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Combining ability analysis in Okra [*Abelmoschus Esculantus* (L.) Moench]

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Abstract Combining ability for yield and its components was analyzed in a 6 x 4 lines x tester crosses, involving six lines and five tester of Okra. The GCA and SCA were significant for all the characters, indicating the importance of both additive and non-additive genetic components. The parents, HRB-9-2 for yield, first flowering node, internodal length; HRB-55 for internodal length; VRO-6 for first flowering node, number of fruit per plant, fruit length, fruit diameter and yield per plant were good general combiners. Among the crosses, HRB-55 x Arka abhay, HRB-9-2 x P-7 and HRB-9-2 x Arka abhay were good specific combiners for yield per plant.

Keywords: Combining ability, Okra, Line x tester

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Introduction

Okra [*Abelmoschus esculantus* (L.) Moench], belonging to the family malvaceae, is one of the most important vegetable crops. It is rich in calcium, iron, protein, vitamins and other minerals. Breeding method for the improvement of a vegetable crop depends primarily on the nature and magnitude of gene action involved in the expression of quantitative traits. Combining ability analysis helps in the identification of parents with high general combining ability (gca) effects and cross combinations with help specific combining ability (sca) effects. Additive and non-additive gene action in the parent 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 heterotic F_1. The present study was conducted to obtain information on combining ability of three high yielding cultivars of okra for yield and its components.

Materials and methods

The experimental material consisting of one hundred and six treatments were shown in randomized block design with three replications at Vegetable Research Farm of IIVR, Varanasi, during 2004-05. Each replication and each treatment was sown in six meter long double row plots keeping 60 cm distance between rows and an approximately distance of 30 cm between plants within rows by thinning. Observations were recorded on ten randomly selected plants for days to first flowering, first flowering node, plant height, internodal length, number of primary branches per plant, single fruit weight, number of fruits per plant, fruit length, fruit diameter and ten fruit yield per plant. Mean data over replications was analyzed for combining ability following Kempthone method (1957). The combining ability analysis was carried out according to Griffing (1956).

Results and Discussion

The analysis of variance revealed both general and specific combining ability to be highly significant for all

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Table 1: Analysis of variance for combining ability

Characters	d.f.	Days to 1st flowering	First flowering node	Plant height (cm)	Internodal length (cm)	No. of primary branches	No. of fruits/ plant	Single fruit wt. (g)	Fruit length (cm)	Fruit diameter (cm)	Yield/ plant (g)
Replication	2.0	2.83	0.70	63.38	0.04	0.031	0.32	0.066	0.086	0.035	62.61
Line (female)	5.0	30.48	1.92**	459.13**	19.95**	1.77**	221.65**	0.58**	51.80**	0.39**	32072.6**
Testers (male)	3.0	132.09**	1.86**	21.72	1.37**	0.17**	96.68**	0.078**	28.79**	0.07**	14409.22**
L x T (Female x Male)	15.0	6.66**	0.77	12.20	0.48**	0.10**	10.06**	0.43**	3.38**	0.077**	153092**
Error	46.0	1.44	0.56	26.71	0.059	0.046	0.55	0.050	0.072	0.016	110.24

*, ** significant at 5% and 1% level

Table 2: Estimation of general combining ability effect for ten traits in Okra

General	Days to 1st flowering	First flowering node	Plant height (cm)	Internodal length (cm)	No. of primary branches	No. of fruits/ plant	Single fruit wt. (g)	Fruit length (cm)	Fruit diameter (cm)	Yield/plant (g)
HRB-55	0.52	0.23	-0.06	0.64**	-0.32**	-1.38**	0.27**	-4.04**	-0.17**	-21.61**
HRB-9-2	-0.44	-.039	0.61	0.87**	-0.10*	2.47**	-0.18**	0.87**	-0.12**	23.46**
VRO-6	-2.19**	-0.32	0.61	0.09	-0.30**	4.68**	0.35	1.00**	0.10**	63.43**
VRO-5	-0.85**	-0.36**	-4.22**	-2.54**	0.73**	1.61**	0.11*	0.91**	8.25**	19.89**
PK	2.56	0.40**	10.69**	0.81**	-0.01	0.34*	-0.02	1.60*	0.12**	3.79
P. Sawani	0.40	0.45**	-7.64*	0.12*	0.01	-7.33*	0.03	-0.34**	-0.18**	-88.96**
P-7	2.48**	0.07	-0.83	0.24*	0.02	-0.44**	0.05	-0.07	-0.01	-3.98*
A. Abhay	1.28**	0.32*	-0.5	0.13**	0.08*	-2.39**	-0.07	-1.46**	0.09**	-29.59**
IIVR-11	-3.77**	-0.45	-0.28	-0.39**	-0.14**	3.18**	0.06	1.63**	-0.06**	38.54**
A. Anamika	0.01	0.05	1.61	0.03	0.04	-0.34**	-0.04	-0.10	-0.01	-4.96**
S.E.(L)	0.27	0.17	1.13	0.05	0.05	0.16	0.05	0.06	0.03	2.32
S.E.(T)	0.21	0.13	0.88	0.04	0.04	0.13	0.04	0.05	0.02	1.80

*,** significant at 5% and 1% level

characters in both the generations (Table 1), indicating the involving of both additive and non-additive type of gene actions in expression of the characters. The relative magnitude of estimates of GCA variance was higher than those of SCA variance for all the characters, indicating the predominance of additive gene action. Partitioning of variance due to crosses into lines, tester and crosses shows that crosses interaction component were highly significant for all characters except for first flowering node, plant height and fruit yield per plant. Similar finding have also been reported by Pratap *et al.* (1981) and the estimates of ó^{2}gca (male) were found positive for all the characters except single fruit weight whereas, the ó^{2}gca (female) estimates were positive for all characters. The estimates of ó^{2}sca of crosses were positive for all characters except for single fruit weight. The higher estimate of ó^{2}gca representing additive gene effect was higher than ó^{2}sca estimates for rest of the characters. The magnitude of dominance variance ó^{2}D higher than the additive variance (ó^{2}A) except for single fruit weight their by indicating pre-dominance of dominance gene action in their inheritance. Variance A (additive gene variance) and variance studied from variance of gca and sca respectively, suggested that the magnitude of the additive genetic variances was higher than those of ó^{2}D (dominance genetic variance) for fruit diameter, fruit flowering node, plant height, internodal length, number of primary branches, number of fruit per plant and fruit length in okra.

The estimates of GCA effects of parents (Table 2) showed that variety BRB-9-2, VRO-6 and VRO-5 were the best general combiner for fruit yield and other yield contributing traits such as first flowering node, internodal length, number of primary branches, number of fruits per plant, single fruit weight, fruit length and fruit diameter. The other superior general combiner for days to first flowering and plant height was PK. These four variations (HRB-9-2, VRO-6, VRO-5 and PK) can be used to improve yield and its components because these varieties were quite stable combiners, which was evident from their high estimates of GCA over generations in line x tester studies.

The negative estimates of GCA effects are desirable for earliness and reduce plant height. Among the parents studied, VRO-6 (only day to flowering), VRO-5 and HRB-9-2 (plant height, first flowering node) were proved good general combiners for earliness and dwarfness in both the generations. The line VRO-6, VRO-5 and IIVR-11 found good general combiner for days to first

Table 3: Estimates of specific combining ability effects for ten traits in Okra

Crosses	Days to 1st flowering	First flowering node	Plant height (cm)	Internodal length (cm)	No. of primary branches	No. of fruits/plant	Single fruit wt. (g)	Fruit length (cm)	Fruit diameter (cm)	Yield/ plant (gm)
HRB-55 x P-7	-0.06	0.01	1.67	-0.30**	0.09	0.33	-0.91**	1.40**	0.09	-15.97**
HRB-55 x A. Abhay	0.42	0.30	-0.67	0.15	0.14	0.72**	0.12	0.45**	-0.11*	12.79**
HRB- 55 x IIVR-11	-0.85	-0.14	0.11	-0.20*	-0.31**	0.02	0.17	-0.90**	-0.16**	3.72
HRB-55 x A. Anamika	1.03*	-0.17	-0.11	0.35**	0.08	-1.07	0.57**	-0.94**	0.18**	-0.71
HRB-9-2 x P-7	-0.15	0.09	1.0	-0.30**	0.08	1.98**	0.36**	-0.95**	0.04	31.27**
HRB-9-2 x A. Abhay	-0.95*-	-0.65*	0.33	-0.29**	0.02**	2.10**	-0.29**	0.61**	0.14**	16.68**
HRB-9-2 x IIVR-11	-0.90**	0.28	-1.56	0.60**	-0.06	-1.30**	-0.16	1.05**	-0.11*	-18.29**
HRB-9-2 x A. Anamika	1.99**	0.28	0.22	-0.02	-0.04	-2.78**	0.08	-0.72**	-0.07	-29.66**
VRO-6 x P-7	0.60	0.62**	-1.33	0.75**	-0.36**	-0.89**	0.06	-1.08**	-0.19**	-9.13*
VRO-6 x A. Abhay	1.47**	-0.15	-0.33	-0.50**	0.05	-1.61**	0.08	-0.96**	-0.09	17.39**
VRO-6 x IIVR-11	0.85	0.01	1.78	0.09	0.24**	-0.51	-0.12	0.15	0.16**	-8.49*
VRO-6 x A. Anamika	-2.92**	0.49	-0.11	-0.34**	0.06	3.01**	-0.02	1.88**	0.11*	35.01**
VRO-5 x P-7	-0.40	-1.14*	-2.17	0.11	0.31**	-0.83**	0.30**	-0.25*	-0.04	-1.79
VRO-5 x A. Abhay	-0.20	0.51	-2.17	0.16	-0.11	0.02	0.15**	0.33**	-0.14**	4.32
VRO-5 x IIVR-11	-0.48	0.25	-0.06	-0.28**	-0.16*	1.72**	-0.25**	0.08	0.08	14.19**
VRO-5 x A. Anamika	1.08	0.38	4.39	0.23**	-0.04	-0.93**	-0.21	-0.16	0.09	-16.71**
PK x P-7	-0.48	0.17	0.92	-0.16	-0.12	0.28	0.20	0.15	0.13**	6.83
PK x A. Abhay	-0.95*	-0.11	2.92	0.08	-0.04	0.20	-0.15	0.48**	0.20**	-0.62
PK x IIVR-11	0.10	-0.48	-1.31	-0.16	0.15	0.67*	0.42**	0.39**	-0.02	17.04**
PK x A. Anamika	13.00 **	0.42	-2.53	0.25**	**0.00**	-1.15**	-0.48**	-1.02**	-0.31**	-23.26**
Pusa Sawani x P-7	1.02*	0.25	-0.08	0.12	-0.01	-0.88**	-0.01	0.73**	0.04	-11.38**
Pusa Sawani x A. Abhay	0.22	0.11	-0.08	0.40**	-0.06	-1.43**	0.04	-0.92**	**0.00**	-15.77**
Pusa Sawani x IIVR-11	1.27**	0.07	1.03	-0.05	0.13	0.60*	0.06	-0.77**	0.05	-8.17*
Pusa Sawani x A. Anamika	-2.51**	-0.43	-0.86	-0.47**	-0.06	2.92**	0.04	0.96**	-0.01	35.33*
S.E.	0.43	0.29	1.96	0.09	0.08	0.28	0.09	0.1	0.05	4.03

*, ** significant at 5% and 1% level

flowering, HRB-9-2 and VRO-5 were found good general combines for first flowering node and HRB-55, HRB-9-2, VRO-5, PK and Pusa Sawani for the internodal length. None of the parents were good general combiners for all the desirable traits studied.

The SCA effects and *per se* performance (Table 3) revealed that the cross combinations HRB-55 x Arka abhay, HRB-9-2 x P-7, HRB-9-2 x Arka abhay, VRO-6 x Arka anamika, VRO-5 x IIVR-11, HRB-9-2 x IIVR-11 and VRO x P-7 were the superior specific combinations as they showed high positive significant SCA effects along with *per se* performance for yield and some of other yield components.

The cross combinations *viz.*, HRB-55 x Arka abhay, HRB-9-2 x P-7, HRB-9-2 x Arka abhay and VRO-6 x Arka abhay exhibited significant positive SCA effects. The additive x additive epistatis effect may be responsible for consistency of SCA effects of these crosses.

The cross combination showing desirable SCA effects for days to first flowering and first flowering node (for earliness) were HRB-9-2 x Arka Abhay. The negative estimates of SCA are desirable for reduced plant height. The good specific combiners was VRO-5 x Arka Anamika for the internodal length the best specific combiner were HRB-55 x Arka anamika, HRB-9-2 x IIVR-11 and VRO-6 x P-7. The cross VRO-6 x IIVR-11, VRO-5 x P-7 exhibited high SCA effects for number of primary branches. The best specific combiners for number of fruit per plant, single fruit weight were HRB-55 x Arka Anamika, HRB-9-2 x P-7, whereas, the crosses HRB-55 x P-7 and HRB-55 x Arka Abhay showed higher SCA effects for fruit length. The best specific combiners for fruit diameter were HRB-55 x Arka Anakika and HRB-9-2 x Arka Abhay.

Further the majority of the crosses, showed significant SCA effects which involved good and poor general combiners, indicating additive x dominance type of gene interaction involved in the expression of characters. However some crosses involving low x low general combiners showed high SCA effect, suggesting that epistatis gene action, may be due to genetic diversity in the form of heterozygous loci. Very few crosses having high x high general combiners showed high SCA effects and indicating the predominance of additive x additive type of gene effect. Similar results have also been reported by Pratap *et al.* (1981), Ahemad *et al.* (1997) and Rajani *et al.* (2001).

In case, where good x good general combiners are involved for high SCA effects. These crosses would be utilized for yield improvement through simple plant selection in segregating generations. But in the crosses showing high SCA effects due to good x poor general combiners, simple pedigree breeding would not be effective to improve the characters. The crosses showing high SCA effects involving poor x poor general combiners could be exploited for heterosis breeding programme. Similar results have also been reported by Dhankar *et al.* (1996), Pathak *et al.* (1998) and Pal and Hussain (2000).

सारांश

भिण्डी की उपज एवं उपज घटको के लिए संयोजन क्षमता का मूल्यांकन 6 x 4 लाइन एवं टेस्टर के माध्यम से किया गया। विशिष्ट संयोजन क्षमता एवं सामान्य संयोजन क्षमता सभी गुणों के लिए सार्थक थे। यह प्रदर्शित करता है कि जैविक घटक योज्य एवं नकारात्मक योज्य दोनो ही महत्वपुर्ण है। प्रजनक एच आर वी. 9. 2 उपज, प्रथम पुष्पन गॉठ आन्तरीक गाँठ लम्बाई, फल प्रति पौध संख्या, फल लम्बाई के लिए एच आर वी. 55 आन्तरिक गाँठ लम्बाई के लिए, वी टी ओ. 6 प्रथम पुष्पन गाँठ फल प्रति संख्य, फल लम्बाई, फल मोटाई और उपज प्रति पौध के लिए अच्छा सामान्य संयोजक है। क्रास में, एच आर वी. 55 x अर्का अभय, एच आर वी. 2 x P-7 और एच आर वी. 9.2 x अर्का अभय, उपज प्रति पौध के लिए उत्तम विशिष्ट संयोजक है।

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