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Hybrid Vigour in Eight Parent Diallel Cross in Okra (*Abelmoschus esculentus* (L.) Moench)*

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ABSTRACT

Diallel analysis was carried out by using eight parents of Okra (*Abelmoschus esculentus* (L.) Moench) alongwith their 28 hybrids. These were evaluated for heterosis. Analysis of variance revealed significant differences for all the characters indicating the presence of genetic diversity in the studied material. The amount of heterosis was high for number of pods per plant and yield per plant, moderate for first fruting node, pod length, pod girth, internodal length and plant height, while remaining characters exhibited low heterosis. The most heterotic hybrids for yield per plant were Padra 18-6 x KS-312, Punjab Selection x KS-312, Parbhani Kranti x Padra 18-6 and Punjab Selection x Padra 18-6.

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INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an important delicious vegetable cultivated extensively throughout India in summer and rainy seasons.

Exploitation of hybrid vigour in okra has been recognised as an important tool by the breeder for increasing the yield. The aim of present study was to spot out the best combinations of parents giving high degree of useful heterosis.

MATERIALS AND METHODS

Eight diverse genotypes of okra viz., Gujarat Okra-1, Punjab Selection, PB-57, Parbhani Kranti, Padra 18-6, KS-312, Selection-2 and AE 36-2 were selected for the present study. These varieties were crossed in all possible combinations excluding reciprocals during summer 1989. A set of 36 genotypes comprising of eight parents and their 28 hybrids were planted during *kharif* 1989 in a randomized block design with three replications. Each plot consisted of a single row of 2.5 m length. Inter and intra row distance was kept 60 cm and 25 cm, respectively, accommodating 10 plants per plot. From each plot five competitive plants were selected at random for recording the data on days to flowering, days to first picking, first fruiting node, pod length, pod girth, number of pods per plant, number of nodes on main stem, internode length, plant height and yield per plant. Relative heterosis and heterobeltiosis expressed by the hybrids, was calculated as the deviation of hybrid from its mid parent and better parent, respectively.

RESULTS AND DISCUSSION

Analysis of variance for experimental design revealed significant differences among genotypes for all the characters

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indicating the presence of considerable genetic variability in the studied material (Table 1). Parents and hybrids differed significantly for all the characters. The diversity among the parents ultimately resulted into hybrids significantly different from each other. The parents Vs hybrids comparison indicated that means of hybrids were significantly different from that of parents as a group for all the characters except days to first picking, number of nodes on main stem and internodal length.

Several crosses exhibited conspicuous heterotic response over mid parental values for different characters. The measure of heterosis over mid parent value has limited commercial value. Therefore, from practical point of view, the haterosis may better be measured in term of superiority of F_1 over better parent(heterobeltiosis). The degree of heterosis varied from cross to cross for all the traits (Table 2). For days to flowering elevan and seven hybrids had significant negative relative heterosis and heterobeltiosis, respectively. Hybrid Gujarat Okra-1 x Punjab Selection exhibited lowest significant relative heterosis(-11.63) and heterobeltiosis(-10.75). Similar results were also reported by Maksoud *et al.* (1986) and Poshiya and Shukla (1986). With regard to days to first picking seven and three hybrids had shown significant negative heterosis over mid and better parent, respectively. Raman (1965) and Jalani and Graham (1973) reported negative heterosis over mid parents, whereas, Kulkarni and Virukshappa (1977) observed negative heterobeltiosis. For first fruiting node, only two hybrids showed significant negative relative heterosis, whereas none of the hybrids exhibited negative heterobeltiosis. The flowering at a lower internode wil be helpful in increasing the number of pods per plant, therefore, the hybrids exhibiting negative heterosis were considered as favourable for this character. These results are in agreement with the results obtained by Elangovan *et al.*, (1981) and Poshiya and Shukla (1986). In case of pod length, thirteen and eight hybrids manifested significant positive relative heterosis and heterobeltiosis, respectively. Moderate heterosis was observed for this character. Similar results were reported by Sharma and Mahajan (1978). Partap and Dhankar (1980), Elangovan *et al* (1981) and Poshiya and Shukla (1986). For pod girth nine and eight hybrids exhibited significant positive heterosis over mid parent and better parent, respectively. Thicker pods beyond certain limit are not preferred by the consumers. However, pod length and pod girth directly contribute to yield and hence their positive values increase the total yield These results are in agreement with Lal and Srivastav (1973), Lal *et al.* (1975) and Swamy Rao and Ramu (1975).

With regards to number of pods per plant, 13 hybrids manifested significant positive heterosis over mid parent and only two cross combinations showed significant positive heterobeltiosis. The range of heterobeltiosis varied from -7.48 per cent to 44.39 per cent. None of the hybrids showed significant negative relative heterosis and heterobeltiosis. Elangovan *et al.* (1981), Dhillon and Sharma (1982) and Changani and Shukla (1985) reported similar results. For number of nodes on main stem, none of the hybrids exhibited significant positive heterosis and heterobeltiosis. Lal *et al.* (1975) found negative heterosis for this character. Only one hybrid Punjab Selection x Parbhani Kranti showed desired significant negative heterosis over mid parent for internode length. None of the hybrids manifested significant negative heterobeltiosis. Similar results were reported by Lal *et al.* (1975), Changani and Shukla (1985) and Poshiya and Shukla (1986). For plant height, thirteen and five hybrids manifested significant positive relative heterosis and heterobeltiosis, respectively. Plant height with shorter internodal length plays an important role in increasing the number of pods per plant as well as pod yield per plant. Elangoven *et al.* (1981), Dhillon and Sharma(1982) and Maksoud *et al* (1986)

TABLE 1

Analysis of variance (mean squares) for experimental design for different characters.

Source of variation	*D. F.*	*Days to flowering*	*Days to first picking*	*First fruiting node*	*Pod length*	*Pod girth*	*Number of pods per plant*	*Number of nodes on main stem*	*Inter nodal length*	*Plant height*	*Yield per plant*
Replications	2	3.867**	3.219*	0.282	0.230	0.033	1.091	1.045	0.219	68.375	21.750
Genotypes	35	11.093**	12.249**	1.286**	9.156**	0.538**	19.744**	9.496**	2.902*	628.550**	2338.593**
Parents	7	13.089**	16.613**	1.417**	3.205**	0.341**	23.334**	16.512**	3.977*	881.781**	1782.469**
Hybrids	27	10.685**	11.519**	1.198**	10.941**	0.590**	14.397**	7.885**	2.724*	565.738**	2301.597**
Parents Vs. Hybrids	1	8.156**	1.438	2.761**	2.619**	0.524**	138.973**	3.879	0.183	551.875**	7230.500**
Error	70	0.471	0.699	0.106	0.326	0.022	4.012	2.688	0.394	13.679	77.089

*, ** = Significant at 5% and 1% level of significance, respectively.

TABLE 2

Heterosis in percentage over mid parent (MP) and better parent (BP) for various characters.

Crosses	Days to flowering		Days to firt picking		First fruiting node		Pod length		Pod girth	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
1	2	3	4	5	6	7	8	9	10	11
G-1 x P.S.	-11.63**	-10.75**	-10.22**	-9.38**	2.06	19.35**	8.11*	-3.79	2.56	0.12
G-1 x PB-57	0.00	1.33	1.85	3.13*	21.98**	33.82**	21.95**	9.52**	2.58	-2.91
G-1 x P.K.	-1.01	-0.67	0.63	0.64	-3.45	1.27	19.80**	14.87**	12.91**	7.79**
G-1 x Padra 18-6	-2.70**	-2.04	1.90	3.21*	13.54**	31.46**	4.85	-1.49	-11..68**	-13.41**
G-1 x KS-312	-0.71	5.28**	0.66	7.06**	-9.09*	-3.62	11.55**	5.89	13.43**	10.61**
G-1 x Selection-2	-4.08**	-2.75**	-2.53*	-1.29	21.65**	42.31**	10.32**	5.11	-2.86	-5.35*
G-1 x AE 36-2	-1.67	-1.35	-1.86	-1.24	12.71**	22.97**	12.19**	8.44	13.70**	10.0**
P.S. x PB-57	-2.95**	-2.64**	-2.14	-1.84	1.91	8.03*	-12.89**	-13.77	1.70	-1.47
P.S. x P.K.	4.67*	-3.37**	-3.41*	-2.49	2.97	14.17**	12.20**	3.78	24.17**	21.37**
P.S. x Padra 18-6	-1.00	0.67	0.31	2.56	2.73	3.58	-14.34**	-19.17**	-6.30**	-10.28**
P.S. x KS-312	-3.16**	3.77**	-0.98	6.34**	4.90	15.00**	-1.60	-8.09*	10.67**	5.41**
P.S. x Selection-2	-10.44**	-8.28**	-10.35**	-8.33**	-4.51	-4.46	-19.81**	-25.37**	-2.99	-3.18
P.S. x AE 36-2	-1.99*	-1.34	-2.15	-1.85	-7.18*	-0.92	-1.32	-9.42**	2.40	1.47
PB-57 x P.K.	0.33	2.03	0.62	1.88	-4.21	0.00	-1.14	-7.68**	14.71**	13.68**
PB-57 x Padra 18-6	-6.00**	-4.08**	-4.38**	-1.92	14.42**	20.15**	-28.62**	-31.98**	-1.02	-8.05**
PB-57 x KS-312	5.59**	13.53**	5.88**	14.09**	4.17	7.58	-14.29**	-19.18**	-2.33	-9.72**
PB-57 x Selection-2	0.00	2.77*	0.63	3.21*	-0.95	5.05	-35.22**	-39.13**	-6.82**	-9.56**
PB-57 x AE 36-2	-0.99	0.00	0.00	0.61	3.55	4.13	4.90	-2.80	18.32**	15.67**
P.K. x Padra 18-6	-7.80**	-7.49**	-6.33**	-5.13**	3.00	13.18**	3.24	1.07	-3.64	-9.72**
P.K. x KS-312	7.47**	13.53**	7.95**	14.79**	9.78*	10.87*	14.11**	12.92**	-2.67	-9.28**
P.K. x Selection-2	-1.71	-0.68	-0.63	0.63	4.95	16.47**	-23.56**	-24.07**	3.25	1.10
P.K. x AE 36-2	0.67	1.36	0.62	1.26	14.29**	18.62**	-0.79	-1.62	5.30**	3.86
Padra 18-6 x KS-312	7.14**	12.79**	7.38**	12.68**	14.85**	24.68**	16.80**	15.52**	-4.00*	-4.53*
Padra 18-6 x Sele.-2	3.43**	4.14**	3.21**	3.21*	-2.73	-1.93	24.93**	23.09**	0.53	-3.91
Padra 18-6 x AE 36-2	1.01	2.04	1.26	3.21	2.42	8.27	23.10**	19.52**	-5.12**	-9.94**
KS-312 x Sele. -2	0.00	4.51**	-0.67	4.23**	14.71**	25.1**	2.19	1.80	-5.87**	-10.50**
KS-312 x AE 36-2	4.59**	11.28**	2.63*	9.87**	12.04**	15.00**	35.61**	33.10**	3.57	-2.21
Selection -2 x AE 36-2	-3.73**	-2.07	-3.15**	-1.29	14.83**	22.51**	26.16**	24.29**	13.95**	13.11**
S.E. ±	0.49	0.56	0.59	0.68	2.32	2.66	0.40	0.47	0.10	0.12

*,** = Significant at 5% and 1% level of significance, respectively.

TABLE -2 (Contd)

Crosses	Number of pods per plant		Number of nods on main stem		Internodal length		Plant height		Yield per plant	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
	12	13	14	15	16	17	18	19	20	21
G-1 x P.S.	14.12	-4.72	11.66	10.53	17.52*	58.14**	5.67*	3.37	14.18**	3.54
G-1 x PB-57	1.12	-3.63	4.96	4.96	-7.85	14.59	0.58	-4.53	11.45**	4.20
G-1 x P.K.	19.28	9.43	-11.48	-12.20	33.41**	70.40**	7.55**	0.90	3.54	-3.42
G-1 x Padra 18-6	9.11	1.00	-0.36	-12.73**	21.21*	39.53**	3.69	-2.11	5.29	-6.38
G-1 x KS-312	33.82**	9.20	11.24	4.75	20.85*	35.06**	-10.41**	-15.61**	24.97**	11.21*
G-1 x Selection-2	-4.51	-6.35	4.63	1.96	-0.46	30.02**	4.12	-0.17	11.02*	6.00
G-1 x AE 36-2	-3.27	-5.90	2.96	-6.61	-8.20	-1.06	-6.32*	-25.13**	-1.04	-5.07
P.S. x PB-57	38.83**	11.53	-7.98	-8.91	1.55	8.53	11.51**	8.13**	14.36**	-2.34
P.S. x P.K.	25.08	12.71	2.64	2.43	-15.15*	-11.43	4.12	-0.24	1.19	-1.85
P.S. x Padra 18-6	36.32**	7.03	3.34	-8.70	5.37	21.10*	12.71**	4.23	30.38**	6.48
P.S. x KS-312	1.09	-1.76	4.80	-0.37	4.53	23.80**	3.94	0.00	46.59**	43.53**
P.S. x Selection-2	37.38**	12.93	6.77	5.10	-9.86	-7.60	1.39	-0.67	29.04**	12.27**
P.S. x AE 36-2	53.29**	30.92**	9.46	-1.62	9.75	35.10**	30.35**	5.95*	2.89	-2.99
PB-57 x P.K.	7.54	-5.56	0.00	-0.81	9.73	12.23	1.51	0.26	13.62**	-0.40
PB-57 x Padra 18-6	0.62	-2.41	8.87	-4.66	-7.23	-6.49	12.67**	1.29	14.53**	8.50*
PB-57 x KS-312	50.82**	18.59	3.10	-2.92	-6.06	3.60	-5.76*	-6.53*	27.26**	6.80
PB-57 x Selection-2	-4.73	-7.48	10.26	7.45	1.00	5.41	10.20**	9.05**	-2.50	-4.62
PB-57 x AE 36-2	10.01	2.14	7.52	-2.48	-1.71	12.43	-5.31	21.12**	16.24**	4.56
P.K. x Padra 18-6	27.23**	8.84	-7.04	-18.01**	4.29	14.45	-0.46	-11.50**	41.95**	18.79**
P.K. x KS-312	45.34**	27.68	-6.15	-10.95	-5.41	6.85	11.31**	10.83**	0.71	-4.29
P.K. x Selection-2	18.49	6.80	12.98	10.98	-11.30	-9.52	5.53*	3.16	2.15	-8.72
P.K. x AE 36-2	30.86**	23.19	-8.35	-17.48**	-4.57	11.88	4.13	-12.38**	-5.00	-7.74
Padra 18-6 x KS-312	55.09**	19.28	-10.07	-16.77**	-13.33	-10.96	-6.38*	-16.44**	51.38**	21.62**
Padra 18-6 x Sele.-2	2.02	-3.82	-1.56	-11.80	16.77*	30.68**	88.55*	-1.50	4.97	-2.61
Padra 18-6 x AE 36-2	21.02*	9.24	-2.51	21.43**	-4.64	1.46	-17.81**	-37.06**	22.26**	4.83
KS-312 x Sele. -2	24.68*	0.23	6.62	2.92	16.87*	34.76**	13.40**	11.32**	24.25**	6.18
KS-312 x AE 36-2	73.09**	44.39**	12.10	-3.65	-12.20	-9.14	24.82**	4.66	-9.23	-16.09**
Selection -2 x AE 36-2	2.38	-2.27	12.39	-0.39	-5.70	12.98	27.57**	5.38	5.92	-2.80
S.E. ±	1.42	1.64	1.16	1.34	0.44	0.51	2.61	3.02	6.21	7.17

*,** = Significant at 5% and 1% level of significance, respectively. Sele. = Selection.

reported similar results. In case of yield per plant, sixteen and six hybrids exhibited significant positive heterosis over mid parent and better parent, respectively. Heterobeltiosis ranged from -16.09 to 43.53 per cent. Hybrid, Punjab Selection x KS-312 recorded maximum heterobeltiosis (43.53). High heterosis for yield per plant seems to have resulted due to the combined effect of heterosis observed in its yield component characters such as number of pods per plant, pod length, pod girth, plant height and internodal length. The genetic divergence of selected parents seems to be another cause for high heterosis observed in yield. Similar results were also reported by Partap and Dhankhar (1980), Elangovan *et al.* (1981) and Poshiya and Shukla (1986).

Considerable high heterosis in certain crosses and low in other crosses revealed that the nature of gene action varied in hybrids depending upon the genetic architecture of parents involved. Considering present study the promising hybrids were Padra 18 5 / KS-312 and Punjab Selection / KS-312. These hybrids offer the best possibilities for their future exploitation in the development of high yielding varieties. The possible methodologies which could be adopted for thier future exploitation could be (1) production of further inbred lines from the identified crosses (2) Development of double cross hybrids from the single cross ones and (3) Conversion of parents involved in heterotic combinations into male sterile lines for commercial exploitation of heterosis. The end products of these scientific endures could be directly handed over to seed producers and farmers so as to organise commercial production.

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