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Study on combining ability in okra [*Abelmoschus esculentus* (L.) Moench]

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ABSTRACT : Combining ability effects were estimated for 8 characters *viz.*, days to first flowering, plant height, number of branches per plant, fruit length, fruit girth, number of fruits per plant, fruit weight and fruit yield per plant through line x tester analysis comprising 21 hybrids produced by crossing 7 lines and 3 testers. Parents and hybrids differed significantly for GCA and SCA effects, respectively. The combining ability variance showed higher magnitude of SCA variance for all the characters indicating preponderance of non-additive (dominance) gene action. On the basis of GCA effects across nine characters, the genotype Sivagangai Local (L_2) was the best combiner for number of fruits per plant and fruit yield per plant followed by Pudukottai Local (L_1) and Arka Anamika (T_2) among testers were found to be good combiners for fruit yield per plant. Hence, these parents may be used as one of the parent in okra hybrid programme. The hybrid (L_4 x T_2) Karaikudi Local x Arka Anamika was found to be most promising for fruit yield per plant on the basis of *per se* performance and SCA effect followed by (L_2 x T_3) Sivagangai Local x Punjab Padmini. The crosses showing high specific combining ability effects and *per se* performance for for fruit yield per plant suggesting that these hybrids may be exploit in further breeding programme.

KEY WORDS : Line x tester, GCA, SCA, Okra

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Okra [*Abelmoschus esculentus* (L.) Moench] popularly known as ladies finger or okra is one of the most important vegetable crop grown in tropical and sub tropical regions of the world. It is originated from South Africa near Ethiopia (De Candolle, 1883 and Vavilov, 1951). It is an important member of the family Malvaceae with 2n = 8x = 72 or 130 or 144 chromosomes and is an alloplyploidy in nature (Joshi and Hardas, 1956 and Suresh Babu, 1987). Exploitation of hybrid vigour is one of the most important tool for increasing the productivity in this crop. Okra is an often cross pollinated crop as the natural crossing occurs in this crop upto a range of 4-19 per cent (Purewal and Randhawa, 1947 and Kumar *et al.*, 2010). Emasculation and pollination events are easier due to large flower and monodelphous stamens. It is essential to mitigate the future thrust of higher productivity by estimating the extent of combining ability in lines and crosses for choosing lines of best combining ability (GCA) and crosses of specific combining ability (SCA) (Sprague and Tatum, 1942). The present study was formulated to find out best general specific combiners with high *per se* performance and heterotic potential in okra through line x tester analysis adopted with Kempthorne (1957).

RESEARCH METHODS

The present investigation was carried out at Department of Horticulture, Faculty of Agriculture,

Annamalai University, Tamil Nadu, in a Randomized Block Design with three replications during 2014-2015. The experimental material consisted of 21 F1' s, involving 7 lines namely AE7- Pudukottai Local (L_1), AE21- Sivagangai Local (L_2), AE13- Dharmapuri Local (L_3), AE6- Karaikudi Local (L_4), AE9- Cuddalore Local (L_5), AE20- Thiruchirappalli Local (L_6) and AE3- Madurai Local (L_7) and 3 testers Parbhani Kranti (T_1), Arka Anamika (T_2) and Punjab Padmini (T_3). All the recommended agronomic practices and plant protection measures were followed during experimentation. A row to row spacing of 60 cm and plant to plant spacing of 30 cm was adopted. Data were recorded on ten randomly selected plants per entry per replication on yield and yield component characters namely, days to first flowering, plant height, number of branches per plant, fruit length, fruit girth, number of fruits per plant, average fruit weight and fruit yield per plant. The analysis of variance (ANOVA) for RBD was estimated crosswise according to Panse and Sukhatme (1967) and ANOVA for line x tester analysis was done according to Kempthorne (1957) and Singh and Chaudhary (1985).

RESEARCH FINDINGS AND DISCUSSION

The analysis of variance due to lines were significant for all the characters except fruit girth (Table 1). Similarly, the variance due to testers were significant for all the characters except fruit girth. This indicated that there exists genetic diversity among the lines and testers of the present investigation. The variance due to lines x testers interaction was significant for all the characters except fruit girth, there by showing their high specific combining ability. The variance due to hybrids were significant for all the character except fruit girth.

The relative estimates of variance due to SCA were higher than those for GCA for all the characters studied (Table 2). This indicated the pre-dominance of non-additive gene action. Similar findings were earlier reported by Manivannan *et al*. (2007); Senthilkumar (2010) and Joshi and Murugan (2012).

Combining ability effects :

The combining ability effects were estimated for yield component traits and the results are furnished below.

Days to first flowering: The GCA effects of lines ranged from -2.50 to 2.45 and among testers, it was from -0.63 to 1.24 (Table 3). Among the lines estimated, L5 registered the GCA effect (-2.50) and among the testers, T_1 noticed maximum significant and negative GCA effect (-0.63). Four hybrids showed significant and negative SCA out of which L_7 x T_2 had the maximum value (-3.37) followed by L_6 x T_3 (-2.83) for days to first flowering (Table 4). Similar results were given by Padmanaban and Manivannan (2009) and Khatik *et al*. (2012).

Plant height :

The GCA effects of lines ranged from -7.65 to 7.63 and among testers it was from -8.76 to 11.93 (Table 3). Among parents, five showed significant positive GCA

Table 1 : Analysis of variance

Source	D.F	Days to first flowering	Plant height (cm)	Number of branches per plant	Fruit length (cm)	Fruit girth (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)
Replication	2	5.60	5.84	0.94	1.21	0.94	6.42	1.15	0.61
Lines	6	37.31**	419.66**	5.89**	41.32**	0.82	137.24**	18.46**	39625.60**
Testers	2	30.99**	669.92**	0.60	13.02**	0.15	17.38**	15.30 **	6362.61**
Line x testers	12	14.14**	256.84**	2.92**	4.84**	0.62	34.21**	7.69 **	13135.16**
Hybrids	20	20.76**	480.71**	4.22**	11.99**	0.67	35.57**	17.89**	13555.10**
Error	60	1.45	3.87	0.10	1.11	0.25	5.05	2.48	6.77

Table 2 : Estimate of combining ability variance (Mean sum square) in okra

Variance	Days to first flowering	Plant height (cm)	Number of branches per plant	Fruit length (cm)	Fruit girth (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)
GCA variance	0.173	5.830	0.034	0.186	0.001	0.035	0.266	10.936
SCA variance	4.230	84.321	0.939	1.245	0.122	9.721	1.735	4376.129
GCA/SCA	0.041	0.069	0.036	0.150	0.010	0.004	0.153	0.003

effect. Among the lines, the highest significant and positive GCA effect (7.63) was observed in L_7 while T_3 (11.16) in testers for plant height. Six hybrids showed significant and positive SCA out of which L_6 x T_2 had the maximum significant and positive SCA effect of 19.16 followed by L_7 x T_3 (9.00) for plant height (Table 4).

Table 3 : Estimate of GCA effect of parents

Parent	Days to first flowering	Plant height (cm)	Number of branches per plant	Fruit length (cm)	Fruit girth (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)
Line								
L_1	0.80*	1.52*	-0.60 **	-0.51	-0.28	0.33	-3.22 **	30.41 **
L_2	-1.20 *	1.78 **	0.19	1.24 **	-0.23	3.46 **	-1.03	56.15 **
L_3	-1.86 **	-6.63 **	-0.11	-1.49 **	-0.44 *	-1.97 *	-1.35 *	-35.32 **
L_4	0.31	-7.65 **	-0.08	0.78 *	0.09	1.03	1.39 **	5.32 **
L_5	-2.50 **	-1.42 *	0.09	1.44 **	0.40 *	-0.38	0.75	9.39 **
L_6	2.45 **	4.77 **	0.11	-0.94 **	0.09	-2.36 **	1.50 **	-39.58 **
L_7	2.00 **	7.63**	0.40 **	-0.51	0.37 *	-0.11	1.96 **	-26.37 **
Tester								
T_1	-0.63*	-3.17**	-0.42 **	-0.82 **	-0.04	1.74 **	-0.96 **	-14.65 **
T_2	-0.61 *	-8.76**	-0.75 **	-1.06 **	-0.03	-0.96	-0.49	37.16 **
T_3	1.24 **	11.93 **	1.17 **	1.88 **	0.07	-0.78	1.45 **	-22.51 **

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 4 : Estimate of SCA effect of hybrids

Cross	Days to first flowering	Plant height (cm)	Number of branches per plant	Fruit length (cm)	Fruit girth (cm)	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (g)
L_1 x T_1	0.30	7.20 **	0.32	-0.52	0.05	-1.84	0.63	-4.16**
L_1 x T_2	-0.49	-3.58 **	-0.26	1.70 **	-0.05	-1.11	1.65	-35.80 **
L_1 x T_3	0.19	-3.62 **	-0.06	-1.19	0.00	2.95 *	-2.28 *	39.95 **
L_2 x T_1	-1.19	-1.10	0.55 **	0.86	0.40	-2.82 *	-0.30	-53.71 **
L_2 x T_2	-0.03	-3.76 **	1.26 **	0.86	-0.18	-2.05	1.65	-41.60 **
L_2 x T_3	1.22	4.86 **	-1.81 **	0.18	-0.22	4.87 **	-1.35	95.31 **
L_3 x T_1	-2.24 **	1.51	1.02 **	0.65	0.31	0.52	1.30	22.44 **
L_3 x T_2	1.75 *	0.96	-0.13	-1.40 *	-0.30	-0.59	-1.13	-18.10 **
L_3 x T_3	0.49	-2.47 *	-0.89 **	0.76	-0.01	0.07	-0.17	-4.34 **
L_4 x T_1	-0.32	8.96 **	-0.35	-0.90	-0.25	-1.27	-1.36	-37.03 **
L_4 x T_2	0.65	-3.85 **	-0.43 *	0.39	0.26	5.26 **	1.18	97.11 **
L_4 x T_3	-0.33	-5.11 **	0.78 **	0.50	-0.02	-3.99 **	0.18	-60.08 **
L_5 x T_1	-1.77 *	-3.75 **	-0.07	-0.50	0.01	-1.06	0.34	-53.05 **
L_5 x T_2	0.06	-4.57 **	-0.39 *	0.79	0.16	1.55	-0.89	57.34 **
L_5 x T_3	1.71 *	8.32 **	0.46 *	-0.29	-0.17	-0.49	0.55	-4.29 **
L_6 x T_1	1.38 *	-8.17 **	-0.63 **	1.82 **	-0.09	1.85	-0.91	42.97 **
L_6 x T_2	1.45 *	19.16 **	0.39 *	-0.99	0.59 *	-0.34	-0.35	0.16
L_6 x T_3	-2.83 **	-10.98 **	0.24	-0.84	-0.50	-1.52	1.26	-43.13 **
L_7 x T_1	3.83 **	-4.65 **	-0.84 **	0.48	-0.43	4.61 **	0.30	82.54 **
L_7 x T_2	-3.37 **	-4.36 **	-0.44 *	-1.35 *	-0.48	-2.72 *	-2.11 *	-59.12 **
L_7 x T_3	-0.46	9.00 **	1.29 **	0.87	0.91 **	-1.89	1.81 *	-23.42 **

* and ** indiacate significance of values at P=0.05 and 0.01, respectively

Number of branches per plant :

The line L_7 (0.40) and the tester T_3 (1.17) registered the maximum significant and positive GCA effect for number of branches per plant among the parents (Table 3). Out of twenty one hybrids, seven hybrids revealed significant positive SCA effects (Table 4). The maximum significant and positive SCA effect (1.29) was reported by L_7 x T_3 among the hybrids.

Fruit length :

Four parents showed significant and positive GCA effects for fruit length (Table 3). Among the seven lines, greater positive significant GCA effect (1.44) was recorded by L_5 for this trait. Among the testers, the maximum significant and positive GCA effect (1.88) was noticed in T_3. Out of twenty one hybrids, only two hybrids exhibited significant and positive SCA effect (Table 4). The best specific combination was L_6 x T_1 (1.82) follwed by L_1 x T_2 (1.70) for fruit length. This is in conformity with the findings by Padmanaban and Manivannan (2009) and Jagan *et al.* (2013).

Fruit girth :

Among ten parents only two parents showed significant positive GCA effects (Table 3). The highest significant and positive GCA effect (0.40) was noticed in L_5 for fruit girth. Among the twenty one hybrids evaluated, only two hybrids exhibited significant and positive SCA effect out of which L_7 x T_3 showed the maximum significant and positive SCA effect (0.91) followed by L_6 x T_2 (0.59) (Table 4).

Number of fruits per plant :

Among the lines, the maximum significant and positive GCA effect (3.46) was registered by L_2 (Table 3). The tester T_1 registered the maximum significant and positive GCA effect (1.74) for number of fruits per plant. Four hybrid combinations showed significant and positive SCA effect for number of fruits per plant. The cross L_4 x T_2 exhibited the maximum significant and positive SCA effect (5.26) followed by L_2 x T_3 (4.87) (Table 4). Similar findings were reported by Kumar *et al.* (2005); Senthilkumar and Anandan (2006); Padmanaban and Manivannan (2009) and Jagan *et al.* (2013).

Average fruit weight :

Four parents showed significant positive GCA effects. The line L_7 (1.96) and the tester T_3 (1.45) exhibited the maximum significant and positive GCA effect for fruit weight (Table 3). The maximum significant and positive SCA effect (1.81) was registered by L_7 x T_3 for average fruit weight (Table 4).

Fruit yield per plant :

Five parents showed significant and positive GCA effects for this charater. The maximum significant and positive GCA effect (56.15) was reported by L_2 among the lines (Table 3). Among the testers, the maximum significant and positive GCA effect (37.16) was recorded by T_2 for fruit yield per plant. Seven crosses proved to be good specific combination for fruit yield per plant. The maximum significant and positive SCA effect (97.11) was noticed in L_4 x T_2 followed by L_2 x T_3 (95.31) (Table 4). Significant SCA effect for fruit yield per plant was reported by Kumar *et al.* (2005); Senthilkumar and Anandan (2006); Padmanaban and Manivannan (2009) and Jagan *et al.* (2013).

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