Pak. j. sci. ind. res., vol. 36, no. 11, November 1993

DIALLEL ANALYSIS FOR COMBINING ABILITY IN RICE

Syed Sultan Ali, S. Jahangeer H. Jafri and M. Anwar Butt

Rice Research Instiute, Kala Shah Kaku, Lahore, Pakistan

(Received May 19, 1992; revised August 11, 1993)

A half diallel analysis of combining ability involving four rice varieties/lines (Basmati 370, Basmati 385, 4048 and Basmati 198) was studied for grain yield, plant height, number of tillers per plant, panicle length, number of spikelets per panicle, number of grain per panical, percent filled spikelets, panicle weight and spikelet density. General (GCA) as well as specific combining ability (SCA) mean squares were significant for all traits except percent filled spikelets and panicle weight for which GCA mean squares were significant. The mean varietal performance was linearly related to their GCA values for grain yield and yield components. Basmati 385 was found good combiner for grain yield and some of its major components. Basmati 198 and 4048 were poor combiners for plant height. Basmati 370 was the good combiner for percent filled spikelets. Based on mean performance coupled with SCA effects of the crosses and varietal GCA effects, crosses *viz*. Basmati 370 x Basmati 385, Basmati 370 x Basmati 198, Basmati 385 x 4048 and 4048 x Basmati 198 could be recommended for pure line development using pedigree method.

Key words: Rice, Genetic, Combining ability, Diallel.

Introduction

Rice breeders face a problem to select parents for hybridization. A wrong choice can undo a meticulously planned and well executed follow up programme. The combining ability analysis developed by Griffing [5] provides useful information on prepotency of parents in F_1 generation. Over the past few years a plateau in yield has been reached. Therefore, there is a need for more efficient utilization of existing genetic variability to improve present yield levels. Equipped with information regarding combining ability, rice breeders can better decide which parents to cross and how to handle segregating populations [4,7,9,13]. Most of the earlier reports have attributed preponderance of genetic variability due to GCA for plant height, grain yield and yield components [1,3,4,6,8-11,13]. The contribution of SCA to genetic variability was either significant [1,3,7,9,11] or non significant [2,8,10,13]. The objective of this study was to determine genetic potential of four rice varieties/lines and discriminate F_1 crosses for future breeding.

Materials and Methods

A 4 x 4 diallel (excluding reciprocals) involving rice varieties/lines *viz*; Basmati 370, Basmati 385, 4048 and Basmati 198 was studied during Kharif 1991. Four parents with their 6 F_1 crosses were sown in a RCB design with three replications. Each plot consisted of a single row 4 meter long, spacings between plants and rows were 30 cm. Observations on ten randomly selected plants for each parent and cross were recorded on plant height (Pl. Ht.), number of tillers per plant (NT/P), panicle length (PL), number of spikelets per panicle (NS/P), number of grains per panicle (NG/P), percent filled spikelets (PFS), panicle weight (PW), spikelet density (SD) and grain yield (GY/P). Plant height and panicle length were measured in centimeters and grain yield in grams. The data were averaged for analysis [12]. Combining ability analysis was performed according to model 1 and method 2 of Griffing [5]. Model 1 was used because the parents represented a selected group of cultivars.

Results and Discussion

The analysis of variance showed that there were highly significant differences between genotypes for nine agronomic traits (Table 1). It gave an indication of available genetic variability to initiate a breeding programme. The genetic variability was partitioned into GCA and SCA. Both GCA and SCA mean squares were highly significant for all traits except panicle weight and percent filled spikelets for which GCA mean squares were non-significant (Table 1). Nevertheless, SCA mean squares were more pronounced for all traits except plant height and panicle length.

Parent Basmati 385 (2.26**) was good general combiner for grain yield and showed positive and desirable GCA effects for more than one important yield component (Table 2). Basmati 370 (2.33*) was good general combiner for percent filled spikelets; 4048 (4.57**) for number of tillers per plant. Basmati 198 (9.15**,5.88**) for number of spikelets per panicle and number of grains per panicle. Since dwarfness is an important attribute in rice, therefore, Basmati 198 (-9.51**) and 40.48 (-6.66**) can be included in hybridization due to negative but desirable GCA effects.

The ranking of parents for GCA matched their mean performance. Basmati 385 showed higher mean performance

TABLE 1. ANALYSIS OF VARIANCE AND COMBINING ABILITY FOR NINE AGRONOMIC TRAITS.

		Mean squares								
S.O.V.	df	Pl.Ht.	NT/P	PL	NS/P	NG/P	PFS	PW	SD	SYPP
Replications	2^{NS}	9.1738^{NS}	4.864^{NS}	6.25^{NS}	55.5811^{NS}	301.435^{NS}	7.0028^{NS}	0.09^{NS}	0.07^{NS}	12.1883^{NS}
Genotypes	9	793.6397**	1166.040**	21.598**	4893.2201**	2297.4253**	93.9439**	2.1914**	2.6289**	55.4638**
Error	18	8.1533	13.3828	2.99	85.7623	196.9261	16.0814	0.1272	0.3133	9.1513
GCA	3	713.708**	95.751**	8.208**	1604.0108**	694.6033**	10.828^{NS}	0.1167^{NS}	0.7524**	15.9693*
SCA	6	39.632**	535.145**	2.591**	1644.605**	801.411**	41.558**	1.0387**	0.9385**	19.7473**
Error	18	2.718	4.461	0.2969	28.5874	65.642	5.3605	0.0424	0.1044	4.4838

** = Significant at 0.01 probability level, NS= Non significant.

TABLE 2. ESTIMATES OF GCA EFFECTS AND MEAN PERFORMANCE OF PARENTS FOR DIFFERENT CHARACTERS.

Varieties/	Characters								
lines	Pl.Ht.	NT/P	PL.	NS/P	NG/P	PFS	PW	SD	SYPP
Basmati 370	14.85**	-3.23**	0.76^{NS}	-21.61**	-12.45**	2.33*	-0.12^{NS}	-0.41**	-1.54**
	160.86**	17.33**	30.77**	154.00**	136.10**	88.49**	3.09**	4.42**	29.31**
Basmati 385	1.32**	-3.47**	1.72**	15.55**	11.53**	-0.18^{NS}	0.17*	0.09^{NS}	2.26**
	140.63**	21.20**	36.27**	201.80**	170.9**	84.61**	4.09**	4.71**	36.79**
Basmati 4048	-6.66**	4.57**	-1.16	3.09^{NS}	-4.97^{NS}	-0.61^{NS}	-0.11^{NS}	-0.12^{NS}	-0.73^{NS}
	129.23**	34.2**	29.93**	133.2**	117.5**	88.13**	2.88**	3.93**	32.80**
Basmati 198	-9.51**	2.12**	-1.33**	9.15**	5.88^{NS}	-1.55^{NS}	0.06^{NS}	0.43**	0.003^{NS}
	117.77**	28.13**	27.09**	162.13**	139.2**	85.83**	3.18**	5.17**	34.00**
S.E.	0.33	0.75	0.12	1.89	2.86	0.82	0.07	0.11	0.75

*,** = Significant at 0.05 and 0.01 levels of probability.

TABLE 3. SCA EFFECTS AND MEAN PERFORMANCE OF SIX CYOSSES.

	Characters								
Crosses	Pl.Ht.	NT/P	PL	NS/P	NG/P	PW	SD	SYPP	% FS
Basmati 370 x385	4.36**	9.26**	0.76^{NS}	-8.16*	3.44^{NS}	0.48**	0.21^{NS}	6.73**	6.57**
	155.4**	49.37**	34.53**	164**	150.7**	4.18**	4.39**	43.23**	92.02**
Basmati 370x4048	-0.31^{NS}	20.39**	-0.55^{NS}	-7.65*	-18.06**	-0.81**	-0.26^{NS}	-3.01*	-7.51**
	142.76**	68.54**	30.35**	145.87**	112.7**	2.62**	3.71**	30.5**	77.51**
Basmati 370x198	3.37**	13.38**	3.85**	-22.19**	11.01*	0.95**	-1.46**	3.06*	-0.15^{NS}
	143.58**	62.08**	34.57**	143.57**	130.6**	4.55**	3.06**	37.3**	83.93**
Basmati 385x4048	-9.23**	10.8**	-2.22**	8.8*	2.16^{NS}	0.48**	-0.61**	2.91*	-1.7^{NS}
	120.3**	58.77**	29.63**	199.48**	156.9**	4.2**	3.86**	40.22**	80.82**
Basmati 385x198	-1.4^{NS}	17.21**	-1.64**	-3.44^{NS}	-4.89^{NS}	-1.19**	0.32^{NS}	-2.65^{NS}	-8.21**
	125.27**	62.67**	30.04**	217.33**	160.7**	2.7**	5.34**	35.39**	73.37**
Basmati 4048x198	-5.83**	12.25**	0.84^{NS}	76.52**	57.41**	1.42**	1.49**	3.15*	-2.89**
	112.87**	65.75**	29.64**	260.8**	206.5**	5.03**	6.3**	38.21**	78.26**
S.E.	1.08	1.34	0.3	3.38	5.12	0.13	0.2	1.34	1.46

**, * Significant at 0.01 and 0.05 levels of probability.

(36.79 g) for grain yield and good GCA effects (2.26**) as well. More or less similar situation was present for other traits. These results proved that combining ability analysis is a useful tool to determine genetic potential of the parents.

For grain yield, significant SCA effects were manifested in 5 crosses. However, positive and significant SCA effects were observed in crosses; Basmati 370 x Basmati 385 (6.73**); Basmati 370 x Basmati 198 (3.06*); Basmati 385 x 4048 (2.91*) and 4048 x Basmati 198 (3.15*) (Table 3). These crosses also exhibited desirable SCA effects for more than one yield components, therefore, these were amenable to selection simultaneously for grain yield and yield components. The cross combination Basmati 385 x Basmati 198 showed non-significant SCA effects for grain yield and for other yield components (Table 3).

High SCA effects for number of spikelets and number of grains per panicle (76.52**, 57.41**) were observed in 4048 x Basmati 198. All the six crosses exhibited significant and desirable SCA effects for number of tillers per plant. In these crosses selection could be practiced for yield components to improve grain yield. Plant height is indirect yield component and negative values are considered more desirable [1,10]. Such values are more pronounced in crosses; Basmati 385 x 4048 (-9.23**) and 4048 x Basmati 198 (-5.83**). Both of the crosses also showed positive and significant SCA effects for grain yield (2.91**, 3.15**).

The mean performance of crosses and magnitude of their SCA effects showed similar pattern (Table 3). The cross Basmati 370 x Basmati 385 ranked first in SCA effects (6.73**) and mean performance (43.23) for grain yield. Some early workers [4,7,8] also cautioned about using SCA effects to discriminate crosses and suggested that while selecting crosses, both mean performance and SCA values should be considered.

Keeping in view SCA effects coupled with mean performance of the crosses and parental GCA effects, four crosses *viz.*, Basmati 370 x Basmati 385, Basmati 370 x Basmati 198, Basmati 385 x 4048 and 4048 x Basmati 198 appeared promising for giving desirable segregants in subsequent generations.

It is concluded that usable genetic variability was present in the material studied. GCA effects of the parents provided a basis to measure their genetic potential. It was also found that SCA effects of crosses coupled with mean performance is the reliable criteria to select better ones. Mean performance and SCA effects of the crosses in conjunction with parental GCA values should be kept in view to identify crosses for further breeding.

References

1. M.S. Bhatti, M.A. Bajwa, N. Islam and A.G. Asi, Pak. J. Agric. Res., **5**, 88 (1984).
2. G.S. Bhular, K.S. Gill and A.S. Khehra, Theor. Appl. Genet., **55**, 77 (1979).
3. M.J. Bitzer, F.L. Patterson and W.E. Nyquist, Crop Sci., **22**, 1126 (1982).
4. P. Chuhan, Z. Ahmad and J.G. Sharma, Crop Imp., **3**, 109 (1967).
5. B. Griffing, Australian J. Biol. Sci., **9**, 463 (1956).
6. K.K. Gyawalli, C.O. Qualset and W.T. Yamazaki, Crop Sci., **8**, 32 (1968).
7. S.N. Jaimini and J.R. Mather, Genetics Polonics, **21**, 163 (1980).
8. R.P. Jain and K.B. Singh, Indian J. Agric. Sci., **46**, 247 (1976).
9. P.N. Narula, SABRAO J., **16**, 9 (1984).
10. M.S. Qari, N. Islam and A.G. Khan, J. Agric. Res., **22**, 95 (1984).
11. M. Saleem and S. Hussain, J. Agric. Res., **24**, 97 (1986).
12. R.G.D. Steel and J.H. Torrie, *Principles and Procedures of Statistics with Special Reference to Biological Sciences* (McGraw Hill Book Co., New York, 1980), pp.560.
13. S.P. Yadav and B.R. Murty, Indian J. Genet. Pl. Br., **36**, 184 (1976).