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Combining ability for yield and yield components in rice

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ABSTRACT

Combining ability analysis for grain yield and its components were carried out in seven parental diallel crosses of rice (Oryza sativa L.) excluding reciprocal. The GCA and SCA were significant for all the seven characters, indicating the importance of both additive and non-additive genetic components for these traits. The per se performance was observed to be a good indication of GCA effects of the parents and SCA effects of the crosses. Among parents studied, Vaidehi and Rajshree were observed to be good general combiners for grain yield. The superior specific cross combinations Saket 4 x Vaidehi, Rajshree x Kamini, Prabhat x Rajshree and Sita x Vaidehi appeared promising for further exploitation in rice breeding programme.

Key words: *Rice, combining ability, yield components*

Combining ability analysis besides providing information on nature and magnitude of gene effects governing yield and yield attributing traits, also help in identification of potential parents, cross combinations and formulation of systematic breeding plan for augmenting the yield. The present investigation was undertaken to study the combining ability effects of seven parents and their twenty one crosses for grain yield and its components. The parents and crosses were evaluated in two rows of 3m length in randomized block design with three replications at the research farm of Rajendra Agricultural University, Bihar, Pusa, Samastipur in wet season, 2001. The planting pattern of one seedling hill^{-1} followed and inter row and inter plant distances were maintained at 30 cm and 20cm, respectively.

Observations were recorded on five random plants in parents and hybrids for days to 50% flowering, plant height, number of effective tillers hill^{-1}, panicle length, number of grains panicle^{-1}, 1000-grain weight and grain yield plant^{-1}. The combining ability analysis was carried out following method II and model I of Griffing (1956).

The analysis of variance for combining ability revealed that mean squares due to GCA and SCA were highly significant for grain yield and yield attributing traits. The magnitude of SCA variance was higher than GCA variance, which reflected that non-additive type of gene action played relatively predominant role in the expression of these traits and confirming the earlier findings of Kumar and Singh (2004).

The estimates of GCA effects of parents (Table 1) showed that the parents Vaidehi and Rajshree were the best general combiners of grain yield and yield contributing traits. The parent Saket 4 was the best general combiner for number of effective tillers hill^{-1}, Kamini for panicle length and Sudha for number for grains panicle^{-1}. Based on GCA effects and *per se* performance Kamini, Sudha, Vaidehi were the better combiners as well as better parent for late flowering behaviour. Among the parents Kamini, Vaidehi and Sudha were good general combiners for tall stature, appeared specifically desirable for breeding rice varieties inherently suited to low and deep water conditions where tall types are desirable. The parent Saket 4 being a semi-dwarf variety would be suitable for developing varieties for upland condition.

The SCA effects and *per se* performance (Table 2) revealed that the cross combination Saket 4 x Sudha, Sita x Vaidehi, Saket 4 x Vaidehi, Prabhat x Sita and Rajshree x Kamini were promising for grain yield and other yield attributing traits. These cross combinations involved two types of combinations between parents of high and low GCA effects, i.e. low x low and low x high or high x low. The cross involving

Table 1. Estimates of general combining ability (GCA) effects of parents for seven characters in rice

Parents	Days to 50% flowering		Plant height		Number of effective tillers hill^{-1}		Panicle length		Number of grains panicle^{-1}		1000-grain weight		Grain yield plant^{-1}	
	$\overline{X}$	GCA	$\overline{X}$ (cm)	GCA	$\overline{X}$	GCA	X(cm)	GCA	$\overline{X}$	GCA	$\overline{X}$ (g)	GCA	$\overline{X}$ (g)	GCA
Prabhat	67.00	-7.44**	87.00	-11.52**	17.33	-1.87**	22.00	-1.79**	51.33	-13.55**	22.17	-2.33**	22.33	-6.04**
Saket 4	83.67	-9.74**	85.33	-10.63**	14.00	4.09**	20.33	0.21**	59.67	4.63**	21.00	-0.99**	27.00	0.44*
Sita	103.67	-4.78**	94.33	-14.00**	12.33	-0.09	19.67	-1.08**	93.67	-0.18**	24.00	-0.42**	31.00	-1.67**
Rajshree	109.00	0.03	133.67	-4.04**	14.67	-0.06	23.00	0.34	80.33	2.59**	21.00	0.39**	32.67	2.93**
Vaidehi	119.33	5.59**	171.67	13.26**	9.33	-1.27**	24.00	0.10	74.67	4.67**	31.67	2.93**	24.33	3.04**
Sudha	121.67	6.96**	161.33	11.59**	12.00	-1.50**	25.00	1.36**	88.33	7.30**	27.00	1.13**	23.67	0.56**
Kamini	125.00	9.37**	156.67	15.33**	11.33	0.58*	25.33	1.54**	44.67	-5.44**	13.00	-0.72**	15.00	0.74**
SEm(gi)		0.19		0.50		0.29		0.22		0.31		0.12		0.21
SE (gi-gi)		0.29		0.77		0.44		0.33		0.41		0.18		0.32

* & ** Significant at P=0.05 and 0.01 respectively.

parents with high x low GCA effects indicated the involvement of additive x dominance type of gene interaction. The superiority of the cross in which both the parents had low GCA was attributed to dominance and epistatic effect (Sreeramachandra Babu *et al*., 2000 and Kumar and Singh, 2004).

The cross combinations showing desirable SCA effects for days to 50% flowering were Prabhat x Kamini, Prabhat x Sudha, Prabhat x Vaidehi, Saket 4 x Vaidehi and Prabhat x Rajshree. For plant height, the significant high SCA effect were recorded for cross combinations Prabhat x Vaidehi, Prabhat x Sudha, Prabhat x Kamini and Saket4 x Vaidehi. For panicle length the best specific combiners were Saket4 x Rajshree, Sita x Rajshree, Vaidehi x Kamini, Saket 4 x Sudha and Saket 4 x Sita. The crosses Saket 4 x Rajshree , Saket 4 x Vaidehi, Rajshree x Kamini, Saket 4 x Sita and Vaidehi x Kamini exhibited high SCA effect for effective tillers hill^{-1}. The best specific combiners for number of grains panicle^{-1} were Saket 4 x Sudha, Prabhat x Sita, Rajshree x Vaidehi and Prabhat x Sudha whereas, the crosses Saket 4 x Sudha, Prabhat x Vaidehi, Sita x Vaidehi, Sita x Rajshree and Prabhat x Sudha showed higher SCA effects for 1000 grains weight.

The majority of the crosses significant SCA effects which involved good and poor general combiners, indicating additive x dominance type of gene interaction involved in the expression of characters. However, some crosses involving low x low general combiners showed high SCA effects, suggesting that epistatic gene action, may be due to genetic diversity in the form of heterozygous loci. Very few crosses having high x high general combiners showed high SCA effects indicating the predominance of additive x additive type of gene action. Similar results were reported by Ram *et al*. (1998), Satyanarayana *et al.* (2000) and Kumar and Singh (2004).

In case , where high x high general combiners are involved for high SCA effects, the crosses would be utilized for yield improvement through single plant selection in segregating generations. But in the crosses showing high SCA effects due to high x low general combiners, simple pedigree breeding would not be effective to improve the characters. Population improvement i.e mass selection with concurrent random mating in early segregating generations (Redden and

Table 2. Specific combining ability effects of crosses for seven characters in rice

Crosses	Days to 50% flowering		Plant height		Number of effective tillers hill^{-1}		Panicle length		Number of grains panicle^{-1}		1000-grain weight		Grain yield plant^{-1}	
	$\overline{X}$	GCA	$\overline{X}$ (cm)	GCA	$\overline{X}$	GCA	X(cm)	GCA	$\overline{X}$	GCA	$\overline{X}$ (g)	GCA	$\overline{X}$ (g)	GCA
Prabhat x Saket 4	78.33	-7.47**	102.33	-27.60**	20.00	-3.87**	24.00	-2.77**	90.00	-14.66**	23.50	-1.05**	25.33	1.01
Prabhat x Sita	98.33	7.97**	124.00	-15.23**	22.33	-1.35**	25.00	-2.14**	71.67	24.16**	19.83	1.38**	22.67	7.12**
Prabhat x Rajshree	98.00	8.49**	130.00	14.14**	26.33	0.83	27.33	0.45	83.67	8.05**	24.00	-2.44**	35.00	4.19**
Prabhat x Vaidehi	111.33	13.27**	144.00	34.84**	23.00	-3.17**	25.00	1.01	102.00	0.31	27.83	5.69**	43.33	-4.25**
Prabhat x Sudha	111.67	14.23**	144.00	26.18**	14.33	-0.28	27.67	0.75	125.67	11.34**	31.50	2.82**	42.00	-2.44**
Prabhat x Kamini	114.00	15.16**	144.33	17.77**	22.00	-3.02**	26.00	0.90	85.00	19.58**	22.83	-9.32**	36.00	-11.29**
Saket 4 x Sita	92.33	4.94**	89.33	13.55**	16.00	2.68**	21.33	1.19*	72.67	-16.03**	20.17	-4.12**	28.00	-7.69**
Saket 4 x Rajshree	96.67	-0.21	129.33	9.58**	16.67	6.54**	25.00	2.79**	85.00	-6.81**	28.50	-0.77**	32.67	0.05
Saket 4 x Vaidehi	110.33	9.56**	148.33	14.95**	13.00	4.54**	24.33	0.01	100.67	9.45**	31.50	0.53	42.33	8.27**
Saket 4 x Sudha	112.00	6.53**	142.33	7.95	14.33	-3.90**	26.00	1.41**	86.67	30.49**	28.00	5.99**	26.33	9.42**
Saket 4 x Kamini	114.67	6.45**	137.67	4.55**	13.67	1.68*	25.00	-0.44	81.33	2.56**	27.00	-0.82**	26.67	3.23**
Sita x Rajshree	108.00	-6.51**	126.33	12.29**	13.67	1.06	22.00	1.75**	87.33	-0.66	28.50	3.16**	38.00	-0.18
Sita x Vaidehi	112.00	1.60**	133.00	13.99**	12.00	-1.28	24.67	0.64	113.00	12.94**	24.33	3.62**	32.67	9.38**
Sita x Sudha	115.00	1.90**	132.33	9.66**	9.33	0.28	25.00	1.05*	74.67	-3.69**	27.17	1.62**	27.67	-4.14**
Sita x Kamini	117.00	2.16**	133.33	-1.26**	19.33	-2.46**	25.33	-0.14	78.00	3.71**	24.50	2.77**	41.33	-3.99**
Rajshree x Vaidehi	114.67	-1.55**	153.33	-11.31**	14.00	-2.43**	24.67	0.23	77.33	22.49**	31.50	-4.36	38.00	-3.88**
Rajshree x Sudha	114.00	0.08	129.33	-10.31**	11.33	-4.87**	23.00	-0.69	83.33	-18.47**	23.67	0.27	24.00	-7.40**
Rajshree x Kamini	115.33	-0.32**	158.33	-13.05**	17.00	3.06**	28.00	-0.55	79.67	-2.40**	27.33	-0.55	36.33	6.08**
Vaidehi x Sudha	116.00	-6.47**	150.33	-30.60**	17.00	-1.53**	27.67	-3.14**	96.67	-11.88**	24.17	-5.77**	39.33	-11.18**
Vaidehi x Kamini	119.67	-7.55**	175.00	-5.34**	16.33	2.06**	27.67	1.68**	79.67	-2.81**	27.50	-0.25	35.33	0.97
Sudha x Kamini	121.00	-4.58**	156.67	12.99**	15.33	1.61*	27.00	0.08	84.33	-5.44**	27.17	1.71**	34.33	2.45**
SEm(±)		0.48		1.25		0.72		0.53		0.77		0.30		0.52
CD (P=0.05)		0.67		1.75		0.99		0.74		1.06		0.40		0.72

* & ** Significant at P=0.05 and 0.01 respectively.

Jensen, 1974) could be a prespective breeding procedure for yield improvement in rice. The crosses showing high SCA effects involving low x low general combiners could be exploited for heterosis breeding programme.

The results indicated that selection of crosses should be based on *per se* performance coupled with high SCA effects. The crosses Saket 4 x Vaidehi, Rajshree x Kamini, Prabhat x Rajshree and Sita x Vaidehi with standard heterosis offer greater scope for exploitation of hybrid vigour in areas of rainfed lowland situation.

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