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Line x Tester analysis for grain yield and related characters in rice

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Abstract: **Twenty seven crosses represented by a 3 lines x 9 testers design along with parents were evaluated for grain yield and related characters. Analysis of variance indicated significant variations among the crosses and parents for all the traits. Combining ability analysis showed both additive and non-additive gene action, but the latter was predominantly operative for most of the traits studied. Among the three Cytoplasmic male sterile (CMS) lines, IR 58025A and among the nine testers, PSRM-1-16-48-1, Pusa 1040 and RAU 1411-4 were found to be good general combiners for yield and other yield attributes. The hybrids IR 68886A x Pusa 1040, IR 58025A x Gautam, IR 68886A x PSRM-1-16-48-1 were identified as good specific combinations for grain yield plant^{-1} and related characters.**

Key words : Rice, Line x Tester analysis, Combining ability.

Introduction

The success of a plant breeding programme greatly depends on correct choice of parents for hybridization and the gene action of different economic traits. Combining ability analysis provides such information so as to frame the breeding programme effectively. The line x tester analysis gives reliable information about the nature and magnitude of gene action and combining ability effects present in the genetic materials. Dhillon (1975) pointed out the combining ability gives useful information on the choice of parents in terms of expected performance of the hybrids and their progenies. Hence, the present investigation was carried out at Research Farm of Rajendra Agricultural University, Pusa during *kharif* 2001, involving three promising cytoplasmic male sterile lines (CMS) and nine local elite cultivars.

Materials and Methods

Three CMS lines IR 58025A, IR 68897A and IR 68886A and nine elite lines *viz.* Gautam, Dhanalaxmi, Prabhat, Saroj, Pusa 1107, Pusa 1040, PSRM-1-16-48-1, RAU 1411-4 and RAU 1411-10 were used as testers in line x tester design to generate 27 hybrids. These 27 F_1 hybrids along with twelve parents were grown in a randomized block design with three replications. Thiry day-old seedlings of the 27 F_1 hybrids and 12 parents were transplanted with a spacing 20 cm between rows and 15 cm between plants. Each test entry consisted single row of 3m length.

The observations were recorded on five plants per plot selected at random from each treatment in each replication for days to flowering, days to physiological maturity, grain filling period, grain filling rate, panicle density, fertility % and grain yield per plant. The line x tester analysis was done based on the procedures developed by Kempthorne (1957).

Results and Discussion

The analysis of variance involving twelve parental lines and twenty seven crosses for seven characters (Table 1) revealed that highly significant difference existed among the parents and crosses. The mean squares due to parents, crosses, and line x tester interactions were significant for all characters. The significant component of variance due to parents vs. crosses indicated prevalence of heterosis for all the characters with the exception of grain filling rate, fertility % and grain yield per plant. The mean squares due to lines and testers were highly significant for all characters indicating the predominance of additive variance. However, mean square due to line x tester was also significant for all the characters indicating that both additive and dominance or non-additive variances were important for those characters.

Table 1. Analysis of variance for grain yield and related characters in rice

Source of variation	d.f.	Days to flowering	Days to physiological maturity	Grain filling period	Grain filling rate	Panicle density	Fertility %	Grain yield plant^{-1}
Replications	2	59.16	288.50	82.98	0.07	1.99	25.99	1.29
Genotype treatments	38	61.08**	8056**	32.22**	1.14**	15.85**	2212.59**	982.64**
Parents	11	67.42**	120.82**	38.51**	1.39**	24.49**	3169.56**	1038.50**
Crosses	26	58.37**	62.06**	30.55**	1.07**	12.64**	1892.79**	996.75**
Parents x Crosses	1	61.75**	118.67**	6.46*	0.015	3.68**	0.72	1.36
Lines	2	28.14**	29.80**	0.70**	1.37**	16.17**	374.40**	1283.97**
Testers	8	44.94**	54.38**	15.69**	0.80**	6.04**	1925.10**	732.00**
Lines x Testers	16	68.87**	69.94**	41.70**	1.17**	15.49**	2966.42**	1093.23**
Error	76	3.99	3.81	1.36	0.02	0.36	23.71	16.60

* and ** significant at P=0.05 and 0.01 respectively.

Table 2. General combining ability effects for seven characters in rice

Parents	Days to flowering	Days to physiological maturity	Grain filling period	Grain filling rate	Panicle density	Fertility %	Grain yield plant^{-1}
Lines (Female, i)							
IR 58025A	-0.04	-0.53	-0.11	0.25**	0.89**	3.36**	7.72**
IR 68897A	1.04**	1.21**	0.18	-0.19**	-0.39**	0.65	-5.55**
IR 68886A	-1.00*	-0.68	-0.07	-0.06*	-0.50**	-4.00**	-2.17**
Testers (Males, j)							
Gautam	-3.92**	-3.68**	-0.85	-0.27**	-1.55**	-25.36**	-9.95**
Dhanlaxmi	3.29**	3.10**	-0.30	-0.04	0.45**	9.11**	-3.00*
Prabhat	-2.15**	-2.12**	-0.07	-0.36**	0.52**	9.65**	-10.17**
Saroj	-0.26	0.77	1.04**	-0.29**	-0.28	3.38*	-7.50
Pusa 1107	1.96**	1.54*	-0.52	-0.22**	0.70**	4.47**	-5.53**
Pusa 1040	1.40**	1.65**	0.70	0.40**	-0.72**	-15.22**	12.66**
PSRM-1-16-48-1	0.96*	0.54	052	0.35**	0.95**	13.79**	9.77**
RAU 1411-4	-1.48**	-3.46**	-2.07**	0.24**	0.47*	17.86**	5.77**
RAU 1411-10	0.19	1.65	2.60	0.20**	-0.54**	-10.93**	7.94**
S.E.(gi) (Lines)	±0.38	±0.37	±0.22	±0.33	±0.11	±0.93	±0.78
S.E.(gj) (Testers)	±0.67	±0.65	±0.39	±0.05	±0.20	±1.62	±1.35

* and ** significant at P=0.05 and 0.01 respectively

Table 3. Specific combining ability (sca) effects of five best crosses for different characters

Characters	Crosses	Mean	sca effects	S.E.
Grain yield plant-1	IR 68886A x Pusa 1040	83.66	41.05**	2.35
	IR 68886A x PSRM-1-16-48-1	57.8	18.11**	
	IR 58025A x Gautam	50.3	20.45**	
	IR 68886A x RAU 1411-10	49.0	14.50**	
	IR 68897A x Dhanlaxmi	40.5	16.94**	
Fertility %	IR 68886A x Prabhat	95.2	21.23**	0.281
	IR 58025A x Gautam	93.1	46.77**	
	IR 68886A x Pusa 1040	91.5	42.40**	
	IR 68897A x Saroj	84.3	18.70**	
	IR 68897A x RAU 1411-10	76.7	18.66**	
Panicle density	IR 58025A x Gautam	7.1	3.38**	0.34
	IR 68886A x Prabhat	6.6	2.13**	
	IR 68897 x Dhanlaxmi	6.3	1.79**	
	IR 68886A x Pusa 1040	6.1	2.90**	
	IR 68897A x RAU 1411-10	5.8	2.25**	
Days to flowering (Earliness)	IR 68897A x RAU 1411-4	81.0	-3.49**	1.15
	IR 68886A x RAU 1411-4	78.3	-4.11**	
	IR 58025A x Prabhat	78.3	-3.74**	
	IR 68897A x RAU 1411-10	78.0	-8.15**	
	IR 68886A x Gautam	73.7	-6.33**	
Days to physiological maturity (Earliness)	IR 58025A x Dhanlaxmi	111.0	-6.91**	1.13
	IR 68886A x RAU 1411-10	111.6	-6.54**	
	IR 68886A x Saroj	110.0	-5.43**	
	IR 68886A x Pusa 1040	112.0	-4.32**	
	IR 68886A x Gautam	107.0	-3.99**	
Grain filling period	IR 68886A x Dhanlaxmi	35.6	5.52**	0.67
	IR 58025A x Pusa 1040	35.6	4.55**	
	IR 68897A x Saroj	35.0	3.26**	
	IR 58025A x Prabhat	34.6	4.33**	
	IR 68886A x RAU 14114	32.0	3.63**	
Grain filling rate	IR 68886A x Pusa 1040	2.8	1.40**	0.09
	IR 58025A x Gautam	1.8	0.75**	
	IR 68897A x RAU 1411-4	1.6	0.47**	
	IR 68897A x Dhanlaxmi	1.44	0.56**	
	IR 68897A x RAU 1411-10	1.4	0.47**	

** = significant at P=0.01 level.

Both additive and non-additive gene actions appeared to play a significant role in controlling the expression of all the traits *i.e.* days to flowering, days to physiological maturity, grain filling period, grain filling rate, panicle diversity, fertility % and grain yield per plant, but non-additive action seemed to be more important. The results are in agreement with those of Singh and Nanda (1976), Shrivastava and Seshu (1983), Sharma *et al.* (1987) and Majumdar *et al.* (1989) for grain yield and Dwivedi *et al.* (1980) for days to flowering. Contrary to this, only additive gene action, has been indicated to flowering and grain yield. This both the types of gene action appear to be playing a considerable role in rice.

General combining ability effects

The general combining ability effects of the parents in the present study have brought to light the parents with high gca effects for seven different traits (Table 2). Among the lines, IR 58025A had favourable genes for fertility %, panicle density, grain filling rate and grain yield plant^{-1} as revealed by superior gca effects for these traits. The gca effects

Among the testers, PSRM-1-16-48-1 possessed desirable genes for grain filling rate, panicle density and grain yield plant^{-1} and RAU 1411-10 for grain filling period, grain filling rate and grain yield plant^{-1}. The tester RAU 1411-4 possessed desirable genes for earliness for flowering, for physiological maturity, grain filling rate, panicle density, fertility % and grain yield plant^{-1}. The testers Pusa 1040 and PSRM-1-16-48-1 had superior gca effects for grain yield. Among the testers studied, Gautam and Prabhat were proved good general combiners for early flowering and maturity. From the above findings it could be inferred that none of the parents had favourable genes for all the characters studied. Therefore, multiple crossing among these parents would be desirable to get superior recombinants with desirable traits along with grain yield. From the overall observations among male parents, PSRM-1-16-48-1 and RAU 1411-4 proved to be the best combiner for yield and its most of the related characters while among female parents, IR 58025A exhibited its superior gca effects for grain yield.

Specific combining ability effects

High specific combining ability results mostly from dominance and interaction effects existing between the hybridizing parents (Table 3). The cross exhibiting high and significant sca effects for grain yield were IR 68886A x Pusa 1040, IR 68886A x PSRM-1-16-48-1, IR 58025 x Gautam, IR 68886A x RAU 1411-10 and IR 68897A x Dhanalaxmi. In addition, the cross IR 58025A x Gautam had high sca effects for fertility %, panicle density and grain filling rate. The cross IR 68886A x Pusa 1040, the best specific combination for grain yield plant^{-1}, was also good specific combination for fertility %, panicle density, grain filling rate and earliness for days to physiological maturity. Likewise, the cross IR 58025A x Gautam was good specific combination for grain yield plant^{-1}, apparently due to good specific combinations for fertility %, panicle density and grain filling rate. The cross IR 68897A x Dhanlaxmi, fifth best specific combination for grain yield plant^{-1}, was also good specific combination for panicle density and grain filling rate. These crosses also showe significant heterosis for yield and its contributin characters. It was observed that crosses involvin one high and the lower low, medium or hig general combiner parents indicating additiv as well as non additive genetic interaction operating in these crosses. Similar results wa also obtained by Peng and Virmani (1990 The best combiners for more than one tra could be utilized in further breeding programm The hybrids IR 68886A x Pusa 1040, IR 58025 x Gautam and IR 68886 x PSRM-1-16 48-1 could be used for the exploitation o heterosis for yield and related characters.

References

Dhillon, B.S. (1975). The application of parti diallel crosses in plant breeding-A revie *Crop Improve.* **2**: 1-7.

Dwivedi, S.L., Rai, K.N. and Singh, R.B. (198 Diallel analysis of heading date in rice (*Or sativa* L.). *Theor. Appl. Genet.* **57**: 43-

Kalaimani, S. and Sundaram, M.K. (1988). Combini ability for yield and yield components rice (*Oryza sativa* L.). *Madras Agric. J.* 7 99-104.

Kempthorne, O. (1957). An introduction to genet statistics. John Wiley and Sons Inc., Ne York.

Majumdar, N.D., Borthakur, D.N. and Rakshit, S.C (1989). Heterosis in rice under phosphoru stress. *Indian J. Genet.* **49**: 231-235.

Peng, J.Y. and Virmani, S.S. (1990). Combinin ability for yield and four yield related trait in relation to breeding in rice. *Oryza*, **27** 1-10.

Sharma, D.K., Srivastava, M.N. and Tiwari, D.K (1987). Line x tester analysis for harves index and related characters in rice (*Oryz sativa* L.). *Indian J. Genet.* **47**: 211-21

Singh, D.P. and Nanda, J.S. (1976). Combinin ability and heritability in rice. *Indian J Genet.* **36**: 10-15.

Srivastava, M.N. and Seshu, D.V. (1983). Combinin ability for yield and associated character in rice. *Crop Sci.* **23**: 741-744.

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