Vegetable Science (2012) 39 (2) : 180-182

Combining ability analysis in okra (*Abelmoschus esculentus* (L.) Moench)

Prashant Kumar, Vikas Singh and RK Dubey

Received : January, 2012 / Accepted : July, 2012

In any crop improvement programme, the proper choice of parents based on their combining ability is a prerequisite. 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 general and specific combining ability in respect of a character is the manifestation of additive and non-additive gene action, respectively. The line x tester analysis is one of the most useful techniques for preliminary evaluation of genotypes for use in hybridization programmes with a view to identify good combiners. In okra, studies on this aspect have been made by several workers elsewhere (Pathak *et al.,* 1998 and Yadav *et al.,* 2002). But such information which forms a back bone of any breeding programme is very meagre. Therefore, an attempt has been made to study the combining ability for 13 characters by line x tester mating design as suggested by Kempthorne (1957).

The material for present investigation comprised of eight genetically diverse females, *viz.,* NDO-5, KS-308, NDO-6, Sel-4, VRO-5, Sel-l, EC-l69393, EC-169358 and four pollen parents viz., Hisar Unnat, NDO-10, VRO-6 and Parbhani Kranti. The crosses were made in line x tester fashion and all the 32 hybrids along with parents were grown in a Randomized Block Design with three replications at Main Experiment Station, Department of Vegetable Science, N.D. University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (UP.). The observations were recorded on 5 randomly selected plants for 13 growth and yield parameters *viz.,* days to first fruit set, height at first fruiting node, number of node at first pod appearance, plant height, internodal length, number of nodes per plant, number of branches per plant, pod length, pod girth, number of pods per plant, number of ridges per pod, average pod weight and pod yield per plant. The analysis of general and specific combining ability for 13 characters was done as per model suggested by Kempthorne (1957).

Analysis of variance for combining ability revealed that significant differences exist due to lines and testers for all the characters except average pod weight only for testers, indicating wide genetic diversity among lines and testers. The lines x tester interaction components also emerged significant for all the 13 characters, which indicated that the combining ability contributed heavily in the expression of these traits. The higher magnitude of sca than gca variance and greater value of average degree of dominance was observed for all the 13 characters suggesting the significant role of non-additive gene action. Similar observations have also been made earlier by Sivagamasundhari et al. (1992), Chaudhary et al. (1993) and Singh et al. (2009). Heterosis breeding is useful approach for the characters showing non-additive gene action while selection in segregating generation could be followed for all the characters showing additive gene action.

The estimates of gca effects of parents are given in Table 1. Among the female parental lines, EC-169358 and Sel-1 were found to be good general combiners for pod yield and its major components. The line Sel-4 was poor general combiner for pod yield and most of the components but showed better ability to combine for number of node at first pod appearance and internodal length. The line EC-169393 was also found as good general combiner for a number of traits.

Among the testers, VRO-6 was the only parent with significant and positive gca effect for pod yield and its major components. Other good combiner was Parbhani Kranti noticed for pod yield and a number of component traits. NDO-10 was only male line which exhibited better combining ability for number of ridges per pod. For many

Prashant Kumar
Department of Vegetable Science, College of Horticulture
N.D. University of Agriculture & Technology
Narendra Nagar (Kumarganj), Faizabad-224 229 (U.P.)

Vikas Singh, R.K. Dubey
Department of Vegetable Science, College of Horticulture & Forestry, Central Agricultural University, Pasighat- 791102 (Arunchal Pradesh); Email Address: vikaschf@gmail.com

Table 1. Estimates of general combining ability effects of parents (line and testers) for 13 characters in okra

S. No.	Parents	1	2	3	4	5	6	7	8	9	10	11	12	13
Lines														
1	NDO-5	0.07	-0.72**	-0.07	-12.20**	-0.13*	-2.20**	-0.27	-1.11**	-0.04**	-1.56**	-0.04*	-0.89**	-41.84**
2	KS-308	0.59**	0.29**	0.41**	4.82**	0.10	0.43	-0.02	-0.01	-0.02	0.08	-0.17**	-0.01	1.92
3	NDO-6	-0.41*	-0.39**	-0.01	-0.15	0.02	-0.18	-0.64**	-0.16	0.06**	0.32	0.07**	-0.02	3.52
4	Sel-4	-0.28	-0.35**	-0.22*	-4.90**	-0.21**	0.05	-0.07	-0.11	0.02	0.11	0.09**	-0.30	-5.08
5	VRO-5	0.64**	0.25*	-0.06	-1.63	0.05	-0.50*	-0.04	-0.43**	-0.05**	-1.31**	0.08**	-0.40**	-23.45**
6	Sel-1	0.45**	0.67**	-0.09	8.39**	0.05	1.67**	0.28	0.39**	-0.03*	1.56**	-0.09**	0.40**	27.95**
7	EC-169393	-0.58**	-0.17	-0.11	1.35	0.01	0.27	0.33*	0.01	0.00	0.10	-0.02	0.19	4.52
8	EC-169358	-0.48**	0.42**	0.14	4.33**	0.10	0.47*	0.43**	1.42**	0.06**	0.70**	0.08	1.03**	32.45**
SE (gi) lines		0.16	0.12	0.09	0.84	0.05	0.23	0.16	0.09	0.01	0.24	0.02	0.16	4.64
SE (gi-gi) lines		0.23	0.16	0.13	1.19	0.08	0.32	0.22	0.13	0.01	0.34	0.03	0.23	6.56
Testers														
1	Hisar Unnat	0.29*	-0.49**	0.02	-4.42**	-0.09*	-0.55**	-0.01	-0.19**	0.00	0.30	-0.11	-0.08	1.33
2	NDO-10	-0.20	-0.23**	0.15*	-3.13**	-0.12**	-0.08	0.08	-0.60**	-0.02*	-1.04**	0.20**	-0.19	-16.34**
3	VRO-6	-0.49**	0.20*	-0.14*	5.75**	0.24**	0.07	-0.30**	0.17*	0.02**	0.45**	-0.11**	0.18	9.59**
4	Parbhani Kranti	0.40**	0.52**	-0.03	1.80**	-0.03	0.57**	0.23*	0.62**	-0.01	0.28	0.02	0.09	5.43
SE (gi) testers		0.12	0.08	0.06	0.59	0.04	0.16	0.11	0.07	0.01	0.17	0.01	0.11	3.28
SE (gi-gi) testers		0.16	0.12	0.09	0.84	0.05	0.23	0.16	0.09	0.01	0.24	0.02	0.16	4.64

1-days to first fruit set, 2- height at first fruiting node, 3- no. of node at first pod appearance, 4- plant height, 5- internodal length, 6- no. of nodes per plant, 7- no. of branches per plant, 8- pod length, 9- pod girth, 10-no. of pods per plant, 11- no. of ridges per pod, 12-average pod weight, 13-pod yield per plant.

*-significant at 5%, **-significant at 1%

of the characters studied, the parents EC-169358, Sel-1, VRO-6 and Parbhani Kranti were found to be good general combiners. Therefore, these lines can be used in hybridization for producing promising recombinants. High gca effects for some characters in okra had been reported by Shukla *et al.* (1989), Mandal and Das (1992).

The sca effects for hybrids pertaining to different characters are given in Table 2. Sca which represents the pre-dominance of non-additive gene action is a major component that may be utilized in heterosis breeding. Out of 32 crosses studied, the cross-exhibiting best sca effects for earliness, number of node at first pod appearance and pod girth was NDO-5 x VRO-6. The cross KS-308 x Parbhani Kranti showed best sca effects for height at first fruiting node while best specific combination for tallness was KS-308 x VRO-6. The higher significant negative sca effect for internodal length was observed in cross Sel-4 x VRO-6. The cross EC-169393 x Parbhani Kranti was the best specific combination for number of nodes and branches per plant. Sel-4 x NDO-10 exhibited best sca effects for pod length and average pod weight. The best three specific cross combinations for number of pods per plant were EC-169358 x Hisar Unnat, KS-308 x VRO-6 and EC-169393 x Parbhani Kranti the cross combination VRO-5 x NDO-10 exhibited significant highest sca for pod yield and desirable significant sca for 7 other traits followed by EC-169358 x Hisar Unnat.

In general, the best crosses which expressed higher per se performance for a particular traits was derived from such parents, one of them showed high gca effect or/and better significant sca effect for that traits. High gca of the parents therefore, seems to be reliable criterion for prediction of sca. Cross with high sca where at least one of the parent was good combiner, the high sca observed may be due to a complementary type of gene action which can be fixed to a great extent in the segregations. Whereas, crosses with high sca effects which involved poor x poor combiners, can be used for commercial exploitation of hybrid vigour as the non-additive, non fixable genes seems to play a greater role.

Generally the crosses VRO-5x NDO-10, EC- 169358 x Hisar Unnat, KS- 308 x VRO-6, Sel-1 x Parbhani Kranti and NDO-5 x Parbhani Kranti showed high sca for pod yield and component traits. Similar results have been reported by Arora (1993) and Singh *et al.* (1996). Therefore, due to exploitable yield potential these hybrids may be considered for future hybrid breeding programme in okra. However, it needs further testing before recommending these combination for exploitation on large scale.

Table 2. Estimates of specific combing ability effects of 32 hybrids for characters in okra

S. No.	Hybrids	1	2	3	4	5	6	7	8	9	10	11	12	13
1	NDO-5 x Hisar Unnat	0.78*	0.04	0.43*	-13.43**	-0.48**	-0.93*	0.05	-2.24**	-0.15**	-1.29**	-0.03	-1.55**	-61.5**
2	NDO-5 x NDO-10	0.06	0.10	0.10	3.09	0.03	0.60	0.44	0.48*	0.03	0.88	0.02	0.29	22.3*
3	NDO-5 X VRO-6	-0.85**	-0.33	-0.34	1.53	0.02	0.45	-0.56	0.71**	0.10**	-0.40	-0.09*	0.63*	12.2
4	NDO-5 X Parbhani Kranti	0.00	0.19	-0.18	8.81**	0.43**	-0.12	0.08	1.05*	0.03	0.82	0.10**	0.62	27.0**
5	KS-308 X Hisar Unnat	0.40	0.36	0.35	0.86	-0.15	1.23**	0.27	-0.11	0.01	0.56	0.09*	0.33	12.8
6	KS-308 X NDO-10	-0.05	0.86**	-0.25	-19.37**	-0.38**	-2.43**	0.23	-0.80**	-0.05*	-2.74**	-0.15**	-0.85**	12.8
7	KS-308 X VRO-6	-0.70*	0.10	-0.09	19.76**	0.49**	1.62**	-0.39	0.57**	0.09**	2.10**	0.06	0.46	34.7**
8	KS-308 X Parbhani Kranti	0.35	-1.32**	0.00	-1.24	0.05	-0.42	0.35	0.34	-0.05*	0.09	-0.01	0.06	0.7
9	NDO-6 X Hisar Unnat	0.06	-0.20	0.10	12.23**	0.23*	1.65**	0.41	0.74**	0.05*	1.47**	0.12**	0.16	21.9*
10	NDO-6 X NDO-10	-0.19	0.00	0.03	2.55	0.17	-0.28	-0.21	-0.54**	0.02	0.22	0.07	-0.38	-5.0
11	NDO-6 X VRO-6	0.30	-0.13	0.19	0.26	-0.14	0.83	0.37	-0.33	-0.04	1.40**	0.16**	0.14	19.8*
12	NDO-6 X Parbhani Kranti	-0.18	0.32	-0.32	-15.04**	-0.25*	-2.20**	-0.56	0.14	-0.04	-3.09**	-0.35**	0.08	-36.7**
13	Sel-4 x Hisar Unnat	0.20	-0.23	-0.29	4.95**	0.42**	-1.12	0.38	-0.49*	0.07**	-2.33**	0.14**	-0.46	-35.0**
14	Sel-4 x NDO-10	-0.32	-0.23	0.11	11.97**	0.23	1.48**	-0.45	1.31**	0.04	0.02	-0.14**	-0.46	25.2**
15	Sel-4 VRO-6	0.17	0.31	0.14	-9.72**	-0.61**	1.20**	0.33	0.05	0.04*	1.71**	0.01	-0.36	12.3
16	Sel-4 x Parbhani Kranti.	-0.05	0.15	0.03	-7.20**	-0.04	-1.57**	-0.26	-0.88**	-0.15**	0.59	0.00	-0.45	-2.5
17	VRO-5 X Hisar Unnat	0.08	-0.46*	-0.19	3.36*	0.22*	-0.37	-0.32	0.69**	0.07**	0.82	-0.16	0.55	21.0*
18	VRO-5 X NDO-10	0.10	-0.06	-0.12	10.28**	-0.18	3.43**	0.65*	0.65**	0.03	1.96**	0.50**	0.98**	41.5**
19	VRO-5 X VRO-6	0.12	0.07	-0.03	-4.84**	0.19	-2.05**	-0.03	-1.59**	-0.12**	-1.18*	-0.22**	-1.50**	-42.2**
20	VRO-5 X Parbhani Kranti	-0.30	0.45	0.23	-8.80**	-0.22*	-1.02*	-0.30	0.25	0.02	-1.67**	-0.12**	-0.03	-20.2*
21	Sel-1 x Hisar Unnat	0.13	1.44**	-0.15	-0.01	-0.12	-0.80	-0.37	0.34	-0.05*	0.24	-0.05	0.48	14.2
22	Sel-1 x NDO-10	-0.45	-1.26**	0.05	-1.50	0.03	-0.53	-0.54	-0.95**	-0.01	0.05	-0.29**	-1.44**	-30.3**
23	Sel-1 x VRO-6	0.24	-0.75**	0.14	-5.32**	0.04	-1.48**	0.45	0.79**	0.03	-1.94**	-0.01	0.65*	-12.0
24	Sel-1 x Parbhani Kranti	0.09	0.56*	-0.03	6.83**	0.06	1.22**	0.46	-0.19	0.03	1.66**	0.35**	0.31	28.2**
25	EC-169393 X Hisar Unnat	-0.84*	-0.28	-0.13	-12.24**	-0.08	-2.47**	-0.49	-0.09	-0.01	-1.43**	-0.12**	0.23	-12.2
26	EC-169393 X NDO-10	-0.09	-0.21	-0.19	-7.43**	0.10	-2.27**	0.09	0.09	-0.02	-0.78	-0.10**	-0.01	-9.5
27	EC-169393 X VRO-6	0.27	0.59*	0.16	-0.05	-0.06	0.32	-0.33	0.26	-0.03	0.27	0.04	0.58	15.5
28	EC-169393 X Parbhani Kranti	0.65*	-0.10	0.16	19.79**	0.04	4.42**	0.74*	-0.27	0.06**	1.94**	0.18**	0.81*	6.2
29	EC-169358 X Hisar Unnat	-0.80*	-0.67**	-0.12	4.28*	-0.03	1.20**	0.08	1.15**	0.01	1.97**	0.01	0.25	38.9**
30	EC-169358 X NDO-10	0.95**	0.79**	0.28	0.41	0.01	0.00	0.25	-0.25	-0.04	0.39	0.10**	0.14	4.1
31	EC-169358 X VRO-6	0.44	0.13	-0.16	-1.62	0.09	-0.88	0.17	-0.47*	-0.07**	-1.95**	0.05	-0.60	-40.4**
32	EC-169358 X Parbhani Kranti	-0.58	-0.26	0.00	-3.07	-0.07	-0.32	-0.50	-0.43*	0. 10**	-0.41	-0.16**	0.21	-2.6
SE (S_{ij})		0.33	0.23	0.18	1.68	0.11	0.46	0.31	0.19	0.02	0.48	0.04	0.32	9.3
SE(S_{ij} -S_{kl})		0.46	0.33	0.25	2.37	0.15	0.64	0.44	0.27	0.03	0.68	0.05	0.45	13.1

1-days to first fruit set, 2- height at first fruiting node, 3- no. of node at first pod appearance, 4- plant height, 5- internodal length, 6- no. of nodes per plant, 7- no. of branches per plant, 8- pod length, 9- pod girth, 10-no. of pods per plant, 11- no. of ridges per pod, 12-average pod weight, 13-pod yield per plant. *-significant at 5%, **-significant at 1%

References

Arora SK (1993) Diallel analysis for combining ability studies in okra *[Abelmoschus esculentus* (L.) Moench]. Punjab Hort J 33 (1-4): 116-122.

Chaudhary DR, Vidyasagar and Kumar J (1993) Nature of gene action governing economic traits in okra hybrids [*Abelmoschus esculentus* (L.) Moench]. J Hort 50 (3): 261-264.

Kempthorne O (1957) An introduction to genetical statistics (Eds.). John Wiley and Sons, New York, pp 458-671

Mandal N and Das ND (1992) Combining ability in okra. Experimental Genetics 8 (1-2): 47-57.

Pathak R, Syamal MM and Singh AK (1998) Line x tester analysis for combining ability in okra [*Abelmoschus esculentus* (L.) Moench]. Recent Hort 4: 127-132.

Shukla AK, Gautam NC, Tiwari AK and Chaturvedi AK (1989) Heterosis and combining ability in okra [*Abelmoschus esculentus* (L.) Moench]. Veg Sci 16 (2): 191- 196.

Singh DR, Singh PK, Syamal MM and Gautam SS (2009) Studies on combining ability in okra. Indian J Hort 66(2): 277-280.

Singh N, Arora SK, Ghai IR and Dhillon TS (1996) Combining ability studies in okra [*Abelmoschus esculentus* (L.) Moench]. Punjab Veg Grower 31: 6-9.

Sivagamasundhari S, Irulappan I, Arumugam R and Jayasankar S (1992) Combining ability in okra [*Abelmoschus esculentus* (L.) Moench]. South Indian Hort 40 (1): 21-27.

Yadav JR, Singh B and Srivastava JP (2002) Combining ability analysis in okra. International Conference on Vegetables-Vegetables for sustainable food and Nutritional Security in the New Millennium held at Bangalore. Abstract, pp 61.