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# Interspecific Hybridization for the Assessment of Polygenic traits in Okra (*Abelmoschus esculentus* (L.) moench)

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## ABSTRACT

The present investigation on okra was conducted to study the combining ability for yield and its contributing traits. The experiment was carried out at Plant Breeding farm, Department of Genetics and Plant Breeding, Faculty of agriculture, Annamalai University. 7 lines and 3 testers were used and 21 crosses were produced using Line x Tester mating design in Randomized Block Design with three replications. The genetic action and superior cross combinations can be evaluated using combining ability analysis. The ratio of GCA/SCA showed the preponderance of non-additive genic effect for the inheritance of all the traits. Lines Arka Abhay, MDU-1, Red Long and testers Varsha Uphar and Arka Anamika were the good general combiners for yield and its contributing traits. The crosses Arka Abhay/Varsha Uphar and Arka Abhay/ Arka Anamika were observed as good specific combinations and they can be used as heterotic hybrids.

*Key words* : Interspecific Hybridization, Okra, Gca, Sca effects.

## Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is an important nutritive vegetable crop of tropical and subtropical region of the world (Badrie, 2016). It is an often-cross pollinated crop. It comes under Malvaceae family (Mishra *et al.*, 2017). India ranks first in okra production in the world (73% of the world production) (Lata *et al.*, 2021). In India, Andhra Pradesh is leading in okra production (21% of total production) (Panwar *et al.*, 2019). The other commonly used names of okra are Bhendi/ Lady's finger in England and Gumbo in United States of America. Bhendi is rich in Vitamin-c, Vitamin-k<sub>1</sub> etc. Vitamin c is a water-soluble nutrient, it contributes to our overall immune system (Yamaguchi, 2012). Since, vitamin-k<sub>1</sub> is a fat-soluble vitamin, it plays

major role in blood clotting. It also has some medicinal properties like antioxidants which helps to reduce the risk of severe diseases and contains polyphenols that contributes to heart and brain health (Rai *et al.*, 2021). This experiment was conducted to estimate the combining ability of parents and hybrids. The Line x tester mating design would be more efficient in studying the combining ability of parents to be chosen for heterosis breeding. Because of easy emasculation and high fruit setting, breeding of okra has high scope for hybrid development.

## Materials and Methods

The experimental material for the present study comprised of 7 lines viz., Pusa-5, Kashi Pragathi,

Arka Abhay, Ankur-41, Green long, Red long, MDU-1 and 3 testers Arka Anamika, Aruna and Varsha Uphar. They were crossed using Line x Tester mating design to form 21 cross combinations. The crosses were grown in Kharif (Aug-Oct) season in experimental plot in Randomized Block Design with three replications at Plant Breeding Farm of Annamalai University. Each cross was grown in two rows with inter and intra row spacing of 45 and 30 cm respectively. The observations were recorded for nine important characters like days to 50% flowering, plant height, number of branches per plant, internodal length, fruit length, fruit girth, single fruit weight, number of fruits per plant, fruit yield per plant. The recommended cultural practices were followed during raising a crop. The collected data were statistically analyzed for all the characters and the combining ability analysis was calculated as per the method suggested by Kempthorne (1957).

**Results and Discussion**

The analysis of variance (ANOVA) for nine characters were presented in Table 1 and the character wise combining ability results for nine characters were presented in the Table 2. As per the procedure given by Kempthorne, 1957 the Analysis of variance (ANOVA) for combining ability for nine traits was carried out. The variances due to General combining ability (GCA) and Specific combining ability (SCA) effects were highly significant for all the nine characters studied. In the present study the ratio of GCA/SCA was lesser than unity for all the characters indicate preponderance of non-additive gene action. Several researchers have reported the importance of non-additive genetic variances such (Jupiter *et al.*, 2017; Tapus *et al.*, 2017 and Hadiya *et al.*, 2018).

The estimates of General combining ability (GCA) character wise for each parent are presented in Table 3 and the Specific combining ability for each hybrid for different characters is presented in Table 4. For days to 50% flowering, the maximum significant and negative GCA was observed in line Pusa-5 (-2.47) followed by Arka Abhay (-1.74) and among the testers, the highest significant and negative GCA was recorded by Varsha Uphar (-0.72). Among the hybrids, Arka Abhay/Varsha Uphar recorded the maximum SCA value (-1.11) followed by the hybrid Arka Abhay/Arka Anamika (-1.0). Similar results were observed by Amba Kumari *et al.*, 2020; Shiba and Supriya (2019).

**Table 1.** Analysis of variance (ANOVA) for nine characters

Source	DF	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Internodal length (cm)	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant (g)
Replication	2	0.0501	0.0940	0.0240	0.0312	0.0053	0.0430	0.0558	0.0790	0.0712
Hybrid	20	11.2947**	11.0071**	0.4702**	0.6956**	5.9455**	1.0230**	5.9124**	20.8133**	17277.2685**
Lines	6	29.1639**	15.5988**	0.3999**	0.7363**	6.6696**	2.5596**	9.5368**	49.7856**	38093.8475**
Testers	2	11.4461**	54.5160**	2.6678**	3.9211**	35.4254**	1.6984**	19.8811**	40.2470**	40890.4548**
LXT	12	2.3349**	1.4597**	0.1391**	0.1377**	0.6701**	0.1421**	1.7721**	3.0882**	2933.4479**
Error	40	0.0543	0.5791	1.0171	0.0103	0.0291	0.0099	0.0121	0.0070	0.0111

\*Significant at 5 percent level,

\*\* Significant at 1 percent level

MSS

In respect to plant height, the highest negative and significant GCA was observed in line Ankur-41 (-1.23) followed by MDU-1 (-1.09) and Arka Abhay (-1.00) and among the testers, the maximum negative and significant GCA was observed by Varsha Uphar (-1.44). The maximum significant and negative SCA among hybrids was recorded by the hybrid Arka Abhay/Varsha Uphar (-0.88) followed by the hybrid Red long/Varsha Uphar (-0.76) respectively. Similar results have been shown by Makdoomi *et al.*, (2018); Joshi *et al.*, (2015), Paul Sharma and Singh (2012). The maximum positive and significant GCA for number of branches per plant was observed by the line Arka Abhay (0.39) and among the testers, Varsha Uphar showed highest positive and significant GCA effect (0.21). The cross Arka Abhay/Varsha Uphar registered highly positive and significant SCA (0.40) followed by Green long/Aruna (0.37) respectively. Similar results were shown by Javiya *et al.*, (2020); Wakode *et al.*, (2016).

Among the lines evaluated for internodal length,

Arka Abhay registered highest negatively significant GCA (-0.51) followed by the line MDU-1 (-0.24) and among the testers, Varsha Uphar observed highest negatively significant GCA effect (-0.31). The cross Arka Abhay/Varsha Uphar recorded maximum significant and negative SCA (-0.25) followed by the cross Ankur-41/Varsha Uphar (-0.23) respectively. Similar results were observed by the researchers *viz*, Javiya *et al.*, (2020) and Sujata Padadalli *et al.*, (2019).

Estimates of GCA effects for fruit length showed that the line Arka Abhay exhibited maximum positively significant GCA effect (1.42) followed by the line Red long (0.53) and among the testers, Varsha Uphar exhibited maximum significant and positive GCA (0.88). Among the crosses evaluated, Arka Abhay/Varsha Uphar registered highest SCA (0.76) followed by the cross Arka Abhay/Arka Anamika (0.45). The result was in accordance with the findings of Javiya *et al.*, (2020) and Jag Paul Sharma and Singh (2012). In respect to fruit girth, the highest positively significant GCA was observed by the line

**Table 2.** Analysis of variance for combining ability for nine characters

Source	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Internodal length (cm)	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant (g)
GCA	0.2333	0.2486	0.0086	0.0145	0.1374	0.0229	0.1078	0.4616	373.5370
SCA	0.7602	0.4818	0.0406	0.0425	0.2137	0.0441	0.5867	1.0270	977.8123
GCA/SCA	0.3068	0.5159	0.2118	0.9764	0.6429	0.5192	0.1837	0.4494	0.3820

\*Significant at 5 percent level\*\* Significant at 1 percent level

**Table 3.** Estimation of GCA effects for nine characters in okra

Parents	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Internodal length (cm)	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant (g)
LINES									
Pusa-5	-2.47**	0.56**	-0.30**	0.31**	-1.15**	-0.84**	-1.14**	-1.79**	-56.78**
Kashi Pragati	-0.94**	-0.68**	0.20	0.07**	-0.26**	-0.31**	-0.64**	-0.44**	-21.72**
Arka Abhay	-1.74**	-1.00**	0.39**	-0.51**	1.42**	0.56**	1.61**	4.91**	129.78**
Ankur-41	0.62**	-1.23**	-0.21**	0.17**	-0.23**	-0.34**	-0.27**	-1.10**	-28.22**
Green long	0.36**	1.59**	-0.20*	0.20**	-0.72**	0.42**	-0.41**	-1.77**	-41.55**
Red long	2.39**	1.85**	0.05	-0.00	0.53**	0.52**	1.28**	0.89**	42.14**
MDU-1	1.78**	-1.09**	0.07	-0.24	0.41**	-0.01	-0.43**	-0.70**	-23.65**
TESTERS									
Arka Anamika	-0.03	-0.30**	0.19**	-0.18**	0.61**	-0.10**	0.23**	0.23**	6.91**
Aruna	0.75**	1.74**	-0.40**	0.49**	-1.49**	-0.22**	-1.07**	-1.49**	-47.17**
Varsha Uphar	-0.72**	-1.44**	0.21**	-0.31**	0.88**	0.32**	0.84**	1.26**	40.26**

\*Significant at 5 percent level

\*\* Significant at 1 percent level

Arka Abhay (0.56) followed by Red long (0.52) and among the testers, Varsha Uphar recorded the highest positively significant GCA (0.32). The cross Pusa-5/Varsha Uphar observed the highest positively significant SCA (0.25) followed by Arka Abhay/Varsha Uphar (0.23). Same findings were reported by Lokeswari *et al.*, (2018) and Jag Paul Sharma and Singh (2012).

For single fruit weight, the line Arka Abhay was observed the maximum positively significant GCA (1.61) followed by Red long (1.28) and among the testers, Varsha Uphar recorded the maximum GCA (0.84). The maximum significant and positive SCA was recorded by the cross Arka Abhay/Varsha Uphar (0.84) followed by the cross MDU-1/Aruna (0.82) respectively. Similar results were recorded by Shiba and Supriya, (2019). The maximum positively significant GCA for number of fruits per plant was observed by Arka Abhay (4.91) followed by Red long (0.89) and for testers, Varsha Uphar recorded the maximum significant GCA (1.26). Among the crosses, Arka Abhay/Varsha Uphar registered the maximum significant and positive SCA (1.28) followed by Ankur-41/Aruna (0.98). The similar results were observed by Javiya *et al.*, 2020 and Wakode *et al.*, (2016). For fruit yield per plant, the line Arka Abhay registered highest positively significant GCA (129.78) followed by Red long (42.14) and among the testers, Varsha Uphar showed maximum positively significant GCA (40.26). The cross Arka Abhay/Varsha Uphar (42.95) followed by Green long/Varsha Uphar (26.89) recorded the maximum positively significant SCA. These findings are in accordance with the earlier findings of Javiya *et al.*, (2020); Sujata Padadalli *et al.*, 2019.

**Table 4.** Estimation of SCA effects for nine characters in okra

Hybrids	Days to 50% flowering	Plant height (cm)	Number of branches per plant	Internodal length (cm)	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Fruit yield per plant (g)
Pusa-5 / Arka Anamika	-0.13	-0.18*	0.03	-0.41**	-0.29**	-0.34**	-0.39**	0.97**	8.90**
Pusa-5/ Aruna	-0.20	-0.02	-0.23**	-0.06	0.30**	0.09	0.62**	-0.12*	13.67**
Pusa-5/ Varsha Uphar	0.32	0.20**	0.20*	0.19**	-0.01	0.25**	-0.23**	-0.86**	-22.56**
KashiPragati/Arka Anamika	0.20	0.11	-0.04	0.21**	0.13	0.09	0.16*	-0.10**	-0.17**
Kashi Pragati/ Aruna	-0.19	0.21**	0.09	-0.07	-0.36**	-0.32**	-0.18**	0.43**	4.79**
Kashi Pragati/ Varsha Uphar	-0.02	-0.32**	-0.04	-0.15*	0.24*	-0.04	0.02	-0.33**	-4.62**
Arka Abhay/ Arka Anamika	-1.0**	0.38**	0.01	-0.07	0.45**	0.13**	0.63**	0.23**	22.32**
Arka Abhay/ Aruna	1.44**	-0.08	-0.19*	0.21**	-0.57**	-0.09	-1.42**	-1.51**	-65.27**
Arka Abhay/ Varsha Uphar	-1.11**	-0.88**	0.40**	-0.25*	0.76**	0.23**	0.84**	1.28**	42.95**
Ankur-41 / Arka Anamika	0.39	0.61**	0.11	0.24**	0.12	-0.04	0.52**	0.60**	21.30**
Ankur-41 / Aruna	0.04	0.06	-0.19*	-0.02	-0.32**	0.18**	-0.55**	0.98**	10.37**
Ankur-41 / Varsha Uphar	-0.43**	-0.67**	0.08	-0.23**	0.20**	-0.14*	0.03	-1.58**	-31.67**
Green long/ Arka Anamika	0.01	-0.45**	0.03	-0.09	-0.02	0.18**	-0.72**	-0.95**	-29.50**
Green long/ Aruna	0.03	-0.32**	0.37**	-0.18**	-0.26*	0.04	0.09	0.03	2.62**
Green long/ Varsha Uphar	-0.03	1.33**	-0.40**	0.27**	0.27**	-0.22**	0.58**	0.92**	26.89**
Red long/ Arka Anamika	-0.96**	-0.12	-0.04	0.10	-0.29**	0.07	-0.40**	-0.63**	-20.50**
Red long/ Aruna	-0.02	0.88**	0.02	-0.06	0.25*	-0.07	0.61**	0.41**	22.55**
Red long/ Varsha Uphar	0.98**	-0.76**	0.02	-0.04	-0.16	-0.01	-0.21**	0.22**	-2.06**
MDU-1/ Arka Anamika	1.49**	-0.35**	-0.10	-0.15**	0.03	-0.10	-0.01	-0.12*	-2.36**
MDU-1/ Aruna	-0.44**	-0.18*	0.13	0.17**	0.32**	0.17**	0.82**	-0.22**	11.28**
MDU-1/ Varsha Uphar	-0.38**	0.52**	0.03	0.09	-0.79**	-0.07	-0.81**	0.34**	-8.93**

\*Significant at 5 percent level\*\* Significant at 1 percent level

## Conclusion

It is concluded from the present experiment that the importance of non-additive gene action for all the yield and its contributing traits in the present study indicated that heterosis breeding is the best possible method for improving these traits in okra. The parents Arka Abhay, Varsha Uphar, Arka Anamika and Red long exhibited high and significant GCA effect and identified as good general combiners for fruit yield and its other component traits. While the hybrids Arka Abhay/Varsha Uphar and Arka Abhay/Arka Anamika were adjudged as good specific combiners. The hybrid Arka Abhay/Varsha Uphar was found to be the best cross for fruit yield per plant and all other attributing traits.

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