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COMBINING ABILITY STUDIES FOR DEVELOPMENT OF NEW HYBRIDS IN RICE (*Oryza Sativa* L.) UNDER COASTAL SALINE CONDITION

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Abstract

In the present study, combining ability analysis was carried out through Line x Tester analysis of eighteen hybrids developed by crossing six lines (male) with three testers (female) to know the genetic architecture of various yield and yield attributing traits in rice under coastal saline condition. The experiment was conducted at the Plant Breeding Farm, Faculty of Agriculture, Annamalai University from December 2014 - October 2015. Analysis of variance revealed significant differences among the genotypes, crosses, lines, testers and line x tester interactions for all the characters studied. SCA variance was predominant for all the characters studied indicated the preponderance of non-additive gene action than additive gene action. The estimates of *gca* effects indicated that the lines, MTU 1010, MDU 5 and KANCHANA and among testers, CO 47 and ADT 39 were found to be good general combiners for grain yield traits. High *sca* effects were observed in the crosses, MTU 1001 x CO 47, KANCHANA x CO 47, MTU 1010 x ADT 39 and MDU 5 x ADT 39 were found to be specific combiners for the characters studied. These crosses could be exploited in the future rice breeding programme by adopting appropriate breeding technique in order to evolve high yielding rice varieties.

Key words: Line x Tester, Combining ability, Saline environment and Rice.

1. Introduction

In terms of importance as a food crop or in terms of calorific value rice crop occupies the first place than any other cereal crops. Nearly 65 % of the global population used rice as a major source of calories. To cop up with the ever increasing demand for rice, present production level needs to be increased by 2 million tones every year which is possible only through heterosis breeding and other innovative breeding approaches (Pandey *et al*., 2010). Therefore, the major focus of rice research in the next decade must be the development of high yielding and early maturing varieties in order to ensure food security and efficient use of natural resources (Swain, 2005).

For breeding high yielding varieties of crop, the breeders often have to face the problem of parents and crosses with desirable characteristics. Combining ability analysis is one of an efficient tool available to estimate the combining ability effects, which aids to the selection of desirable parents and crosses for the exploitation of heterosis (Rashid *et al*., 2007). The information on nature of gene action involved in the expression of qualitative traits in terms of combining ability is necessary since, the performance of parents may not necessarily reveal whether it is a good or poor combiner. Griffing (1956) stated that *GCA* includes the additive

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genetic portion, while *SCA* includes non-additive genetic portion of the total variation. The presence of non-additive genetic variance is the primary justification for initiating the hybrid programme (Cockerham, 1961; Pradhan *et al*, 2006). In this study, an attempt has been made to evaluate GCA and SCA in rice cultivars of different traits for identifying good combiners.

2. Materials and Methods

The experimental site was a coastal saline situation with EC of the soil range from 3.5-4.0 d Sm^{-1}. The experimental materials includes 6 genotypes (MDU 5, MTU 1001, MTU 1010, AATHIRA, KANCHANA and IR 72) as lines and 3 popular cultivars (CO 47, ASD 16, ADT 39) as testers. These genotypes were crossed to produce 18 hybrids in Line x Tester combinations used to determine the heterosis, combining ability as well as gene action on yield and yield components. This study was conducted during 2014 - 2016 at the plant breeding farm of Faculty of Agriculture, Annamalai University. Single seedling per hill was transplanted at a spacing of 30 cm between rows and 20 cm within the rows in a randomized block design with three replications. All the recommended agronomic and plant protection measures were uniformly applied throughout the crop growth.

Data were collected from ten randomly selected plants of parents as well as hybrids. The following data were recorded: days to 50 % flowering, plant height, number of tillers per plant, number of productive tillers per plant, panicle length, number of grains per panicle, 100 grain weight and grain yield per plant. The statistical analysis was performed by using Line x Tester analysis by Kempthorne (1957) and genetic components of each parameter following Singh and Chaudhary (1985).

3. Results and Discussion

Analysis of variance

The analysis of variance showed significant variations for the yield and different yield contributing characters among the genotypes, crosses, lines, testers and line x tester interactions. The significant differences among the lines, testers and line x testers indicated that the genotype had wide genetic diversity among themselves for all traits (Table - 1). The significant differences between line x testers interaction indicates that SCA attributed heavily in the expression of these traits and demonstrates the importance of dominance or non additive variances for all the traits (Sanghera and Hussain, 2012). And also the variances of SCA were higher than the GCA variances for these characters which indicated preponderance of non-additive gene action in the inheritance of traits. It suggested greater importance of non-additive gene action in the expression and indicated very good prospect for exploitation of non additive genetic variation for yield and its component characters through hybrid breeding. MTU 1010, MDU 5, KANCHANA and ADT 39 are recorded as good general combiners for all traits studied.

General combining ability (GCA) effects

Among the lines studied, MDU 5 recorded the highest mean value for the traits *viz*., 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. Also, genotype MDU 5 registered the earliness with minimum plant height. The line, MTU 1001 also had significant high mean for all the characters. This genotype recorded significantly high mean value for hundred grain weight. Another line, MTU 1010 showed significant high mean for all the characters except plant height and the same genotype was founded to be earliest in duration. Genotype KANCHANA recorded significantly high mean value for the foresaid characters except grain yield per plant. Among the testers, CO 47 recorded high *per se* performance for the all the traits *viz*., days to 50 per cent flowering, plant height, number of tillers per plant, number of productive tillers per plant, panicle length, grains per panicle, hundred grain weight and grain yield per plant. The tester, ADT 39 recorded significantly high mean performance for number of productive tillers per plant, panicle

Table - 1: ANOVA for combining ability analysis in rice

Source of variation	df	MSS							
		Days to 50 % flowering (days)	Plant height (cm)	No. of tillers per plant	No. of productive tillers/plant	Panicle length (cm)	No. of grains per panicle	Hundred grain weight (g)	Grain yield per plant (g)
Replication	2	23.81	10.10	51.36	60.90	10.56	52.04	0.02	0.84
Genotype	26	237.64**	59.67**	60.05**	53.57**	28.30**	814.35**	2.40**	116.21**
Cross	17	55.42**	61.01**	67.61**	58.01**	21.99**	359.98**	2.52**	130.90**
Line	5	30.96**	101.13**	74.19**	60.76**	37.07**	728.85**	2.43*	135.65**
Tester	2	67.18**	42.56**	55.93**	35.43**	4.18*	397.20**	3.27*	107.19**
L×T	10	65.29**	44.64**	66.65**	61.16**	18.01**	168.11**	2.63**	133.28**
Error	52	6.18	6.53	5.01	2.96	4.56	4.10	0.01	3.34
GCA Variance		0.29	0.49	0.03	0.09	0.11	5.75	0.01	0.07
SCA Variance		19.70	12.70	20.54	19.39	4.48	54.67	0.08	43.31
GCA/SCA Variance		0.02	0.04	0.01	0.01	0.02	0.10	0.13	0.002

*** Significant at 5 and 1 per cent respectively

Table – 2: General combining ability effects of parents for different traits in rice genotypes

Parents	Days to 50 % flowering	Plant height	No. of tillers per plant	No. of productive tillers per plant	Panicle length	No. of grains per panicle	Hundred grain weight	Grain yield per plant
Lines								
MDU 5	-2.48**	-3.67**	2.33**	2.08**	1.17**	1.84**	0.03	1.81**
MTU 1001	-0.81	0.18	1.69*	1.17*	1.20**	6.17**	0.10**	3.01**
MTU 1010	-1.56*	-1.76*	2.81**	2.27**	1.57***	7.94**	0.28**	2.63**
AATHIRA	3.25**	3.81**	-4.34**	-3.31**	-2.90**	-10.10**	-0.23**	-5.50**
KANCHANA	-0.81	-2.74**	1.56*	1.43*	1.26**	6.60**	0.08*	1.87**
IR 72	2.41**	4.19**	-4.05**	-3.64**	-2.30**	-12.45**	-0.26**	-3.82**
S.E.(GCA effects for line)	0.83	0.85	0.74	0.57	0.71	0.67	0.03	0.61
Testers								
CO 47	-1.48*	-1.75**	0.92	0.59	1.19**	2.52**	0.06*	1.47**
ASD 16	2.19**	0.60	-2.03**	-1.60**	-2.54**	-5.42**	-0.11**	-2.82**
ADT 39	-0.70	1.15	1.12*	1.01*	1.35**	2.90**	0.05*	1.35**
S.E.(GCA effects for tester)	0.58	0.60	0.52	0.40	0.50	0.47	0.02	0.43

*** - Significant at 0.05 and 0.01 level of probability, respectively S.E - Standard Error

Table – 3: Specific combining ability effects of hybrids for different traits in rice genotypes

Hybrids	Days to 50 % flowering	Plant height	No. of tillers per plant	No. of productive tillers per plant	Panicle length	No. of grains per panicle	Hundred grain weight	Grain yield per plant
MDU 5 x CO 47	1.81	2.20	2.74*	2.73	-0.62	-5.63**	0.23**	3.51**
MDU 5 x ASD 16	3.70*	2.26	-4.61**	-4.67**	-1.63	4.71**	-0.29**	-5.21**
MDU 5 x ADT 39	-2.52	-2.26	1.87	1.94	2.25	0.92	0.06	1.69
MTU 1001 x CO 47	-2.96*	-3.92**	6.69**	6.20**	3.14*	8.50**	0.44**	8.45**
MTU 1001 x ASD 16	-6.41**	-1.64	-2.66*	-2.41*	-1.89	-5.43**	-0.18**	-4.31**
MTU 1001 x ADT 39	3.04*	5.57**	-4.03**	-3.79**	-1.25	-3.06*	-0.26**	-4.14**
MTU 1010 x CO 47	4.59**	1.57	-1.87	-1.27	-0.90	-6.42**	-0.17**	-2.37*
MTU 1010 x ASD 16	1.18	0.08	1.22	0.75	0.21	-5.57**	0.08	2.50*
MTU 1010 x ADT 39	-0.07	-1.65	0.65	0.52	0.69	1.96	0.09	1.02
AATHIRA x CO 47	2.48	-1.08	-3.03*	-2.78**	-2.51*	-3.26**	-0.15*	-3.63**
AATHIRA x ASD 16	-5.96**	0.08	0.86	0.68	0.00	4.52**	0.08	0.82
AATHIRA x ADT 39	3.48*	1.00	2.16	2.10*	2.51*	-1.26	0.07	2.81**
KANCHANA x CO 47	-5.52**	-4.46**	3.20*	2.70**	3.13*	6.49**	0.22**	6.35**
KANCHANA x ASD 16	0.04	4.08**	-0.99	-0.56	0.19	11.99**	-0.03	-3.28**
KANCHANA x ADT 39	2.48	-1.82	-2.22	-2.14*	-2.04	-8.45**	-0.19**	-3.07**
IR 72 x CO 47	-3.41*	3.48*	-6.86**	-6.79**	-0.96	0.32	-0.40**	-10.49**
IR 72 x ASD 16	0.48	-4.85**	6.18**	6.21**	1.85	3.60**	0.34**	9.47**
IR 72 x ADT 39	2.93*	1.37	0.69	0.57	-2.17	-3.93**	0.06	-0.13
S.E. (SCA effects for hybrids)	1.43	1.47	1.29	0.99	1.23	1.17	0.06	1.05

*** - Significant at 0.05 and 0.01 level of probability, respectively S.E = Standard Error length, number of grains per panicle, hundred grain weight and grain yield per plant. Thus, based on the *per se* performance the lines, MDU 5, MTU 1001, MTU 1010 and KANCHANA and the testers CO 47 and ADT 39 have been estimated as superior parents and they might be useful for the incorporation of the respective traits in hybridization programme (Table - 3).

Specific combining ability (SCA) effects

MTU 1001 X CO 47 and KANCHANA x CO 47 had positive and highly significant *sca* effects for 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 along with negative significant *sca* effects for days to 50 % flowering and plant height. Similar results were obtained by Upadhyay and Jaiswal (2015) in his studies on rice. The crosses, MTU 1010 X ADT 39 and MDU 5 X ADT 39 possessed high *per se* performance for number of tillers per plant, number of productive tillers per plant, panicle length, number of grains per panicle, hundred grain weight and grain yield along with good performance for the plant height and days to 50 % flowering. Also, these two hybrids had high x high combiners with non significant *sca* effects for grain yield and all its component traits with negative and non significant values for plant height and days to 50 % flowering. This indicated that these crosses possessed favourable recombinants with short stature and earliness in later segregating generations. Similar results were found by Zeinab Montazer *et al*. (2014) and Gayathri (2015) in their studies in rice (Table - 3).

4. Conclusion

In the present study, MTU 1010, MDU 5, KANCHANA and ADT 39 are identified as good general combiners for almost all the characters studied. MTU 1001 X CO 47 and KANCHANA X CO 47 were recorded with high *per se* performance, highly significant *sca* effects for grain yield and its component traits are suitable for heterosis breeding. The combinations, MTU 1010 X ADT 39 and MDU 5 X ADT 39 were recorded with high mean, non significant *sca* effects and these genotypes were governed by additive gene action which is fixable and were found to be suitable for recombination breeding.

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