Journal of Tropical Agriculture 39 (2001): 98-101

COMBINING ABILITY IN OKRA *(ABELMOSCHUS ESCULENTUS* [L.] MOENCH)

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Abstract: A study was conducted to estimate the combining ability of six genetically divergent parental strains of okra by diallel analysis with respect to yield and a few related attributes. The combining ability analysis by the Method I of Griffing's (1959) approach revealed that the parent NBPGR/TCR 861 was the best general combiner for single fruit weight and length and NBPGR/TCR 864 for yellow vein mosaic resistance. Among hybrids, NBPGR/TCR 893 x NBPGR/TCR 864 exhibited outstanding sca effect for yield while NBPGR/TCR 865 x NBPGR/TCR 438 and NBPGR/TCR 893 x NBPGR/TCR 861 were notable for single fruit weight, length and girth. The hybrid NBPGR/TCR 854 x NBPGR/TCR 865 showed maximum tolerance to YVM.

Key words: *Abelmoschus esculentus*, okra, combining ability.

INTRODUCTION

Okra is an autogamous crop and so the breeding methods suitable for improving self-pollinated crops can successfully be employed in this crop. Exploitation of heterosis has been attempted and hybrid vigour has been reported with as much as 86% increased yield (Elmaksoud *et al.,* 1986). Combining ability of the parents is becoming increasingly important in plant breeding, especially in hybrid production. It is useful in connection with the testing procedures in which it is desired to study and compare the performance of the lines in hybrid combinations. Information on the general and specific combining abilities will be helpful in the analysis and interpretation of the genetic basis of important traits. Hence, the present study was undertaken with a view to assess the combining ability of six genetically divergent lines of okra in a diallel analysis.

MATERIALS AND METHODS

Six genetically divergent parent lines of okra were crossed in all possible combinations in a diallel fashion for the present study conducted in the Department of Plant Breeding and Genetics, College of Agriculture, Trivandrum. The six parents viz. NBPGR/TCR 893 (P_1), NBPGR/TCR 862 (P_2), NBPGR/TCR 854 (P_3), NBPGR/TCR 864 (P_4), NBPGR/TCR 865 (P_5) and NBPGR/TCR 438 (P_6) and the 30 F_1 hybrids were laid out in randomized block design with three replications during November 1994. Cultural and manurial practices were done as per package of practices recommendations of the Kerala Agricultural University (KAU, 1993). The data generated were utilized to estimate the combining ability by the Method I under Model I as suggested by Griffing (1956).

RESULTS AND DISCUSSION

The variances due to gca, sca and reciprocal effects are given in Table 1. The estimates of the gca effects of six parents and the sca effects of F_1 hybrids and the reciprocal crosses are presented in Tables 2 and 3.

Plant height: The variances due to gca, sca and reciprocal effects (Table 1) were significant indicating the operation of both additive and non-additive types of gene action in the inheritance of plant height. However, the greater magnitude of gca variance than that of sca pointed out the predominance of the additive gene action as was reported by Vijay and Manohar (1968) and Veeraraghavathatham and Irulappan (1991). The parent P_6 alone exhibited significant positive gca effect of 4.61 while the hybrids P_6 x P_1, P_2 x P_5, P_4x P_3, P_4 x P_6 and P_1 x P_4 showed significant positive sca effects of 9.30, 9.20, 9.08, 7.10 and 6.55 respectively. Thus the cross P6 x P1 was the best specific combination closely followed by P_2 x P_5 and P_4 x P_3.

Number of branches: The significance of gca and sca variances indicated the importance of both additive and non-additive gene actions. This is in conformity with the reports of Vijay and Manohar (1986). Among the parents, P_4 was the best general combiner with the highest gca effect of 0.44. The outstanding specific combination was P_1 x P_2 (0.54) followed by P_2 x P_6 (0.48) and P_3 x P_5 (0.42). Three reciprocal crosses viz. P_3 x P_1 (0.50), P_5 x P_1 (0.43)

Table 1. Analysis of variance for combining ability for the seven characters

Sl. No.	Characters	Mean squares			
		gca	sca	Reciprocal effects	Error
1	Plant height	110.73**	97.62**	66.02*	29.14
2	Number of branches	0.68**	0.63**	0.33**	0.06
3	Length of fruit	1.56*	1.79*	0.59	0.54
4	Girth of fruit	0.12	0.15*	0.07	0.05
5	Weight of single fruit	4.39*	4.79**	3.13*	1.61
6	Weight of fruits per plant	425.50	874.41**	610.14**	222.73
7	Incidence of YVM	0.17**	0.11**	0.12**	0.03

*Significant (P<0.05), **significant (P<0.01)

Table 2. Estimates of gca effects of the six parents

Character	P_1	P_2	P_3	P_4	P_5	P_6	SE	CD(0.05)
Plant height	1.40	1.67	-2.63	-3.00*	-2.05	4.61**	2.204	4.364
Number of branches	-0.23**	-0.04	-0.07	0.44**	-0.08	-0.17**	0.097	0.192
Length of fruit	0.31	0.41*	-0.36	0.05	0.08	-0.50*	0.300	0.594
Girth of fruit	-	-	-	-	-	-	-	-
Weight of single fruit	0.03	0.74*	-0.10	0.28	0.12	-1.08**	0.519	1.028
Weight of fruits per plant	-	-	-	-	-	-	-	-
Incidence of YVM	-0.06	-0.08	0.22**	-0.11	0.01	0.02	0.075	0.149

*Significant (P<0.05), **significant (P<0.01)

and P_6 x PI (0.37) also showed significant positive sca effects. Thus many crosses proved to be good specific combinations for branch number.

Length of fruit: The gca and sca variances were significant as was reported by Shukla *et al* (1989) and Veeraraghavathatham and Irulappan (1990). The ratio of gca to sca variance was less than unity indicating that the non-additive component of genetic variance was more important. This is in line with the findings of Vijay and Manohar (1986), Chaudhary *et al.* (1991) and Shivagamasundari *et al* (1992). Parent P_2 was outstanding with a gca effect of 0.41. The best specific combination was P_5 x P_6 (1.34) followed by P_1 x P_2 (1.19) and P_1 x P_4 (0.88).

Girth of fruit: The combining ability analysis indicated significance only for sca variance, implying that non-additive genetic variance was important for fruit girth. This is in conformity with the findings of Chaudhary *et al.* (1991) and Shivagamasundari *et al* (1992). None of the parents showed significant gca effects while significant positive sca effects were exhibited by three crosses P_5 x P6 (0.41), P_1 x P_2 (0.35) and P_1 x P_4 (0.30).

Weight of single fruit: Significant variances due to gca, sca and reciprocal effects were obtained indicating importance for both additive and non-additive genetic variance. This is in line with the findings of Vijay and Manohar(1986) and Veeraraghavathatham and Irulappan (1990). However, the sca variance was slightly greater than gca variance implying a major role of non-additive gene action as was reported by Chaudhari *et al.* (1991) and Shivagamasundari *et al* (1992). The parent P_2 alone exhibited significant positive gca effect of 0.74 while two crosses P_5 x P_6 and P_1 x P_4 and two reciprocal crosses P_4 x P_1 and P_3 x P_1 had significant positive sca effects of 1.98, 1.49, 2.99 and 2.09 respectively.

Weight of fruits per plant: The variances due to sca and reciprocal effects were significant indicating the predominant role of non-additive gene action. This is in conformity with the reports of Chaudhari *et al.* (1991), Shivagamasundari *et al.* (1992) and Wankhade *et al.* (1995). Significant positive sca effects

Table 3. Estimates of sca effects of the 30 hybrids

Crosses	Plant height	Number of branches	Length of fruit	Girth of fruit	Weight of single fruit	Weight of fruits /plant	Incidence of YVM
$P_1 \times P_2$	4.20	0.54**	1.19**	0.35**	1.29	32.52**	0.20
$P_1 \times P_3$	-1.12	-0.30	0.38	0.08	0.51	-3.29	0.24*
$P_1 \times P_4$	6.55*	-0.11	0.88**	0.30*	1.49*	33.62**	-0.16
$P_1 \times P_5$	-2.52	0.11	-1.74**	-0.26	-2.41	-28.44**	0.07
$P_1 \times P_6$	-3.12	-0.13	0.26	0.02	1.20	6.39	0.07
$P_2 \times P_3$	3.73	0.34*	-0.21	0.00	0.06	12.04	-0.15
$P_2 \times P_4$	-0.92	-0.81	0.55	0.08	1.04	-0.64	-0.26*
$P_2 \times P_5$	9.20**	-0.80	0.71	0.04	0.95	2.39	-0.11
$P_2 \times P_6$	-4.36	0.48**	-0.93*	0.08	-2.40**	18.82	-0.35
$P_3 \times P_4$	5.58	-0.30*	0.63	-0.05	0.97	3.08	-0.01
$P_3 \times P_5$	1.12	0.42**	-0.92*	-0.42**	-1.91*	12.50	-0.38**
$P_3 \times P_6$	-6.49*	-0.20	0.25	-0.16	-0.71	-0.70	0.22**
$P_4 \times P_5$	2.38	0.11	-0.14	0.26	0.24	8.42	0.22**
$P_4 \times P_6$	7.10*	-0.70**	-0.53	-0.21	-1.10	-4.46	-0.15
$P_5 \times P_6$	3.38	0.38**	1.34**	0.41**	1.98**	23.36**	-0.08
$P_2 \times P_1$	-9.25*	0.23	-	-	0.29	-17.10	-0.33*
$P_3 \times P_1$	-6.32	0.50**	-	-	2.09*	28.97**	0.20
$P_5 \times P_2$	-7.40*	0.40*	-	-	-0.13	2.60	-0.07
$P_4 \times P_1$	-3.70	0.67**	-	-	2.99**	30.65**	0.20
$P_4 \times P_2$	0.87	-0.03	-	-	-1.12	-5.12	-0.17
$P_4 \times P_5$	9.08*	0.03	-	-	-0.12	12.02	-0.23
$P_5 \times P_1$	5.56	0.43*	-	-	-2.01*	-14.07	0.03
$P_5 \times P_2$	-6.43	0.03	-	-	0.65	-1.13	-0.27*
$P_5 \times P_1$	1.67	-0.97**	-	-	0.96	0.92	-0.07
$P_5 \times P_4$	1.68	-0.37*	-	-	0.60	-0.28	0.47**
$P_6 \times P_1$	9.30*	0.37*	-	-	0.85	32.73**	0.30*
$P_6 \times P_2$	5.75	0.10	-	-	-1.40	-7.12	0.13
$P_6 \times P_3$	2.34	0.07	-	-	-0.26	3.15	0.40**
$P_6 \times P_4$	-3.64	-0.33**	-	-	-0.51	18.77	0.23
$P_6 \times P_5$	1.35	0.23	-	-	-0.16	25.37*	-0.17
SE (Sij-Sik)	4.93	0.22	0.67	0.21	1.16	13.62	0.17
SE (Sij-Skl)	4.41	0.19	0.60	0.19	1.04	12.19	0.15
CD (Sij-Sik)(0.05)	9.761	0.436	1.327	0.416	2.297	26.968	0.337
SE (Sij-Skl) (0.05)	8.732	0.376	1.188	0.376	2.059	24.136	0.297

were exhibited by three hybrids P_1 x P_4 (33.62), P_1 x P_2 (32.52) and P_5 x. P_6 (23.36) and four reciprocal crosses viz. P_6 x P_1 (32.73), P_4 x P_1 (30.65), P_3 x P_1 (28.97), and P_6 x P_5 (25.37). Thus the cross P] x P_4 was the best specific combination for fruit yield per plant followed closely by P_6 x P_1 and P_1 x P_2.

Incidence of yellow vein mosaic: Significant gca and sca effects were observed for the incidence of the disease. The ratio of gca to sca variance was greater than unity indicating a greater role of additive genetic variance as was observed by Veeraraghavathatham and Irulappan (1990, 1991). The parent P_4 alone

showed significant negative sca effect of -0.38. The disease incidence was influenced by reciprocal differences also with the crosses P_2 x P_1 having significant sca effects of -0.33 and -0.27 respectively. Thus the three crosses P_3 x P_5, P_2 x P_1 and P_5 x P_2 possessed some tolerance to the disease incidence.

The reciprocal differences seen for plant height, branch number, weight of single fruit, fruit yield per plant and disease incidence may be due to cytoplasmic inheritance.

In some of the characters studied, parents with high gca effects produced hybrids with low sca effects. This may be due to the lack of complementation of the parental genes. On the other hand, parents with poor gca produced hybrids with high sca effects which can be attributed to complementary gene action.

The combining ability analysis revealed that the parent P_4 was the best general combiner for a few yield related characters. Among the crosses, P_1 x P_4 exhibited outstanding sca effects for yield per plant.

ACKNOWLEDGEMENT

This paper forms a part of M.Sc (Ag.) thesis of the senior author submitted to the Kerala Agricultural University.

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