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Research Article

Combining ability in bhindi [*Abelmoschus* spp.]

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Abstract: Combining ability was estimated for six diverse okra genotypes or varieties by diallel analysis. The combining analysis revealed that Arka Anamika was found to be a good general combiner for fruit number, fruit weight and fruit length. KL9 showed high gca for days to first flowering, internode number and fruit weight. In this study, it was observed that presence of overdominance for most of the yield contributing traits.

Key words: okra, gca, sca, combining ability

Introduction

Bhindi, *Abelmoschus esculentus* (L.) Moench (syn. okra, bhindi, lady's finger and gumbo) is an important warm season vegetable crop grown for its tender pods in tropical and sub tropical regions. Combining ability of the genotypes is becoming increasingly important in plant breeding especially for exploitation of heterosis and comparisons of performance of lines in hybrid combination (Rani and Arora,2003). Information on the gca and sca will be helpful in the analysis and interpretation of the genetic basis of important traits (Singh *et.al*., 2001). Suresh Babu *et al*. (1994) evaluated F_1 hybrids of okra for various quantitative traits and estimated high heterosis in case of number of fruits and fruit yield. Hence this study was conducted to estimate the combining ability of six genetically divergent parental strains of bhindi by diallel analysis with respect to yield and yield related traits.

Materials and Methods

The experiment was conducted by using the shoot and fruit borer resistant genotypes identified in earlier studies conducted at Kerala Agricultural University, Trichur (Karuppaiyan, 2006) and were raised along with high yielding varieties and were crossed to get fruit and shoot borer resistant high yielding F_1s. The crossing was done in a 6 x 6 full diallel mating design involving four genotypes in the species *A. esculentus viz*, Arka Anamika, KL9, Salkeerthy and Sel 2 and two genotypes from *A. caillei viz*, Susthira and AC5. Thirty crosses were made out of which 24 F_1s were fertile and six interspecific crosses were sterile. Twenty four F_1s were raised along with their parents in green house at normal temperature and relative humidity for pest free conditions with three replications for each treatment. All cultural operations were carried out as per the package of practices recommendations of KAU, 2007. Biometrical observations were recorded from three randomly selected plants from each replication for the characters like days to first flowering, plant height, number of leaves per plant, number of internode on main shoot, internode length, fruit number per plant, fruit weight, fruit length and fruit yield per plant. The data from the crosses involving AC 5 was not utilised for the analysis as most of the crosses were not fertile. The data recorded from 5 x 5 diallel crosses was analysed for gca and sca effects and variance following Method I and Model I of Griffing's approach (1956). Variance components such as additive variance (σ^2A), dominance variance (σ^2D) and environmental variance (σ^2e) were estimated (Sharma ,1998). Combining ability studies were conducted to evaluate the genetic value of inbreds, to identify superior cross combinations and to assess the gene action involved in the expression of various quantitative characters.

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Results and Discussion

Combining ability of parents and specific parental combinations are of principal importance in plant breeding for the production of hybrids and OP lines . It is useful in studying and comparing the performance of lines in hybrid combinations. The general combining ability and specific combining ability were significant for plant height, days to first flowering, number of internodes, fruit yield, fruit length and fruit weight. The mean squares for reciprocal effects were significant for days to first flowering, plant height, fruit length and fruit weight. The estimate of gca variance and genetic parameters in the diallel analysis will give an idea about the gene action. Combining ability analysis for the 5x5 full diallel cross revealed the gene action for every trait under the study. Components of variation due to the dominance effect of the genes were greater than components of variation due to additive effect of the genes for all characters except internodal length (Table 1). This signifies the importance of non-additive effects of these characters indicating the presence of over dominance. Consequently it is suggested that these traits could be improved through heterosis breeding rather than selection. In okra presence of non additive gene action for most of the characters like days to first flowering, plant height, number of fruits per plant, single fruit weight and fruit yield were reported by Sharma and Mahajan (1978), Shukla *et al.* (1989), Cahudhary *et al.* (1991) Singh *et al.* (2001) and Kumar *et al.* (2005). On the basis of direction and magnitude of gca effects, it was found that Arka Anamika was good general combiner for fruit number, fruit weight and fruit length (Table 2). The genotype KL9 was a good general combiner for plant height, days to first flowering, leaf number, internodal number and fruit weight.

The cross combination Arka Anamika x Sel2 was found to be good specific combiners for the traits like plant height, days to first flowering, leaf number, internodal number and internodal length. For fruit weight, all the cross combinations have shown significant specific combining ability. In case of fruit length, Arka Anamika x Salkeerthy has shown significant positive specific combining ability and Arka Anamika x KL9 have shown significant negative combining ability. The cross combination Arka Anamika x Salkeerthy had significant gca for fruit yield and can be considered as good specific combiner for improving fruit yield. The variances for sca were greater than gca variances for most of the characters studied indicating the predominant role of dominance gene action governing the epistasis. For some traits, parents with high gca effects produced hybrids with low sca effects maybe due to lack of complementation of parental genes. Whereas some hybrids with high sca effects had parents with poor gca which can be due to complementary gene action. This is in line with the findings of Rajani *et al.* (2001).

The ANOVA revealed the significance of reciprocal effects for all the traits under study except for leaf number, internode length and fruit number. Therefore, during selection of crosses in addition to sca, importance may be give to reciprocal differences also. In case of fruit yield per plant, considering the magnitude and direction of reciprocal effects, it is understood that Arka Anamika x Salkeerthy will give better progenies only when Arka Anamika was taken as female parent. Similarly in case of other traits also these differences should be taken into account while making the crosses. The reciprocal differences are mainly due to difference in chromosome number in interspecific crosses and may be due to cytoplasmic inheritance.

Hence from this study it is concluded that Arka Anamika was found to be good general combiner for fruit number, fruit weight and fruit length and KL9 was identified for plant height, days to first flowering, leaf number, internode number and fruit weight. Arka Anamika x Sel 2 for good specific combination for the characters like plant height, days to first flowering, leaf number, internodal number and internode length. The F_1 hybrid of Arka Anamika x Salkeerthy identified as the best specific combination for fruit yield. The characters like plant height, days to first flowering, number of leaves, number of internodes, fruit length and fruit yield was controlled mainly by non additive genes indicating the presence of overdominance and it can be exploited for development of hybrids.

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Table 1. Estimation of Components of Variation for F1 Population of Okra

Components	Plant height	Days to first flowering	Number of leaves	Inter-nodal length	No. of internodes	Number of ridges	Fruit length	Fruit no	Fruit weight	Fruit yield
E	39.59	6.87**	0.79**	0.81**	0.98	0.00	1.44	0.55**	0.20**	4.31
D	207.79**	58.56**	6.14**	4.10**	4.09**	1.20**	32.15**	4.20**	1.20	4985.48**
F	54.92	17.63	-0.77	2.29	0.54	0.70**	28.72**	2.78**	7.49	5639.26**
H_1	976.76**	75.13**	21.49**	4.16**	16.05**	2.33**	45.63**	5.92**	8.75	7754.37**
H_2	856.28**	73.92**	21.63**	3.60**	15.42**	1.96**	36.22**	5.58**	7.20	5628.94**
h^2	1644.64**	226.64**	65.04**	1.85**	45.39**	4.19**	60.50**	17.22**	3.28	4765.04**
MDD	2.17	1.13	1.87	1.01	1.98	1.39	1.19	1.19	1.15	1.24
P/N	0.22	0.25	0.25	0.22	0.24	0.21	0.20	0.24	0.15	0.18
D/R	1.13	1.31	0.25	1.77	1.07	1.53	2.20	1.77	0.31	2.65
H(ns)	0.35	0.45	0.35	0.41	0.30	0.47	0.38	0.31	-0.24	0.34

Table 2. Combining ability and reciprocal effects of four parents and F_1s of Okra

Parents/ F1s	Plant height	Days to first flowering	Number of leaves	Number of internodes	Internodal length	Fruit number	Number of ridges	Fruit weight (g)	Fruit yield (g)	Fruit length (cm)
General Combining Ability Effects										
Arka Anamika (P1)	-2.36	-3.67**	-0.72	-1.27**	0.18	-0.73**	-0.28	298.52	12.86**	-1.49**
KL9 (P2)	-9.21**	-3.42**	-2.12**	-1.42**	-0.48	-0.63	0.92	-476.82	20.57**	1.07
Salkeerthy(P3)	-5.59	1.88	0.08	0.88	-0.96**	-0.18	-0.28	303.53	-0.09	2.69**
Sel 2 (P4)	16.84**	-0.17	1.93**	1.13**	1.48**	0.42	-0.38	-63.16	34.92**	0.20
Specific Combining Ability Effects										
P1x P2	-13.39**	0.17	-0.28	-0.28	-0.87	-0.12	0.68	-298.36	20.90**	1.60**
P1 x P3	-13.01**	0.12	0.27	0.27	1.76**	0.18	-0.12	2796.85**	-43.48**	-0.07
P1 x P4	-10.19**	-5.08**	-2.08**	-2.08**	-1.33**	0.08	-0.02	-714.40	11.81**	-0.31
P2 x P3	2.84	1.62	-1.33**	-1.33**	-0.25	-0.67	0.18	-299.08	-44.28**	-3.03**
P2 x P4	18.41**	1.17	0.57	0.57	2.13**	0.48	0.28	60.93	-24.42**	0.96
P3 x P4	4.29	0.12	0.12	0.12	0.74	-0.22	-0.02	-719.54	10.40**	0.82
Reciprocal Effects										
P2 x P1	1.50	1.00	1.00**	-0.75	-0.83	-	-	1.55	111.00**	-2.00**
P3 x P1	-1.00	-5.25**	0.75	0.50	1.83**	-0.25	-	-3880.39**	-34.09**	-5.45**
P3 x P2	-2.00	-5.00**	-0.75	-1.25**	2.20**	-	1.50	-5.00	-32.50**	-3.35**
P4 x P1	-21.75**	2.50**	-2.75**	-2.25**	-0.78	-1.75**	-	0.47	48.25**	-2.83**
P4 x P2	-45.00**	-3.50**	-4.50**	-4.00**	-2.38**	-1.25**	1.50	-1.16	-26.77**	-0.85
P4 x P3	-12.00**	1.25	-2.25**	-1.75**	-3.80**	0.50	-	0.85	15.45**	0.38