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Combining ability and gene behaviour studies for fruit yield and its component traits in okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract
The experimental stuff consisted of ten parents and their $45F_1$ hybrids through half-diallel analysis. An experiment was carried out in randomized complete block design with three replications to asses combining abilities for fruit yield and its attributing traits at Vegetable Research Station, Junagadh Agricultural University, Junagadh (Gujarat) during *kharif*-2022. The mean square due to GCA and SCA were highly significant for all traits. This was also confirmed by the GCA and SCA ratio ($\sigma^2_{GCA}/\sigma^2_{SCA}$) which was less than unity for all the traits (except days to first picking) indicated that non-additive gene action was more pronounced than that of additive gene action. However, the number of branches per plant. The parents Punjab Suhavani and GAO-8 were found to be good general combiners for most of the traits. The perusal of SCA effects revealed that the six cross combinations *viz.*, AOL-19-12 × AOL-18-08, GAO-8 × GO-2, GAO-5 × AOL-18-06, GAO-5 × AOL-18-08, Punjab Suhavani × Pusa Sawani and Kashi Kranti × AOL-18-06 manifested good specific combining ability for fruit yield and some of its related traits. Crosses with high SCA effects for fruit yield per plant were in combinations of good × poor, moderate × moderate, moderate × good, moderate × poor and *vice versa* general combiners.

Keywords: Half-diallel, gene action, general combining ability, specific combining ability, okra

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench.] (2n=4x=130) commonly known as lady's finger belongs to the family *Malvaceae*. Tender okra fruits are used as vegetable in countries like India, Brazil, West Africa and is also available in dehydrated and canned forms. The average nutritive value (ANV) of okra is 3.21%, which is higher than tomato, brinjal and cucurbitaceous vegetables (Sharma and Arora, 1993) [2]. The roots and stems of okra are used for cleaning the cane juice. Mature fruits and stems containing crude fibre are used in the paper industry (Chauhan, 1972) [5].

The nicking ability is better genetic tool which provides directions for assessing of the relative breeding strength of the parents or identifying the best combiners, which may be hybridized either to exploit heterosis or to accumulate fixable genes. In order to identify potential crosses for further exploitation, it is important to have prior information about nicking ability of the parents involved, since it helps in the identification of superior parents with good general combining ability and crosses with high and desirable specific combining ability effects (Singh *et al.*, 1991) [22].

Materials and Methods

The present investigation on okra comprised of 55 genotypes, a half-diallel set of ten parents and their 45 crosses. The experiment was laid out in randomized complete block design with three replications at Vegetable Research Station, Junagadh Agricultural University, Junagadh (Gujarat) during *kharif* 2022. Observations were recorded for nine traits of five representative plants in each replication on plant height (cm), number of branches per plant, number of nodes per plant, internodal length (cm), number of fruits per plant, fruit length (cm), fruit diameter (cm), ten fruit weight (g) and fruit yield per plant (g). Data was analysed according to Model-I, Method-II proposed by Griffing (1956) [8] to study combining ability variances and effects.

Results and Discussion

The analysis of variance for combining ability let out that the mean square due to both general combining ability (GCA) and specific combining ability (SCA) were significant/highly significant for all the characters (Table 1). This indicated that both additive as well as non-additive genetic variances had decisive role in the inheritance of all these traits under studied. The results are in consonance with the findings of Weerasekara *et al.* (2008) [28]; Patil *et al.* (2016) [15]; Wakode *et al.* (2016) [26]; Sugani *et al.* (2017) [23]; Hadiya *et al.* (2018) [9]; Reddy and Sridevi (2018) [19]; Shwetha *et al.* (2018) [21]; Kousalya *et al.* (2021) [12]; Rajani *et al.* (2021) [16] and Anyaoha *et al.* (2022) [2].

Table 1: ANOVA (mean squares) for nicking ability in half-diallel design for fruit yield and its contributing characters in okra

Source	DF	Plant height (cm)	Number of branches per plant	Number of nodes per plant	Inter nodal length (cm)	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Ten fruit weight (g)	Fruit yield per plant (g)
GCA	9	76.63**	0.12**	4.25**	0.58**	4.62**	2.99**	0.27**	330.37**	1906.39**
SCA	45	26.82**	0.02**	1.49**	0.15**	0.94**	0.61**	0.06**	287.43**	606.54**
Error	108	7.41	0.01	0.83	0.03	0.19	0.25	0.03	71.54	108.29
σ^2_{GCA}		5.77	0.01	0.28	0.05	0.37	0.23	0.02	21.57	149.84
σ^2_{SCA}		19.40	0.01	0.66	0.12	0.74	0.36	0.03	215.89	498.25
$\sigma^2_{GCA}/\sigma^2_{SCA}$		0.29	1.00	0.43	0.41	0.50	0.63	0.66	0.09	0.30

*, ** Significant at 5% and 1% levels, respectively

The breadth of GCA and SCA variances revealed that the SCA variances were farther up than their respective GCA variances for all the characters (Table 1). This was further supported by the potent ratio ($\sigma^2_{GCA}/\sigma^2_{SCA}$) subordinate to unity confirmed the preponderance of non-additive gene action for characters under studied and emphasized the utility of hybrid breeding approach to exploit existing heterosis in okra genotypes. However, the number of branches per plant delineated equal importance of both additive and non-additive gene effect. The predominance of non-additive gene action for fruit yield and its component traits were also reported by Rani *et al.* (2002) [18]; Mitra and Das (2003) [13]; El-Gendy *et al.* (2012) [7]; Mrinmoy *et al.* (2013) [14]; Akotkar and De (2014) [1]; Bhatt *et al.* (2015) [4]; Verma and Sood (2015) [24]; Verma *et al.* (2016) [25]; Rameshkumar *et al.* (2017) [17]; Shwetha *et al.* (2018) [21] and Rajani *et al.* (2021) [16].

Estimation of general combining ability effects (Table 2) showed that it was difficult to pick up a good combiner for all the characters together as the combining ability effect were not consistent for all the yield attributing characters. Punjab Suhavani was found to be most desirable for number of nodes per plant, internodal length, number of fruits per plant, ten fruit weight and fruit yield per plant. Likewise, GO-2 was good general combiner for plant height and fruit length; GAO-8 for number of branches per plant, fruit girth, ten fruit weight and fruit yield per plant; AOL-19-09 for internodal length and fruit girth; Pusa Sawani for number of branches per plant and Kashi Kranti for number of branches per plant. Similar reports have been also reported by Akotkar *et al.* (2014) [1]; Verma *et al.* (2016) [25] and Jupiter *et al.* (2017) [11]. With regard to parental lines, significant and positive correlation was observed between per se performance and GCA effects for most of the traits including number of branches per plant, internodal length, fruit length and fruit girth and ten fruit weight indicating strong association between both parameters for these traits. These suggested that while selecting the parents for hybridization programme, per se performance of parents should be given due consideration. Thus, if a character is unifacially managed by a set of alleles and incremental effects are important, the choice of parents on the basis of per se performance may be quite beneficial.

Specific combining ability effects helps in the identification of superior cross combinations for development of promising hybrids. Five cross combinations (Table 3) *viz.*, Punjab Suhavani × GAO-8 (8.03), Punjab Suhavani × Kashi Kranti (6.91), GAO-8 × Kashi Kranti (6.59), GAO-8 × GO-2 (6.00) and

Table 2: Gauging of GCA effects of parents for fruit yield and its contributing characters in okra

Sr. no.	Parents	Plant height (cm)	Number of branches per plant	Number of nodes per plant	Internodal length (cm)	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Ten fruit weight (g)	Fruit yield per plant (g)
1	Punjab Suhavani	5.78**	-0.12**	1.20**	-0.11*	1.57**	0.25	0.07	9.70**	31.29**
2	GAO-8	0.49	0.06**	-0.29	0.09	0.23	0.31*	0.11*	5.03*	8.52**
3	GO-2	1.94**	0.02	0.18	0.35**	-0.69**	0.48**	-0.05	0.67	-9.03**
4	AOL-19-09	-0.40	-0.05*	0.29	-0.17**	-0.51**	-0.04	0.15**	0.45	-5.61*
5	Pusa Sawani	-0.58	0.13**	-0.61*	0.14**	0.01	-0.24	0.12*	2.09	-0.27
6	Kashi Kranti	-0.65	0.09**	-0.58*	0.03	-0.09	-0.45*	0.09	-0.13	-2.96
7	GAO-5	-0.64	-0.03	-0.11	-0.08	-0.02	0.71*	-0.02	-0.97	0.05
8	AOL-18-06	-3.99**	-0.19**	0.19	-0.43**	-0.43**	-0.94**	-0.32**	-8.11**	-14.69**
9	AOL-19-12	-0.30	0.06*	-0.75**	0.22**	-0.14	0.29*	0.04	-7.41**	-6.25*
10	AOL-18-08	-1.64*	0.01	0.48	-0.04	0.07	-0.35**	-0.18**	-1.33	-1.03
SE (g_i) ±		0.75	0.02	0.25	0.05	0.12	0.14	0.05	2.31	2.85
SE (g_i - g_j)±		1.11	0.04	0.37	0.07	0.18	0.20	0.07	3.45	4.25
Correlation coefficient between per se performance of parents and GCA effects		0.29	0.68*	0.54	0.95**	0.56	0.80**	0.90**	0.62*	0.45

*, ** Significant at 5% and 1% levels, respectively

Pusa Sawani × GAO-5 (5.79) were identified as the best specific cross combinations by exhibiting significant and positive SCA effects for plant height. Likewise, four cross combinations *viz.*, AOL-19-09 × Kashi Kranti (0.23), GAO-5 × AOL-18-08 (0.22), GAO-8 × Pusa Sawani (0.20) and GAO-5 × AOL-19-12 (0.17) for number of branches per plant; five crosses *viz.*, Punjab Suhavani × GAO-8 (2.19), Pusa Sawani × GAO-5 (2.17), GAO-8 × AOL-18-08 (1.85), Punjab Suhavani × Pusa Sawani (1.72) and AOL-19-09 × AOL-18-08 (1.68) for number of nodes per plant; six cross combinations *viz.*, GAO-8 × AOL-18-06 (2.13), AOL-19-12 × AOL-18-08 (1.63), GAO-5 × AOL-18-08 (1.56), Punjab Suhavani × GAO-8 (1.03) and Punjab Suhavani × GO-2 (0.95) and GAO-8 × GO-2 (0.09) for number of fruits per plant; four cross combinations *viz.*, Punjab Suhavani × AOL-19-12 (1.58), GO-2 × AOL-19-09 (1.43), Punjab Suhavani × GAO-5 (1.10) and GAO-8 × AOL-19-09 (1.06) for fruit length (cm); three crosses namely Pusa Sawani × AOL-18-06 (0.50), Punjab Suhavani × AOL-18-08 (0.39) and Kashi Kranti × GAO-5 (0.32) for fruit girth (cm); eight crosses with maximum magnitude of GAO-5 × AOL-18-08 (37.06) followed by GAO-8 × AOL-18-06 (35.50), GAO-5 × AOL-18-06 (34.50) and Kashi Kranti × AOL-19-12 (31.31) for ten fruit weight (g); six hybrids namely AOL-19-12 × AOL-18-08 (50.97), GAO-8 × AOL-18-06 (41.32), GAO-5 × AOL-18-06 (41.30), GAO-5 × AOL-18-08 (36.32), Punjab Suhavani × Pusa Sawani (23.90) and Kashi Kranti × AOL-18-06 (20.05) for fruit yield per plant (g). For internodal length (cm), eight crosses exhibited significant and negative SCA effect which is desirable. Among negative estimates the cross GO-2 × Pusa Sawani (-0.90) depicted the highest SCA effect followed by AOL-19-09 × Kashi Kranti (-0.64), AOL-19-09 × AOL-18-08 (-0.59) and AOL-18-06 × AOL-19-12 (-0.59) for internodal length revealing them as good specific combiners.

The most desirable cross combinations based on per se performance and SCA effects were Punjab Suhavani × GAO-8 for plant height and number of nodes per plant; GAO-8 × Pusa Sawani for number of branches per plant; AOL-19-09 × Kashi Kranti and AOL-19-09 × AOL-18-08 for internodal length; GAO-8 × AOL-18-06 for number of fruits per plant, ten fruit weight; Punjab Suhavani × AOL-19-12 and Punjab Suhavani × GAO-5 for fruit length; Kashi Kranti × GAO-5 for fruit girth; AOL-19-12 × AOL-18-06 for fruit yield per plant. These results were in close conformity of Wammanda *et al.* (2010) [27]; Verma *et al.* (2016) [25]; Das *et al.* (2020) [6] and Arvind *et al.* (2021) [3].

As can be seen, the hybrid performance itself and their SCA effect (Table 3) were significant and positively for all characters which means that progressing in good direction in an action will lead to an increase in SCA effect and *vice versa*. It is fact that per se performance is a realized value, whereas SCA effect is an estimate value, measured as the deviation of F_1 over the parental performance. Therefore, for a given cross, performance of SCA effect may or may not be highly depending upon the performance of parental lines. The association between per se performance of parents and their GCA effects (Table 2) suggested that while selecting the parents for hybridization programme, per se performance of parents should be given due consideration. If a cross combination showing high SCA effects involving both the parents with good GCA effects, the same is likely to be exploited rather more profitably in a varietal breeding programme.

The best five specific cross combinations of SCA effects for fruit yield per plant along with their desirable SCA effects for component characters are shown in Table 4. Perusal of the Table 4 indicated that the highest SCA effect for fruit yield per plant was manifested by cross AOL-19-12 × AOL-18-08, which also exhibited significant SCA effects in desired direction for number of fruits per plant and ten fruit weight. This cross was involved poor × average general combining parents with second highest per se performance for fruit yield per plant (Table 4). Therefore, it can be said that it might be outcome of superior allelic combination within heterozygous state of F_1 hybrids or due to the favourable effect of environments. Similarly, GAO-5 × AOL-18-06 and GAO-5 × AOL-18-08 also involved average × poor and average × average general combining parents, respectively. On the other hand, the rest of hybrids were also involved at least one good general combining parents in their crosses. These findings are in agreement with the findings of Reddy and Sridevi (2018) [19] and Javiya *et al.* (2020) [10].

Table 3: Gauging of SCA effects of hybrids for fruit yield per plant (g) along with its component traits in okra

Sr. No.	Crosses	Plant height	Number of branches per plant	Number of nodes per plant	Internodal length (cm)	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Ten fruit weight (g)	Fruit yield per plant (g)
1	Punjab Suhavani × GAO-8	8.03**	0.12	2.19**	0.15	1.03*	0.08	0.17	-7.97	16.63
2	Punjab Suhavani × GO-2	3.25	0.03	-0.14	-0.08	0.95*	-1.18*	-0.06	22.06**	15.59
3	Punjab Suhavani × AOL-19-09	0.46	-0.03	-0.52	0.24	0.24	-1.03*	-0.12	1.95	10.03
4	Punjab Suhavani × Pusa Sawani	1.57	-0.15	1.72*	-0.48**	0.73	0.46	-0.04	19.64*	23.90*
5	Punjab Suhavani × Kashi Kranti	6.91**	-0.17*	1.22	0.06	-0.37	0.57	-0.10	3.19	4.29
6	Punjab Suhavani × GAO-5	3.76	-0.06	-0.65	0.53**	0.19	1.10*	0.13	-11.64	-10.99
7	Punjab Suhavani × AOL-18-06	0.12	-0.09	-0.83	0.45**	-1.04*	-0.43	0.19	6.50	-5.93
8	Punjab Suhavani × AOL-19-12	3.96	-0.21**	1.18	-0.21	-0.39	1.58**	0.18	-11.86	-13.76
9	Punjab Suhavani × AOL-18-08	0.03	-0.16*	0.29	-0.24	-0.34	-0.14	0.39*	-5.28	-7.91
10	GAO-8 × GO-2	6.00*	0.11	0.28	-0.04	0.09*	0.35	-0.03	-0.94	2.39
11	GAO-8 × AOL-19-09	-0.12	-0.08	-1.23	-0.04	0.18	1.06*	0.09	-2.39	-2.73
12	GAO-8 × Pusa Sawani	0.38	0.20*	-1.06	0.48**	-1.20**	0.31	-0.01	-3.36	-13.66
13	GAO-8 × Kashi Kranti	6.59**	-0.02	-0.36	0.19	0.09	-0.05	-0.25	-5.80	0.67
14	GAO-8 × GAO-5	-3.62	-0.11	-0.76	-0.30	-0.46	-0.37	-0.11	-10.97	-16.06
15	GAO-8 × AOL-18-06	1.93	-0.01	1.59	-0.12	2.13**	0.49	0.08	35.50**	41.32**
16	GAO-8 × AOL-19-12	1.11	-0.06	-0.26	0.15	0.08	-0.23	-0.16	-0.19	2.61
17	GAO-8 × AOL-18-08	1.05	-0.14	1.85*	-0.49**	-0.94*	0.44	0.07	9.39	-3.64
18	GO-2 × AOL-19-09	-1.63	-0.04	-1.09	-0.07	-0.30	1.43**	-0.11	16.98*	8.07
19	GO-2 × Pusa Sawani	-7.59**	0.11	0.94	-0.90**	-0.15	-0.51	0.06	-3.99	-2.51
20	GO-2 × Kashi Kranti	-6.78**	0.02	-1.29	-0.43**	-1.71**	-1.22**	-0.09	-14.77	-36.61**
21	GO-2 × GAO-5	-2.86	-0.06	0.04	-0.11	-1.01*	0.64	-0.30	-3.61	-19.51*
22	GO-2 × AOL-18-06	-8.58**	-0.10	-2.93**	-0.19	-1.18**	-0.48	0.24	-37.80**	-46.47**

23	GO-2 × AOL-19-12	-5.39*	-0.08	-0.72	-0.28	-1.87**	-0.73	0.06	-24.83**	-49.54**
24	GO-2 × AOL-18-08	0.21	-0.17	0.06	0.56**	-1.35**	-0.55	0.18	-16.58*	-33.04**
25	AOL-19-09 × Pusa Sawani	-0.91	-0.08	0.77	-0.03	0.04	-0.64	-0.35*	-7.44	-2.59
26	AOL-19-09 × Kashi Kranti	-10.10**	0.23**	-0.27	-0.64**	0.31	-1.04*	-0.38*	-10.89	-3.49
27	AOL-19-09 × GAO-5	-1.39	0.01	1.20	-0.42*	-0.19	-0.28	-0.02	-15.39*	-17.92

Sr. No.	Crosses	Plant height	Number of branches per plant	Number of nodes per plant	Internodal length (cm)	Number of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Ten fruit weight (g)	Fruit yield per plant (g)
28	AOL-19-09 × AOL-18-06	3.77	0.11	-0.18	0.42*	-0.36	0.69	0.29	-3.91	-8.29
29	AOL-19-09 × AOL-19-12	4.68	0.12	-0.63	0.83**	0.09	0.32	0.21	13.39	12.08
30	AOL-19-09 × AOL-18-08	-1.25	0.11	1.68*	-0.59**	-0.39	-0.06	0.10	-4.02	-8.58
31	Pusa Sawani × Kashi Kranti	-0.99	0.11	-0.23	0.12	0.13	-0.34	0.01	-10.86	-9.35
32	Pusa Sawani × GAO-5	5.79*	-0.17*	2.17**	-0.02	0.16	0.75	0.13	-3.02	-3.26
33	Pusa Sawani × AOL-18-06	0.74	-0.08	-0.01	-0.21	0.33	0.46	0.50**	2.11	4.99
34	Pusa Sawani × AOL-19-12	-1.88	0.14	-0.20	-0.19	-0.83*	-1.03*	-0.32*	-3.91	-21.71*
35	Pusa Sawani × AOL-18-08	3.86	-0.21**	-1.56	0.39*	0.29	1.32	0.19	-6.99	-3.18
36	Kashi Kranti × GAO-5	2.53	-0.13	-0.53	0.26	0.53	0.59	0.32*	-0.80	3.85
37	Kashi Kranti × AOL-18-06	2.29	-0.17*	1.09	-0.10	0.56	0.48	0.27	14.67	20.05*
38	Kashi Kranti × AOL-19-12	-1.94	0.12	-0.70	0.11	0.07	-0.48	-0.04	31.31**	18.19
39	Kashi Kranti × AOL-18-08	-3.99	-0.03	-0.79	-0.20	-0.21	0.29	-0.12	-5.44	-3.39
40	GAO-5 × AOL-18-06	0.13	0.02	-0.31	0.11	0.16	-0.13	0.05	34.50**	41.30**
41	GAO-5 × AOL-19-12	-3.09	0.17*	-0.50	-0.28	0.04	0.83	-0.11	-6.86	-4.79
42	GAO-5 × AOL-18-08	-0.81	0.22**	-0.26	0.25	1.56**	-0.92*	-0.21	37.06**	36.32**
43	AOL-18-06 × AOL-19-12	-1.39	-0.01	0.86	-0.59**	-0.26	-0.47	-0.56**	-24.72**	-23.48*
44	AOL-18-06 × AOL-18-08	-1.73	-0.02	-0.17	0.18	-0.81*	-0.16	-0.76**	-14.14	-17.99
45	AOL-19-12 × AOL-18-08	4.79	0.06	0.84	0.11	1.63**	0.33	0.28	19.17*	50.97**
SE (S_{ij}) ±		2.51	0.08	0.84	0.17	0.41	0.46	0.16	7.79	9.58
SE (S_{ij}-S_{ik}) ±		3.68	0.12	1.23	0.25	0.59	0.67	0.24	11.45	14.09
SE (S_{ij}-S_{kl}) ±		3.51	0.12	1.17	0.23	0.57	0.64	0.23	10.91	13.43
Range of SCA effect		-10.10 to 8.03	-0.21 to 0.23	-2.93 to 2.19	-0.90 to 0.83	-1.87 to 2.13	-1.22 to 2.13	-0.76 to 0.50	-37.80 to 37.06	-49.54to 50.97
Number of significant and positive crosses		5	4	5	7	6	4	3	8	6
Number of significant and negative crosses		5	6	1	8	10	6	4	5	6
Correlation between SCA effect and per se of hybrids		0.84**	0.76**	0.84**	0.74**	0.80**	0.76**	0.77**	0.92**	0.84**

Table 4: The best five specific cross combinations for SCA effects for fruit yield per plant along with their desirable SCA effects of component characters including GCA effects of their parents in okra

Crosses	SCA effect for fruit yield per plant	Per se of fruit yield per plant (g)	GCA effect for fruit yield per plant		Significant desirable SCA effects for component traits
			Female	Male	
AOL-19-12 × AOL-18-08	50.97** (P × A)	211.74	-6.25* (P)	-1.03 (A)	Number of fruits per plant, Ten fruit weight (g)
GAO-8 × GO-2	41.32** (G × P)	169.93	8.52** (G)	-9.03** (P)	Number of fruits per plant, Ten fruit weight (g)
GAO-5 × AOL-18-06	41.30** (A × P)	194.71	0.05 (A)	-14.69** (P)	Ten fruit weight (g)
GAO-5 × AOL-18-08	36.32** (A × A)	203.39	0.05 (A)	-1.03 (A)	Number of branches per plant, Number of fruits per plant, Ten fruit weight (g)
Punjab Suhavani × Pusa Sawani	23.90* (G × A)	222.97	31.29** (G)	-0.27 (A)	Number of nodes per plant, Internodal length (cm), Ten fruit weight (g)

A = Average combiner (non-significant); G = Good combiner (Significant and desirable direction); P = poor combiner (Significant and undesirable direction)

In contrast to general combining ability effects, the specific combining ability effects represent dominance and epistatic components of variation which are not fixable. But if the crosses showing high SCA effects involving either both or one good general parents, they could be successfully exploited for varietal improvement and expected to throw stable performing transgressive segregants carrying fixable gene effects. The most of the cross combinations which were either due to good × poor, poor × good, moderate × moderate or moderate × poor crosses besides exhibiting favourable and high additive effect of parents and manifest the complementary interaction effects and thus leads to higher SCA effects.
In commenced investigation, GCA and SCA variance were found important for all the characters studied with predominance of SCA variance which delineated considerable scope for okra crop improvement through hybrid breeding. The parents Punjab Suhavani and GAO-8 were found to be good general combiners for fruit yield and its contributing traits. The crosses with high SCA effects were involved in to good × poor, poor × good, moderate × moderate and moderate × moderate general combiners. This reflected the role of additive and non-additive gene actions in the genetic control of traits. A situation wherein both additive and non-additive gene outcomes are essential, biparental matings as well as mating of selected flowers in early segregating generations must be attempted in developing potential populations having choicest levels of homozygosity and heterozygosity in okra.

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