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COMBINING ABILITY STUDIES IN OKRA (*Abelmoschus esculentus* L. MOENCH)

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ABSTRACT

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. Similarly, 11-1 x 14-11-5, 38HU X 11-14, MPTH X AKOV-107, MPTH X 93M and NO-3 X 11-6were the good specific combinations and could be used as heterotic hybrids.

Key words : *Combining ability, gca effects, sca effects, line x tester analysis***.**

Okra (*Abelmoschus esculentus* L. Moench), is known by many local names in different parts of the world. It is called as lady's finger in England, gumbo in the United States of America, guino-gombo in Spanish, guibeiro in Portuguese and bhendi in India. Mainly grown in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malayasia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. It is commonly known as bhindi or lady's finger, belongs to the class dicotyledonae, order Malvales and family Malvaceae. It is propagated by seeds. Okra flowers classified as an often cross-pollinated crop with somatic chromosome number 2n=130. It is believed to be originated from India, Ethiopia, West Africa and Tropical Asia. Okra fruits are nutritionally rich. Its 100 g edible part contains 89.6 g moisture, 1.9 g protein, 0.2 g fibre, 6.4 g other carbohydrates, 66 mg calcium, 53 mg magnesium, 56 gm phosphorus, 0.35 mg iron, 6.98 mg sodium, 103 mg potassium, 0.19 mg copper, 30 mg sulphur, 88 IU vitamin A, 0.07 mg thiamine, 0.1 mg riboflavin, 0.6 mg nicotine acid, 13 mg vitamin C and 0.7 g mineral (1). It is grown commercially in most of the states of India as Kharif as well as summer crop in the area of about 532 thousand hectare with production 6346.4 thousand metric tonnes and productivity 11.9 tonnes/ha.

Combining ability of the parents is becoming increasingly important in plant breeding programme, especially in hybrid production it helps in the evaluation of inbreds in terms of their genetic value, in the selection of suitable parents for hybridization also in the identification of superior cross combination which may be utilized for commercial exploitation of heterosis. The general combining ability and specific combining ability effects are the foundation for any fruitful breeding programme. (2) pointed out that the common approach of selecting the parents on the basis of per se performance is not a good indicator of their superior combining ability. The choice of parents in any breeding programme has to be based on complete genetic information and knowledge of combining ability of the parents. Hence, the present investigation was carried out to identify best general combiners and specific cross combinations for increasing the yield and its components 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 Chilli and Vegetable research station Department of Botany, Post-graduation Institute, 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.

RESULTS AND DISCUSSION

The knowledge of combining ability is necessary for selection of appropriate parents in hybridization programme. Since it gives an idea whether a particular parent combines well in a cross and also denote the specific performance of a cross combination against the expectations from the gca of the parents. The analysis of variance for the combining ability was carried out for all the observed fourteen characters (Table-1). The mean squares due to gca, scaeffects were significant for all the

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)	Internodal Length (cm)	Number of branches /plant	Number of internode s/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 and 1% levels of significance, respectively.

characters, indicating substantial genetic variations for gca, sca effect 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 38HUare the best general combiners for yield per plant along with other yield contributing traits (Table 2). It has been reported that 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 F1 hybrids based on specific combining ability effect for yield and its components are presented in Table 3. 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

Table-2 : Estimates of general combining ability effects of parents 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)
	1	2	3	4	5	6	7	8	9	10	11
Female (Lines)											
MTPH	-0.89**	-0.73**	3.91**	-2.22**	0.56**	-3.89**	0.18	0.07**	-0.26	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 and 1% levels of significance, respectively.

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 (3, 4). 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 ofheterosis. 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 (5).

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 (3, 5, 7).

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 study it reveals that the parents 11-6, 14-11-5, 38HU were best parents for yield per plant. The crosses viz.,11-1 x 14-11-5, 38HU X 11-14, MPTH X AKOV-107, MPTH X 93M were identified as best crosses for yield per plant in terms of sca effects.

Table-3 : Specific combining ability effects of the crosses.

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 and 1% levels of significance, respectively

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