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Estimation of hybrid vigour for fruit yield and its attributing traits in okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract

The present investigation was carried out to generate information on heterosis for yield and its components in okra [*Abelmoschus esculentus* (L.) Moench] through line x tester analysis. The experimental materials comprised of 6 lines, 4 testers and resultant 24 hybrids along with a standard check variety GJOH-4. The experiment was conducted in a Randomized Block Design with three replications for fourteen characters at Vegetable Research Station, Junagadh Agricultural University, Junagadh during summer and *kharif* 2021.Analysis of variance revealed highly significant differences among genotypes and hybrids for all the characters indicating the presence of sufficient amount of genetic variability for all the characters under study. On the basis of *per se* performance and standard heterosis 2017/OKYVRES-1 x HRB-108-2 was the best cross combination for fruit yield and its contributing characters followed by AOL-8-05 x Kashi Kranti.

Keywords: Heterosis, heterobeltiosis, standard heterosis, fruit yield, okra

Introduction

Okra is an important annual vegetable crop grown for its immature, green and fibrous edible fruits in the tropical and subtropical regions of the world. The fruits are fairly good in nutritive value and 100 g consumable portion contains 10.4 g dry matter, 3100 calorie energy, 1.8 g protein, 90 mg calcium, 1.0 mg iron, 0.1 mg carotene, 0.07 mg thiamin, 0.08 mg riboflavin and niacin, and 18 mg vitamin C with almost comparable constituents, barring few, in leaves (Grubben, 1977) [3]. The oil content of the seed is quite high (18-20 percent) and the oil yield from okra crop is 794 kg per ha (Mays *et al.*, 1990) [12]. The most frequently observed somatic chromosome number in okra is 2n=130, although the numbers 2n=72, 108, 120, 132 and 144 are in regular series of polyploids with n=12 (Datta and Naug, 1968) [1]. Okra also known as lady's finger, bhindi, gumbo *etc*., is a seed propagated hot weather crop sensitive to frost, low temperature (below 15 °C), water-logging as well as drought conditions. It is grown in tropical and sub-tropical regions and also in warmer parts of temperate regions. The crop thrives well under hot humid climate. The best plant growth and fruiting is observed at around 25 °C average temperatures with high relative humidity (65-85%).

The nature and magnitude of heterosis help in identifying superior cross combinations that may produce desirable segregants from the advanced generations. Heterosis breeding provides the ways to overcome yield barriers. The crosses exhibiting high heterosis could be exploited for obtaining transgressive segregants for improvement of yield and yield components. The heterosis and combining ability studies are useful for the evaluation of newly developed lines for their parental usefulness and to know the gene actions involved in the inheritance of various characters. For improving the genetic yield potential of the varieties and hybrids, the choice of suitable parents for evolving better varieties/hybrids is a matter of great concern to the plant breeders. The present investigation was undertaken to work out for further exploitation of heterosis for fruit yield in okra.

Materials and Methods

The experimental material consisting of 35 genotypes, including six lines *viz.*, 2017/OKYVRES-1, 2017/OKYVRES-9, 2018/OKYVRES-3, 2018/OKYVRES-4, NOL-7-9 and AOL-8-05, four testers namely HRB-108-2, AOL-12-59, AOL-16-04 and Kashi Kranti, 24 crosses and one standard check variety GJOH-4 were used in randomized block design with three replications during *kharif* 2021 at Vegetable Research Station, Junagadh Agricultural University, Junagadh. Each genotype was presented by a double-row plot of ten plants, spaced at 45 cm x 20 cm.

The observations on five randomly selected plants in each genotype of three replications were recorded for number of branches per plant, number of nodes per plant, number of fruits per plant, plant height (cm), internodal length (cm), fruit length (cm) and fruit girth (cm). The observations on days to 50% flowering, days to first picking, number of pickings, days to last picking, ten fruits weight (g), fruit borer infestation (%) and fruit yield per plant (g) were recorded on plot basis.

Results and Discussion

Commercial exploitation of heterosis in vegetable crops is regarded as the major breakthrough in the field of vegetable improvement programme. The first important step in the exploitation of heterosis is to know its magnitude and direction. The aim of estimation of heterosis in the present investigation was to spot out the best combination of parents giving high degree of economic heterosis as well as its exploitation to get better transgressive segregants and characterization of parents for their genotypic worth for future use in breeding programme.

The degree of heterosis varied from cross to cross for all the traits studied. Considerably high heterosis in certain hybrids and low in others revealed that nature of gene action varied with the genetic architecture of the parents involved. Such nature as well as magnitude of heterosis helps in identifying superior cross combinations for its exploitation commercially to isolate better transgressive segregants from segregating generations. The commercial usefulness of a hybrid would primarily depend on its performance in comparison with the best existing cultivars of that crop species.

The analysis of variance indicated sufficient highly significant differences among the genotypes for all the traits studied (Table 1). The mean square due to parents *vs.* hybrids were also found significant for all the characters studied except number of branches per plant and internodal length, which indicated that heterosis could be exploited for these traits. Similar observations were also reported by Tiwari *et al.* (2015) [22], Patel and Patel (2016) [15], Pithiya *et al.* (2019) [17], Sapavadiya *et al.* (2019) [19], Koli *et al.* (2020) [8] and Sidapara *et al.* (2020) [21].

In case of standard heterosis, many crosses manifested significant shift in desired direction *viz*., for days 50% flowering eleven crosses, days to first picking twelve crosses, number of branches per plant six crosses, number of nodes per plant two crosses, number of fruits per plant seven crosses, number of pickings eight crosses, days to last picking eight crosses, plant height thirteen crosses, internodal length fourteen crosses, fruit girth twenty three crosses, ten fruits weight five crosses, fruit borer infestation seventeen crosses and fruit yield per plant two crosses.

In case of days to 50% flowering, cross 2017/OKYVRES-9 x HRB-108-2 was the earliest to better parent and cross AOL-8-05 x HRB-108-2 was earliest to standard check Heterosis for earliness in okra was reported by Jindal *et al.* (2010) [7], Makdoomi *et al.* (2018) [11], Sapavadiya *et al.* (2019) [19], Panchal *et al.* (2021) [14] and Rajani *et al.* (2021) [18].

In case of days to first picking cross 2018/OKYVRES-3 x AOL-16-04 was the earliest to better parent and cross 2017/OKYVRES-1 x HRB-108-2 was earliest to standard check. Heterosis for earliness in okra was reported by Tiwari *et al.* (2015) [22], Makdoomi *et al.* (2018) [11], Sapavadiya *et al.* (2019) [19], Sidapara *et al.* (2020) [21] and Rajani *et al.* (2021a) [18].

The number of branches per plant is a major yield attributing component contributing to higher productivity. The cross 2017/OKYVRES-9 x AOL-16-04 showed highest heterobeltiosis and cross 2017/OKYVRES-1 x HRB-108-2 showed highest standard heterosis for number of branches per plant. Similar findings for number of branches per plant in okra have been reported by Hadiya *et al.* (2018), Pithiya *et al.* (2019) [17], Koli *et al.* (2020) [8], Panchal *et al.* (2021) [14] and Shwetha *et al.* (2021) [21].

In okra only one fruit is borne at each axil, therefore, more number of fruiting nodes on main stem with shorter distance would be helpful in increasing number of fruits per plant which in turn gives more yield per plant. Highest heterobeltiosis and standard heterosis was exhibited by crosses 2017/OKYVRES-1 x HRB-108-2 and AOL-8-05 x Kashi Kranti respectively. Positive heterosis for this trait in okra was reported by Javia (2013), Patel *et al.* (2013), Gajera and Vaddoria (2014), Makdoomi *et al.* (2018) [11] and Shwetha *et al.* (2021) [21].

Number of fruits per plant is a major fruit yield attributing character. Regarding number of fruits per plant, highest heterobeltiosis was observed in cross 2018/OKYVRES-3 x AOL-16-04 and highest standard herterosis was observed in the cross 2017/OKYVRES-1 x HRB-108-2. Nagesh *et al.* (2014), Koli *et al.* (2020) [8], Sidapara *et al.* (2020) [21], Panchal *et al.* (2021) [14] and Rajani *et al.* (2021) [18] observed similar findings.

Higher value of number of pickings and days to last picking both the traits indicated the longer period of fruit bearing. The best performing cross for heterobeltiosis and standard heterosis for both the traits was NOL-17-9 x Kashi Kranti. Similar findings was reported by Kumar and Pathania (2007) and Rajani *et al.* (2021) [18].

For plant height dwarf stature is preferred over tall one in okra. The best performing cross over better parent and standard check was NOL-17-9 x Kashi Kranti. Heterosis for plant height in desired direction was reported by Jindal *et al.* (2010) [7] Gajera and Vaddoria (2014) Sapavadiya *et al.* (2019) [19], Sidapara *et al.* (2020) [21] and Panchal *et al.* (2021) [14].

Shorter internode plays an important role in increasing the yield as fruiting takes place at each node. For internodal length 2017/OKYVRES-1 x Kashi Kranti was the best performing cross. Heterosis in desirable direction for internodal length in okra was reported by Gajera and Vaddoria (2014), Makdoomi *et al.* (2018) [11], Sidapara *et al.* (2020) [21], Rajani *et al.* (2021) [18] and Shwetha *et al.* (2021) [21].

For fruit length the cross 2018/OKYVRES-3 x AOL-16-04 showed highest heterobeltiosis whereas no hybrid showed positive and significant standard heterosis. Above pronounced results regarding fruit length have been supported by Kumar and Sreeparvathy (2010), Tiwari *et al.* (2015) [22], Makdoomi *et al.* (2018) [11], Pithiya *et al.* (2019) [17] Panchal *et al.* (2021) [14] and Rajani *et al.* (2021) [18].

Conspicuous heterosis was observed for fruit girth in the present investigation. The cross showing highest heterobeltiosis and standard heterosis was 2018/OKYVRES-3 x AOL-12-59. The present finding was in agreement with the findings of Kumar and Sreeparvathy (2010), Makdoomi *et al.* (2018) [11], Pithiya *et al.* (2019) [17], Sidapara *et al.* (2020) [21] and Rajani *et al.* (2021) [18].

Ten fruits weight is one of the important attributes contributing to the yield, higher value of fruit weight increases the yield of the plant. Highest heterobeltiosis was observed in cross 2018/OKYVRES-3 x AOL-16-04 whereas highest standard heterosis was observed in the cross 2017/OKYVRES-1 x HRB-108-2. Heterosis for fruit weight was also recorded by Jaiprakashnarayan *et al.* (2008), Kumar and Sreeparvathy (2010), Tiwari *et al.* (2015) [22], Makdoomi *et al.* (2018) [11], Pithiya *et al.* (2019) [17], Sidapara *et al.* (2020) [21] and Rajani *et al.* (2021) [18].

Significant and negative heterosis is desired for this trait since lower fruit borer infestation leads to improved production. Crosses 2018/OKYVRES-4 x Kashi Kranti and 2017/OKYVRES-9 x Kashi Kranti showed highest heterobeltiosis and standard heterosis respectively.

Yield is the character of economic importance. It is a complex trait and multiplicative product of several basic components. The cross combination 2018/OKYVRES-3 x AOL-16-04 had highest, significant and desirable heterobeltiosis. While, the cross combination 2017/OKYVRES-1 x HRB-108-2 exhibited highest significant and positive standard heterosis. Positive heterosis for fruit yield per plant was reported by Makdoomi *et al.* (2018) [11], Pithiya *et al.* (2019) [17], Sapavadiya *et al.* (2019) [19], Koli *et al.* (2020) [8], Sidapara *et al.* (2020) [21], Panchal *et al.* (2021) [14], Rajani *et al.* (2021) [18] and Shwetha *et al.* (2021) [21].

Table 1: Analysis of variance (mean square) for fruit yield and its contributing characters in okra

Source	df	Days to 50% flowering	Days to first picking	Number of branches per plant	Number of nodes per plant	Number of fruits per plant	Number of picking	Days to last picking
		1	2	3	4	5	6	7
Replications	2	0.89	4.77*	0.27**	12.82**	3.47**	1.92	14.48
Genotypes	33	27.07**	24.22**	1.21**	8.91**	10.42**	9.48**	77.64**
Parents (P)	9	31.36**	27.42**	0.90**	9.20**	3.74**	1.79**	21.78*
Hybrids (H)	23	23.81**	21.27**	1.38**	7.21**	11.29**	12.31**	97.81**
P *vs* H	1	63.41**	63.21**	0.04	45.38**	50.44**	13.45**	116.39**
Error	66	2.91	1.50	0.03	1.19	0.61	0.61	8.51

Source	df	Plant height (cm)	Internodal length (cm)	Fruit length (cm)	Fruit girth (cm)	Ten fruits weight (g)	Fruit borer infestation (%)	Fruit yield per plant (g)
		8	9	10	11	12	13	14
Replications	2	6.74	0.98**	0.36	0.06	27.49	3.52	3380.00**
Genotypes	33	485.96**	2.69**	8.35**	0.50**	1872.69**	80.68**	3203.51**
Parents (P)	9	579.72**	4.29**	10.30**	0.43**	1078.84**	78.19**	2594.7**
Hybrids (H)	23	424.35**	2.17**	7.49**	0.41**	1929.06**	76.23**	3094.41**
P *vs* H	1	1059.16**	0.35	10.71**	3.23**	7720.78**	205.39**	1114.56**
Error	66	35.25	0.10	0.24	0.11	70.65	1.72	428.36

Table 2: Estimation of Heterobeltiosis (HB) and Standard Heterosis (SH) for days to 50% flowering, days to first picking, number of branches per plant, number of nodes per plant and number of fruits per plant

Hybrids	Days to 50% flowering		Days to first picking		Number of branches per plant		Number of nodes per plant		Number of fruits per plant	
	1		2		3		4		5	
	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH
2017/OKYVRES-1 x HRB-108-2	-11.26**	-13.55**	-8.33**	-10.98**	26.19**	39.47**	15.52**	11.50*	35.56**	31.65**
2017/OKYVRES-1 x AOL-12-59	-3.31	-5.81*	-3.57*	-6.36**	19.05**	31.58**	12.45*	6.97	31.85**	28.06**
2017/OKYVRES-1 x AOL-16-04	-10.65**	-2.58	-9.09**	-1.73	16.67**	28.95**	6.94	-8.71	-13.33*	-15.83**
2017/OKYVRES-1 x Kashi Kranti	2.65	0.00	1.19	-1.73	-16.67**	-7.89	-11.36*	-15.68**	-20.00**	-22.30**
2017/OKYVRES-9 x HRB-108-2	-15.00**	-12.26**	-7.43**	-6.36**	-14.29**	-5.26	4.20	3.83	10.21	6.24
2017/OKYVRES-9 x AOL-12-59	-10.00**	-7.10**	-2.86	-1.73	-34.38**	-44.74**	-1.75	-2.09	-7.52	-11.51*
2017/OKYVRES-9 x AOL-16-04	-14.79**	-7.10**	-10.70**	-3.47*	53.57**	13.16*	-3.50	-3.83	-6.02	-10.07
2017/OKYVRES-9 x Kashi Kranti	-3.75	-0.65	-0.57	0.58	-21.88**	-34.21**	-11.89*	-12.20*	-12.78*	-16.55**
2018/OKYVRES-3 x HRB-108-2	-10.32**	-10.32**	-4.73**	-6.94**	-38.10**	-31.58**	-7.58	-10.80*	-12.69*	-15.83*
2018/OKYVRES-3 x AOL-12-59	-7.74**	-7.74**	-7.10**	-9.25**	-25.00**	-36.84**	2.20	-2.79	6.35	-3.60
2018/OKYVRES-3 x AOL-16-04	-13.61**	-5.81*	-13.37**	-6.36**	15.38	-21.05**	20.48**	4.53	54.55**	22.30**
2018/OKYVRES-3 x Kashi Kranti	-2.58	-2.58	-1.78	-4.05*	3.13	-13.16*	9.52	4.18	40.50**	22.30**
2018/OKYVRES-4 x HRB-108-2	1.32	-1.29	-0.59	-2.31	-42.86**	-36.84**	10.47*	6.62	22.39**	17.99**
2018/OKYVRES-4 x AOL-12-59	-1.32	-3.87	-2.35	-4.05*	-50.00**	-57.89**	8.79	3.48	24.60**	12.95*
2018/OKYVRES-4 x AOL-16-04	-11.83**	-3.87	-8.02**	-0.58	-3.12	-18.42**	7.88	-9.41*	25.23**	-3.60
2018/OKYVRES-4 x Kashi Kranti	0.66	-1.94	-1.18	-2.89	-18.75**	-31.58**	-2.20	-6.97	10.74	-3.60
NOL-17-9 x HRB-108-2	-7.19**	0.00	-9.04**	-1.16	-14.29**	10.53	-0.36	-3.83	2.24	-1.44
NOL-17-9 x AOL-12-59	-5.99*	1.29	-7.98**	0.00	-6.12	21.05**	-0.73	-5.57	3.97	-5.76
NOL-17-9 x AOL-16-04	-1.18	7.74**	1.06	9.83**	-24.49**	-2.63	-5.18	-17.07**	-10.14	-27.60**
NOL-17-9 x Kashi Kranti	-6.59**	0.65	-6.91**	1.16	-12.24**	13.16*	-3.30	-8.01	4.13	-9.35
AOL-8-05 x HRB-108-2	-9.66**	-15.48**	-7.23**	-10.98**	-30.95**	-23.68**	2.43	2.79	5.80	5.04
AOL-8-05 x AOL-12-59	0.00	-6.45*	-3.61	-7.51**	-37.14**	-42.11**	-5.56	-5.23	-5.07	-5.76
AOL-8-05 x AOL-16-04	-10.06**	-1.94	-11.76**	-4.62**	11.43	2.63	0.69	1.05	2.17	1.44
AOL-8-05 x Kashi Kranti	-6.85*	-12.26**	-6.59**	-9.83**	17.14**	7.89	12.15*	12.54**	26.81**	25.90**
SEd±	1.53	1.53	1.09	1.09	0.15	0.15	0.93	0.93	0.64	0.64
Range of heterosis	-15.00 to 2.65	-15.48 to 7.74	-13.37 to 1.19	-10.98 to 9.83	-50.00 to 53.57	-57.89 to 39.47	-11.89 to 20.48	-17.07 to 12.54	-20.00 to 54.55	-27.60 to 31.65
No. of positive and significant crosses	0	1	0	1	5	6	5	2	8	7
No. of negative and significant crosses	15	11	16	12	14	12	2	5	4	6

Table 3: Estimation of Heterobeltiosis (HB) and standard heterosis (SH) for number of pickings, days to last picking, plant height (cm) internodal length (cm) and fruit length (cm)

Hybrids	Number of pickings		Days to last picking		Plant height (cm)		Internodal length (cm)		Fruit length (cm)	
	6		7		8		9		10	
	HB	SH	HB	SH	HB	SH	HB	SH	HB	SH
2017/OKYVRES-1 x HRB-108-2	22.86**	16.22**	6.31**	5.04*	6.84	7.47	-16.05**	-6.66	15.07**	0.06
2017/OKYVRES-1 x AOL-12-59	23.53**	13.51*	6.68**	4.15	-9.53	-5.92	-19.93**	9.38	5.13	-2.61
2017/OKYVRES-1 x AOL-16-04	-17.65**	-24.32**	-7.06**	-10.09**	-3.27	24.63**	-19.21**	-1.36	33.65**	-9.74**
2017/OKYVRES-1 x Kashi Kranti	-13.33*	-29.73**	-0.62	-5.93**	1.07	12.28*	-34.31**	-22.39**	-18.97**	-45.28**
2017/OKYVRES-9 x HRB-108-2	-17.14**	-21.62**	-5.11*	-6.23**	-1.25	16.42**	-8.67	21.18**	-7.60	-19.65**
2017/OKYVRES-9 x AOL-12-59	-11.76*	-18.92**	-4.22	-5.64**	-11.92*	3.85	-1.88	34.04**	-0.94	-8.23*
2017/OKYVRES-9 x AOL-16-04	20.59**	10.81*	4.82*	3.26	-2.53	25.59**	-6.39	24.21**	-6.79	-21.16**
2017/OKYVRES-9 x Kashi Kranti	-5.88	-13.51*	-3.01	-4.45*	2.63	21.01**	1.37	34.49**	-31.39**	-41.97**
2018/OKYVRES-3 x HRB-108-2	-17.14**	-21.62**	-4.80*	-5.93**	5.31	5.55	-5.69	-2.12	2.87	-10.55**
2018/OKYVRES-3 x AOL-12-59	-2.94	-10.81*	-0.61	-2.97	8.11	12.43*	-4.76	30.11**	-18.40**	-24.41**
2018/OKYVRES-3 x AOL-16-04	20.59**	10.81*	6.75**	3.26	1.38	30.62**	1.49	23.90**	64.31**	-5.51
2018/OKYVRES-3 x Kashi Kranti	24.24**	10.81*	6.44**	2.97	-7.32	2.96	-8.96	7.56	47.25**	-6.96*
2018/OKYVRES-4 x HRB-108-2	14.29*	8.11	4.20	2.97	7.81	31.73**	-13.87**	44.63**	-17.27**	-28.06**
2018/OKYVRES-4 x AOL-12-59	-11.76*	-18.92**	-3.35	-5.64**	6.66	30.33**	-12.70**	46.60**	-19.27**	-25.22**
2018/OKYVRES-4 x AOL-16-04	-8.82	-16.22**	-2.46	-5.64**	-0.06	28.77**	-7.12	55.98**	51.70**	-14.61**
2018/OKYVRES-4 x Kashi Kranti	-12.50*	-24.32**	-4.00	-7.42**	1.03	23.45**	-18.83**	36.31**	12.94*	-28.64**
NOL-17-9 x HRB-108-2	-28.57**	-32.43**	-9.01**	-10.09**	5.46	5.70	9.04	13.16*	-2.53	-15.25**
NOL-17-9 x AOL-12-59	20.59**	10.81*	5.77**	3.26	-3.13	0.74	-3.54	31.77**	-13.58**	-19.94**
NOL-17-9 x AOL-16-04	23.53**	13.51*	7.29**	4.75*	-24.28**	-2.44	-17.72**	0.45	-34.93**	-50.32**
NOL-17-9 x Kashi Kranti	29.41**	18.92**	8.81**	6.23**	-26.23**	-18.05**	-18.95**	-4.24	-16.40**	-36.17**
AOL-8-05 x HRB-108-2	-5.71	-10.81*	-1.80	-2.97	0.74	0.96	14.12*	19.82**	-25.19**	-27.54**
AOL-8-05 x AOL-12-59	0.00	-8.11	0.30	-2.08	7.18	11.46*	-24.70**	2.87	25.43**	-27.77**
AOL-8-05 x AOL-16-04	2.94	-5.41	1.53	-1.78	-5.05	22.34**	2.11	24.66**	-10.17**	-12.99**
AOL-8-05 x Kashi Kranti	23.33**	0.00	6.27**	0.59	-4.93	5.62	-3.59	13.92*	-2.09	-5.16
SEd±	0.65	0.65	2.33	2.33	5.25	5.25	0.24	0.24	0.37	0.37
Range of heterosis	-28.57 to 29.41	-32.43 to 18.92	-9.01 to 8.81	-10.09 to 6.23	-26.23 to 8.11	-18.05 to 31.73	-34.31 to 14.12	-22.39 to 55.98	-34.93 to 64.31	-50.32 to 0.06
No. of positive and significant crosses	10	8	8	3	0	13	0	14	6	0
No. of negative and significant crosses	8	12	4	10	3	1	10	1	11	20

Table 4: Estimation of Heterobeltiosis (HB) and Standard Heterosis (SH) for fruit girth (cm), ten fruit weight (g), fruit borer infestation (%), fruit yield per plant (gm)

Hybrids	Fruit girth (cm)		Ten fruit weight (g)		Fruit borer infestation (%)		Fruit yield per plant (g)	
	11		12		13		14	
	HB	SH	HB	SH	HB	SH	HB	SH
2017/OKYVRES-1 x HRB-108-2	-8.14	19.17**	36.26**	34.34**	-18.62*	18.29	18.62*	16.29*
2017/OKYVRES-1 x AOL-12-59	0.12	12.64*	27.69**	25.89**	20.24**	111.55**	15.38	13.12
2017/OKYVRES-1 x AOL-16-04	12.35*	30.14**	-12.64**	-13.87**	-20.10**	32.78**	-17.23*	-18.85*
2017/OKYVRES-1 x Kashi Kranti	9.01	22.64**	-25.30**	-26.35**	8.89	68.14**	-28.00**	-29.41**
2017/OKYVRES-9 x HRB-108-2	0.75	30.69**	7.54	4.28	-37.98**	13.80	9.77	8.45
2017/OKYVRES-9 x AOL-12-59	5.79	21.81**	-6.22	-7.64	-11.76*	61.89**	-1.07	-2.26
2017/OKYVRES-9 x AOL-16-04	14.63**	32.78**	-8.99*	-11.76**	-23.01**	41.26**	-9.47	-10.56
2017/OKYVRES-9 x Kashi Kranti	11.10*	27.92**	-13.82**	-16.44**	-78.11**	-59.85**	-21.22*	-22.17**
2018/OKYVRES-3 x HRB-108-2	2.68	33.19**	-0.88	-14.63**	-41.80**	30.74**	-15.99	-19.16*
2018/OKYVRES-3 x AOL-12-59	16.10**	41.25**	-1.32	-2.82	-20.47**	78.64**	2.89	-3.32
2018/OKYVRES-3 x AOL-16-04	-1.03	20.42**	43.39**	12.32**	-23.39**	72.09**	47.47**	10.11
2018/OKYVRES-3 x Kashi Kranti	1.94	24.03**	22.57**	7.96	-23.80**	71.18**	30.30**	10.26
2018/OKYVRES-4 x HRB-108-2	-9.74*	17.08**	32.58**	14.19**	-60.61**	2.22	15.99	11.61
2018/OKYVRES-4 x AOL-12-59	11.42*	20.56**	9.08*	7.42	-70.29**	-22.91*	16.69*	9.65
2018/OKYVRES-4 x AOL-16-04	9.23	26.53**	26.69**	-12.78**	-45.65**	41.04**	34.13**	-6.33
2018/OKYVRES-4 x Kashi Kranti	8.99	17.92**	-1.97	-13.65**	-83.07**	-56.06**	3.57	-12.37
NOL-17-9 x HRB-108-2	-13.28**	12.50*	15.41**	-0.60	-37.69**	-17.22	2.98	-0.90
NOL-17-9 x AOL-12-59	9.30	27.36**	-6.11	-7.53	-51.65**	-14.93	-2.09	-7.99
NOL-17-9 x AOL-16-04	5.36	22.78**	-18.84**	-33.69**	-66.54**	-44.40**	-13.69	-34.39**
NOL-17-9 x Kashi Kranti	8.70	26.67**	11.81*	-1.52	-10.40	38.35**	1.60	-14.03
AOL-8-05 x HRB-108-2	-2.46	26.53**	1.10	1.41	17.00*	55.66**	4.71	7.24
AOL-8-05 x AOL-12-59	-14.55**	4.44	-1.71	-1.41	8.65	91.16**	-9.43	-7.24
AOL-8-05 x AOL-16-04	-1.93	19.86**	0.94	1.25	17.29**	94.91**	1.62	4.07
AOL-8-05 x Kashi Kranti	0.57	22.92**	28.16**	28.55**	33.37**	105.94**	12.67	15.38*
SEd±	0.30	0.30	6.93	6.93	1.22	1.22	14.39	14.39
Range of heterosis	-14.55 to 16.10	4.44 to 41.25	-25.30 to 43.39	-33.69 to 34.34	-83.07 to 33.37	-59.85 to 111.55	-28.00 to 47.47	-34.39 to 16.29
No. of positive and significant crosses	5	23	10	5	4	17	4	2
No. of negative and significant crosses	3	0	5	8	18	4	3	5

Conclusion

From present investigation it can be concluded that different cross combinations showed desirable significant heterosis for different characters. No cross combination showed desirable heterosis in all characters. The cross combination 2017/OKYVRES-1 x HRB-108-2 was found to be highest standard heterotic cross for fruit yield per plant and other attributing characters. This cross also recorded first rank in *per se* performance with significant and positive heterobeltiosis and standard heterosis for fruit yield per plant. Hence, such cross combination may be utilized for commercial exploitation of heterosis for fruit yield improvement in okra.

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