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Full Length Review Article

STUDIES ON COMBINING ABILITY FOR YIELD ATTRIBUTES IN RICE (Oryza sativa L.)

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A line × tester analysis was made in rice with six ovule parents and five pollinator parents so as to identify suitable general and specific combiner for breeding program. Dominant types of gene action for all the seven traits namely, days to first flower, plant height, number of productive tillers per plant, panicle length, filled grains per panicle, hundred grain weight and grain yield per plant was observed. Parents TRY 1, ADT 36, AURC 8 and AURC 10 were good general combiners for grain yield per plant and most of the yield traits. The cross combinations AURC 10 × ADT 43, AURC 8 × ADT 43, AURC 8 × ADT 36 and AURC 25 × ADT 36 were the best specific combiners for grain yield per plant. Hence, these four cross combinations may be used for exploitation of heterosis for yield contributing traits in rice

Key words: Rice, Combining ability, Line × tester analysis.

INTRODUCTION

The success of any breeding programme depends on the choice of right parents for hybridization programme. Combining ability analysis of the parents and their crosses provide information on the two variance *viz.,* additive and dominance, which are important to decide the parents and crosses be selected for eventual success and also the appropriate breeding procedures to be followed to select desirable segregants. Hence, a study on combining ability of six lines and five testers was undertaken.

MATERIALS AND METHODS

Six lines *viz.,* AURC 1, AURC 8, AURC 10, AURC 14, AURC 22 and AURC 25 and five testers (ADT 36, ADT 39, ADT 43, IR 64 and TRY1) and their thirty hybrids were grown in randomized block design during June 2011 with three replications. For each entry, 20 plants were maintained in each replication with spacing of 20 cm between rows and 15 cm between plants with in a row. Observations were recorded on days to first flower, plant height, number of productive tillers per plant, panicle length, filled grains per panicle, hundred grain weight and grain yield per plant. Estimates of combining ability were computed according to Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed highly significant differences among the hybrids with respect to all the characters (Table1) studied. The significance of mean square due to lines (varieties being used as female parent) and testers (varieties being used as male parent) indicated prevalence of additive variance for most of the characters. The significance of mean squares due to line × tester for all the characters indicated that non-additive variance was important for majority of the characters. The predominance of SCA variance for all the characters suggested that dominance was important for controlling these traits, confirming the earlier findings of Satyanarayana *et al.* (2000); Panwar (2005) and Saravanan *et al.* (2006). The mean performance of parents in line AURC 22 (33.08 g) and tester ADT 36 (27.08 g) had registered significantly higher mean of grain yield per plant (Table 2). The mean performance of hybrid AURC 14 × TRY 1 had registered significantly higher mean for number of productive tillers per plant (23.40), panicle length (23.30), filled grains per panicle (123.90), hundred grain weight (2.53 g) and grain yield per plant (34.08 g) (Table 3).

General combining ability effects

Analysis of mean performance of the parents and their *gca* effects reveal that gca is reflective of mean for almost all the characters studied (Table 2). Based on *gca* effects TRY 1, ADT 36, AURC 8 and AURC 10 were found to be good general combiner for grain yield per plant. AURC 22 was found to be good general combiner for plant height, number of productive tillers per plant, panicle length, filled grains per panicle and hundred grain weight. ADT 36 was identified as good general combiner for days to first flower.

Specific combining ability effects

High *sca* effect results mostly from the dominance and interaction effects existing between the hybridized parents. In the present study, positive significant *sca* effects for grain yield per plant was exhibited by 10 crosses *viz.,* AURC 1 × ADT 36, AURC 8 × ADT 36, AURC 8 × ADT 43, AURC 10 × ADT 43, AURC 14 × ADT 36, AURC 14 × TRY1, AURC 22 × ADT 39, AURC 22 × IR 64, AURC 22 × TRY 1 and AURC 25 × ADT 36 (Table 3). Most of the crosses having significant *sca* effects recorded higher *per se* performance. The cross combinations having significant *sca* effects but failed to recoded high *per se* performance results from parents with low × low *gca* effects. The present findings also indicate that crosses having significant *sca* effects recorded the highest *per se* performance where either of the parent involved in the combination have high *gca* effects. In addition to grain yield per plant, the crosses having significant and positive *sca* effects for different traits were AURC 8 × ADT 43 for number of productive tillers per plant, panicle length, filled grains per panicle,

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Table 1. Analysis of variance for combining ability for seven characters in rice

Source	df	Days to first flower	Plant height	Number of productive tillers per plant	Panicle length	Filled grains per panicle	Hundred grain weight	Grain yield per plant
Replication	2	2.6890	7.8849	0.9990	0.0061	41.5015	0.0011	0.1124
Hybrid	29	119.8103**	257.3107**	9.3302**	6.3560**	150.8746**	0.1286**	37.6092**
Line	5	105.2800**	568.0260**	3.0048**	1.4914**	162.9640**	0.4357**	5.2098**
Tester	4	497.1875**	780.3937**	21.2665**	3.2910**	438.5710**	0.3050**	136.7559**
LXT	20	47.9675**	75.0152**	8.5243**	8.1852**	90.3130**	0.0165**	25.8797**
Error	80	1.7265	1.1146	0.2320	0.1020	3.4880	0.0024	0.4686
Estimation of variance								
GCA		1.5748	3.9959	0.0177	0.0401	1.3275	0.0025	0.2571
SCA		15.5145	24.7486	2.8152	2.6981	29.7171	0.0055	8.4701
GCA/SCA		0.0105	0.1614	0.0062	0.0148	0.0446	0.4545	0.0303

** Significant at 1 *per cent* level

Table 2. Mean and general combining ability effects of parents for seven characters in rice

Parents	Mean/ gca	Days to first flower	Plant height (cm)	Number of productive tillers per plant	Panicle length (cm)	Filled grains per panicle	Hundred grain weight (g)	Grain yield per plant (g)
LINES								
AURC 1	Mean	90.50	112.45	15.90	22.35**	111.65**	2.61**	25.62
	gca	-1.93**	4.65**	-0.16*	0.56**	-5.15**	-0.01**	0.21
AURC 8	Mean	84.00**	115.10	18.40**	21.60	122.40**	2.63**	26.05
	gca	-1.13**	6.82**	0.38**	-0.18*	1.69**	0.05**	0.63**
AURC 10	Mean	90.51	100.50**	18.40**	22.10	108.30	2.08	32.09**
	gca	3.67**	-6.39**	-0.62**	-0.30**	1.13**	-0.28**	0.36*
AURC 14	Mean	90.01	90.65**	17.20	20.90	93.40	2.47	25.29
	gca	3.07**	-8.57**	0.54**	-0.11	2.77**	-0.08**	0.03
AURC 22	Mean	80.00**	106.75**	15.00	21.90	110.00	3.07**	33.08**
	gca	-2.33**	2.37**	0.20**	0.15*	2.61**	0.23**	-1.06**
AURC 25	Mean	83.01**	115.60	17.50**	23.40**	116.60**	2.57*	25.19
	gca	-1.33**	1.14**	-0.34**	-0.13	-3.03**	0.07**	-0.17
SE	Mean	0.435	0.320	0.102	0.110	0.393	0.002	0.250
	gca	0.308	0.226	0.072	0.077	0.278	0.001	0.176
TESTERS								
ADT 36	Mean	65.50**	82.40**	24.10**	22.00	95.60**	1.96	27.08**
	gca	-4.00**	-0.07	-0.61**	0.44**	1.95**	-0.03**	1.24**
ADT 39	Mean	91.50	96.75	17.50	23.80**	78.00	1.89	23.16
	gca	5.42**	-1.22**	-0.11	-0.34**	-7.10**	-0.07**	-2.37**
ADT 43	Mean	65.02**	73.90**	24.20**	21.80	76.00	1.66	24.06
	gca	-3.67**	-7.84**	1.04**	-0.21**	-0.90**	-0.16**	-2.59**
ADT 64	Mean	67.01**	92.00	17.20	23.60**	97.90**	2.33**	22.41
	gca	-3.83**	-1.30**	-1.43**	-0.37**	-0.44	0.08**	-0.33*
TRY 1	Mean	92.50	108.75	15.00	21.70	97.00**	2.58**	23.68
	gca	6.08**	10.43**	1.11*	0.49**	6.50**	0.17**	4.05**
SE	Mean	0.397	0.292	0.093	0.100	0.359	0.002	0.228
	gca	0.281	0.206	0.066	0.071	0.254	0.001	0.161

*Significant at 5 *per cent* level ** Significant at 1 *per cent* level

Table 3. Mean and specific combining ability effects of hybrid for seven characters in rice

Hybrids	Mean/ *sca*	Days to first flower (days)	Plant height (cm)	Number of productive tillers per plant	Panicle length (cm)	Filled grains per panicle	Hundred grain weight (g)	Grain yield per plant (g)
AURC 1 × ADT 36	Mean	61.00**	112.70	20.50	25.00**	105.00	2.21	31.83**
	sca	-11.40**	5.67**	-0.09	1.45**	-0.95	-0.09**	1.32**
AURC 1 × ADT 39	Mean	85.50	105.20	18.60	24.10**	100.60	2.42**	29.83
	sca	3.68**	-0.68	-2.49**	1.34**	3.70**	0.16**	-2.18**
AURC 1 × ADT 43	Mean	71.00**	96.20**	22.30**	20.30	98.70	2.16	22.83
	sca	-1.73*	-3.06**	0.06	-2.60**	-4.40**	-0.02**	-3.85**
AURC 1 × IR 64	Mean	79.03	101.70	20.60	24.25**	109.40	2.44**	29.44
	sca	6.43**	-4.10**	0.83**	1.51**	5.84**	0.01**	0.49
AURC 1 × TRY 1	Mean	85.50	119.70	24.00**	21.90	106.30	2.46**	32.43**
	sca	3.02**	2.17**	1.69**	-1.70**	-4.20**	-0.05**	-0.89*
AURC 8 × ADT 36	Mean	79.00	106.20	23.60**	21.00	112.80**	2.43**	31.61**
	sca	5.80**	-3.00*	2.47**	-1.80**	0.01	0.06**	2.93**
AURC 8 × ADT 39	Mean	79.00	111.60	21.10	22.50	99.50	2.22	27.48
	sca	-3.62**	3.55**	-0.53**	0.48**	-4.24**	-0.11**	0.16
AURC 8 × ADT 43	Mean	76.02*	99.40**	24.10**	24.80**	114.90**	2.37**	32.08**
	sca	2.47**	-2.03**	1.32**	2.65**	4.96**	0.13**	4.97**
AURC 8 × IR 64	Mean	71.00**	106.55	19.10	20.40	119.30**	2.45**	27.83
	sca	-2.37**	-1.42**	-1.21**	-1.59**	8.90**	-0.03**	-1.54**
AURC 8 × TRY 1	Mean	81.00	122.60	20.80	23.10*	107.70	2.50**	32.33**
	sca	-2.28**	2.90**	-2.05**	0.25	-9.64**	-0.06**	-1.41**

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AURC 14 × ADT 36	Mean	81.00	93.10**	21.20	24.40**	115.80**	2.23	32.33**
	sca	3.60**	-0.71	-0.09	1.52**	1.93**	0.01**	2.00**
AURC 14 × ADT 39	Mean	87.00	89.00**	23.20**	20.80	104.20	2.18	26.81
	sca	0.18	-3.66**	1.41**	-1.30**	-0.62	-0.01**	0.10
AURC 14 × ADT 43	Mean	77.01	89.50**	22.60**	22.50	111.00*	2.06	23.61
	sca	-0.73	3.46**	-0.34**	0.27	-0.02	-0.04**	-2.89**
AURC 14 × IR 64	Mean	75.00**	96.10**	19.10	21.20	104.70	2.30	28.61
	sca	-2.57**	3.52**	-1.37**	-0.87**	-6.78**	-0.04**	-0.15
AURC 14 × TRY 1	Mean	87.00	101.70	23.40**	23.30**	123.90**	2.53**	34.08**
	sca	-0.48	-2.61**	0.39**	0.37*	5.48*	0.09**	0.94*
AURC 22 × ADT 36	Mean	73.01**	107.20	20.80	23.90**	115.20**	2.61**	28.49
	sca	1.00	2.45**	-0.15	0.76**	1.49**	0.07**	-0.74
AURC 22 × ADT 39	Mean	83.00	112.00	23.20**	22.10	106.60	2.46**	26.41
	sca	1.58**	8.40**	1.75**	-0.25	1.94**	-0.04**	0.79*
AURC 22 × ADT 43	Mean	72.00**	101.20	19.00	20.60	106.90	2.36**	22.21
	sca	-0.33	4.22**	-3.60**	-1.89**	-3.96**	-0.05**	-3.19**
AURC 22 × IR 64	Mean	69.01**	94.40**	22.00**	23.30**	112.80**	2.60**	32.08**
	sca	-3.17**	-9.12**	1.87**	0.97**	1.48*	-0.05**	1.42**
AURC 22 × TRY 1	Mean	83.02	109.30	22.80**	23.60**	117.30**	2.80**	33.78**
	sca	0.92	-5.95**	0.13	0.41*	-0.96	0.06**	1.73**
AURC 25 × ADT 36	Mean	73.00**	103.00	19.20	23.30**	111.80**	2.36**	32.44**
	sca	0.01	-0.52	-1.21**	0.44*	3.73**	-0.02**	2.31**
AURC 25 × ADT 39	Mean	83.00	98.90**	20.10	21.60	100.90	2.32	26.36
	sca	0.58	-3.48**	-0.81**	-0.47**	1.88**	-0.02**	-0.16
AURC 25 × ADT 43	Mean	71.00**	96.58**	22.80**	21.10	103.30	2.26	24.14
	sca	-2.33**	0.82	0.74**	-1.11**	-1.92**	0.01**	-2.16**
AURC 25 × IR 64	Mean	75.00**	106.00	20.00	22.50	98.80	2.54**	28.60
	sca	1.83**	3.70**	0.41*	0.45*	-6.88**	0.05**	0.03
AURC 25 × TRY 1	Mean	83.00	113.50	23.00**	23.60**	115.80**	2.56**	32.93**
	sca	-0.08	-0.52	0.87**	0.69**	3.18**	-0.02**	-0.02
SE	Mean	0.974	0.716	0.228	0.246	0.880	0.004	0.559
	sca	0.689	0.506	0.161	0.174	0.622	0.003	0.395

*Significant at 5 *per cent* level ** Significant at 1 *per cent* level

hundred grain weight and grain yield per plant, AURC 14 × TRY 1 for number of productive tillers per plant, panicle length, filled grains per panicle, hundred grain weight and grain yield per plant, also AURC 22 × IR 64 for days to first flower, number of productive tillers per plant, panicle length, filled grains per panicle and grain yield per plant. Among the 30 hybrids, 10 crosses exhibited positive significant *sca* effects for grain yield per plant. Out of these 10 cross combination, the crosses AURC 8 × ADT 43 and AURC 10 × ADT 43 involved one parent with high *gca* effect and other having low *gca* effect, indicating additive as well as non-additive genetic actions operating in the crosses. These results are in conformity with the earlier findings of Peng and Virmani (1990), Hasib *et al.,* (2001), Panwar (2005), Sabesan (2005), Saravanan *et al.,* (2006), Satheeshkumar *et al.,* (2010), Waghmode *et al.,* (2011) and Padmavathi *et al.,* (2012). From this study, it was observed that non additive gene action was important in controlling various characters. The best combiner AURC 8, AURC 10, ADT 36 and TRY 1 could be utilized in future breeding programmes. The hybrid AURC 10 × ADT 43, AURC 8 × ADT 43, AURC 8 × ADT 36 and AURC 25 × ADT 36 could be used for exploitation of heterosis for yield and yield contributing traits.

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