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COMBINING ABILITY STUDIES IN RICE (*ORYZA SATIVA* L.)

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Abstract

Combining ability analysis for yield contributing traits was carried out in rice through line x tester analysis of 32 hybridsdeveloped by crossing 8 female lines and 4 male testers. The 32 hybrids along with 12 parents andone standard checks were grown in a randomized block design with three replications and were evaluated for eight biometrical traits. Theexperiments were conducted at Annamalai University, Tamilnadu, India in Navarai, 2014 - 2015. The estimates of *gca* effects indicated that, among females, IVT 1220, IVT 1209 and IVT 1243 and among males ADT 36, ADT 38 and TRY3 were good general combinersfor grain yield per plant. High*sca* effectswere observed in the crosses, IVT 1220 X ADT 36, IVT 1209 × TRY 3, IVT 1243 x ADT 36 and IVT 1209 × ADT 38 they were found to be the best combinations for grain yield per plant and other quantitative traits.

Introduction

Success of any plant breeding programme depends on the choice of appropriate genotypes as parents in the hybridization programme. The combining ability studies of the parents provide information which helps in the selection of better parents for effective breeding. Combining ability analysis also provides information on additive and dominance variance. Its role is important to decide parents, crosses and appropriate breeding procedure to be followed to selectdesirable segregants (Salgotra *et al*., 2009). Accordingly, the present investigation was undertaken to get an idea of the combining ability for yield and its contributing traits with a view to identify good combiners which may be used to create a population with favourable genesfor yield and biometric traits in rice.

Materials and Methods

The experimental material comprising of eight cultures as a lines (IVT 1204, IVT 1207, IVT 1209, IVT 1220, IVT 1222, IVT 1235, IVT 1243, IVT 1248) and varieties as a testers (ADT 36, ADT 38, TRY3, SWARNA SUB-1) wereselected on the basis of the morphological differences. Crosses were made in line x tester fashion by adopting the "Isolation Free System" design advocated by Virmani and Casal (1993), as well as by pollinating theline by the respective donors. The resulting 32 hybrids along with 12 parents andone standard checks (SWARNA SUB-1) were grown in randomized block design in three replications at Annamalai University, Tamilnadu, India during Navarai, 2014 and 2015. Each entry was planted in a 3 meter long row withinter and intra row spacing of 20 x 15 cm. One line of each entry was planted in each replication. All the recommended agronomical and plant protection practices were uniformly applied throughout the crop growth period. Five competitive plants were randomly selected to record the observations on eight quantitative characters *viz*., days to 50 per cent flowering, plant height, total number of tillers per plant, number of productive tillers per plant, panicle length, number of grains per panicle, hundred grain weight and grain yield per plant and their mean values were subjected to statistical analysis.

Results and Discussion

Analysis of variance for combining ability Table1 revealed that the mean squares due tofemales (lines) were significant for all the character studied. The variance due to hybrids differed significantly for all the characters. The mean squares due to males (testers) were found significant for all the characters. Thus, suggesting the importance of heterosis breeding for improvement of rice.

General combining ability (gca) effects

gca effects of eight quantitative traits of the present study are presented in Table 2. The table showed that IVT 1209, IVT 1220 and IVT 1204 were produced highly significant gca for plant height, days to 50 per cent flowering, number of tillers per plant, number of productive tillers per plant, panicle length, number of grains per panicle and hundred grain weight, therefore these four lines were considered as

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the best general combiner for the respective traits. The results were in agreement with the findings of kavimani (2004), (Sood and Gartan, 1991) Similarly, IVT 1220 was identified as good general combiner for shorter plant height (-3.28) and days to 50 per cent flowering (-7.49) Significant negative *gca* effects for plant height and growth duration are useful for the development of early dwarf variety. Hossain *et al*. (2009) also mentioned similar report with the same parents. Results also showed that among the parental lines used in this study only IVT 1209, IVT 1220 andIVT 1204 produced significant positive *gca* for yield per plant which could be regarded as good general combiner for higher grain yield. On the other hand, for restorer, positive and significant gca effects were found in ADT 36 for plant height (-5.93), days to 50 per cent flowering (-5.48), hundred grain weight (0.31) and grain yield per plant (4.81) (Table 2). The results were in agreement with the findings of Hossain *et al*. (2009), Rashid *et al.* (2007) and Singh and Kumar (2004). However, the restorer line was found under significant *gca* effect for yield per plant. It could be mentioned that the parents with significant and positive *gca* values might be contributed positive alleles in their hybrid due to its additive nature of gene action for the respective traits and the gca effects of parents has been attributed to additive gene effects are readily transmitted from one generation to another (Gravois and Mc New, 1993).

Specific combining ability (sca) effects

Specific combining ability (sca) of a cross is the estimation and the understanding of the effect of non additive gene action for a trait. Non-additive gene action of a trait is an indicator for the selection of a hybrid combination. Therefore, a highly significant sca effect is desirable for a successful hybrid breeding program. The results of sca effect of the present study are given in the Table 3. The results showed that out of 32 hybrid combinations two of them *viz*. IVT 1220 x ADT 36, IVT 1209 x TRY 3 recorded significant and negative sca effect for shortening plant height. Similarly, for growth duration eight combinations possessed significant and negative sca which were desirable for early maturity hybrid and almost all the traits studied. This combination could be selected for further evaluation for high yield heterosis. The other two crosses *viz*., IVT 1243 x ADT 36, IVT 1209 x ADT 38 combinations possessed highly non-significant and positive sca for most the character studied These combinations might be used for further evaluation. The results were confirmed with the findings of Ganesen and Rangaswamy (1997), Roy and Mandal (2001), kumar and singh (2004) and Rashid *et al.* (2007), Padmavathi *et al*. (1997), Amar Gholizadeh Ghara *et al*. (2014)

Conclusion

All the yield contributing characters were found under less than unity of gca : sca ration which might be influenced by non-additive gene actio and may be impressive in favor of hybrid development. The *sca* effect of the hybrids IVT 1220 X ADT 36 and IVT 1209 X TRY 3 was found to be highly significant for grain yield and its component traits studied thus indicated the predominance of non additive gene action. These combinations could be used for exploitation of heterosis . The other two hybrids, IVT 1243 X ADT 36 and IVT 1209 X ADT 38 which recorded high mean for grain yield and its components also had non-significant *sca* effects for grain yield and its component traits indicated the presence of additive gene action. The crosses *viz.,* IVT 1243 X ADT 36 and IVT 1209 X ADT 38 which revealed high mean with non significant *sca* effects could be undertaken for further improvement of hybridization programme for grain yield and its attributing characters.

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Table 1: ANOVA for combining ability analysis in rice

Source of variance	Df	MSS							
		Days to 50 percent flowering (days)	Plant height (cm)	Total number of tillers per plant	Number of productive tillers per plant	Panicle length (cm)	Number of grains per panicle	Hundred grain weight (g)	Grain yield per plant (g)
Replication	2	5.02	1.84	1.43	10.04	10.28	43.25	0.001	4.02
Genotype	43	235.12**	136.78**	33.36**	43.28**	24.44**	619.04**	1.60*	78.17**
Cross	31	245.83**	133.14**	26.39**	37.40**	15.45**	453.52**	1.65*	76.89**
Line	7	122.53**	88.72**	72.28**	110.73**	25.59**	524.88**	2.63*	188.90**
Tester	3	1743.75**	864.31**	14.43**	8.39**	10.22**	250.33**	2.78*	34.98**
L X T	21	72.94**	43.50**	12.80**	17.11**	12.81**	458.76**	1.78*	45.54**
Error	86	1.28	1.75	0.65	2.09	2.86	10.29	0.01	1.71
GCA variance		3.43	1.78	0.27	0.40	0.05	0.10	0.00	0.62
SCA variance		23.88	13.91	4.05	5.00	3.31	149.49	0.02	14.61
GCA/SCA variance		0.14	0.12	0.06	0.08	0.02	6.68	0.00	0.04

Note :* and ** indicate level of significance at 5% and 1% respectively

Table 2: Estimation of general combining ability (gca) effects of parents for various traits in rice

S.No.	SOURCE	Days to 50 per cent flowering	Plant height	Total number of tillers per plant	Number of productive tillers per plant	Panicle length	Number of grains per panicle	Hundred grain weight	Grain yield Per plant
Lines									
1.	IVT 1204	1.79**	4.37**	-1.93**	-2.67**	0.81	-6.00**	-0.17**	-3.18**
2	IVT 1207	0.74*	1.64**	-1.64**	-1.08*	-2.79**	-5.30**	-0.03**	-1.50**
3	IVT 1209	-0.19	-3.61**	1.09**	1.68**	1.61**	12.54**	0.11**	5.23**
4	IVT 1220	-7.49**	-3.28**	2.03**	3.20**	1.60**	5.79**	0.31**	4.81**
5	IVT 1222	2.74**	1.30**-	2.07**	0.90*	-0.07	-0.40	-0.21**	-0.12
6	IVT 1235	1.92**	0.29	2.28**	3.18**	-1.14**	-7.01**	-0.06**	-0.64
7	IVT 1243	-0.17	-1.79**	0.62**	0.44	0.08	1.25	0.08**	1.96**
8	IVT 1248	0.66*	1.08**	-4.54**	-5.67**	-0.10	-0.87	-0.02*	-6.56**
Testers									
1.	ADT 36	-5.48**	-5.93**	0.07	0.12	0.64	-0.76	0.07**	1.03**
2.	ADT 38	-4.94**	-2.70**	0.04	0.79**	0.49	0.42	0.04**	1.01**
3.	TRY-3	-2.18**	0.56*	1.08**	-0.41	-0.58	4.07**	0.02**	0.69*
4.	SWARNA SUB -1	12.60**	8.08**	-1.19**	-0.50	-0.54	-3.74**	-0.13**	-2.73**
	SEd.	0.92	1.08	0.65	1.18	1.38	2.61	0.02	1.06

Note :* and ** indicate level of significance at 5% and 1% respectively

Table 3: Estimation of specific combining ability (sca) effects for various traits in rice

S.No.	Hybrids	Days to 50 per cent flowering	Plant Height	Total number of tillers per plant	Number of productive tillers per plant	Panicle length	Number of grains per panicle	Hundred grain weight	Grain yield Per plant
1	$L_1 \times T_1$	-4.16**	-3.62**	0.62	-0.55	-1.55	-5.88**	-0.03	-1.71*
2	$L_1 \times T_2$	-4.23**	-0.85**	0.71	0.13	0.39	0.54	0.02	-1.00
3	$L_1 \times T_3$	-0.65	-0.37**	-2.00**	0.19	1.30	-0.12	-0.10**	-0.89
4	$L_1 \times T_4$	9.03**	4.84**	0.67	0.23	-0.14	5.46**	0.11**	3.60**
5	$L_2 \times T_1$	2.02**	1.58*	-0.47	-2.84**	1.85	1.45	0.03	-1.75*
6	$L_2 \times T_2$	2.35**	0.58	-2.09**	-0.56	2.89**	-6.43**	-0.09**	7.07**
7	$L_2 \times T_3$	-1.91**	2.59**	2.18**	2.42**	-3.37**	3.05	0.06**	1.97*
8	$L_2 \times T_4$	-2.46**	-4.76**	0.38	0.98	-1.37	1.93	0.00	-1.71*
9	$L_3 \times T_1$	0.29	5.20**	-2.23**	-2.6**	-3.12**	-29.28**	-0.11**	-3.12**
10	$L_3 \times T_2$	-1.38*	-3.11**	2.32**	2.43**	0.96	19.53**	0.02	0.96
11	$L_3 \times T_3$	-3.53**	0.01	-0.01	2.48**	1.57	11.22**	0.22**	2.46**
12	$L_3 \times T_4$	4.62**	-2.11**	-0.08	-2.31**	0.59	-1.47	-0.13**	-0.30
13	$L_4 \times T_1$	3.42**	-4.06**	3.33**	3.38**	1.95*	26.93**	0.21**	2.94**
14	$L_4 \times T_2$	4.65**	0.70	-0.82	-1.19	-1.63	-14.26**	-0.07**	-2.82**
15	$L_4 \times T_3$	3.09**	-3.12**	-1.59**	0.27	-0.49	-12.57**	-0.09**	-2.30**
16	$L_4 \times T_4$	-11.16**	6.49**	-0.92*	-2.46**	0.17	-0.10	-0.04**	2.18**
17	$L_5 \times T_1$	0.24	3.28**	-2.71**	-0.94	-1.60	0.55	-0.35**	-1.02
18	$L_5 \times T_2$	0.43	-0.48	-0.26	1.16	0.14	6.80**	-0.01	-2.64**
19	$L_5 \times T_3$	-1.99**	-2.64**	1.14**	-3.28v	0.52	-0.65	0.21**	4.87**
20	$L_5 \times T_4$	1.32*	-0.16	1.84**	3.06**	0.94	-6.71**	0.15**	-1.21
21	$L_6 \times T_1$	-0.89	3.23**	-0.39	-0.70	1.64	0.84	-0.14**	2.62**
22	$L_6 \times T_2$	-1.93**	-1.07	0.06	-0.62	0.38	1.25	0.04**	1.07
23	$L_6 \times T_3$	5.02	-1.26	-0.07	0.67	0.41	-4.46*	0.07**	-1.12
24	$L_6 \times T_4$	-2.20**	-0.91	0.39	0.65	-2.43*	2.38	0.38**	-2.57**
25	$L_7 \times T_1$	-0.91	-5.87**	4.37**	5.01**	2.79**	13.67**	0.03	1.50
26	$L_7 \times T_2$	-0.61	1.99*	-1.38**	-1.98*	-3.20**	-14.32**	-0.10**	-5.72**
27	$L_7 \times T_3$	-5.10**	1.63*	-0.45	-2.58**	-1.16	0.90	-0.16**	-2.02**
28	$L_7 \times T_4$	6.62**	2.25**	-2.55**	-0.44	1.57	-0.26	-0.11**	0.67**
29	$L_8 \times T_1$	-0.02	0.24	-2.54**	-0.75	-1.95*	-8.27**	0.02	-5.03**
30	$L_8 \times T_2$	0.71	2.24**	1.45**	0.63	0.06	6.88**	-0.01	8.65**
31	$L_8 \times T_3$	5.08**	3.15**	0.81	-0.18	1.23	2.63	0.00	-2.97**
32	$L_8 \times T_4$	-5.77**	-5.64**	0.28	0.30	0.66	-1.23	-0.01	-0.65
	S.Ed.	0.92	1.08	0.65	1.18	1.38	2.61	0.02	1.06

Note :* and ** indicate level of significance at 5% and 1% respectively