36	21.59**	11.43**	14.71**	21.57**	11.42**	14.69**
18	L17 x T44	5.03**	-6.67**	2.94**	5.02**	-6.66**	2.94**
19	L22 x T23	-20.41**	-31.93**	-26.32**	-20.40**	-31.93**	-26.33**
20	L22 x T36	40.90**	22.85**	26.47**	40.63**	22.83**	26.44**
21	L22 x T44	30.50**	10.66**	22.05**	30.47**	10.73**	22.08**
22	L24 x T23	-25.84**	-33.70**	-28.24**	-25.84**	-33.69**	-28.24**
23	L24 x T36	-7.19**	-15.14**	-12.65**	-7.22**	-15.16**	-12.67**
24	L24 x T44	-12.03**	-22.00**	-13.97**	-7.98**	-18.40**	-10.01**
25	L31 x T23	12.99**	8.69**	17.64**	13.05**	8.73**	17.63**
26	L31 x T36	7.54**	6.00**	9.12**	7.51**	5.98**	9.09**
27	L31 x T44	-18.46**	-22.27**	-14.26**	-18.45**	-22.25**	-14.26**
28	L37 x T23	17.10**	-14.40**	-7.35**	17.15**	-14.39**	-7.35**
29	L37 x T36	3.85**	-22.86**	-20.59**	3.84**	-22.88**	-20.61**
30	L37 x T44	-19.27**	-41.33**	-35.29**	-19.31**	-41.38**	-35.35**
31	L38 x T23	2.08**	-3.53**	4.41**	2.06**	-3.56**	4.37**
32	L38 x T36	-32.10**	-34.29**	-32.35**	-32.15**	-34.34**	-32.41**

Contd.

Sl. No.	Crosses	Fruit yield per plot			Fruit yield per hectare		
		MP	BP	CC	MP	BP	CC
33	L38 x T44	-25.98**	-30.67**	-23.53**	-25.99**	-30.68**	-23.55**
34	L39 x T23	7.67**	-0.82**	7.35**	7.67**	-0.81	7.35**
35	L39 x T36	-24.24**	-28.57**	-26.47**	-24.30**	-28.63**	-26.53**
36	L39 x T44	0.73**	-8.00**	1.47**	0.73	-7.99**	1.47*
37	L42 x T23	27.39**	8.70**	17.65**	27.40**	8.70**	17.63**
38	L42 x T36	-37.70**	-45.71**	-44.12**	-37.75**	-45.76**	-44.16**
39	L42 x T44	-8.66**	-22.67**	-14.71**	-8.63**	-22.65**	-14.69*
40	L43 x T23	11.77**	10.33**	-2.94**	11.80**	-10.31**	-2.94**
41	L43 x T36	7.25**	-12.29**	-9.71**	7.24**	-12.31**	-9.73**
42	L43 x T44	51.00**	20.00**	32.35**	50.76 **	20.02**	32.32**
43	L47 x T23	-30.94**	-34.78**	-29.41**	-30.99**	-34.83**	-29.47**
44	L47 x T36	9.76**	6.00**	9.11**	9.65**	6.01**	9.13**
45	L47 x T44	-25.93**	-30.67**	-23.53**	-25.95**	-30.68**	-23.55**
46	L50 x T23	-39.27**	-41.58**	-36.76**	-39.19**	-41.61**	-36.81**
47	L50 x T36	-17.25**	-18.43**	-16.03**	-17.10**	-18.44**	-16.04**
48	L50 x T44	-33.57**	-36.67**	-30.15**	-33.47**	-36.69**	-30.18**
49	L53 x T23	-31.01**	-38.18**	-33.09**	-31.04**	-38.20**	-33.12**
50	L53 x T36	26.56**	15.71**	19.11**	26.56**	15.71**	19.11**
51	L53 x T44	-12.98**	-22.67**	-14.71**	-12.97*	-22.65**	-14.69**
52	L65 x T23	-22.32**	-25.27**	-19.12**	-22.19**	-25.28**	-19.14**
53	L65 x T36	-18.84**	-20.00**	-17.65**	-18.71**	-20.02**	-17.67**
54	L65 x T44	-32.31**	-35.47**	-28.82**	-32.19**	-35.47**	-28.83**
	SEm ±	0.15	0.18	0.18	0.62	0.71	0.71
	CD @ 5%	0.31	0.36	0.36	1.24	1.44	1.44
	CD @ 1%	0.42	0.48	0.48	1.66	1.92	1.92

Overall the study revealed that the magnitude of percentage over commercial check were found more or less similar among all the characters of okra. Out of 54 crosses five crosses, namely L43 × T44, L22 × T36, L22 × T44, L53 × T36 and L31 × T23 were found potential for the production of fruit yield per plant and other desired characters. The high heterosis and *per se* performance was found in hybrid L43 × T44 over both better parents and standard check for fruit yield per plant. This indicates that the cross can be exploited commercially for yield enhancement in okra**.**

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