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Comparative performance of diallel, partial dialled and line x tester mating designs in selection of parental lines in basmati rice (*Oryza sativa* L.)

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ABSTRACT

Comparative performance of extensively used mating designs was studied for their ability to discriminate parental line with good or poor general combining ability in a set of crosses involving nine parents of indica rice. Based on the general combining ability estimates for 24 agro-morphological and quality characters, dialled analysis (Griffing, 1956) discriminated the maximum number of parents as good or poor combiners irrespective of method used. Partial diallel analysis with either sample size (four or six), sorted minimum number of parents with positively or negatively significant GCA effects. The line x tester analysis varied with the change of tester parents. Using testers with broader genetic base line x tester analysis could identify relatively large number of good or poor combining parents. Among the diallel, partial diallel and line x tester mating designs, diallel design emerged most effective followed by line x tester design with broad based testers for selection of better parental line for recombination breeding.

Key words: *Mating designs, diallel, partial diallel, line x tester, gca, Oryza sativa, selection of parents*

The idea of general combining ability (Sprague and Tatum, 1942) has widely been used by the crop breeders to assess the nicking ability of the parental lines using several mating designs like diallel (Griffing, 1956), partial diallel (Kempthorne and Curnow, 1961) and line x tester (Kempthorne, 1957). This, in turn, helps in selecting the advantageous parental lines for mission-oriented recombination breeding programme. However, limited information is available on the comparative performance of these mating designs for selection of parental lines. In the present investigation an attempt has been made to study the relative performance of diallel (DL), partial diallel (PD) and line x tester (LT) mating designs based on the GCA estimates in a set of crosses developed in basmati parents.

MATERIALS AND METHODS

Nine genotypes/cultivars of *indica* rice viz., Basmati C622, Basmati 5853, Basmati 370, Kasturi, Pusa Basmati 1, Haryana Basmati 1, UPR 85-71-8-1 (all basmati), TN1 and Pant Dhan 11 (non-basmati) were crossed in all possible combination to generate diallel set of crosses. All the 36 F_1 and nine parents were transplanted in a well-puddled field using randomized complete block design with three replications. Recommended package of practices were followed to raise a good crop. Observations were recorded on 24 characters consisting of 12 agro-morphological [days to 50% flowering, plant height (cm) panicle bearing tillers plant^{-1}, flag leaf area (cm^2), panicle length (cm), primary and secondary branches panicle^{-1}, grains panicle^{-1}, grain weight panicle^{-1} (g), harvest index, grain yield plant^{-1} (g)], six physical [grain length, grain breadth, L/B ratio and hulling, milling and head rice recovery percentage] and six biochemical characters [alkali digestion value, water uptake value, gel consistency, kernel elongation ratio, volume expansion and amylose content].

Data were subjected to DL (Griffing 1956) PD (Kempthorne and Curnow, 1961) using two-sample size six and four and LT (Kempthorne, 1957) analyses. LT analyses were performed in the form of these sets so that each parent may be evaluated as a tester as well as a line. For this, the parental lines were divided into three groups of three parents each. Newly released improved basmati varieties like Kasturi, Pusa, Basmati

1 and Haryana Basmati 1 were grouped together in-group A while traditional tall varities viz., Basmati C622, Basmati 5853 and Basmati 370 were put together in-group B, Group C consisted of TN 1, Pant Dhan 11 (non basmati) and UPR 85-71-8-1(basmati). Three parents of each group were used as testers while remaining six parents of other two groups were taken as lines in each set of LT analyses.

RESUTLS AND DISCUSSION

Highly significant differences were observed among the genotypes for all the traits examined indicating suitability of the material under study. Estimates of variance for combining ability indicated that both GCA (general combining ability) and SCA (specific combining ability) variance were significant in DL, PD and LT analyses barring few exception. Based on the estimates of GCA estimates, the parental lines were classified as good, poor and average combiners for each of characters in different mating design (Table 1). In general, method 2 of DL analysis identified a total of 126 (66 good and 60 poor) characters combiners. On the other hand method 4 of DL analysis identified 57 parents with significantly positive GCA and 62 parents with significantly negative GCA. PD analysis could recognize only 17 and 20 parents with good and poor general combining abilities with sample 6 and 13 and 13 with sample size 4, respectively. In LT analysis, set A, consisted of recently released semi-tall basmati varieties as tester parents recognized 46 parents with

Table 1. Comparative performance of DL, PD and LT analysis for the identification of good and poor combiners

Characters	Diallel				Partial diallel				Line x tester					
	Method 2		Method 4		s = 6		s =4		Set A		Set B		Sect C	
	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)
Days to 50% flowering	4	2	3	2	-	-	-	-	4	3	3	4	4	4
Plant height	5	3	4	4	-	-	2	6	5	3	3	3	-	-
Panicle bearing tiller plant^{-1}	3	3	3	2	1	-	1	1	-	1	1	1	2	1
Flag leaf area	3	4	3	5	2	5	3	2	2	2	2	2	3	3
Panicle length	2	3	2	3	3	3	-	-	2	3	2	1	2	3
Primary branches panicle^{-1}	-	1	-	-	-	-	-	-	-	-	1	-	-	-
Secondary branches panicle^{-1}	2	2	2	2	3	6	-	-	1	1	1	1	1	-
Grains panicle^{-1}	3	3	2	4	-	-	-	-	2	-	2	1	2	2
Grain weight panicle^{-1}	3	2	2	3	-	-	-	-	1	2	1	1	2	2
100 grain weight	3	4	2	1	-	-	-	-	2	3	-	-	1	-
Harvest index	4	5	4	3	-	-	4	2	3	2	4	3	4	3
Grain yield plant^{-1}	2	2	1	1	-	-	-	-	2	2	1	1	3	2
Grain length	4	3	4	2	1	-	-	-	-	-	2	2	2	3
Grain breadth	3	4	4	4	1	1	-	-	2	-	4	3	3	3
L/B ratio	3	3	2	1	2	1	-	-	2	1	2	2	2	1
Hulling recovery percent	1	-	1	1	1	-	-	-	1	2	-	-	2	1
Milling recovery percent	2	1	1	1	-	-	-	1	1	2	-	-	1	-
Head rice recovery percent	3	2	2	2	-	1	-	-	2	3	1	1	2	3
Alkali digestion value	4	2	3	5	1	1	1	1	3	3	4	4	3	4
Water uptake value	2	2	2	2	-	-	-	-	1	1	1	1	2	2
Gel consistency	-	-	1	3	-	-	-	-	2	3	1	1	6	3
Kernel elongation ratio	3	4	1	3	-	-	-	-	2	2	1	2	1	3
Volume expansion	3	3	3	3	1	-	1	-	3	2	3	2	3	3
Amylose content	4	2	4	2	1	2	1	-	3	3	3	2	2	2
Total	66	60	57	59	17	20	13	13	46	44	43	38	53	48

+,- sign in parenthesis indicated positively and negatively significant gca effect, s represent sample size

positively significant GCA effects and 44 parents with negatively significant GCA effects. The set B, having traditionally tall basmati varieties as testers, recognized 43 and 47 parents as good and poor general combiners. Third set (set C) included both non-basmati and basmati lines as testers recognized 53 parents as good general combiners and 48 parents as poor general combiners.

The choice of parents for hybridization is the most crucial and critical aspect for the success of any breeding programme. *Per se* performance of parents might not always serve an index of their nicking ability and hence for evaluation of parental lines for their genetic value breeders mainly used the concept of general combining ability. The GCA is the average performance of a genotype in cross combinations involving a set of genotypes. Use of good general combiners as the parents in breeding programme is expected to give useful seggregants (Dhillon, 1975). Various mating design like DL, PD, LT etc., were extensively used by the breeders to generate the cross combinations in a set to identify the parents with good general combining ability. Hence, among the various mating designs, the design which is capable of identifying parental lines as good or poor combiners effectively should be more desirable for the purpose of identifying the parental lines for breeding programme. In the present investigation DL analysis identified higher number of parents as good or poor combiners. When method 2 and 4 of diallel analysis were compared, it was found that method 2 identified relatively larger number of parents either as good or poor combiners suggesting thereby that inclusion of parents also plays a role in estimating the GCA. Contrary to it, Hays and Paroda, 1974 reported that the exclusion of parental lines from diallel analysis increased the precision of estimates.

The PD analysis, in which only a sample of crosses were analyzed, could identify least number of parents as poor or good combiners. Several factors like type of gene action, sample size (Christie and Shattuck, 1992) and higher magnitude of SCA variance (Gordon 1980) have been reported to greatly influence the usefulness of PD analysis. In the present investigation, preponderance of non-additive gene action were found for most of the characters. Several workers like Govil and Murty (1979), Dhillon and Singh (1978) showed the limitations of small sample size (less than half of the number of parents) in PD analysis. These factors limit the utility of PD analysis to discriminate the parents as desirable/undesirable parents based on the combining ability alone.

The set C in LT analysis identified the maximum number of parents as good (53) or poor (48) combiner followed by set A (good 46 and poor 44) and while set B could identify least number of parents as good (43) or poor (37) combiners suggesting thereby the important role played by the tester parents in estimating GCA of the parents. The tester parents involved in set C (TN1, Pant Dhan 11 and UPR 85-71-8-1) and set A (Kasturi, Haryana Basmati 1 and Pusa Basmati 1) were evolved through genetic disassortative mating (except TN1) and represent wider genetic base. The result of present study indicated that LT analysis with a group of tester having wide or diverse genetic base or proven good combining ability may be able to differentiate large number of parents as good or poor combiners.

The result of present study is in perfect agreement with the findings of Malik (1980) who compared the efficiency of DL and LT analysis in wheat for combining ability and reported that DL analysis identified large number of parents with significant GCA in comparison to Lt analysis. The advantages of PD and LT mating designs over DL mating design lies in the fact that for evaluating the similar number of parents relatively lesser number of F_1 combinations is required. However, unsuitability of PD analysis to discriminate the parents limits the usefulness of this mating design. The DL mating design is reported to become unmanageable with large number of parents particularly in self-pollinated crops where number of seed per reproductive unit is low. Therefore, DL analysis within manageable number of parents appears to be more desirable.

REFERENCES

Christic BR and Shattuck VI 1992. The diallel cross: design, analysis and use for plant breeder. Plant Breeding Review 9: 9-36

Dhillon BS 1975. The application of partial diallel crosses in plant breeding-a review. Crop Improv 2: 1-8

Dhillon BS and Singh J 1978. Evaluation of circlulent partial diallel crosses in maize. Theor Appl Genet 62: 29-37

Gordon GH 1980. A method of parental selection and cross prediction using incomplete partial diallels. I. A simulation study. Theor Appl Genet 56: 225-232

Govil JN and Murty BR 1979. A comparative study on diallel and partial diallel analyses. Indian J Genet 39: 298-304

Griffing B 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust J Biol Sci 9: 229-250

Hays JD and Paroda RS 1974. Parental generation in relation to combining ability in spring barley. Theor Appl Genet 44: 373-377

Kempthorne O 1957. An introduction of Genetical Statistics. John Wiley and Sons, New York: 545

Kempthorne O and Curnow RN 1961. The partial diallel cross. Biometrics 17: 229-250

Malick SK 1980. Studies on genetic divergence and combining in bread wheat (*Triticum aestivum* L.em. thell). Thesis submitted to GBPUA & T, Pantnagar.

Sprague GF and Tatum LA 1942. General versus specific combining ability in single cross of corn. J Am Soc Agron 34: 923-932