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Combining Ability for Yield and Yield Components through Diallel Analysis in Okra (*Abelmoschus esculentus* (L.) moench)

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Abstract: *Combining ability analysis was carried out for fruit yield and its components in okra in a 8 x 8 full diallel cross. Both general a combining ability (GCA) and specific combining ability (SCA) variances were highly significant for all the characters indicating the importance of both additive and non additive gene actions. The proportion of variance due to GCA/SCA was found to be less than unity for all the characters except for fruit length indicating predominance of non-additive gene action in determining these traits except fruit length which is determined by additive gene action. The highest gca effect for fruit yield per hectare recorded in Arka Anamika followed by Arka Abhay. The highest significant positive sca effect was observed in the cross Arka Anamika x DBh-43 followed by DBh-47 x Arka Anamika and DBh-47 x DBh-30. Based on the total score values it is observed that among the parents Arka Anmika had higher gca scores and is a good combiner followed by Arka abhay and DBh-43. Among hybrids, Arka Anamika x DBh-43 had highest sca score and is a good combiner followed by Arka Anamika x DBh-37 and DBh-30 x DBh-55 hybrids.*
Keywords: *Combining ability, Gene action, Diallel, Fruit yield, Okra*

I. Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), one of the important vegetable crops of India, belongs to family Malvaceae and the genus *Abelmoschus.* It is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. It is native of tropical Africa. It is called lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhendi in India. It is often cross pollinated crop and thus heterosis can be exploited in it. Breeding method for the improvement of a crop depends primarily on the nature and magnitude of gene action involved in the expression of quantitative and qualitative traits. Combining ability analysis helps in the identification of parents with high general combining ability (GCA) effects and cross combinations with high specific combining ability (SCA) effects. Additive and non additive gene actions in the parents estimated through combining ability analysis may be useful in determining the possibility for commercial exploitation of heterosis and isolation of purelines among the progenies of the heterotic F_1. The present study was conducted to obtain the information on combining ability of 8 varieties of Okra (Abelmoschus esculentus L.) for fruit yield and its components.

II. Materials And Methods

Eight parents *viz.*, Arka Anamika, Arka Abhay, DBh-30, DBh-37, DBh-39, DBh-43, DBh-47 and DBh-55 selected and were crossed in full diallel fashion to analyse the combining ability and heterosis for yield and yield component traits. Fifty six hybrids, eight parents along with four popular hybrids (Syngenta 152, Mahyco No. 10, Mahyco No. 55, and Mahyco No. 64) were evaluated in three replications of Randomized Block Design during rabi season of 2011-2012.

Observations were recorded on five competitive plants excluding border plants in each replication for days to 50 per cent flowering, plant height, number of branches, inter-nodal length, fruit length, fruit diameter, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare. As the data was obtained from chosen set of parents along with direct and reciprocal crosses, method 1 and model 1 of Griffing (1956) was employed for the analysis.

III. Results And Discussion

The variance due to treatments was found highly significant for all the characters studied. The parents and hybrids exhibited highly significant variation for all the characters studied. It indicates significant difference among parents and hybrids. Parents Vs hybrids exhibited significant variation for days to 50% flowering, plant height, number of branches days, inter-nodal length, number of fruits, fruit weight, average fruit yield per plant and yield per hectare and non-significant variation for fruit length and fruit diameter. Variance due to F_1's and reciprocal was found significant for all characters studied. Variance due to F_1's v/s reciprocal interaction was highly significant for days to 50% flowering, number of branches per plant, inter-nodal length, number of fruits, average fruit yield per plant and non-significant for plant height, fruit length, fruit diameter, fruit weight and fruit yield per hectare (Table 1).

The mean sum of squares due to SCA, GCA, reciprocals were found highly significant for days to 50 per cent flowering, plant height, number of branches, inter-nodal length, fruit length, fruit diameter, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare. The estimates of SCA variance were high for all characters than GCA variance except for fruit length. The proportion of variance due to GCA/SCA was found to be less than one for all the characters except for fruit length. The estimates of SCA variances were high for all the characters *viz.*, days to 50 per cent flowering, plant height, number of branches per plant, inter nodal length, fruit diameter, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare indicating predominance of non-additive gene action in determining these traits. Dhankar and Dhankar (2002), Dahake and Bangar (2006) and Sanjay Singh *et al.* (2006) reported a major role of non-additive gene action on days to 50 per cent flowering. The predominance of SCA variance for fruit weight and fruit diameter has been reported by Sharma and Mahajan (1978), Vijay and Manohar (1986), Chaudhary *et al.* (1991), Dahake and Bangar (2006) and Sharma and Mahajan (1978). The predominance of SCA variance for fruit weight and fruit diameter has been reported by Sharma and Mahajan (1978), Vijay and Manohar (1986), Chaudhary *et al.* (1991) and Dahake and Bangar (2006). Non-additive gene action as a predominant factor in determining the number of branches per plant and number of fruits per plant was reported by Sharma and Mahajan (1978), Shukla *et al.* (1989), Senthil Kumar *et al.* (2006) and Ahmed *et al.* (1997). Poshiya and Shukla (1986), Vijay and Manohar (1986) and Sanjay Singh *et al.* (2006) reported that predominance of non-additve gene action for fruit yield per plant. The proportion of variance due to GCA/SCA was found to be more than one for fruit length which was determined by additive gene action (Table 2). Yield parameters like number of fruits per plant and average fruit weight predominantly controlled by non-additive gene action and hence these traits can be exploited through heterosis breeding. The predominance of GCA variance for fruit length, indicates additive gene action in expression of this character. Vijay and Manohar (1986), Sivagamasundari *et al.* (1992) and Wankhade *et al.* (1995) obtained similar results.

The estimates of gca effects revealed that Arka anamika and DBh-30 for lesser days to fifty per cent flowering, DBh-37 and 39 for higher plant height, Arka abhay and DBh-47 for more number of branches per plant, DBh-47 and Arka abhay for lesser inter nodal length, Arka anamika and Arka abhay for higher fruit length, DBh-43 and 39 for reduced fruit diameter, Arka anamika and Arka abhay for more number of fruits per plant, Arka anmika and DBh-30 for higher fruit weight, Arka anamika and Arka abhay for higher yield per plant and fruit yield per hectare. The parent Arka anamika showed higher combining ability for six characters *viz.*, days to 50 per cent flowering, fruit length, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare followed by the parent Arka abhay (Table 3). F_2 and later segregating population from cross combinations involving parents with high gca effects can be used for participating selection.

In case of days to 50 per cent flowering, Arka Anamika (-1.255) recorded highest significant negative gca effect and The highest significant negative sca effect was observed in DBh-55 x Arka Anamika (-2.167) cross followed by DBh-43 x Arka Abhay (-2.00) and Arka Abhay x DBh-37 (-1.682). The sca effect ranged from –2.167 (DBh-55 x Arka Anamika) to 1.833 (DBh-37 x Arka Abhay). 17 hybrids recorded significant negative sca effect which is considered to be desirable since, earliness is desirable. The sca effects ranged from -26.183 to 15.1 for the plant height, –0.833 to 0.667 for number of branches, -0.7 to 0.733 for inter-nodal length, -0.617 to 0.983 for fruit length, -8.333 to 11.667 for fruit diameter, -1.458 to 2.167 for average fruit weight and -2.583 to 2.627 for fruit yield per hectare.

In case of fruit yield per plant, the highest gca effect recorded in Arka Anamika (1.726) followed by Arka Abhay (0.457). The sca effect ranged from -2.583 (DBh-37 x Arka Abhay) to 2.627 (Arka Anamika x DBh-43). The highest significant positive sca effect was observed in the cross Arka Anamika x DBh-43 (2.627) followed by DBh-47 x Arka Anamika (2.032) and DBh-47 x DBh-30 (1.607). Among 56 hybrids tested, 16 hybrids recorded significant positive sca effects (Table 4).

Based on the total score values it is observed that among the parents Arka Anmika had higher *gca* scores and is a good combiner for days to 50 per cent flowering, fruit length, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare, followed by Arka Abhay and DBh-43. The parents *viz.*, Arka Anamika, Arka Abhay and DBh-43 identified as good general combining ability for fruit yield can be further tried with new parental combination for realizing higher magnitude of heterosis. Among hybrids, Arka Anamika x DBh-43 had higher *sca* score and is a good combiner for seven traits like plant height, number of branches, fruit length, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare. Arka Anamika x DBh-37 and DBh-30 x DBh-55 crosses have higher scores followed by crosses DBh-43 x Arka Anamika, DBh-47 x DBh-37 and DBh-47 x DBh-39 (Table 3 and Table 4).

For all the characters studied except days to 50 per cent flowering, plant height, number of branches and fruit yield per plant the low x low combination of gca status were present in heterotic cross combinations indicating predominance of non-additive gene action and very less of additive gene action in these crosses. The study of high yielding top three hybrids revealed that fruit yield was high in crosses involving lines exhibiting majority of high x low and low x high *gca* effects. The study on sca effects revealed that the performance of the hybrids for all the traits was higher when the parents were of high x high, high x low and low x low gca status, which indicates presence of additive and non additive gene action. The high x low gca parental combinations resulted in the higher frequency of significant heterosis for different traits in the present study. The sca effects for fruit yield per hectare were positive and significant in the hybrids of which the highest sca effects with positive significance was in hybrid Arka Anamika x DBh-43. It is suggested to evaluate the hybrids Arka Anamika x DBh-43, DBh-37 x Arka Abhay and Arka Anamika x DBh-47 over locations and seasons to confirm their potentiality for exploitation of heterosis and their use in commercial cultivation. The hybrid combination exhibiting highest *per se* performance also manifested high *sca* effects, justifying the existence of high degree of dominance and additive gene action (Table 5).

IV. Conclusion

Arka Anmika had higher *gca* scores and is a good combiner for days to 50 per cent flowering, fruit length, number of fruits per plant, fruit weight, fruit yield per plant and fruit yield per hectare, followed by Arka Abhay and DBh-43. The study on sca effects revealed that the performance of the hybrids for all the traits was higher when the parents were of high x high, high x low and low x low gca status, which indicates presence of additive and non additive gene action. It is suggested to evaluate the hybrids Arka Anamika x DBh-43, DBh-37 x Arka Abhay and Arka Anamika x DBh-47 over locations and seasons to confirm their potentiality for exploitation of heterosis and their use in commercial cultivation.

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Table 1: Analysis of variance (mean sum of square) for Fruit yield and its component traits in okra

Character	d.f.	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Inter nodal length (cm)	Fruit length (cm)	Fruit Diameter (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (T/ha)
Replicates	2	1.943	7.06	0.021	0.11	0.46	63.021	0.328	0.161	63.453	0.715
Treatments	63	9.680**	527.220**	0.735**	1.037**	1.406**	134.053**	15.497**	3.603**	4030.338**	10.314**
Parents	7	3.310**	383.501**	1.048**	0.911**	2.486**	190.476**	23.708**	2.381**	4714.736**	14.480**
Hybrids	55	9.787**	529.491**	0.696**	0.927**	1.281**	128.820**	14.018**	3.678**	3773.176**	8.951**
Parent Vs. Hybrids	1	48.382**	1408.352**	0.715*	7.955**	0.679	26.86	39.360**	8.048**	13383.510**	56.146**
F_1's	27	11.247**	606.506**	0.619**	0.902**	1.116**	154.630**	14.827**	4.802**	4475.661**	10.902**

Reciprocals	27	8.354**	471.788**	0.750**	0.863**	1.494**	107.231**	13.321**	2.224**	3122.593**	7.280**
F_1 Vs Reciprocals	1	9.054**	8.061	1.339**	3.343**	0.005	14.881	11.006**	12.595	2371.810**	1.414
Error	126	0.959	35.549	0.148	0.089	0.177	40.799	1.566	1.05	89.282	0.958
Total	191	3.846	197.425	0.34	0.402	0.585	71.79	6.148	1.883	1388.941	4.042

* - Significant at 5%; ** - Significant at 1%

Table 2: ANOVA for combining ability for Fruit yield and yield component traits in okra

Source	GCA	SCA	Reciprocal	Error	Fixed effects					
df	7	28	28	126	σγ″	σσ″	GCA /SCA	σιχερ″	$\sigma^2\alpha$	σΔ″
Days to 50% flowering	10.698**	2.413**	2.173**	0.320	0.649	2.093	0.31	0.927	1.297	2.093
Plant height (cm)	739.652**	87.225**	123.276**	11.850	45.488	75.376	0.603	55.713	90.975	75.376
Number of branches	0.390**	0.261**	0.192**	0.049	0.021	0.212	0.099	0.072	0.043	0.212
Inter nodal length (cm)	0.453**	0.326**	0.338**	0.030	0.026	0.297	0.088	0.154	0.053	0.297
Fruit length (cm)	2.670**	0.135**	0.252**	0.059	0.163	0.076	2.145	0.097	0.326	0.076
Fruit diameter (cm)	59.871**	44.103**	41.468**	13.6	2.892	30.504	0.095	13.934	5.784	30.504
Number of fruits	19.819**	3.245**	3.423**	0.522	1.206	2.723	0.443	1.450	2.412	2.723
Average fruit weight (g)	0.613**	1.207**	1.341**	0.350	0.016	0.86	0.019	0.496	0.033	0.857
Fruit yield per plant (g)	4682.361**	865.913**	986.251**	29.761	290.788	836.15	0.348	478.245	581.575	836.15
Fruit yield per hectare (T)	12.593**	2.532**	2.056**	0.319	0.767	2.212	0.347	0.868	1.534	2.212

* - Significant at 5%; ** - Significant at 1%

Table 3: gca effects of parents for yield and yield component traits in okra

Parents	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Inter nodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (T)	Total Score
Arka Abhay	-0.339*	-10.941**	0.255**	-0.061	0.330**	-2.448**	1.031**	-0.208	8.854**	0.457**	4
Arka Anamika	-1.255**	-2.070*	0.047	-0.014	0.849**	-0.156	1.719**	0.375 **	34.328**	1.726**	5
DBh-30	-0.714**	-5.030**	-0.161**	0.076	-0.309**	-1.198	0.052	0.021	-1.552	-0.095	-2
DBh-37	0.932**	10.849**	-0.036	0.174**	-0.039	-0.573	-0.052	0.042	-5.104**	-0.310*	-3
DBh-39	1.224**	6.605**	-0.078	0.095*	-0.272**	2.135*	-0.365*	-0.104	-4.468**	-0.231	-4
DBh-43	0.266*	3.118**	0.089	0.126**	0.018	3.594**	0.469**	0.083	4.585**	0.416**	3
DBh-47	-0.193	-1.441	0.109*	-0.364**	-0.278**	-0.573	-1.094**	0.042	-13.273**	-0.804**	-2
DBh-55	0.078	-1.091	-0.224**	-0.032	-0.299**	-0.781	-1.760**	-0.250	-23.370**	-1.159**	-5

* - Significant at 5% ; ** - Significant at 1%

Table 4: SCA effects of hybrids for different yield and yield component traits in okra

Crosses	Days to 50% flowering	Plant height (cm)	Number of branches Per plant	Inter nodal length (cm)	Fruit length (cm)	Fruit Diameter (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)	Fruit yield per hectare (T)	Total Score
Arka Abhay x Arka Anamika	-0.16	-4.25	0.03	0.65**	-0.18	-6.71**	0.17	0.54	34.56**	-1.01**	-2
Arka Abhay x DBh-30	0.79*	-7.14**	0.57**	0.51**	0.27	-0.67	1.5**	-1.10*	-7.73*	0.46	-3
Arka Abhay x DBh-37	-1.68**	1.87	-0.38*	-0.38**	0.15	3.69	0.94*	0.70	-44.09*	1.43**	2
Arka Abhay x DBh-39	0.35	-1.29	-0.00	-0.3**	-0.11	4.32	0.92*	0.68	-12.29**	0.75*	2
Arka Abhay x DBh-43	-0.84*	4.02	0.66**	0.4**	0.31*	1.19	-1.24*	0.50	-7.84*	-0.07	0
Arka Abhay x DBh-47	0.44	1.01	-0.02	-0.06	-0.18	-2.96	-0.51	-0.45	-1.59	-1.00**	-1
Arka Abhay x DBh-55	0.00	0.93	-0.02	0.43**	-0.21	-2.76	-1.01*	-0.50	-10.06**	-0.56	-3
Arka Anamika	-0.16	0.66	0.33*	0.13	-0.28	-1.66	2.33**	-0.16	-12.51**	1.38**	2

x Arka Abhay											
Arka Anamika x DBh-30	0.12	-1.59	-0.21	0.06	-0.60**	-6.30*	-1.84**	-1.18**	-13.87**	-1.71**	-6
Arka Anamika x DBh-37	-0.93*	14.65**	-0.17	0.51**	-0.03	6.40**	0.76	-0.04	13.20**	0.74*	4
Arka Anamika x DBh-39	-1.22**	2.69	0.20	0.11	0.03	2.03	0.073	-0.06	-1.32	0.35	1
Arka Anamika x DBh-43	-0.43	10.35**	0.37*	-0.03	0.31*	3.90	3.07**	0.25	26.11**	2.62**	6
Arka Anamika x DBh-47	0.19	-3.98	-0.48**	0.31**	0.39*	-0.26	-0.86	1.45**	52.85**	0.98**	2
Arka Anamika x DBh-55	-0.91*	-1.97	0.34*	0.73**	0.26	-1.71	0.46	-0.08	-13.79**	0.28	0
DBh-30 x Arka Abhay	0.33	-1.28	0.66**	0.04	0.11	-3.33	1.00	-0.83	3.02	-0.00	1
DBh-30 x Arka Anamika	-0.83*	-0.06	0.33*	-0.28*	-0.21	-6.66*	0.00	0.00	-31.31**	-0.77	1
DBh-30 x DBh-37	0.19	-1.58	-0.29*	-0.4**	-0.01	4.11	-1.57**	-0.02	-8.88*	0.012	-2
DBh-30 x DBh-39	-1.26**	6.22**	0.07	0.00	0.09	-6.92**	0.073	0.45	-13.26**	0.34	0
DBh-30 x DBh-43	-1.47**	0.21	0.07	-0.31**	-0.37*	-0.05	0.24	-0.06	-3.09	-0.23	1
DBh-30 x DBh-47	-0.84*	0.60	0.22	0.36**	0.31*	2.44	-0.19	-0.02	35.83**	0.41	2
DBh-30 x DBh-55	-0.78*	11.58**	-0.44**	0.71**	0.40*	5.99*	0.96*	0.77	-3.01	0.94*	4
DBh-37 x Arka Abhay	1.83**	-26.18**	0.5**	0.54**	-0.03	-5.00	-3.33**	0.33	30.10**	-2.58**	-3
DBh-37 x Arka Anamika	-1.33**	-1.53	0.5**	0.03	-0.46*	0.00	0.16	1.16**	12.41**	0.72	3
DBh-37 x DBh-30	-0.66	-11.73**	-0.16	-0.24	-0.4*	0.00	0.16	-0.5	-6.99	-0.95*	-3
DBh-37 x DBh-39	0.75*	-6.65**	0.28*	-0.35**	0.12	4.11	-0.9*	-1.22**	-15.76**	-0.89*	-4
DBh-37 x DBh-43	1.21**	1.26	-0.04	-0.13	-0.04	-7.34**	-0.32	0.08	2.57	-0.56	-2
DBh-37 x DBh-47	0.50	2.62	-0.06	0.23*	0.01	0.15	0.40	-0.04	22.83**	0.01	0
DBh-37 x DBh-55	-0.266	4.143	-0.068	0.25*	-0.166	-1.302	1.406**	-0.25	5.237	0.233	0
DBh-39 x Arka Abhay	0.167	-6.6*	0.167	0.207	-0.2.00	-1.667	-1.00	-0.5.00	10.874**	-0.382	0
DBh-39 x Arka Anamika	-1.00*	-12.4**	-0.167	0.343**	-0.567**	-8.333**	0.500	0.667	6.538	-0.073	-3
DBh-39 x DBh-30	-0.500	-1.167	-0.167	0.37**	0.100	1.667	-0.500	-0.167	9.515*	-0.733	0
DBh-39 x DBh-37	0.167	-1.833	-0.167	-0.278*	0.00	-3.333	-1.00	-0.167	-20.408**	-0.472	0
DBh-39 x DBh-43	1.422**	-2.755	0.161	0.717**	-0.099	1.615	-0.177	-0.271	39.858**	-0.076	-1
DBh-39 x DBh-47	-0.286	6.97**	-0.026	0.267*	0.08	4.115	1.552**	0.104	34.282**	0.269	2
DBh-39 x DBh-55	0.276	2.586	-0.193	0.283*	0.084	-0.677	0.219	-0.104	21.145**	1.091**	1
DBh-43 x Arka Abhay	-2.00**	-3.433	0.00	0.343**	-0.617**	0.00	-1.00	0.500	-4.131	-0.733	-1
DBh-43 x Arka Anamika	-1.500**	15.1**	-0.833**	0.028	0.200	1.667	1.00	2.167**	50**	1.448**	4
DBh-43 x DBh-30	1.667**	-2.667	0.00	0.355**	0.317	-6.667*	0.167	-0.500	1.585	-0.173	-3
DBh-43 x DBh-37	0.333	5.60*	0.00	0.107	-0.217	-3.333	0.50	-0.667	-4.571	0.132	1
DBh-43 x DBh-39	-0.500	9.00**	0.167	-0.097	-0.133	5.00	2.333**	0.833	-9.611*	1.402**	2
DBh-43 x DBh-47	0.339	-5.976**	-0.193	0.35**	-0.226	-2.344	0.552	-0.083	6.77	0.544	-2
DBh-43 x DBh-55	-0.099	-5.459*	0.141	-0.3**	-0.122	-5.469*	-1.448**	-1.458**	-10.383**	-1.052**	-5
DBh-47 x Arka Abhay	-0.500	0.00	0.333*	-0.101	-0.017	-5.00	0.167	-0.500	-18.443**	0.005	0
DBh-47 x Arka Anamika	-0.667	6.00*	-0.333*	0.434**	0.983**	3.333	0.50	2.00**	11.306**	2.032**	3
DBh-47 x DBh-30	-0.500	4.967	0.167	0.395**	0.383*	1.667	2.5**	0.500	2.174	1.607**	2
DBh-47 x DBh-37	0.167	8.267**	0.00	0.164	0.683**	0.00	1.00	0.167	-1.294	1.103*	3
DBh-47 x DBh-	1.00*	10.833**	0.00	0.076	0.317	6.667*	2.167*	1.167**	25.017**	0.903*	5

39							*				
DBh-47 x DBh-43	1.00*	5.933*	0.00	-0.539**	0.200	5.00	-0.333	-0.167	1.342	0.748	1
DBh-47 x DBh-55	-0.474	-0.434	0.12	-0.7**	0.141	5.365*	-1.615**	-0.75	-23.053**	1.407**	1
DBh-55 x Arka Abhay	-1.00*	0.733	0.00	-0.366**	-0.067	-5.00	-0.333	0.833	-8.152*	-0.392	1
DBh-55 x Arka Anamika	-2.167**	5.567*	0.167	-0.147	0.00	1.667	1.167*	0.833	7.644	-0.752	3
DBh-55 x DBh-30	0.50	0.567	0.167	0.68**	-0.083	1.667	0.333	0.00	22.445**	-0.168	0
DBh-55 x DBh-37	-0.667	2.733	0.333*	0.249*	0.35	11.667**	1.00	-1.000*	6.115	0.117	0
DBh-55 x DBh-39	-1.5**	2.533	0.5**	0.161	0.100	5.00	-1.833**	0.667	7.738	0.937*	2
DBh-55 x DBh-43	0.833*	-0.40	0.00	-0.42*	0.117	1.667	0.667	0.500	-28.657**	-0.665	-1
DBh-55 x DBh-47	1.00*	-3.067	0.00	-0.03	-0.417*	-5.00	-1.167*	0.500	26.617**	-1.11**	-3

* - Significant at 5% ; ** - Significant at 1%

Table 5: Top three desirable hybrids with respect to sca effects for 10 characters in okra

Characters	Crosses	sca effect	Mean	GCA study of	
				Female	Male
Days to 50% flowering	DBh-55 x Arka Anamika	-2.167**	59.67	low	high
	DBh-43 x Arka Abhay	-2.000**	60.67	low	high
	Arka Abhay x DBh-37	-1.682**	60.33	high	low
Plant height (cm)	DBh-43 x DBh-39	9.000**	66.33	high	high
	DBh-47 x DBh-37	8.267**	72.13	low	high
	DBh-39 x DBh-47	6.970**	91.33	high	low
Number of branches per plant	DBh-30 x Arka Abhay	0.667**	3.00	low	high
	Arka Abhay x DBh-43	0.661**	4.00	high	low
	Arka Abhay x DBh-30	0.578**	4.33	high	low
Inter nodal length (cm)	DBh-47 x DBh-55	-0.700**	4.30	high	low
	DBh-47 x DBh-43	-0.539**	4.30	high	low
	DBh-55 x DBh-43	-0.420*	5.40	low	low
Fruit length (cm)	DBh-47 x Arka Anamika	0.983**	14.83	low	high
	DBh-47 x DBh-37	0.683**	13.87	low	low
	DBh-30 x DBh-55	0.405*	14.57	low	low
Fruit diameter (cm)	DBh-47 x DBh-39	6.667*	1.83	low	high
	Arka Anamika x DBh-37	6.406**	1.90	low	low
	DBh-30 x DBh-55	5.990*	1.90	low	low
Number of fruits per plant	Arka Anamika x DBh-43	3.073**	20.67	high	high
	DBh-47 x DBh-30	2.500**	10.67	low	low
	DBh-43 x DBh-39	2.333**	12.00	high	low
Average fruit weight (g)	DBh-43 x Arka Anamika	2.167**	12.00	low	high
	DBh-47 x Arka Anamika	2.000**	11.00	low	high
	Arka Anamika x DBh-47	1.458**	16.00	high	low
Fruit yield per plant (g)	Arka Anamika x DBh-47	52.853**	255.29	high	low
	DBh-43 x Arka Anamika	50.00**	232.88	high	high
	DBh-39 x DBh-43	39.858**	200.44	low	high
Fruit yield per hectare (T/ha)	Arka Anamika x DBh-43	2.627**	15.84	high	high
	DBh-47 x Arka Anamika	2.032**	9.49	low	high
	DBh-47 x DBh-30	1.607**	7.53	low	low

* - Significant at 5% ; ** - Significant at 1%