SHORT COMMUNICATION

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Combining ability studies in rice

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ABSTRACT

Four well adapted lines and eight testers of rice were crossed in Line x *Tester fashion to elicit information regarding the desirable parents and crosses for their use in crop improvement programme. Sufficient genetic variability was observed among the parents, lines and crosses for all the traits studied. Analysis of variance revealed significant differences among genotypes, crosses, lines, testers and lines x testers interaction for tiller number, plant height, days to 50% flowering, panicle length, number of spikelets panicle^{-1}, spikelet fertility and grain yield. Variance of SCA were higher than GCA variances for all the traits except for number of filled spikelets panicle^{-1} which indicated predominance of additive gene action in the inheritance of these traits. The estimates of gca effects revealed that the genotype Pusa-5A among the lines and Dubraj (nagri) among the testers were found to be the best general combiners for grain yield plant^{-1} and its components. Significant sca effect was exhibited by three crosses viz. PMS-11A/Basmati -370, PMS-11A/MTU-1001 and CRMS-32A/Dubraj (nagri).*

Key words: *rice, combining ability, variability*

Rice occupies the prime place among the food crops cultivated around the world. Breeding strategies based on selection of hybrids require expected level of heterosis as well as the specific combining ability (SCA). Combining ability analysis is one of the powerful tools available to estimate the combining ability effects and aids in selecting the desirable parents and crosses for the exploitation of heterosis (Sarker *et al*., 2002; Rashid *et al*., 2007). Therefore, an attempt has been made to assess the combining ability and to determine the nature and magnitude of gene action for yield and yield related traits to explore the best combination of male sterile and restorer lines for exploitation of maximum heterosis.

The experimental materials comprised of 12 rice genotypes, four CMS lines (Pusa-5A, PMS-11A, PMS-17A and CRMS-32A) and eight testers [R-304-34, Pusa Basmati, Swarna, Bamleshwari, Basmati-370, Mahamaya, MTU-1001 and Dubraj (nagri)] were used. The parents were crossed to produce 32 F_1 hybrids according to line x tester mating design (Kempthorne, 1957). The study was conducted at Indira Gandhi Krishi Vishwavidyalaya, Chhattisgarh during wet season. Single seedlings of each entry were transplanted at 20 x 15 cm spacing in a randomized complete block design with three replications. All the recommended cultural practices were followed. In this study 12 traits namely, days to 50% flowering, plant height, panicle length, effective tillers plant^{-1}, total no. of spikelets panicle^{-1}, total no. of filled spikelets panicle^{-1}, total number of chaffy spikelets panicle^{-1}, spikelets fertility percentage, pollen sterility percentage, 100-grain weight, Harvest index and grain yield plant^{-1} were studied.

Data were recorded on ten randomly selected plants from parents and F_1 plant samples. Combining ability analysis was done using line x tester method (Kempthorne, 1957). The variances for general combining ability and specific combining ability were tested against their respective error variances derived from ANOVA reduced to mean level. Significance test for GCA and SCA effects were performed using t-test.

The analysis of variance revealed that highly significant differences existed for all the characters The sca variance was higher than the gca variance for all the traits except for total number of filled spikelets panicle^{-1}, where gca variance was higher than sca variance. The ratio for gca/sca variances were found positive for all the characters indicating the

preponderance of non-additive gene action for all the traits except for total no. of filled spikelets panicle^{-1}. Similar results were also reported by Dwivedi *et al*. (1999) and Mehta *et al*. (2000).

There were significant differences among the genotypes for characters (Table 1), which lead to the combining ability analysis. These were partitioned genetic effects between genotypes into general combining ability and specific combining ability. The variance due to lines was significant for all the characters except effective tillers plant^{-1}. The variances due to testers as well as line x testers were also significant for all the characters studied. The above results showed that the base genotypes displayed high degree of genetic variability for different characters, which is an essential prerequisite for the success of any breeding programme.

None of the CMS lines or pollinators was found to be good general combiner for all the characters studied. The line Pusa-5A was found as best general combiner for total number of filled spikelets panicle^{-1}, spikelet fertility percentage, pollen sterility percentage, harvest index and grain yield plant^{-1} indicating that this genotype was good general combiner for higher yield. The line PMS-11A was the best general combiner for effective tillers plant^{-1} and 100-grain weight. The line PMS-17A was the best general combiner for panicle length. Among the testers Basmati-370 was the best general combiner for total number of filled spikelet panicle^{-1}, spikelet fertility percentage and 100-grain weight. Dubraj (nagri) was the best general combiner for panicle length, total number of spikelet panicle^{-1}, harvest index and grain yield plant^{-1}. The parents Pusa-5A, PMS-11A, Basmati-370 and Dubraj (nagri) were evaluated as superior parents as they recorded high *per se* performance and highly significant gca effects towards desirable directions for most of the traits studied. Mehla *et al*. (2000) also applied the criteria of *per se* performance and gca effects for judging the potentiality of the parents.

None of the crosses exhibited high sca effects for all the characters studied (Table 2). The four cross combinations have been found superior for different characters. PMS-11A x Mahamaya for days to 50 per cent flowering, PMS-17A x Basmati-370 for panicle length, Pusa-5A x Basmati-370 for 100-grain weight and PMS-11A x MTU-1001 for grain yield plant^{-1}. The investigation revealed that the importance of non additive gene action for all the characters studied except for total number of filled spikelets panicle^{-1}. However preponderance of non additive gene action was observed for all the trait studied except for the trait total number of filled spikelets panicle^{-1}. Specific combining ability effect is the index to determine the usefulness of a particular cross combination in the exploitation of heterosis.

Table 1. General combining ability (GCA) effects of lines and testers

	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	Effective tillers plant^{-1}	Total no. spikelets panicle^{-1}	Total no. of filled spikelets panicle^{-1}	Total no. of chaffy spikelets panicle^{-1}	Spikelet fertility (%)	Pollen sterility (%)	100-grain weight (g)	Harvest index (%)	Grain yield plant^{-1} (g)
Lines												
Pusa-5A	0.03	-9.92*	-1.75*	-0.22	33.06*	45.68*	-12.94*	11.63*	-13.13*	-0.36*	6.24 *	2.23*
PMS-11A	-2.30*	7.69*	0.58*	0.63*	-31.04*	-27.12*	-3.00	-5.01*	3.69*	0.25*	-6.31 *	1.50*
PMS-17A	3.53*	2.44*	0.75*	0.06	8.50	-31.03*	39.02*	-14.92*	18.01*	0.08*	-4.32 *	-4.71*
CRMS-32A	-1.53*	-0.20	0.42*	-0.48*	-10.27*	12.48 *	-23.08*	8.30*	-8.56*	0.03	4.39*	0.97*
Testers												
R-304-34	-2.03*	- 0.97*	-0.42*	0.80*	0.15	-3.21	2.98	-1.69*	-17.06*	0.00	-2.96 *	-2.11*
Pusa Basmati	6.59*	-11.42*	0.90*	3.15*	-19.30*	-75.46*	55.83*	-36.00*	42.89*	-0.07*	-10.26*	-9.20*
Swarna	2.22*	-11.95*	-1.92*	-1.68*	-27.80*	-5.01*	-20.49*	10.01*	-8.75*	0.07*	-6.35*	-4.00*
Bamleshwari	2.22*	- 4.22*	-0.40*	-1.65*	16.02*	15.79*	-0.09	3.59*	-4.85*	-0.01	-0.46	-0.16*
Basmati-370	-3.53*	12.08*	1.50 *	-0.23*	-11.80	9.32*	-21.44*	7.55*	-9.98*	-0.03	2.67*	4.44*
Mahamaya	-2.66*	2.33*	-0.65*	-1.05*	7.12	26.72*	-19.92*	10.33*	-5.98*	0.14*	8.09*	2.48*
MTU-1001	-2.28*	-2.80*	-0.60*	-0.83*	-0.65	9.84*	-10.82	4.71*	-1.44*	0.05	0.60	3.32*
Dubraj(nagri)	-0.53*	16.98*	1.58 *	1.50*	36.27*	22.02*	13.93*	1.51*	5.14*	-0.15*	8.67*	5.23*

Table 2. Specific combining ability (SCA) effects of Hybrids

Hybrids	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	Effective tillers plant^{-1}	Total no. spikelets panicle^{-1}	Total no. of filled spikelets panicle^{-1}	Total no. of chaffy spikelets panicle^{-1}	Spikelet fertility (%)	Pollen sterility (%)	100-grain weight (g)	Harvest index (%)	Grain yield plant^{-1} (g)
Pusa-5A/												
R- 304-34	0.97*	4.12*	-0.20	1.32*	2.67	8.12	-5.08*	2.82	1.99	-0.22*	-1.89	-0.40
Pusa Basmati	-3.66*	8.37*	-1.93*	-1.93*	- 9.38	57.67*	-66.73*	36.88*	-48.99*	-0.21*	5.12*	9.00*
Swarna	1.72*	-0.30	1.60*	2.39*	16.32	-20.28*	34.29*	-17.82*	21.29*	0.33*	3.66	4.67*
Bamleshwari	0.72*	2.07	-0.23	0.87	32.09*	10.32	22.09*	-6.05*	13.30*	-0.23*	1.96	1.39
Basmati-370	-7.03*	1.97	0.37	0.54	-7.78	-33.90*	26.44*	-13.12*	18.35*	0.60*	-3.83	1.40
Mahamaya	4.59*	-2.98*	1.62*	-0.03	-11.11	-28.50*	17.72*	-9.82*	9.47*	-0.36*	-0.49	-4.21*
MTU-1001	-5.78*	13.05*	1.17*	-1.76*	-24.83*	-1.13	-23.38*	7.59*	-8.54*	0.27*	-3.55	-5.50*
Dubraj(nagri)	8.47*	-26.33*	-2.40	-1.38*	2.04	7.70	-5.33	-0.48	-6.86*	-0.18*	-0.97	-6.35*
PMS- 11A/												
R-304 -34	6.03*	-6.39*	0.07	-0.63	1.67	-4.08	4.78	-2.98	-3.98*	-0.10*	-6.35*	-3.46*
Pusa Basmati	-1.59*	-8.54*	0.75*	-3.78*	-9.38	-10.13	-0.17	-12.40*	20.99*	-0.17*	-0.56	-7.35*
Swarna	2.78*	-9.21*	-2.93*	-1.66*	-69.88*	-32.88*	-30.55*	8.02*	-1.11	-0.27*	2.45	-8.33*
Bamleshwari	1.78*	7.06*	1.45*	1.32*	6.19	-5.38	10.65	-4.10	4.97*	0.22*	3.55	2.22*
Basmati-370	7.53*	0.16	0.45	0.09	20.32	29.90*	-10.50	11.66*	-16.50*	0.08*	5.96*	8.15*
Mahamaya	-8.84*	15.61*	-0.90*	-0.08	25.99*	-16.00*	41.08*	-14.77*	15.03*	0.54*	-6.89*	1.59
MTU-1001	-5.72*	1.74	0.25	2.19*	20.47	50.07*	-30.52*	21.02	-20.75*	-0.49*	3.47	10.50*
Dubraj(nagri)		-0.44	0.87*	2.57*	4.64	-11.50	15.23	-6.45*	1.35	0.20*	-1.63	-3.02*
PMS-17A/												
R- 304-34	0.53*	-3.24*	-0.40	0.04	16.98	26.13	-8.85	7.83*	-10.05*	0.02	4.13*	2.91
Pusa Basmati	1.34*	2.41*	1.67*	3.99*	43.83*	-3.62	-47.70*	0-3.08	5.01*	0.15*	1.25*	0.18
Swarna	1.22*	-3.06*	-0.20*	0.18*	62.33*	37.53*	22.93*	-4.14	-9.85*	-0.02	4.75*	7.50*
Bamleshwari	-2.78*	-4.49*	-1.23	-1.21*	1.10	14.23*	-15.07*	5.80*	-13.64*	0.11*	-11.94*	-2.76*
Basmati-370	-1.53*	13.41*	1.87	1.17*	-50.97*	-21.29*	-29.42*	0.23	-1.47	-0.05	-1.53	-0.21
Mahamaya	0.09	-0.64	-0.98*	-1.11*	-52.10*	5.61	-57.45*	18.43*	18.63*	0.21*	2.22	-2.13
MTU-1001	6.72*	-15.41*	-1.53*	-1.73*	-34.02*	-45.92	12.15	-18.17*	21.06*	-0.11*	5.49*	-6.17*
Dubraj(nagri)	-4.53*	11.01*	-0.80	-0.96*	15.05	-12.69	28.00*	-6.90*	27.84*	-0.10*	-4.38*	0.68
CRMS- 32A/												
R-304 -34	-6.46*	5.50*	0.53	-0.75	-21.31	-30.18*	9.15	-7.67*	12.04*	0.30*	4.10*	1.25
Pusa Basmati	3.91*	-2.25*	-0.49	1.73*	-25.06*	-43.93*	19.20*	-21.40*	22.99*	0.23*	-5.81*	-1.83
Swarna	-5.72*	12.57*	1.53*	-0.55	-8.76	15.62*	-26.67*	13.95*	-10.33*	-0.04*	-10.86*	-3.84*
Bamleshwari	0.28	-4.65*	0.01	-0.97	-37.18*	-19.18*	-17.67	4.35	-4.62*	0.12*	6.43*	-0.84
Basmati-370	1.03*	-15.55*	-2.69*	-1.80*	38.44*	25.30*	13.48	1.22	-0.11	-0.63*	-0.60	-9.34*
Mahamaya	4.16*	-12.00*	0.26	1.23*	37.22*	38.90*	-1.35	6.16*	-5.87*	-0.40*	5.16*	4.75*
MTU-1001	4.78*	0.62	0.11	1.30*	38.39*	-3.03	41.75*	-10.44*	8.24*	0.34*	-5.40*	1.16
Dubraj(nagri)	-1.97*	15.75*	0.73*	-0.22	-21.73	16.50*	-37.90*	13.83*	-22.33*	0.07*	6.98*	8.69*

*Significance at P< 0.05 level

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