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HETEROSIS AND GENE ACTION IN OKRA

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Abstract

Forty two hybrids generated by crossing three testers with fourteen lines were studied along with parents for studying heterosis and gene action for days to first flowering, days to 50 percent flowering, fruit weight, fruit length, plant height, number of seeds per fruit, 100-seed weight and fruit yield per plant during rainy season and summer season of 2002-03 at Department of Horticulture, Indira Gandhi Agricultural University, Raipur, Chhattisgarh, India. The most heterotic combinations were VRO-6 x Parbhani Kranti, VRO-4 x Parbhani Kranti, Daftari-1 x Arka Abhaya and Kaveri Selection x Ankur Abhaya for fruit yield per ptant. The *sca* variances for days to fruit flower, days to 50 percent flowering, fruit weight, fruit length, plant height, number of seeds per fruit and 100-seed weight were higher than so gca variance so there is a preponderance of non-additive gene action. The *gca* variances was greater than *sca* variances for fruit yield per plant indicating preponderance of additive gene action for this trait. Overall, the results discussed above are quite indicative of the fact that hybrid okra has great potentialities of maximizing fruit yield in Chhattisgarh plains.

Introduction

The knowledge of combining ability helps in identifying best combiners, which may be hybridized either to exploit heterosis or to accumulate fixable genes through selection. The heterosis revealed the type of gene action involved and it helps in the selection of suitable breeding methodology and parameters, which are employed for crop improvement programme.

In okra very little work has been done in estimating the heterosis effects on fruit yield and its components particularly in context to Chhattisgarh plains. In okra studies on this aspect have been made by some workers (Singh *et al.*, 1996). Hence, an attempt has, therefore, been make to study the combining for eight characters in okra by following line x tester analysis given by Kempthorne (1957)

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Materials and Method

The experimental material comprised of fourteen genetically diverse genotypes of okra, namely Daftari-45, Shagun-1, Kaveri Selection, X-2, okra Dharwad, Bilaspur-55, Harsha, VRO-43, VRO-4, VRO-5, VRO-6, Ks-410, Daftari-1 as lines and three genotypes, namely Arka Anamika, Arka Abhaya and Parbhani Kranti as testers. Forty two hybrids obtained from line x tester cross along with 17 parents were grown in randomized work design with three replications at Horticultural Research Farm, Department of Horticulture, Indira Gandhi Agricultural University, Raipur. In each replication, each entry was grown in three rows having 30 plants spaced 45 cm and 30 cm inter row and inter row spacing and intra-row spacing, respectively. The observations were recorded on 5 randomly selected plants from each genotype in each replication for eight quantitiave characters viz., days to first flowering, days to 50% flowering, fruit weight, fruit length, plant height, number of seeds per fruit, 100-seed weight and fruit yield per plant. The data was subjected to line x tester analysis suggested by Kempthorne (1957). The magnitude to heterosis as the difference in F_1s performance over better parent in percentage was calculated and presented as per Singh *et al.* (1996).

Results and Discussion

The analysis of variance for combining ability revealed that the variance due to lines were significant for days to first flowering, days of 50% flowering and plant height. The significant variations among testers were recoded for days to first flowering, days to 50% flowering, fruit weight and fruits per plant. The variation due to interaction between lines x testers were highly significant for all the characters except fruit yield per plant, indicating the presence of variability and high degree of additive and dominance variance in the experimental material (Table 1). The concept of combining ability is a measure of gene action i.e. additive and non additive. General combining ability effect involves additive gene action, whereas, specific combining ability effect presents only non-additive gene action. The presence of non-additive genetic variance offers scope for exploration of heterosis. The mean values of parents and hybrids as well as percentage heterosis over better parent for eight characters are presented in Table 2.

Table 1. Analysis of variance for line x tester.

Source of variation	Degree of freedom	Days to first flowering	Days to 50% flowering	Fruit weight (g)	Diameter of fruit	Fruit length (cm)	Plant height (cm)	Number of seeds/fruit	100 seed weight (g)	Fruit yield/plant
Replication	2	0.49	0.54	0.58	0.18	4.07	22.44	18.13	0.28	589.52
Parents	16	12.54**	15.26**	2.99**	0.01	2.12**	132.89**	90.46**	0.27	370.48
Hybrids	41	16.98**	7.99**	1.63**	0.21	1.11**	116.11**	47.33**	0.38**	396.76**
Parents Vs hybrids	1	79.82**	103.95**	75.40**	0.24	22.47**	752.75**	858.71**	4.16**	10834.5**
Lines	13	31.06**	11.91*	1.18	0.20	1.58	219.87**	58.73	0.24	395.64
Testers	2	49.81**	26.79**	8.7**	0.35	1.23	47.85	26.16	0.74	1789.71**
L x T	26	7.41**	4.58**	1.31**	0.21	0.86**	69.49**	43.29**	0.48*	290.17
Error	116	0.93	0.09	0.09	0.19	0.31	16.22	9.21	0.17	235.44

*, ** Significantly at 5% and 1% respectively

Table 2: The mean value of parents, F_1 hybrids and heterobeltiosis in percentage of okra.

Parents and F_1 hybrids	Days to first flowering		Days to 50% flowering		Fruit weight (g)		Fruit length (cm)		Plant height (cm)		Number of seeds/ fruit		100 seed weight (g)		Fruit yield/plant (g)	
	Mean	HBT %	Mean	HBT %	Mean	HBT %	Mean	HBT %	Mean	HBT%	Mean	HBT %	Mean	HBT %	Mean	HBT%
Female																
Daftari-45	50.00		57.23		8.82		9.59		75.73		43.74		6.29		75.24	
Shagun	49.83		56.20		7.50		9.21		71.13		44.59		6.39		68.56	
Kaveri Selection	49.77		53.50		7.47		9.29		71.27		42.87		6.55		57.66	
X-2	48.57		55.67		9.32		10.75		89.00		44.49		5.98		82.39	
O. D.	50.37		56.27		10.31		10.29		76.40		42.78		6.14		89.38	
Bilaspur-55	52.07		55.03		10.53		10.32		71.13		44.41		5.92		88.03	
Harsha	49.83		56.47		8.31		10.68		69.93		44.73		6.27		71.59	
VRO-3	47.77		51.37		9.89		11.13		81.93		54.20		6.48		87.33	
VRO-4	49.70		52.47		9.21		11.29		83.07		52.50		6.82		76.82	
VRO-5	47.73		53.83		8.37		11.61		91.67		49.29		6.74		76.68	
VRO-6	44.30		49.83		11.11		10.69		84.00		57.46		6.78		109.52	
KS-410	46.77		51.47		9.23		10.70		83.67		50.73		6.34		77.21	
AVT-II	47.50		53.67		8.53		12.51		77.53		45.97		6.81		72.12	
Daftari-1	44.93		50.63		8.70		10.37		73.87		57.87		6.00		72.06	
Male																
Arka Anamika	49.37		52.67		8.73		9.77		79.33		46.92		6.33		79.05	
Arka Abhay	50.57		55.37		8.26		10.69		70.93		53.51		6.67		73.15	
Parbhani Kranti	47.23		52.07		8.81		11.12		81.53		57.54		6.72		79.73	
Hybrids																
X Arka Anamika																
Daftari-45	48.23	0.98*	52.63	2.47*	10.67	7.85*	11.16	0.30*	85.60	4.48*	45.41	-16.21*	7.15	10.23	102.00	16.81*
Shagun	50.37	2.03*	51.47	-1.99*	9.44	2.50*	11.37	0.65*	83.40	0.40*	51.73	-1.46*	6.59	-3.47*	89.99	13.84*
Kaveri Selection	45.23	-5.24*	51.50	-2.22*	10.88	24.64*	12.53	7.86*	92.40	0.80	52.21	5.92*	6.64	-1.43*	95.12	20.33*
X-2	46.57	5.12*	53.23	6.82*	10.21	-8.10*	11.33	6.05*	84.47	0.56*	54.19	-5.70*	6.27	-7.57*	103.31	-5.66*
O.D.	49.97	6.84*	54.27	5.44*	9.77	5.89*	10.67	-0.25*	75.73	-9.48*	56.14	10.67*	6.64	4.84*	95.93	21.36*

Table 2. Cont'd.

Parents and F_1 hybrids	Days to first flowering		Days to 50% flowering		Fruit weight (g)		Fruit length (cm)		Plant height (cm)		Number of seeds/ fruit		100 seed weight (g)		Fruit yield/plant (g)	
	Mean	HBT %	Mean	HBT %	Mean	HBT %	Mean	HBT %	Mean	HBT%	Mean	HBT %	Mean	HBT %	Mean	HBT%
Bilaspur-55	45.77	-3.65*	51.73	-1.77*	10.27	20.41*	11.27	-9.91*	87.20	9.92*	53.72	14.49*	7.51	10.28*	86.98	10.04*
Harsha	47.03	4.67	51.50	1.17*	10.47	30.38*	11.21	14.73*	74.67	-5.88*	57.35	-0.89*	6.69	5.69*	81.82	3.50*
VRO-3	50.67	2.63	51.43	-2.34*	10.65	20.79*	10.47	7.09*	80.27	1.18*	49.85	6.24*	7.20	13.80*	100.73	27.43*
VRO-4	51.10	3.51*	52.53	-6.52*	9.40	7.72*	10.91	11.60	86.13	8.57*	52.49	11.88*	6.50	1.77*	77.55	-1.89*
VRO-5	47.00	-4.79*	50.73	-3.67*	9.20	5.42*	11.35	16.17*	90.93	14.62*	53.48	13.98*	7.37	12.46*	86.64	9.61*
VRO-6	45.07	-7.21*	50.23	-4.62*	10.25	10.02*	11.94	11.10*	82.07	-7.79*	52.21	11.27*	6.29	-0.58*	91.91	11.55*
KS-410	51.37	4.05*	55.40	5.91*	9.60	-8.77*	11.35	9.95*	84.80	6.89*	53.53	14.09*	6.63	4.85*	96.45	4.93*
Parents and F_1 hybrids																
AVT-II	46.07	-6.68*	51.43	-2.34	11.47	11.25*	9.89	-3.95	79.40	0.08*	59.77	27.39	6.45	1.90*	93.78	93.75*
Daftari-1	45.57	-7.70*	50.70	-3.73*	10.53	20.70*	11.24	5.24*	75.13	-5.29*	49.73	5.98*	6.82	7.80*	86.04	8.84*
x Arka Abhay																
Daftari-45	46.10	-3.49*	51.07	-0.58*	10.53	6.40*	11.43	2.70*	82.33	0.49*	48.15	-11.17*	5.87	-11.94*	93.29	6.83*
Shagun	47.30	-4.83*	52.03	-0.83*	10.78	17.05*	11.47	1.53*	85.13	2.49*	52.76	-1.41*	6.96	1.95*	104.95	36.61*
Kaveri Selection	46.30	-3.00*	53.79	-0.07*	9.73	16.29*	11.95	2.93*	86.67	-5.45*	49.85	-6.85*	7.18	6.63*	97.77	27.50*
X-2	46.77	5.57*	54.40	9.16*	9.77	-12.00*	11.79	10.26*	83.40	-0.71*	58.93	2.56	6.78	-0.10*	97.40	-11.06*
O. D.	53.43	14.26	55.53	7.90*	9.72	5.27*	10.94	2.24*	78.80	-5.82*	58.91	10.09*	6.85	2.75*	85.25	10.41*
Bilaspur-55	45.60	-4.00*	51.87	-3.35*	10.07	18.14*	11.73	-6.29*	81.67	5.33*	59.21	10.65*	6.63	-2.64*	89.35	22.15*
Harsha	48.10	7.05*	56.03	10.66*	10.47	20.31*	10.37	-3.02*	76.27	3.25*	54.62	-5.61*	7.49	12.29*	83.50	14.15*
VRO-3	49.37	-1.27*	56.33	1.75*	10.75	21.84*	12.05	12.69*	87.27	15.23*	52.52	-1.86*	6.85	2.75*	92.35	22.75*
VRO-4	45.63	-8.43*	51.43	-7.10*	10.70	29.49*	10.91	2.09*	86.00	20.90*	54.64	2.11*	6.57	-1.45*	93.29	27.53*
VRO-5	47.57	-4.42*	51.57	-3.61*	10.53	27.47*	12.47	16.68*	95.73	34.33*	55.98	4.61*	6.64	-0.50*	89.69	22.61*
VRO-6	46.97	-3.29	51.67	-6.68*	9.91	6.37*	11.69	8.81*	83.33	-6.67*	57.37	7.20*	6.97	4.45*	83.54	1.40*
KS-410	53.37	5.54*	52.47	-4.66*	8.73	-17.10*	11.87	11.07*	83.87	17.90*	52.25	-2.37*	6.80	2.00*	81.30	-7.65*
AVT-II	46.13	-8.41	51.27	-7.41*	9.50	-7.83*	11.31	5.77*	91.33	19.55*	50.85	-4.97*	6.91	3.65*	86.66	-3.04*
Daftari-1	44.30	-11.1	50.50	-8.79*	11.13	34.03*	11.47	7.33*	73.20	3.20*	54.75	2.30*	6.76	1.30*	112.88	54.31*
x Parbhani Kranti																
Daftari-45	45.57	-3.53	51.50	0.26*	10.63	7.48*	11.70	5.15*	81.93	0.00	49.61	-13.79*	6.86	1.98*	97.53	11.68*
Shagun	44.07	-6.7	51.00	-2.05*	11.18	21.39*	12.46	10.33*	82.60	-0.56*	63.81	10.89*	6.61	-3.13*	114.00	42.99*
Kaveri Selection	45	-4.73	51.47	-1.15*	10.27	16.49*	11.44	-1.49*	76.27	-16.80*	55.22	-4.03*	6.46	-4.11*	83.84	5.16*
X-2	44.77	1.05	51.37	3.08*	11.44	3.00*	12.36	11.15*	83.67	-0.40*	54.91	-4.56*	7.23	6.58*	109.67	0.14*
O. D.	46.57	-0.43	53.37	3.69*	10.35	12.17*	11.20	0.72*	72.00	13.94*	45.55	-20.84*	6.62	-1.54*	99.32	24.57*
Bilaspur-55	47.40	0.35	52.27	0.38*	9.90	12.29*	11.59	-7.35*	83.73	2.70*	54.20	-5.80*	6.25	-8.18*	82.11	2.98*

Table 2. Cont'd.

Parents and F_1 hybrids	Days to first flowering		Days to 50% flowering		Fruit weight (g)		Fruit length (cm)		Plant height (cm)		Number of seeds/ fruit		100 seed weight (g)		Fruit yield/plant (g)	
	Mean	HBT %	Mean	HBT %	Mean	HBT %	Mean	HBT %	Mean	HBT%	Mean	HBT %	Mean	HBT %	Mean	HBT%
Harsha	45.67	1.63	51.10	0.92*	10.63	22.22*	11.12	0.03*	73.93	-9.32*	56.56	-2.26*	6.91	2.78*	87.48	9.72*
VRO-3	46.67	-1.2	52.40	0.64*	11.43	29.63*	10.98	-1.26*	88.40	8.42*	57.01	-0.93*	6.50	-3.37*	109.31	37.10*
VRO-4	45.30	-4.09	50.50	-3.01*	11.11	26.10*	10.49	-5.64*	83.67	2.62*	53.70	-6.67*	6.70	-0.30*	111.37	39.68*
VRO-5	46.93	-0.64	49.50	-4.93*	10.63	20.65*	12.03	8.15*	90.93	11.53*	55.27	-3.95*	7.06	5.06*	99.12	24.32*
VRO-6	45.23	-4.23	50.10	-3.78*	12.50	34.17*	10.09	-9.23*	99.33	11.61*	53.99	-6.18*	6.23	-7.34*	128.25	55.67*
KS-410	49.83	5.5	51.37	-1.34*	11.28	7.19*	11.28	1.44*	75.20	-7.77*	54.03	-6.09*	6.84	1.69*	107.81	22.47*
AVT-II	44.10	-6.63	50.00	-3.97*	10.70	3.78*	11.16	0.36*	75.53	-7.36*	60.99	5.99*	6.44	-4.21*	95.95	7.35*
Daftari-1	45.13	-4.45	51.70	-0.70*	11.53	30.86*	11.75	5.64*	78.00	-4.33*	46.32	-19.50*	7.38	9.82*	122.27	53.35*

* Significant at 5 per cent level
HBT% Heterobeltiosis percentage

The number of days taken to first flowering among the parents and hybrids varied from 44.30 to 52.07 days, respectively. Twenty-six hybrids showed favourable heterobeltiosis, varied from –4.03 to –11.10 percent, which was significant for 13 hybrids. The highest heterobeltiosis for early flowering was observed in Daftari-1 x Arka Abhay (-11.10) followed by VRO-4 x Arka Abhay (-8.43), OV x Arka Abhay (-8.41) and Daftari-1 x Arka Anamika (-7.70). Similar results have been reported by Singh *et al.* (1996).

The variation in parents ranged from 49.83 to 57.23 days and in hybrids from 49.50 to 56.33 days. Twenty-six hybrids showed significant favourable heterobeltiosis. Highest heterobeltiosis for this character was observed in Daftari-1 x Arka Abhay (-8.79) followed by OV x Arka Abhay (-7.41), VRO-4 x Arka Abhay (-7.1) and VRO-6 x Arka Abhay (-6.68). Similar results in okra were reported by Pathak and Syamal (1977).

The range of fruit weight varied from 7.47 to 11.10g and 8.37 to 12.50g among parents and hybrids, respectively. Thirty-seven hybrids showed significant heterobeltiosis. The highest heterobeltiosis was observed in VRO-6 x Parbhani Kranti (34.17) followed by Daftari-1 x Arka Abhay (34.03), Daftari-1 x Parbhani Kranti (30.86), Harsha x Arka Anamika (30.38) and VRO-3 x Parbhani Kranti (29.63). Ahmed *et al.*(1999) also reported similar results.

The range of fruit length varied from 9.21 to 12.51 cm and 9.89 to 12.53 cm among parents and hybrids, respectively. Thirty-two hybrids showed significant heterobeltiosis in desirable direction. The highest heterobeltiosis was observed in VRO-5 x Arka Abhay (16.88) and VRO-5 x Arka Anamika (16.17). Similar results have been reported by Thakur *et al.* (1981), Singh *et al.* (1996a), Pathak and Syamal (1997) and Ahmed *et al.* (1999) in Okra.

The variation for plant height ranged from 69.93 to 91.67 cm and 72.00 to 99.33 cm in parents and hybrids, respectively. Twenty-seven hybrids showed significant positive heterobeltiosis. The best hybrids for this character was VRO-5 x Arka Abhay (34.33) followed by VRO-4 x Arka Abhay (20.90), OV x Arka Abhay (19.55) and KS-410 x Arka Abhay (17.90). These are in accordance with the findings of Pathak and Syamal (1997), Ahmad *et al.* (1999).

The variation for number of seeds per fruit ranged from 42.78 to 57.87 and 45.41 to 63.81 among parents and hybrid, respectively. Nineteen hybrids showed significant positive heterobeltiosis. The best cross combinations for this character were OV x Arka Anamika (27.39) followed by Bilaspur-55 x Arka Anamika (14.49) and KS-410 x Arka Anamika (14.09). Similar results were reported by Rao and Ramu (1979).

Table 3. Estimates of general combing ability (*gca*) effects of parents for different characters in okra.

Parents	Days to first flowering	Days to 50% flowering	Fruit wt (g)	Fruit length (cm)	Plant height (cm)	No. of seeds / fruit	100-seed wt (g)	Fruit yield/plant (g)
Female parents								
Daftari-45	1.78*	1.33*	0.50*	-0.21	2.40*	-0.77	0.09	4.9
Shagun	0.22	-0.57*	-0.04	-0.60*	2.35*	-0.29	-0.17	-1.82
Kaveri	0.04	-1.46*	-0.32*	0.58*	9.62*	1.01	0.26*	-4.08
Selection								
X-2	1.37*	-1.39*	0.44*	-0.13	5.33*	0.62	-0.27*	5.34
O.D.	1.69*	-1.16*	0.11	-0.59*	-0.83	3.31*	-0.16	-3.76
Bilaspur-55	4.40*	1.02*	-0.57*	0.12	-1.63	-0.63	-0.01	-0.7
Harsha	2.12*	-1.09*	0.62*	0.11	-7.47*	-3.63*	0.22*	11.17*
VRO-3	-0.49	-0.32*	0.16*	0.05	0.37	-6.18*	-0.14	1.71
VRO-4	0.12	-0.56*	0.02	0.39*	0.80	2.20*	-0.05	7.09
VRO-5	-1.61*	0.20*	-0.15	0.60*	2.20*	-1.47	0.00	-3.65
VRO-6	-1.09*	0.94*	0.03	0.45*	0.93*	2.11*	-0.01	7.57
KS-410	-2.87*	2.33*	-0.50*	-0.44*	-7.40*	-0.37	-0.06	-2.39
AVT-II	-0.87*	-0.10	-0.37*	0.16	1.29	1.81*	0.03	-9.75*
Daftari-1	-0.19	0.82*	0.08	-0.47*	-7.96*	2.28*	0.26*	-11.63*
Male parent								
Arka Anamika	0.73*	0.00	-0.24*	-0.18*	0.10	-0.91*	0.00	-3.87*
Arka Abhay	0.52*	0.80*	-0.28*	0.16*	1.01*	0.44	0.04	-3.66*
Parbhani Kranti	-1.25*	-0.80*	-0.53*	0.03	-1.11*	0.47	-0.04	7.54*
SE (female)	0.26	0.08	0.08	0.15	1.09	0.80	0.10	4.10
SE (male)	0.10	0.03	0.03	0.06	0.43	0.32	0.04	1.63

* Significant at P = 0.05 level

Table 4. Best hybrids on the basis of heterosis and specific combining ability (sca) effects for 8 characters in okra.

Parents	Best hybrid on the basis of standard heterosis over Parbhani Kranti	Best specific combiner
Days to first flowering	Shagun ×Parbhani Kranti-1, OV × Parbhani Kranti, Daftari-1 ×Arka Abhay	VRO-4 × Arka Abhay, OV × Parbhani Kranti, Shagun × Parbhani Kranti
Days to 50% flowering	VRO-5 × Parbhani Kranti, OV × Parbhani Kranti, VRO-6 × Parbhani Kranti	VRO-3 × Arka Anamika, Daftari-1 × Arka Abhay, OV × Arka Abhay
Fruit weight (g)	VRO-6 × Parbhani Kranti, Daftari-1 × Parbhani Kranti, OV × Arka Abhay	KS-410 × Arka Anamika, VRO-6 × Parbhani Kranti, OV × Parbhani Kranti
Fruit length (cm)	Kaveri Selection × Arka Anamika, VRO-5 × Arka Abhay, Shagun × Parbhani Kranti	VRO-6 × Arka Anamika, Kaveri Selection × Arka Anamika, Shagun × Parbhani Kranti
Plant height (cm)	VRO-6 × Parbhani Kranti, VRO-5 × Arka Abhay, Kaveri Selection × Arka Anamika	VRO-6 × Parbhani Kranti, KS-410 × Arka Abhay, Kaveri Selection × Parbhani Kranti
Number of seeds/fruit	Shagun × Parbhani Kranti, OV × Parbhani Kranti, OV × Arka Anamika	Shagun × Parbhani Kranti, OV × Arka Abhay, Daftari-1 × Arka Abhay
100 seed weight (g)	Bilaspur-55 × Arka Anamika, Harsha × Arka Abahy, Daftari-1 × Parbhani Kranti	Bilaspur-55 × Arka Anamika, Daftari-45 × Arka Anamika, X-2 × Parbhani Kranti
Fruit yield/plant (g)	VRO-6 × Parbhnai Kranti, Daftari-1 × Parbhani Kranti, Shagun × Parbhani Kranti	VRO-6 × Parbhani Kranti, VRO-4 × Parbhani Kranti, Daftari-1 × Arka Abhay

Table 5. Estimates of variance components (Line × Tester)

S. No.	Characters	Var (gca)	Var (sca)	Var (A)	Var (D)
1	Days to first flowering	1.30	2.16	2.60	2.16
2	Days to 50% flowering	0.58	1.50	1.16	1.50
3	Fruit weight (g)	0.14	0.41	0.28	0.41
4	Fruit length (cm)	0.02	0.18	0.04	0.18
5	Plant height (cm)	2.52	17.75	5.04	17.75
6	Number of seeds/fruit	0.03	11.22	0.06	11.22
7	100 seed weight (g)	0.01	0.05	0.02	0.05
8	Fruit yield/plant (g)	31.47	18.24	62.94	18.24

The variation for 100-seed weight ranged from 5.92 to 6.82 g and 5.87 to 7.51 g among parents and hybrids, respectively. Twenty-five hybrids showed significant positive heterobeltiosis. The best cross combination for this character was VRO-3 x Arka Anamika (13.83%). These are in agreement with the findings of Korla and Sharma (1988).

The variation for fruit yield ranged from 57.66 to 109.52 g and 77.55 to 128.25 g among parents and hybrids, respectively. Thirty seven hybrids showed significant positive heterobeltiosis. The higher heterobeltiosis was observed in VRO-6 x Parbhani Kranti (55.67) followed by Daftari-1 x Arka Abhay (54.31) and Daftari-1 x Parbhani Kranti (53.35). Similar results were reported by Singh *et al.* (1996a) and Ahmed *et al.* (1999).

Result showed (Table 3) that among the lines, Harsha was good general combiner of all the characters except for fruit length, plant height and number of seeds per fruit and Kaveri Selection was the second overall general combiner. Among testers, Parbhani Kranti was the best general combiner for fruit yield per plant, days to fruit flowering and days to 50% flowering indicating its role in breeding of high yield with early maturity. Similar results were reported by Kulkarni *et al.* (1991), Arora (1993) and Patel *et al.* (1994).

Out of 42 hybrids, (VRO-6 x Parbhani Kranti) showed significant sc effect for fruit yield per plant. The hybrid VRO-4 x Arka Abhay showed highest sca effect in desirable direction for days to first flowering (Table 4). VRO-3 x Arka Anamika showed highest sca effect in desirable direction for days to 50% flowering. The highest sca effect for fruit weight was exhibited by KS-410 x Arka Anamika. The cross VRO-6 x Arka Anamika has the highest sca effect for fruit length. The cross VRO-6 x Parbhani Kranti exhibited the highest sca effects for plant height and fruit yield per plant. The cross Shangun x Parbhani Kranti appeared to have high sca effects for number of seeds per fruit, days to first flowering and fruit length. The hybrid Bilaspur-55 x Arka Anamika exhibited high sca effect for 100-seed weight. The sca variances for days to 50% flowering, fruit weight, fruit length, plant height, number of seeds per fruit and hundred seed weight were higher than sca indicating preponderance of additive gene action for this trait. Similar results were reported by Rao and Ramu (1978), Sharma and Mahajan (1978), Elangovan *et al.* (1981b), Vijay and Manohar (1986), Patel *et al.* (1994).

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