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Combining ability studies for yield and yield associated traits in rice (*Oryza sativa* L.) involving Assam rice cultures

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ABSTRACT

The nature of combining ability in rice was studied at Killikulam with 42 rice hybrids derived from seven diverse genotypes including three Assam rice cultures with full diallel mating design. Preponderance of additive gene action was observed for all the eleven characters studied. Based on the *per se* performance and *gca* effects. ARC 15759 and ARC18214 were the best parents for the improvement of yield associated traits besides grain yield. ARC 18023 X ADT 36 and ASD 16 X ARC 15759 may be exploited for heterosis breeding, while ASD 16 X ARC 18214 and ARC 18214 X ADT 43 are suitable for recombination breeding.

Key words : Rice, Combining ability, GCA, Grain yield.

INTRODUCTION

Selection of parents for hybridization assumes greater importance in heterosis breeding programme. The superiority of parents has to be assessed based on GCA of parents and its ability to produce specific combining hybrids. Knowledge on the combining ability of parents and hybrids will facilitate appropriate choice of parents in breeding programme. Additive and non-additive gene action in the parent, estimated through combining ability analysis is useful in determining the possibility for commercial exploitation of heterosis. Thus, the present investigation was aimed to analyze the combining ability of seven locally adopted, diverse genotypes including three Assam rice cultures.

MATERIALS AND METHODS

The experimental material comprised of 42 hybrid progenies derived from seven diverse, rice genotypes *viz*., IR 64, ASD 16, ARC 18214, ARC 15759, ARC 18023, ADT 43 and ADT 36 through a full-diallel mating system. The hybrids of first filial generation and their respective parents were raised in Randomized Block Design with three replications. Twenty three days old seedlings were transplanted with 20cm inter and 10 cm intra-row spacings. Observations were recorded on five plants selected at random in each entry in each replication (in parents and hybrids) for days to 50 per cent flowering, plant height, panicle length, panicles per plant, grains per panicle, grain yield per plant, spikelet fertility, 1000 grain weight, harvest index, protein content and amylose content. For finding out the crude protein content, the total nitrogen content was estimated by following Micro kjeldhal method (A.O.A.C., 1965) and from which the crude protein content is calculated. Amylose content was estimated by the method prescribed by Juliano (1971). Analysis for combining ability was done as per Griffings (1956) for method I and model I of diallel mating design.

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RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed highly significant differences among the genotypes for all the characters and the variances due to GCA were greater in magnitude than SCA indicating additive gene action for these characters (Table 1).

Preponderance of additive gene action for days to 50 per cent flowering (Bidhan Roy and Mandal, 2001), plant height (Lavanya, 2000), panicle length (Kalita and Upadhaya, 2000), panicles per plant (Padmavathi *et al*., 1997), grains per panicle (Sharma and Koranne, 1995), grain yield per plant (Meenakshi and Amirthadevarathinam, 1999), spikelet fertility (Munhot *et al*., 2000), 1000 grain weight (Lavanya, 2000), harvest index (Verma *et al*., 1995), protein content (Yolanda, 1993), and Amylose content (Kuo and Liu, 1986) has been reported earlier in rice.

High mean value was the main criterion among the breeders for a long time. Gilbert (1958) suggested that parents with good *per se* performance would result in better genotypes. Further, the parents having high *gca* effects could be useful since the *gca* effect is due to additive gene action and is fixable. Hence the parents were evaluated based on *per se* performance and *gca* effects (Table 2).

ADT 43 and IR 64 were the best genotypes for dwarf ness where as ARC 15759, ARC 18023 and ADT 36 for earliness. For grain yield, ADT 43 and ASD 16 recorded

Table 1 : Analysis of variance for combining ability

Source	Df	Mean sum of squares										
		Days to 50 per cent flowering	Plant height (cm)	Panicle length (cm)	No. of panicles per plant	No. of Grains per panicle	Grain yield per plant (g)	Spikelet fertility (%)	1000 grain weight (g)	Harvest index (%)	Protein content(%)	Amylose content (%)
GCA	6	152.72**	743.91**	9.42**	4.69**	1086.20*	91.31**	110.01**	12.67**	35.03**	0.84**	3.54**
SCA	21	12.64**	90.72**	1.14	1.08	486.62**	39.72**	18.89**	3.42**	3.14**	0.22	1.12**
RCA	21	27.57**	77.86**	5.77**	1.73**	488.83*	31.07**	22.55**	3.42**	17.93**	0.48*	2.04**
Error	96	0.64	11.55	0.82	0.69	269.73	11.01	1.95	0.15	0.87	0.24	0.34
GCA/SCA		12.08	8.20	8.26	4.34	2.23	2.29	5.82	3.53	11.16	3.82	3.16

* - Significance at P=0.05 level ** - Significance at P=0.01 level

Table 2 : Mean performance and general combining ability for yield traits

Parent	Days to 50 per cent flowering		Plant height (cm)		Panicle length (cm)		No. of panicles per plant		No. of Grains per panicle	
	Mean	*gca*	Mean	*gca*	Mean	*gca*	Mean	*gca*	Mean	*gca*
IR 64	78.5	0.78**	86.2	-5.92**	16.3	-1.37**	9.89	0.67**	120.55	-0.42
ASD 16	84.3	4.32**	98.1	-2.29**	23.6*	1.22**	10.44	0.41*	148.67	17.98**
ARC18214	72.3*	-1.27**	136.1*	12.04**	21.18	0.26	7.33	-0.48*	93.22	-3.09
ARC 15759	65.8*	-5.09**	109.7	3.42**	18.13	0.55*	6.55	-0.55**	83.78	-8.59*
ARC18023	72.5*	-3.04**	130.44*	5.63**	22.2	0.51*	7.55	-0.24	123.78	3.56
ADT 43	77.8	2.29**	84.7	-8.27**	19.1	-0.13	7.89	-0.52*	120.33	-3.97
ADT 36	75.5	-2.51**	87.5	-4.60**	21.4	0.06	9.67	0.71**	130.22	-5.46
SE	1.13	0.19	4.81	0.84	1.28	0.22	1.17	0.20	23.23	4.06

Parent	Grain yield per plant (g)		Spikelet fertility (%)		1000 grain weight (g)		Harvest index (%)		Protein content (%)		Amylose content (%)	
	Mean	*gca*	Mean	*gca*	Mean	*gca*	Mean	*gca*	Mean	*gca*	Mean	*gca*
IR 64	24.70	-1.78*	69.32	2.51**	22.99*	0.25*	38.35	-1.93**	8.67	-0.26*	21.59	0.04
ASD 16	28.24	2.29**	74.37	0.38	21.48	0.57**	41.50	0.12	9.06	-0.21	21.54	-0.86**
ARC18214	30.52	1.71*	77.30	1.49**	19.86	-0.03	47.51*	2.42**	9.70	0.29*	23.86	0.22
ARC 15759	16.59	-2.30*	75.69*	1.02*	24.64*	0.98**	44.27*	1.60**	10.00	0.17	24.77*	0.83**
ARC18023	23.51	-1.71*	72.82	2.33**	23.65*	0.13	38.70	-0.57*	8.48	-0.27*	22.14	-0.07
ADT 43	40.00*	3.88**	69.39	-2.88**	15.94	-1.94**	40.25	-0.08	10.26	0.11	21.85	-0.01
ADT 36	20.17	-2.09*	63.52	4.86**	21.08	-0.14	39.01	-1.56**	9.99	0.18	21.36	-0.14
SE	4.69	0.82	1.97	0.34	0.55	0.09	1.32	0.23	0.69	0.11	0.82	0.14

* - Significance at P=0.05 level ** - Significance at P=0.01 level

significant *gca* effects. Among the seven parents high *per se* performance and high *gca* effects were observed in ARC 15759, for days to 50 per cent flowering, spikelet fertility, 1000 grain weight, harvest index and amylose content, where as ARC 18214 for days to 50 per cent flowering, plant height, spikelet fertility and harvest index. Hence multiple crosses involving the above parents may produce desirable segregants possessing all the economic traits.

Hybrids for recombination breeding

The criterion for the selection of hybrids for recombination breeding is that the parents should have better *per se* performance significant *gca* effects and the hybrids with non-significant *sca* and non-significant *rca* effects. Based on this, the hybrids were evaluated (Table 3). The parents ASD 16 possessed favourable and significant *gca* effects for plant height, panicle length, panicles per plant, grains per panicle, grain yield per plant and 1000 grain weight and ADT 43 for plant height and grain yield per plant. The parent ARC 18214 recorded significant *gca* effects for most of the yield associated traits. The resultant hybrids involving these parents *i.e.*

ASD 16 X ARC 18214 and ARC 18214 X ADT 43 had non-significant *sca* and *rca* and can be exploited for recombination breeding.

Table 3 : Promising hybrids for recombination breeding

Character	Parent	*gca* effect	Cross	*sca* effect	*rca* effect	Selected hybrids
Days to 50 per cent flowering	ARC 15759,	-5.09**	ARC 18214 X ADT 36	0.72	-1.59**	ARC 18214 X ADT 36
	ARC 18023	-3.04**				
	ADT 36	-2.51**				
	ARC 18214	-1.27**				
Plant height (cm)	ADT 43,	-8.27**	IR 64 X ADT 43	2.22	2.19	IR 64 X ADT 43
	IR 64	-5.92**				
Panicle length (cm)	ASD 16,	1.22**	ASD 16 X ARC18023	-0.48	-1.06	ASD 16 X ARC18023
	ARC 18023	0.51**				
No. of panicles per plant	ADT 36	0.71**	IR 64 X ADT 36	0.26	1.78	IR 64 X ADT 36
	IR 64	0.67**				
No. of Grains per panicle	ASD 16	17.98**	ASD 16 X ARC 15759	8.03	50.17**	ASD 16 X ARC 15759
	ARC 15759	-8.59*				
Grain yield per plant (g)	ADT 43,	3.88**	ASD 16 X ARC18214	-1.96	1.53	ASD 16 X ARC18214
	ASD 16	2.29**	ARC 18214 X ADT 43	-2.94	0.08	ARC 18214 X ADT 43
	ARC 18214	1.71*				
Spikelet fertility (%)	IR 64,	2.51**	IR 64 X ARC 18214	-0.33	2.28	IR 64 X ARC 18214
	ARC 18214	1.49**				
1000 grain weight (g)	ARC 15759,	0.98**	IR 64 X ARC15759	-1.29**	-0.14	
	IR 64	0.25**				
Harvest index (%)	ARC 18214,	2.42**	ARC 18214 X ARC15759	0.62	-0.81	ARC 18214 X ARC15759
	ARC 15759	1.60**				
Protein content(%)	ARC 18214	0.29*	-	-		
Amylose content (%)	ARC 15759	0.83**	ASD 16 X ARC 15759	-0.13	-0.56	ASD 16 X ARC 15759
	ASD 16	-0.86**				

* - Significance at P=0.05 level ** - Significance at P=0.01 level

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