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Original Research Article

Selection of Parents Based on Combining Ability Studies in Okra (*Abelmoschus esculentus* L. Moench)

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A B S T R A C T

The experiment was undertaken to study the combining ability for yield and its contributing traits in okra. The experimental material consisted of eleven parents and 28 F_1s produced from line x tester mating design in randomised block design for eleven characters. The mean squares due to gca, sca effects were significant for pod yield and yield contributing traits studied. The parents 38HU,MTPH, 14-11-5, 11-14, PF and 11-6 were identified as good general combiners for most of the characters including yield per plant and can be exploited well in further breeding programme. The estimates of *sca* effects revealed that the cross combinations 11-1 x 14-11-5, 38HU X 11-14, MPTH X AKOV-107, MPTH X 93M and NO-3 X 11-6 were observed most promising for fruit yield and some of its related traits could be used as heterotic hybrids.

Keywords

Combining ability, gca effects, sca effects, line x tester analysis

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is a versatile vegetable crop from Malvaceae family and is comprising of valuable nutrients. Okra is the important vegetable crop of India and is grown successfully during both summer and rainy seasons for its green tender fruits. One of the major problems in okra cultivation in India is lack of location specific high yielding varieties. In often cross-pollinated crops like okra, improvement in the past was based on selection in locally adapted populations. During recent past, exploitation of hybrid vigour and selection of parents on the basis of combining ability effects have opened a new line of approach in crop improvement. Application of biometrical techniques like line x tester analysis has appeared to be the best and vastly useful breeding tool, which gives generalized picture of genetics of the characters under study. Combining ability analysis provides clues to the usefulness of individuals to be employed as the parents in the hybridization programme as well as simultaneously to screen the hybrids. Besides, it also ascertains the magnitude and nature of quantitative genetic variation which could be of great use to plant breeders for deciding efficient and effective breeding programme. Study of gene action involved is very crucial for choosing of best parents and crosses for okra yield improvement and has been reported by many researchers viz; Reddy *et al.,* (2012), Adiger *et al.,* (2013). Hence the present investigation was done to assess the combining ability of parents and crosses to identify the best suitable parents and cross combinations which can be utilized for exploitation of heterosis in okra.

Materials and Methods

Eleven parents, among which four lines viz., MTPH, 11-1, NO-3, 38HU and seven testers viz., 14-11-5, 11-14, PF, 11-6, BH-55, 93M and AKOV-107 were selected for line x tester mating, to generate 28 F_1 hybrids.

The eleven parents and the 28 F_1S were evaluated in randomized block design with two replications at the experimental farm of Department of Agril. Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during Kharif 2016. The Exp Hy-1 was used as standard check. The spacing of 60 between row to row and 60 cm between plants to plant was adopted. The observations on five randomly selected plants in each genotype of two replications were recorded for days to initiation of flowering, days required to first harvesting, plant height, Internode length, number of branches per plant, number of internodes per plant, fruit length, breadth of the fruit, fruit weight, number of fruits per plant and yield per plant. The data were analyzed for combining ability following Kempthorne (1957).

Results and Discussion

The analysis of variance for the combining ability with respect to fourteen characters is presented in Table 1. The mean squares due to GCA, SCA effects were significant for all the characters, indicating substantial genetic variability for both general and specific combining ability for all the characters studied.

The variance due to lines was significant for days required to first harvesting, plant height, internodal length, number of branches per plant, number of internodes per plant. Whereas, the variances due to testers were significant for days required to first harvesting, plant height, internodal length, number of branches per plant, number of internodes per plant, fruit length and fruit diameter. The variances due to crosses were highly significant for all the characters. The variances due to parents x crosses were also highly significant for almost all the traits studied except for number of branches per plant, number of internodes per plant, diameter of fruit, weight of fruit and yield per plant. Significant variance indicated the presence of substantial amount of genetic variability among the parents and crosses for respective characters.

Among parents 11-6, 14-11-5 and 38HU are the best general combiners for yield per plant along with other yield contributing traits (Table 2). Parent MTPH is considered as best combiner for yield per plant along with the other three component characters i.e. early flowering, days for first harvest, internodal length and number of branches per plant. Thus this line is found to best general combiner with significant gca effects in desirable direction for fruit yield and yield contributing characters. The parents PF, 38HU is for dwarf stature plants and 14-11-5, 11-14 is for more number of branches per plant, in addition to the fruit yield per plant.

Specific combining ability effects are indicative of heterosis. The promising F_1 hybrids based on specific combining ability effect for yield and its components are presented in Table 3.

Table.1 Analysis of variance for combining ability

Source of Variations	df	Days to Initiation of flowering	Days required to first harvesting	Plant Height (cm)	Intern-odal Length (cm)	Number of branches /plant	Number of internodes/ plant	Fruit length (cm)	Diameter of fruit (cm)	Weight of fruit (g)	Number of fruits /plant	Yield /Plant (g)
		1	2	3	4	5	6	7	8	9	10	11
Replication	1	1.85	1.28	1.94	0.06	0.10	2.44	0.44	0.03	2.53	2.51	1434.63
Treatments	38	1.99**	3.05**	243.21**	3.74**	1.46**	19.86**	2.70**	0.04**	3.09*	6.27*	2478.40**
Females (lines)	3	0.33	3.33**	163.23**	1.77**	2.32**	7.72**	0.12	0.003	3.39	0.46	562.46
Males (testers)	6	1.07	2.57**	129.82**	0.84**	0.40*	8.92**	2.35**	0.03**	2.75	3.62	1963.79
Parents	10	1.32	2.54**	151.10**	1.03**	0.97**	13.39**	1.80**	0.03**	3.44	2.33	1562.03
Parents vs Crosses	1	6.46**	16.05**	281.67**	8.43**	0.20	0.47	24.35**	0.08	0.46	15.64*	3483.75
Crosses	27	2.08**	2.75**	211.45**	4.58**	1.69**	22.97**	2.23**	0.01**	3.06*	7.38**	2780.56**
Error	38	0.79	0.54	1.20	0.03	0.15	0.92	0.33	0.004	1.68	2.32	898.18

Note: * Significant at 5% level of significance; **Significant at 1% level of significance

Table.2 General combining ability (GCA) effects of parents for different traits in okra

Parents	Days to initial flowering	Days required to first harvesting	Plant height (cm)	Internodal length (cm)	Number of branches /plant	Number of internodes /plant	Fruit length (cm)	Diameter of fruit(cm)	Weight of fruit(g)	Number of fruits /plant	Yield/ Plant(g)
Female (Lines)	1	2	3	4	5	6	7	8	9	10	11
MTPH	-0.89**	-0.89 ** -0.73**	3.91**	-0.26 -2.22**	0.56**	-3.89**	-0.732 *** 0.18	0.07**	3.913 *** -0.26	-2.225 *** 0.66	10.12
11-1	0.53*	0.55**	2.44**	0.24 **	0.41**	1.71**	-0.07	0.11**	0.34	-0.84*	-16.43*
NO-3	-0.03	-0.16	-1.78**	0.87**	-0.04	1.42**	0.71**	-0.08**	-0.52	-0.55	-16.15
38HU	0.39	0.34	-4.56**	1.10**	-0.93**	0.75**	-0.81**	-0.10**	0.44	0.73	22.4**
Male (testers)											
14-11-5	-0.43	-0.07	12.94**	-0.47**	-0.06	-0.82 *	-0.84**	-0.04	-0.11	1.35*	26.58*
11-14	0.07	0.30	1.48**	-0.19**	0.49**	0.04	-0.13	-0.08**	0.56	-0.02	5.42
PF	0.57	0.05	-6.20**	0.37**	0.61**	-0.78*	0.08	0.03	-0.08	0.48	6.31
11-6	0.07	-0.19	5.78**	0.31**	-0.31*	1.10**	0.45*	0.12**	-0.38	1.60**	29.57**
BH-55	-0.67*	-0.32	-3.55**	-0.23**	-0.63**	0.46	0.24	0.07**	-0.001	-1.39*	-19.48
93M	-0.18	-0.69*	-5.50**	0.02	-0.06	0.66	0.42*	-0.09**	0.47	-1.51**	-23.76*
AKOV-107	0.57	0.92**	-4.95**	0.19**	-0.02	-0.66	-0.24	-0.005	-0.45	-0.51	-24.64*

Note: * Significant at 5% level of significant
**Significant at 1% level of significance

Table.3 Specific combining ability effects (SCA) of the crosses for different traits in okra

Crosses	Days to Initiation of flowering	Days required to first harvesting	Plant height (cm)	Internodal length (cm)	Number of branches / plant	Number of internodes / plant	Fruit length (cm)	Diameter of fruit (cm)	Weight of fruit (g)	Number of fruits/ plant	Yield / Plant (g)
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
MTPH X 14-11-5	0.64	-0.64	-20.67**	0.34*	-0.51	-4.52**	-0.31	-0.03	-2.65**	0.71	-15.27
MPTH X 11-14	1.14	-0.02	5.18**	0.39**	1.47**	0.72	-0.61	0.08	1.31	-0.91	3.52
MPTH X PF	-0.35	0.23	4.42**	-0.27*	0.81**	-0.55	0.88*	-0.08	0.26	-1.41	-37.60
MPTH X 11-6	0.14	-0.51	5.98**	-0.25	-0.06	1.45*	0.64	-0.01	0.55	-0.53	-6.61
MPTH X BH-55	-1.10	-0.89	-4.87**	0.01	-0.34	-2.35**	-0.77	0.12*	0.52	-1.03	-10.65
MPTH X 93M	-0.60	-0.02	8.37**	-0.16	-0.81**	2.44**	-0.07	-0.01	1.66	0.58	30.17
MPTH X AKOV-107	0.14	1.85**	1.57	-0.06	-0.55	2.81**	0.25	-0.07	-1.65	2.58*	36.45
11-1 X 14-11-5	-0.78	1.07*	17.39**	-1.73**	0.23	-2.82**	0.89*	0.04	0.39	1.71	41.58
11-1 X 11-14	0.71	0.69	-9.49**	0.32*	-0.42	-1.64 *	0.83	0.04	0.04	-0.41	-12.00
11-1 X PF	0.21	-1.05	-15.20**	-0.43**	-0.74*	-2.51**	-1.05*	0.11*	-0.11	0.59	19.65
11-1 X 11-6	0.71	0.19	-10.09**	-0.39**	-0.96**	0.54	-0.31	0.14**	-1.38	-1.53	-31.63
11-1 X BH-55	-0.53	-0.68	-0.75	0.17	0.51	2.68**	-0.79	-0.22**	0.75	-0.036	17.10
11-1 X 93M	-0.03	-0.30	11.64**	1.63**	0.68*	1.73*	1.11*	-0.04	-0.44	-0.41	-10.21
11-1 X AKOV-107	-0.28	0.07	6.49**	0.42**	0.69*	2.01**	-0.68	-0.07	0.75	0.09	-24.49
NO-3 X 14-11-5	0.28	0.78	-2.62**	0.73**	-0.01	5.26**	-0.52	-0.05	0.57	-2.07	-36.57
NO-3 X 11-14	-0.71	0.41	0.83	-0.60**	-0.42	0.79	-0.97*	-0.12*	-0.17	-1.69	-31.99
NO-3 X PF	-0.21	-0.34	1.97*	0.51**	0.32	-0.23	-0.56	0.064	-0.01	-0.19	0.35
NO-3 X 11-6	-0.71	-1.09*	-5.01**	-0.14	0.49	-0.61	0.30	-0.18**	-0.84	2.18	24.22
NO-3 X BH-55	0.03	0.03	4.82**	0.09	-0.33	-2.03**	0.19	0.023	0.32	1.18	20.87
NO-3 X 93M	1.53*	1.41*	0.17	-0.51**	-0.01	-0.83	0.20	0.074	-1.27	0.80	1.42
NO-3 X AKOV-107	-0.21	-1.21*	-0.17	-0.07	-0.04	-2.35**	1.36**	0.20**	1.40	-0.19	21.70
38HU X 14-11-5	-0.14	-1.21*	5.90**	0.65**	0.28	2.08**	-0.06	0.04	1.68	-0.35	10.26
38HU X 11-14	-1.14	-1.09*	3.46**	-0.11	-0.62*	0.12	0.75	-0.01	-1.18	3.01**	40.47
38HU X PF	0.35	1.16*	8.80**	0.19	-0.39	3.30**	0.73	-0.09	-0.14	1.02	17.56
38HU X 11-6	-0.14	1.41*	9.11**	0.78**	0.53	-1.38	-0.63	0.05	1.68	-0.10	14.03
38HU X BH-55	1.60*	1.53**	0.80	-0.27*	0.16	1.70*	1.37**	0.07	-1.59	-0.10	-27.31
38HU X 93M	-0.89	-1.09*	-20.19**	-0.95**	0.13	-3.35**	-1.23**	-0.02	0.06	-0.98	-21.38
38HU X AKOV-107	0.35	-0.71	-7.89**	-0.28*	-0.10	-2.47**	-0.93*	-0.05	-0.50	-2.48*	-33.66
SE (D)	0.63	0.52	0.77	0.129	0.27	0.67	0.41	0.05	0.91	1.07	21.19
CD (5%)	1.23	1.07	1.59	0.26	0.56	1.39	0.84	0.01	1.88	2.21	43.48
CD (1%)	1.74	1.44	2.15	0.35	0.76	1.88	1.13	0.13	2.53	2.98	58.71

Note:

* Significant at 5% level of significant

**Significant at 1% level of significance

Out of 28 crosses, no cross have shown significant positive sca for yield per plant trait. Fifteen crosses exhibited positive sca effects for the trait along with the positive significant standard heterosis for yield per plant. The cross 11-1 X 14-11-5 exhibited highest sca effect (41.58) for fruit yield along with the component traits like internodal length and fruit length with positive significant standard heterosis (29.08 %). The cross 38HU X 11-14 recorded second positive sca effect (40.47) for yield per plant along with the component characters like days to first harvest and number of fruits per plant having positive significant standard heterosis (37.60 %). Third cross MTPH X AKOV-107 exhibited positive sca effect (36.45) for yield per plant along with the component characters like number of internodes and number of fruits with positive significant standard heterosis (13.82 %). The cross NO-3 X AKOV-107 (-1.21) and 38HU X 14-11-5 (-1.21) showed highest significant sca effect for days to early harvesting. For plant height the cross MTPH X 14-11-5 (-20.67) showed highest significant sca effect. The cross MTPH X 11-14 (1.47) have recorded highest significant positive sca effect for number of branches per plant. Significant sca effect for yield per plant reflected in hybrids may be due to high x high and high x low gca effect of the parents indicating pre-dominant role of additive x additive and additive x dominance gene action in these crosses. No cross combination had high x high gca effects, eleven hybrids involved in high x low type or low x high of parents involved in the cross combination. While four cross combination involved low x low type of gca of parents.

Thus, it may be predicted that, for getting higher yield 38HU must be used as female parent only with 11-6 and 14-11-5. The results are in confirmation with the earlier findings of Kalpande (2003), Rani and Arora (2003), Shekhawat *et al.,* (2005), Kumar and Sreeparvathy (2010), Singh and Kumar (2010) and Adigar *et al.,* (2013). Thus, it can be suggested that, the crosses with high *sca* involving high x high *gca* of the parent with higher mean performance of the cross can be exploited in practical heterosis breeding. But there is no cross with high x high *gca* in this cross combination. Therefore, high x low or low x high cross combination can be exploited for further exploitation of heterosis. In crosses showing high specific combining ability involving one good combiner and other with moderate combiner, such crosses may throw up the desirable transgressive segregants (Singh and Kumar, 2010 and Hazem *et al.,* 2013).

With respect to specific combining ability effects, none of the cross combination exhibited consistently high *sca* effect for all the characters studied. The crosses exhibiting high sca effect for yield per plant may or may not have high *sca* effect for its contributing characters. These findings are in line with the earlier findings of Poshiya and Shukla (1986), Vijay and Manohar (1986), Kalpande (2003) and Balakrishnan *et al.,* (2009).

Thus, it appears that the selection of crosses merely on the basis of per se performance and sca effects may not be helpful, but gca effects of the parents should be considered. An ideal combination to be exploited is one with higher degree of *sca* with higher per se performance and at least one parent with good general combining ability.

From the present study it can be concluded that 11-6, 14-11-5, 38HU can be used further as parent material in hybridization programme to get high yielding tansgressive segregants for exploitation of hybrid vigor. Among the hybrids 11-1 x 14-11-5, 38HU X 11-14, MPTH X AKOV-107, MPTH X 93M could be exploited fully in future okra breeding programme by adopting appropriate breeding technique in order to evolve high yielding varieties.

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