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RESEARCH PAPER

Selection of superior genotypes in rice (*Oryza sativa* L.) through combining ability analysis

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Abstract : Combining ability analysis was studied in a line x tester analysis of rice (*Oryza sativa* L.). The analysis of variance for combining ability revealed that the variance due to GCA and SCA were highly significant for all the characters indicated that non-additive gene actions were involved in the expression of the traits. Among the line AURC 14 and testers IR 64 and ADT 43 were considered as the best general combiners, while hybrids AURC 1 x ADT 36, AURC 8 x ADT 36, AURC 8 ADT 43, AURC 10 x ADT 43, AURC 14 x ADT 36, AURC 14 x TRY 1, AURC 22 x IR 64, AURC 22 x TRY 1 and AURC 25 x ADT 36 as good specific combiners for grain yield and other yield contributing and quality traits. The promising line AURC 14 and testers IR 64 and ADT 43 which are having high GCA effects in desirable direction for yield components and for quality traits may be incorporated in crossing programme. The crosses AURC 14 x TRY 1 and AURC 22 x IR 64 exhibited good SCA effects for major yield and more than seven yield contributing characters. This may be exploited for better yield and quality either by exploiting them through heterosis breeding or involving them in multiple cross breeding programme.

Key Words : Rice, Combining ability analysis, Gene action, Line x tester analysis

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INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most important food crops and a primary source of food for more than half of the world population. Now the rice productivity has reached a ceiling in yield. To overcome the yield barriers and quality improvement, the combining ability analysis is a powerful tool to discriminate good as well as poor combiners.This helps in choosing appropriate parental materials for particular traits in the rice improvement programme. Therefore, rice improvement for quality depends intensive on hybridization using quality and high yielding commercial parental lines. To evolve an effective hybridization programme combining ability analysis is used to test the performance of genotypes in different cross combinations and characterize the nature and magnitude of gene effects in the expression of various yield and quality parameters. However, breeding of yield contributing and quality resistance genotypes requires selection of parents on their combining ability of the traits. In view of this, objective of present study was to identify the best combining parents on the basis of their general and specific combining ability for various traits for further

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yield components and quality improvement in rice.

Material and Methods

The basic material for the present investigation comprised of eleven rice genotypes/ varieties for six lines *viz.*, AURC 1, AURC 8, AURC 10, AURC 14, AURC 22 and AURC 25 and five testers *viz.*, ADT 36, ADT 39, ADT 43, IR 64 and TRY 1 was obtained from various place were utilized for the study. The genotypes were used for crossing programme in a line x tester analysis (6 lines x 5 testers). Field plot was well prepared for sowing of the experimental material (41 genotypes – comprising 11 parents and 30 F_1's seeds). The experiment was conducted in a Randomized Block Design during Samba (August–December), 2011 with three replications. Each genotype was accommodated in a row of 3 m length. The seedlings were transplanted at the rate of one seedling per hill, after 25 days with the spacing of 20 x 15 cm. A uniform population of 20 plants in a row per replication was maintained. Normal agronomic practices and need based plant protection measures were adopted to raise the crop. Observations were recorded on ten randomly selected plants both in parents and hybrids per replication. Observation were recorded on days to first flower, plant height, number of productive tillers per plant, panicle length, filled grains per panicle, hundred grain weight, grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio 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 (Table 1) revealed that the variance due to general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the characters. The greater magnitude of SCA variance than GCA variance indicated the role of non-additive gene action for all the thirteen characters. Similar results were also reported by Deepa *et al.* (2008) and Tiwari *et al.* (2011) for days to first flowering, Amudha *et al.* (2011) and Padmavathi *et al.* (2013) for plant height, Saidaiah *et al.* (2010) and Sanghera and Hussain (2012) for number of productive tillers per plant, Ghosh *et al.* (2013) for panicle length, Padmavathi *et al.* (2013) for filled grains per panicle, Roy and Senapati (2012) for hundred grain weight and Ghosh *et al.* (2013) for grain yield per plant. The additive variance (σ^2A) and dominance variance (σ^2D) revealed that dominance variance (σ^2D) was greater than the additive variance (σ^2A) for all the characters. The ratio of (σ^2A)/(σ^2D) ranged from 0.0062 (number of productive tillers per plant) to 0.4804 (grain L/B ratio).

The range and mean performance along with GCA effects of 11 parents (6 lines and 5 testers) for all the 13 attributes have been presented in Table 2. Based on the combining ability effects, the parents values were categorized in three groups as good (G), average (A) and poor (P) general combiners. The parents with significant GCA effects towards desirable direction were considered as good general combiners (G), with positive GCA effects were considered as average general combiners (A) basis of good general combiner was taken as desirable *per se* performance and significance GCA and the parents with negative GCA effects were designated as poor general combiners (P).

The good combiners on the basis of *per se* performance and significant GCA effects in desirable direction were observed in line AURC1 for panicle length. Similarly, line AURC 8 for days to first flowering, number of productive tillers per plant, filled grains per panicle and hundred grain weight. The line AURC 10

Table 1 : Analysis of variance for combining ability for 13 characters in rice

Parents and hybrids variation	Days to first flowering (days)	Plant height (cm)	Number of productive tillers per plant	Panicle length (cm)	Filled grains per panicle	Hundred grain weight (g)	Grain length (mm)	Grain breadth (mm)	Grain L/B ratio	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Grain yield per plant (g)
GCA	1.5748	3.9959	0.0177	0.0401	1.3275	0.0025	0.0046	0.0078	0.0160	0.0059	0.0012	0.0013	0.2571
SCA	15.5145	24.7486	2.8152	2.6981	29.7171	0.0055	0.0157	0.0169	0.0333	0.0187	0.0030	0.0121	8.4701
Estimated variances due to													
σ^2A (F=1)	3.1496	7.9918	0.0353	0.0802	2.6550	0.0049	0.0091	0.0156	0.0319	0.0118	0.0001	0.0027	0.5142
σ^2D (F=1)	15.5145	24.7486	2.8152	2.6981	29.7171	0.0055	0.0157	0.0169	0.0333	0.0187	0.0022	0.0121	8.4701
σ^2A/ σ^2D	0.2030	0.3229	0.0125	0.0297	0.0893	0.8909	0.5796	0.9230	0.9579	0.6310	0.0454	0.2231	0.0607
GCA/SCA	0.0105	0.1614	0.0062	0.0148	0.0446	0.4545	0.2929	0.4615	0.4804	0.3155	0.4000	0.1074	0.0303

Table 2: Mean performance of parents along with GCA effects for grain yield and its components traits in rice

Genotypes (Parents)	Days to first flowering (days)		Plant height (cm)		Number of productive tillers per plant		Panicle length (cm)		Filled grains per panicle		Hundred grain weight (g)	
Lines	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
AURC 1	90.50	-1.93**	112.45	4.65**	15.90	-0.16*	22.35**	0.56**	111.65**	-5.15**	2.61**	-0.01**
AURC 8	84.00**	-1.13**	115.10	6.82**	18.40**	0.38**	21.60	-0.18*	122.40**	1.69**	2.63**	0.05**
AURC 1 0	90.51	3.67**	100.50**	-6.39**	18.40**	-0.62**	22.10	-0.30**	108.30	1.13**	2.08	-0.28**
AURC 14	90.01	3.07**	90.65**	-8.57**	17.20	0.54**	20.90	-0.11	93.40	2.77**	2.47	-0.08**
AURC 22	80.00**	-2.33**	106.75**	2.37**	15.00	0.20**	21.90	0.15*	110.00	2.61**	3.07**	0.23**
AURC 25	83.01**	-1.33**	115.60	1.14**	17.50**	-0.34**	23.40**	-0.13	116.60**	-3.03**	2.57*	0.07**
S.E.±	0.435	0.308	0.320	0.226	0.102	0.072	0.110	0.077	0.393	0.278	0.002	0.001
Mean	86.33		108.50		17.06		22.04		110.39		2.57	
C.D. (P=0.05)	0.862		0.634		0.202		0.218		0.779		0.003	
C.D. (P=0.01)	1.146		0.842		0.269		0.289		1.035		0.005	
Testers	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
ADT 36	65.50**	-4.00**	82.40**	-0.07	24.10**	-0.61**	22.00	0.44**	95.60**	1.95**	1.96	-0.03**
ADT 39	91.50	5.42**	96.75	-1.22**	17.50	-0.11	23.80**	-0.34**	78.00	-7.10**	1.89	-0.07**
ADT 43	65.02**	-3.67**	73.90**	-7.84**	24.20**	1.04**	21.80	-0.21**	76.00	-0.90**	1.66	-0.16**
IR 64	67.01**	-3.83**	92.00	-1.30**	17.20	-1.43**	23.60**	-0.37**	97.90**	-0.44	2.33**	0.08**
TRY 1	92.50	6.08**	108.75	10.43**	15.00	1.11*	21.70	0.49**	97.00**	6.50**	2.58**	0.17**
S.E.±	0.397	0.281	0.292	0.206	0.093	0.066	0.100	0.071	0.359	0.254	0.002	0.001
Mean	76.30		90.76		19.60		22.58		88.90		2.08	
C.D. (P=0.05)	0.787		0.579		0.185		0.199		0.711		0.003	
C.D. (P=0.01)	1.046		0.769		0.245		0.264		0.944		0.004	

Table 2: Contd………..

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Genotypes (Parents)	Grain length (mm)		Grain breadth (mm)		Grain L/B ratio		Kernel length (mm)		Kernel breadth (mm)		Kernel L/B ratio		Grain yield per plant (g)	
Lines	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
AURC 1	7.96	-0.21**	2.94	0.14**	2.70	-0.28**	5.96	-0.18**	2.41	0.02**	2.47	-0.11**	25.62	0.21
AURC 8	7.98	-0.01**	3.01	0.15**	2.65	-0.22**	5.99	-0.21**	2.40	0.03**	2.49	-0.13**	26.05	0.63**
AURC 1 0	9.11**	0.33**	2.00**	-0.43**	3.99**	0.53**	5.45	-0.11**	1.43**	-0.03**	3.81**	-0.01**	25.29	0.03
AURC 14	7.99	-0.19**	2.02**	-0.24**	4.50**	0.46**	6.46**	0.36**	1.50**	0.01**	4.30**	0.17**	32.09**	0.36*
AURC 22	9.01**	0.22**	2.99	0.23**	3.01	-0.23**	6.93**	0.34**	2.41	0.03**	2.87	0.13**	33.08**	-1.06**
AURC 25	8.05	-0.14**	2.98	0.15**	2.70	-0.27**	5.95	-0.21**	2.31	-0.03*	2.57	-0.05**	25.19	-0.17
S.E.±	0.004	0.003	0.004	0.003	0.005	0.004	0.004	0.003	0.004	0.003	0.006	0.004	0.250	0.176
Mean	8.34		2.65		3.25		6.33		2.02		3.12		27.88	
C.D. (P=0.05)	0.007		0.007		0.010		0.007		0.007		0.011		0.495	
C.D. (P=0.01)	0.010		0.010		0.014		0.010		0.010		0.015		0.658	
Testers	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
ADT 36	8.06	-0.08**	3.06	0.36**	2.63	-0.48**	5.02	0.07**	2.03	0.01	2.47	0.03**	22.41	-0.33*
ADT 39	8.10	-0.09**	2.04**	-0.16**	3.97**	0.13**	5.06	-0.33**	1.51**	0.03**	3.35**	-0.20**	23.16	-2.37**
ADT 43	8.15	0.01**	2.01**	-0.22**	4.05**	0.28**	5.74	0.11**	1.45**	-0.02**	3.95**	0.08**	24.06	-2.59**
IR 64	9.10**	0.32**	2.03**	-0.21**	4.48**	0.41**	5.96**	0.02**	1.52**	-0.01**	3.92**	0.03**	27.08**	1.24**
TRY 1	8.04	-0.15**	3.07	0.23**	2.61	-0.33**	5.83**	0.14**	2.43	0.01**	2.39	0.06**	23.68	4.05**
S.E.±	0.003	0.002	0.003	0.002	0.005	0.003	0.003	0.002	0.003	0.002	0.005	0.004	0.228	0.161
Mean	8.27		2.43		3.55		5.82		2.02		2.87		24.08	
C.D. (P=0.05)	0.007		0.007		0.010		0.007		0.007		0.010		0.452	
C.D. (P=0.01)	0.009		0.009		0.013		0.009		0.009		0.014		0.600	

* and** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Mean performance of crosses along with SCA effects for grain yield and its components traits in rice

Crosses	Days to first flowering (days)		Plant height (cm)		Number of productive tillers per plant		Panicle length (cm)		Filled grains per panicle		Hundred grain weight (g)	
	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
AURC 1 × ADT 36	61.00**	-11.40**	112.70	5.67**	20.50	-0.09	25.00**	1.45**	105.00	-0.95	2.21	-0.09**
AURC 1 × ADT 39	85.50	3.68**	105.20	-0.68	18.60	-2.49**	24.10**	1.34**	100.60	3.70**	2.42**	0.16**
AURC 1 × ADT 43	71.00**	-1.73*	96.20**	-3.06**	22.30**	0.06	20.30	-2.60**	98.70	-4.40**	2.16	-0.02**
AURC 1 × IR 64	79.03	6.43**	101.70	-4.10**	20.60	0.83**	24.25**	1.51**	109.40	5.84**	2.44**	0.01**
AURC 1 × TRY 1	85.50	3.02**	119.70	2.17**	24.00**	1.69**	21.90	-1.70**	106.30	-4.20**	2.46**	-0.05**
AURC 8 × ADT 36	79.00	5.80**	106.20	-3.00*	23.60**	2.47**	21.00	-1.80**	112.80**	0.01	2.43**	0.06**
AURC 8 × ADT 39	79.00	-3.62**	111.60	3.55**	21.10	-0.53**	22.50	0.48**	99.50	-4.24**	2.22	-0.11**
AURC 8 × ADT 43	76.02*	2.47**	99.40**	-2.03**	24.10**	1.32**	24.80**	2.65**	114.90**	4.96**	2.37**	0.13**
AURC 8 × IR 64	71.00**	-2.37**	106.55	-1.42**	19.10	-1.21**	20.40	-1.59**	119.30**	8.90**	2.45**	-0.03**
AURC 8 × TRY 1	81.00	-2.28**	122.60	2.90**	20.80	-2.05**	23.10*	0.25	107.70	-9.64**	2.50**	-0.06**
AURC 10 × ADT 36	79.00	1.00	92.10**	-3.89**	19.20	-0.93**	20.30	-2.38**	106.00	-6.23**	2.00	-0.03**
AURC 10 × ADT 39	85.00	-2.42**	90.70**	-4.41**	21.30	0.67**	22.10	0.21	100.50	-2.68**	2.00	0.01**
AURC 10 × ADT 43	81.03	2.67**	84.80**	-3.42**	23.60**	1.82**	24.70**	2.67**	114.70**	5.32**	1.88	-0.02**
AURC 10 × IR 64	78.00	-0.17	102.20	7.44**	18.80	-0.51**	21.40	-0.47**	107.30	-2.54**	2.20	0.06**
AURC 10 × TRY 1	87.04	-1.08	110.50	4.01**	20.80	-1.05**	22.70	-0.03	122.90**	6.12**	2.21	-0.02**
AURC 14 × ADT 36	81.00	3.60**	93.10**	-0.71	21.20	-0.09	24.40**	1.52**	115.80**	1.93**	2.23	0.01**
AURC 14 × ADT 39	87.00	0.18	89.00**	-3.66**	23.20**	1.41**	20.80	-1.30**	104.20	-0.62	2.18	-0.01**
AURC 14 × ADT 43	77.01	-0.73	89.50**	3.46**	22.60**	-0.34**	22.50	0.27	111.00*	-0.02	2.06	-0.04**
AURC 14 × IR 64	75.00**	-2.57**	96.10**	3.52**	19.10	-1.37**	21.20	-0.87**	104.70	-6.78**	2.30	-0.04**
AURC 14 × TRY 1	87.00	-0.48	101.70	-2.61**	23.40**	0.39**	23.30**	0.37*	123.90**	5.48*	2.53**	0.09**
AURC 22 × ADT 36	73.01**	1.00	107.20	2.45**	20.80	-0.15	23.90**	0.76**	115.20**	1.49**	2.61**	0.07**
AURC 22 × ADT 39	83.00	1.58**	112.00	8.40**	23.20**	1.75**	22.10	-0.25	106.60	1.94**	2.46**	-0.04**
AURC 22 × ADT 43	72.00**	-0.33	101.20	4.22**	19.00	-3.60**	20.60	-1.89**	106.90	-3.96**	2.36**	-0.05**
AURC 22 × IR 64	69.01**	-3.17**	94.40**	-9.12**	22.00**	1.87**	23.30**	0.97**	112.80**	1.48*	2.60**	-0.05**
AURC 22 × TRY 1	83.02	0.92	109.30	-5.95**	22.80**	0.13	23.60**	0.41*	117.30**	-0.96	2.80**	0.06**
AURC 25 × ADT 36	73.00**	0.01	103.00	-0.52	19.20	-1.21**	23.30**	0.44*	111.80**	3.73**	2.36**	-0.02**
AURC 25 × ADT 39	83.00	0.58	98.90**	-3.48**	20.10	-0.81**	21.60	-0.47**	100.90	1.88**	2.32	-0.02**
AURC 25 × ADT 43	71.00**	-2.33**	96.58**	0.82	22.80**	0.74**	21.10	-1.11**	103.30	-1.92**	2.26	0.01**
AURC 25 × IR 64	75.00**	1.83**	106.00	3.70**	20.00	0.41*	22.50	0.45*	98.80	-6.88**	2.54**	0.05**
AURC 25 × TRY 1	83.00	-0.08	113.50	-0.52	23.00**	0.87**	23.60**	0.69**	115.80**	3.18**	2.56**	-0.02**
S.E.±	0.974	0.689	0.716	0.506	0.228	0.161	0.246	0.174	0.880	0.622	0.004	0.003
Mean	78.33		102.45		21.36		22.54		109.15		2.34	
C.D. (P=0.05)	1.929		1.418		0.453		0.487		1.742		0.008	
C.D.(P=0.01)	2.562		1.883		0.601		0.648		2.314		0.010	

Table 3 : Contd………….

Table 3: Contd.........

Crosses	Grain length (mm)		Grain breadth (mm)		Grain L/B ratio		Kernel length (mm)		Kernel breadth (mm)		Kernel L/B ratio		Grain yield per plant (g)	
	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
AURC 1 × ADT 36	7.99	-0.03**	3.01	-0.02**	2.65	0.07**	5.99	0.06**	2.01*	-0.03**	2.98	0.08**	31.83**	1.32**
AURC 1 × ADT 39	8.02	0.01**	2.41**	-0.10**	3.32	0.12**	5.41	-0.12**	2.03	-0.05**	2.67	0.01	29.83	-2.18**
AURC 1 × ADT 43	8.05	-0.06**	2.46**	0.01**	3.28	-0.07**	6.05	0.07**	2.05	0.03**	2.94	-0.01**	22.83	-3.85**
AURC 1 × IR 64	8.55**	0.12**	2.43**	-0.03**	3.52**	0.04**	5.87	-0.01**	2.12	0.08**	2.78	-0.12**	29.44	0.49
AURC 1 × TRY 1	7.90	-0.05**	3.05	0.15**	2.59	-0.16**	6.01	0.01**	2.02	-0.03**	2.98	0.05**	32.43**	-0.89*
AURC 8 × ADT 36	8.21	-0.01**	3.04	-0.01**	2.71	0.06**	6.04	0.14**	2.03	-0.03**	2.98	0.10**	31.61**	2.93**
AURC 8 × ADT 39	8.30	0.09**	2.36**	-0.17**	3.53**	0.27**	5.26	-0.25**	2.21	0.13**	2.38	-0.28**	27.48	0.16
AURC 8 × ADT 43	8.56**	0.26**	2.53	0.06**	3.39**	-0.02**	6.01	0.06*	2.02	-0.02**	2.98	0.06**	32.08**	1.42**
AURC 8 × IR 64	8.54**	-0.08**	2.50**	0.03**	3.41**	-0.12**	5.87	0.02**	2.00**	-0.04**	2.93	0.06**	27.83	-1.54**
AURC 8 × TRY 1	7.89	-0.26**	3.02	0.10**	2.62	-0.19**	6.00	0.03**	2.02	-0.04**	2.97	0.06**	32.33**	-1.41**
AURC 10 × ADT 36	8.02	-0.02**	2.51*	0.04**	3.20	-0.20**	6.03	0.02**	2.02	0.02**	2.98	-0.02**	27.94	-2.72**
AURC 10 × ADT 39	8.03	-0.01**	2.01**	0.06**	4.00**	-0.01**	5.65	0.05**	2.00**	-0.02**	2.83	0.05**	23.24	-3.81**
AURC 10 × ADT 43	8.04	-0.09**	1.99**	0.11**	4.03**	-0.13**	6.01	-0.04**	1.97**	-0.01**	3.04**	-0.01**	32.08**	0.94*
AURC 10 × IR 64	8.53**	0.08**	2.01**	0.11**	4.25**	-0.04**	6.00	0.05**	1.99**	0.01**	3.02**	0.02**	28.33	-0.26
AURC 10 × TRY 1	7.99	0.02**	2.03**	-0.31**	3.95**	0.39**	6.00	-0.08**	2.00**	0.01**	3.00**	-0.04**	33.13**	-0.34
AURC 14 × ADT 36	8.59**	0.02**	2.56	-0.09**	3.35	0.02**	6.41**	-0.07**	2.05	0.02*	3.12**	-0.07**	32.33**	2.00**
AURC 14 × ADT 39	8.46**	-0.09**	2.41**	0.27**	3.52**	-0.42**	6.00	-0.07**	2.06	0.01**	2.91	-0.05**	26.81	0.10
AURC 14 × ADT 43	8.52**	-0.13**	2.01**	-0.07**	4.25**	0.16**	6.51**	-0.01**	1.99**	-0.03**	3.27**	0.04**	23.61	-2.89**
AURC 14 × IR 64	9.00**	0.03**	2.04**	-0.05**	4.42**	0.20**	6.55**	0.13**	2.00**	-0.02**	3.27**	0.09**	28.61	-0.15
AURC 14 × TRY 1	8.65**	0.15**	2.45**	-0.07**	3.53**	0.04**	6.55**	0.01**	2.00**	-0.02**	3.21**	0.02**	34.08**	7.12**
AURC 22 × ADT 36	8.54**	0.09**	3.25	0.12**	2.63	-0.01**	6.25**	-0.21**	2.06	0.01**	3.03**	-0.11**	28.49	-0.74
AURC 22 × ADT 39	8.45**	0.01**	2.55	-0.06**	3.31	0.06**	6.40**	0.34**	2.04	-0.04**	3.14**	0.22**	26.41	0.79*
AURC 22 × ADT 43	8.52**	-0.02**	2.47**	-0.07**	3.45**	0.04**	6.36**	-0.15**	2.04	0.01**	3.12**	-0.07**	22.21	-3.19**
AURC 22 × IR 64	8.65**	-0.21**	2.53	-0.03**	3.43**	-0.11**	6.42**	0.01**	2.01*	-0.04**	3.20**	0.06**	33.95**	4.97**
AURC 22 × TRY 1	8.52**	0.14**	3.03	0.03**	2.82	0.02**	6.53**	-0.01**	2.12	0.07**	3.08**	-0.10**	33.78**	1.73**
AURC 25 × ADT 36	8.03	-0.06**	3.00	-0.04**	2.68	0.08**	5.96	0.05**	2.00**	0.01**	2.98	0.02**	32.44**	2.31**
AURC 25 × ADT 39	8.05	-0.02**	2.52	-0.01	3.20	-0.02**	5.55	0.05**	2.00**	-0.02**	2.78	0.05**	26.36	-0.16
AURC 25 × ADT 43	8.20	0.03**	2.42**	-0.04**	3.39**	0.02**	6.00	0.05**	2.00**	0.02**	3.00*	-0.01**	24.14	-2.16**
AURC 25 × IR 64	8.54**	0.05**	2.44**	-0.03**	3.51**	0.02**	5.66	-0.19**	1.99**	0.01**	2.84	-0.11**	28.60	0.03
AURC 25 × TRY 1	8.02	0.01**	3.02	0.11**	2.66	-0.10**	6.02	0.04**	1.98**	-0.02**	3.04**	0.05**	32.93**	-0.02
S.E±	0.008	0.006	0.008	0.006	0.012	0.008	0.008	0.006	0.008	0.006	0.013	0.009	0.559	0.395
Mean	8.31		2.53		3.35		6.05		2.03		2.98		29.06	
C.D. (P=0.05)	0.016		0.016		0.023		0.016		0.016		0.026		1.107	
C.D.(P=0.01)	0.021		0.022		0.031		0.022		0.022		0.034		1.471	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

for plant height, grain length, grain breadth, grain L/B ratio and kernel breadth. AURC 14 for plant height, grain breadth, grain L/B ratio, kernel length, kernel L/B ratio and grain yield per plant. Line AURC 22 for days to first flowering, hundred grain weight, grain length and kernel length. Line AURC 25 for days to first flowering and hundred grain weight. Tester, ADT 36 was found to be significant *per se* with good general combiner for days to first flowering and filled grains per panicle. Tester, ADT 39 for grain breadth and grain L/B ratio. Tester, ADT 43 for days to first flowering, plant height, number of productive tillers per plant, grain breadth, grain L/B ratio, kernel breadth and kernel L/B ratio. Tester, IR 64 for days to first flowering, hundred grain weight, grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant. Tester, TRY 1 for filled grains per panicle, hundred grain weight and kernel length. A close examination of the result revealed that the tester IR 64 combined well for the highest number of nine characters followed by the tester ADT 43 for seven characters, line AURC 14 for six characters, line AURC 10 for five characters, lines AURC 8 and AURC 22 for four characters each, tester, TRY 1 for three characters, line AURC 25 and testers ADT 36 and ADT 39 for two characters each, line AURC 1 for one character was good general combiner based on *per se* and general combining ability effects.

The estimates for GCA effects of the parental lines for different characters revealed that none of the parental lines excelled in GCA effects for all the characters studied. The parents evaluated both *per se* and GCA effects leads to the identification of the testers IR 64 and ADT 43 followed by line AURC 14 as best. These may be used for exploiting additive type genetic variability which is fixable type and selection may be effective in segregating population for development of better genotype with regards to yield. However, lines AURC 10, AURC 8 and AURC 22 which possessed favourable *per se* performance and GCA effects may be used for multiple parent participation through multiple crossing to effect substantial improvement having for broad genetic base population. Similar results were reported by Souresh and Rabiei (2010) and Dwivedi and Pandey (2012) for grain yield per plant. The SCA effects represent the non-additive gene action which is non-fixable (Table 3). The estimation of specific combining ability (SCA) effects for 30 hybrids along with mean performance for all the thirteen characters are presented in Table 3, significant positive or negative SCA effects were observed in F_1 generation for yield and various yields attributing traits. In the present investigation, none of the crosses expressed good specific combining ability effect for all the traits under study. Out of 30 crosses, nine for days to first flowering, thirteen for plant height and number of productive tillers per plant, fourteen for panicle length and filled grains per panicle, twelve for hundred grain weight, fifteen for grain length, kernel breadth and kernel L/B ratio, sixteen for grain breadth and grain L/B ratio, eighteen for kernel length and ten crosses showed significant and positive SCA effect for grain yield per plant.

The cross combinations *viz.,* AURC 1 x ADT 36, AURC 8 x ADT 36, AURC 8 x ADT 43, AURC 10 x ADT 43, AURC 14 x ADT 36, AURC 14 x TRY 1, AURC 22 x IR 64, AURC 22 x TRY 1 and AURC 25 x ADT 36 which showed good *per se* performance and significant positive SCA effects for grain yield per plant, also showed significant SCA effects for other important yield component traits. Out of these 9 crosses, two crosses *viz.,* AURC 14 x TRY 1 and AURC 22 x IR 64 which showed highest significant *per se* performance and significant SCA effect for grain yield may be used in breeding programme and might be expected to give transgressive segregants in F_2. On the other hand, the crosses *viz.,* AURC 14 ´ TRY 1 and AURC 22 IR 64 with good *per se* performance and significant SCA effect were common for number of productive tillers per plant, panicle length, filled grains per panicle, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant. Hence, these crosses may be exploited for developing hybrid/genotypes with better yield and quality. These cross combinations may be exploited in heterosis breeding programme for developing genotype having broad genetic base by multiple crossing programme.

The good specific combiners involved all the four possible combinations of the parents with high and low GCA effects *viz.,* high x high, high x low, low x low and low x high, indicated additive and non-additive type of gene action. Similar results were reported by Patil *et al.* (2012) for number of productive tillers per plant and Devaraja *et al.* (2012) for grain yield per plant. The non-additive components of genetic variation appeared important in the expression of almost all the traits in present set of material. For exploitation of the non-additive component of variation, material may be handled though pedigree method, reciprocal recurrent selection or biparental mating for obtaining superior segregants and genotypes. The promising parents namely for line AURC 14 and tester IR 64 which are having *per se* performance and GCA effects in desirable direction for yield, yield components and for quality traits may be incorporated in crossing programme to have better genotypes for better and quality.

The crosses AURC 14 x TRY 1 and AURC 22 x IR 64 with good *per se* performance and significant SCA effect for major yield and 7 yield components were also found superior for number of productive tillers per plant, panicle length, filled grains per panicle, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant, may be exploited for better yield and quality either by exploiting them through heterosis breeding or involving them in multiple cross breeding programme for obtaining transgressive segregants and broad genetic base population in rice for improvement in yield.

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