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Study on combining ability in okra (*Abelmoschus esculentus* (L.) Moench)

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ABSTRACT

The present study was undertaken with a view to estimate the extent of combining ability parameters of eight genotypes in okra (*Abelmoschus esculentus* (L.) Moench) for fruit yield, quality traits and other important traits. Combining ability analysis of 28 F_1s (excluding reciprocals) with parents showed that general combining ability variance was highly significant for all the characters. While specific combining ability variance was highly significant for all the characters except internode length, for the expression of Fruit yield (g) and its component traits. The parents Parbhani Kranti, Pusa Sawani and Panjab-7 were good general combiners for fruit yield and it's components traits. Twelve out of 28 hybrids showed significant positive sca effects for fruit yield and it's components traits. The crosses Arka Bahar x JOL-04-08, Gujarat Okra 2 x Parbhani Kranti and Panjab-7 x JOL-04-08 were found to be most promising cross combinations for their exploitation in breeding programme.

Key words : General combining ability, specific combining ability, okra

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable crop grown for its green tender fruits in tropical and sub-tropical regions. Combining ability analysis helps to choose suitable parents for hybridization and provides valuable information regarding F_1 crosses to be exploited commercially. Information on the combining abilities of the genotypes will be helpful in the analysis and interpretation of the genetic basis of important traits. Hence, the present study was undertaken with a view to assess the combining ability of eight genetically divergent lines of okra following a diallel mating design.

MATERIALS AND METHODS

A set of 28 hybrids were developed using 8 parents (Gujarat Okra 2, Parbhani Kranti, Arka Bahar, Arka Abhay, Pusa Sawani, Panjab 7, AOL-03-1, and JOL-04-08) of okra through diallel mating design excluding reciprocals during *Summer*-2009. The trials consisting of 28 hybrids and their 8 parents were raised in randomized block design with three replications at Department of Genetics and Plant Breeding, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *Kharif*, 2009. Each entry was sown in 3.0 m long single row plot at 60 x 30 cm spacing. Observations on five randomly selected competitive plants were recorded for days to flowering, days to first picking, fruit length, fruit girth, number of nodes on main stem, internodal length, plant height, fruit yield per plant, crude protein content, crude fiber content and vitamin C content. The data generated were utilized to estimate the combining ability by the method II under model I as suggested by Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability (Table 1) revealed that general combining ability variances were highly significant for all the characters indicating the involvement of additive type of gene action in the inheritance of all the traits under study. Specific combining ability variances were significant for all the characters except internode length indicating the involvement of non-additive gene action in the inheritance of these characters. This signifies the importance of non-additive effects of these characters indicating the presence of over dominance.

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Table 1 Analysis of variance for combining ability for various characters in okra

Source of variation	d.f.	Days to flowering	Days to first picking	Fruit l ength (cm)	Fruit girth (cm)	Number of nodes on main stem	Internodal length	Plant height (cm)	Fruit yield per plant (g)	Crude protein content (%)	Crude fiber content (%)	Vitamin C content (mg/100g fruit)
GCA	7	9.33**	9.94**	1.99**	0.56**	7.95**	0.48**	343.19**	864.19**	1.26**	128.45**	2.08**
SCA	28	2.49**	2.38**	1.78**	0.14**	3.72**	0.13	209.92**	503.35**	0.76**	58.54**	2.12**
Error	70	0.30	0.32	0.09	0.02	0.31	0.12	14.13	34.19	0.11	1.55	0.16
σ^2 GCA		0.90	0.96	0.19	0.05	0.76	0.04	32.91	83.00	0.12	12.69	0.19
σ^2 SCA		2.19	2.07	1.69	0.13	3.41	0.01	195.79	469.16	0.65	57.00	1.96
σ^2 GCA/σ^2SCA		0.41	0.47	0.11	0.43	0.22	3.32	0.17	0.18	0.18	0.22	0.10

*, ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

Table 2 Estimation of general combining ability (GCA) effects associated with each parental genotype

Parents	Days to flowering	Days to first picking	Fruit length (cm)	Fruit girth (cm)	Number of nodes on main stem	Internodal length	Plant height (cm)	Fruit yield per plant (g)	Crude protein content (%)	Crude fiber content (%)	Vitamin C content (mg/100g fruit)
Gujarat Okra 2	0.14	0.19	0.72**	-0.11**	0.41*	0.39**	7.95**	-7.71**	0.20	-5.13**	-0.04
Parbhani Kranti	-0.66**	-0.74**	0.12	-0.18**	-0.62**	0.15	-1.82	10.81**	-0.43**	-0.23	0.52**
Arka Bahar	-0.19	-0.24	-0.34**	0.33**	0.15	-0.38**	-3.67**	2.56	0.00	3.68**	-0.45**
Arka Abhay	0.11	0.16	0.32**	0.39**	-0.73**	-0.09	-6.05**	0.32	0.20*	-1.73**	-0.17
Pusa Sawani	-0.23	-0.21	0.19*	0.05	-0.29	0.05	0.23	6.70**	0.28**	-1.63**	0.52**
Panjab-7	-0.43**	-0.44*	-0.75**	-0.18**	0.55**	-0.07	2.78*	5.90**	-0.47**	3.98**	-0.73**
AOL-03-1	-0.96**	-0.98**	-0.07	-0.14**	-1.14**	0.01	-7.32**	-0.07	-0.27**	4.28**	-0.04
JOL-04-08	2.21**	2.26**	-0.19*	-0.17**	1.67**	-0.06	7.89**	-18.50**	0.50**	-3.23**	0.38**
S.E.(gi) ±	0.16	0.17	0.09	0.04	0.17	0.10	1.11	1.73	0.10	0.37	0.12
S.E.(gi-gj) ±	0.25	0.25	0.13	0.05	0.25	0.16	1.68	2.61	0.15	0.56	0.18

*, ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

Consequently it is suggested that these traits could be improved through heterosis breeding rather than selection. Similar results of importance of both additive and non-additive genetic component in the inheritance of various traits were reported by Kanchan *et al.*, (2007) in okra.

The σ^2 gca/σ^2 sca variance ratio being less than unity for all the traits except internodal length which suggested non additive type of gene action was predominantly involved in the expression of all traits except internodal length. The additive type of gene action was predominantly involved in the expression of internode length, only. Thus, it the use of heterosis breeding approach will be fruitful for rapid improvement in the fruit yield governed by non-additive gene action. Role of non additive gene effects was also reported by Singh *et al.*, (2001), Mamta and Arora (2003) and Kumar & Anandan, (2006).

The general combining ability effects of parents (Table 2) revealed that none of the parents proved to be good general combiner for all the characters. The gca effects of parents revealed that the parents Parbhani Kranti, Pusa Sawani and Panjab-7were good general combiner for fruit yield and it's components *viz.*, days to flowering, days to first picking, fruit length, number of nodes on main stem, plant height. As observed in the present investigation, good general combining ability of these parents for yield and its components were also reported Rajendra Kumar *et al.*, (2005) and Manivannan *et al.* (2007). With regard to quality traits, parents Arka Abhay, Pusa Sawani and JOL-04-08 were good general combiners for crude protein content, crude fiber content and vitamin C content.

In the present study, the parents exhibiting high mean performance also had high general combining ability effects. A close relationship between the mean performance and general combining ability effects was noted by Elangovan *et al.* (1981) and Poshiya and Shukla (1986). Such parallel behavior indicated that selection for good combiners for different characters could also be made on the basis of mean performance. The estimates of sca effects revealed that 12 out of 36 hybrids showed significant positive sca effects for fruit yield per plant. Ten best specific combiners with mean performance, gca status and their significant response of sca effects to other traits are presented in Table 3. Five crosses showed significant positive response to fruit length and three for fruit girth indicating its direct effect for increasing fruit yield. However, five crosses showed significant response to days flowering, four for days to first picking and plant height,

Table 3 Ten best specific combiners for seed yield/plant and their performance for other traits in pigeonpea

Hybrids	Fruit yield / plant (g)	Mean fruit yield / plant (g)	GCA status	Significant response in other traits for SCA effects
Arka Bahar x JOL-04-08	31.30**	188.64	(A x P)	FL, CPC,
Guj. Okra 2 x Parbhani Kranti	28.19**	204.57	(P x G)	FG, PH, CPC,
Panjab-7 x JOL-04-08	24.53**	185.22	(G x P)	DF, DFP, FL, FG, VCC
Guj. Okra 2 x JOL-04-08	24.34**	171.41	(P x P)	FL, CFC
AOL-03-1 x JOL-04-08	23.99**	178.71	(A x P)	DF, DFP, NNMS, PH, VCC
Parbhani Kranti x Panjab-7	21.13**	211.13	(G x G)	DF, FL, PH, VCC
Guj. Okra 2 x AOL-03-1	20.78**	186.29	(P x A)	DF, DFP, FL
Pusa Sawani x JOL-04-08	18.79**	180.27	(G x P)	FG
Parbhani Kranti x JOL-04-08	14.96**	180.55	(G x P)	CFC
Parbhani Kranti x Pusa Sawani	13.58*	204.37	(G x G)	DF, DFP, NNMS, PH

G = Good; A = Average; P = Poor general combining ability, respectively.
Figure in the parenthesis indicates per se performance for fruit yield per plant.
*, ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

DF : Days to flowering
CFC : Crude fiber content
IL : Internodal length
FL : Fruit length
FG : Fruit girth
NNMS : Number of nodes on main stem
DFP : Days to first picking
VCC : Vitamin C content
PH : Plant height
CPC : Crude protein content

three for vitamin C content, two for number of nodes on main stem, crude protein content and crude fiber content. This may be because of very complex nature of fruit yield and its dependence on its components. Out of ten crosses showing high mean and significant positive sca effects for fruit yield, two crosses (Arka Bahar x JOL-04-08 and AOL-03-1 x JOL-04-08) involved average x poor gca parents, one cross (Gujarat Okra 2 x Parbhani Kranti) with poor x good, three crosses (Panjab-7 x JOL-04-08, Pusa Sawani x JOL-04-08 and Parbhani Kranti x]JOL-04-08) with good x poor, one cross (Gujarat Okra 2 x JOL-04-08) with poor x poor, two crosses (Parbhani Kranti x Panjab-7 and Parbhani Kranti x Pusa Sawani) with good x good and one cross (Gujarat Okra 2 x AOL-03-1) with poor x average gca parents. Better performance of hybrids involving poor x poor or average x poor general combiners indicated dominance x dominance (epitasis) type of gene action (Jinks, 1955). The crosses showing high sca effects involving one good general combiner indicated additive x dominance type gene interaction which could produce desirable transgressive segregants in subsequent generations. In a situation where predominance of additive and non-additive gene effect has been observed for most of the traits, it is better to advocate the biparental mating and diallel selective mating to exploit both additive and non-additive gene effects.

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