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Inheritance of qualitative and quantitative traits in rice *(Oryza sativa* L.)

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Abstract : Eleven rice genotypes were selected to produce 33 F_1 partial diallel crosses. They were evaluated over two years in Compact Family Randomized Block Design for the characters namely, plant height, number of effective tillers, number of grains per panicle, test weight, grain yield per plant, days to maturity, alkali digestion value, and volume expansion. Combining ability effects and variances were estimated following partial diallel mating analysis. Parents, namely IET 1443 and NDR 118 were good general combiners for dwarfness and earliness. For days to maturity (2002), test weight and volume expansion, parent Sashyashree exhibited desirable *gca* effects. Parent NDR 359 was best general combiner for grain yield and number of effective tillers per plant. In general, non-additive genetic variance was larger than the additive for most of the characters studied except number of grains per panicle and test weight. Most of the traits exhibited over dominance. Partial dominance was exhibited by number of grains per panicle whereas water uptake number exhibited complete dominance.

Key words : Rice, partial diallel, combining ability, nature of dominance.

Introduction

The present rice scientists are intensifying rice breeding efforts for attaining a quantum jump in productivity, qualitatively and quantitatively. The development of high yielding cultivars of rice has been basically directed towards pure line selections based on *per se* performances because of its self fertilizing nature. The application of the genetic informations to a breeding programme, derived from a suitable mating design, regarding the inheritance of a character would certainly be a great value to a plant breeder in achieving his goal. Among the various available mating designs, partial diallel, which suffers little with the serious genetic assumptions, was employed to characterize the nature and magnitude of genetic variances and combining ability effects of the parental genotypes for the some of the quantitative and qualitative characters in a set of diverse and elite genotypes of rice.

Materials and Methods

Eleven diverse and elite rice genotypes were selected to producec 33 F_1 partial diallel crosses. Each parental line was represented at least in six F_1 crosses (s = 6). The F_1 crosses were produced during *kharif 2000* and 2001 and evaluated in Compact Family Randomized Block Design with three replications during *kharif* 2001(Y_1) and 2002(Y_2), respectively. Observations were recorded on ten randomly selected plants per F_1 crosses for six quantitative (plant height, number of effective tillers per plant, number of grains per panicle, test weight, grain yield per plant and days to maturity)

Table 1. Estimate of general combining ability effects for nine traits of the parents used in partial diallel crosses in rice.

Parents	Characters										
								DM		TW	
	PH	NETP	NGP	GY	WUN	ADV	VE	Y1	Y2	Y1	Y2
Pusa Basmati	7.394	0.041	-6.069	-1.654	-55.724**	-0.210	-0.609**	-0.764	6.169**	-0.639*	0.612*
Malviya 36	8.530	0.077	25.218	4.724**	19.486	0.292	0.072	4.666*	10.339**	0.071	0.072
DBS 20	-1.914	1.443	-28.606	0.675	-3.897	0.335	-0.059	9.665**	14.592**	-0.312	-0.175
NDR 359	-5.705	1.826*	8.327	5.363**	4.868	0.483	-0.038	11.76**	11.487**	-0.112	-0.138
Taraori Basmati	14.626**	0.800	54.996**	0.892	4.822	0.409**	-0.623**	5.563*	0.838	-0.332	-0.335
Sasya Shree	7.785	-0.996	11.857	-0.230	-11.968	-0.224	0.217*	-2.817	-4.329**	0.667*	0.605*
MPR7-1	1.884	-0.177	7.570	0.100	2.554	-0.104	0.248**	-5.556**	-6.819**	-0.177	-0.193
LM 1	-4.063	-0.770	-45.773**	-4.790**	-13.467	-0.230	0.187	-1.285	-5.747**	0.051	0.075
DBS 24	-6.145	-0.726	-23.732	2.808	-4.727	-0.100	-0.066	-3.331	-6.450	0.698*	0.610*
IET 1443	-11.721*	-1.023	-22.727	-1.179	35.932**	-0.231	0.156	-9.144**	-9.597**	0.121	0.076
NDR 118	-10.672*	-0.498	18.938	-2.210	22.138	-0.419**	0.514**	-8.76**	-10.48**	-0.036	0.015
SEgi	±5.023	±0.774	±27.81	±1.82	±17.26	±0.148	±0.092	±1.946	±1.539	±0.278	±0.249

** Significant at P=0.01, * Significant at P=0.05

PH = Plant height; NETP = Number of effective tillers / plant; NGP = Number of grains / panicle; GY = Grain yield / plant; DM = Days to maturity; TW = Test weight; WUN = Water uptake number; ADV = Alkali digestion value; VE = Volume expansion Y1 = *kharif*-2001, Y2 = *kharif*-2002 and three qualitative (water uptake number, alkali digestion value and volume expansion) traits. The statistical analysis of partial diallel mating design was carried out following Kempthorne and Curnow (1961).

Results and Discussion

Treatments mean sum of squares indicated significant differences among the F_1s in each year as well as pooled data over years for all the characters studied. The analysis of variance for pooled over two years showed non-significant for treatment x year interaction for all the characters, except test weight and days to maturity, suggesting that the estimates of the various genetic parameters could be obtained by pooling the data of two years.
However, for test weight and days to maturity, estimates of genetic parameter were derived separately for each year. Analysis of variance for combing ability indicated significant differences for *gca* and *sca* among parents and F_1s, respectively for all the quantitative and qualitative traits under study.

Combining ability effects

The estimates of *gca* effects of eleven parents for various characters are presented in Table 1. The parents IET 1443 and NDR 118 exhibited desirable *gca* effects for dwarfness, while Taravari basmati was a poor general combiner for this trait. A single parent namely, NDR 359 emerged as good general combiner for number of effective tillers per plant. In the case of panicle length, parent DBS 20 showed positive and significant *gca* effect while parent MPR7 1 was recorded as poor general combiner. For the character, number of grains per panicle, the parent Taravari basmati was found to be a good general combiner. On the other hand, parent LM 1 was recorded as poor general combiner. The parent IET 1443, NDR 118 and MPR7-1, exhibited desirable *gca* effects for earliness in both the years. Parent Sasyashree, LM 1 and DBS 24 were recorded as good general combiners for this trait only in the year 2002. Parents Sasyashree and DBS 20 were good general combiners for test weight over both the years.Parents, Malviya 36 and NDR 359 exhibited positive and significant *gca* effects for grain yield per plant while parent LM 1 was a poor general combiner. Among the qualitative characters, the parents, IET 1443 exhibited positive and significant *gca* effect for water uptake number, while Pusa basmati showed negative and significant *gca* effect. Parent Taravari basmati recorded positive and significant *gca* effect for alkali digestive value and reverse was true for the parent NDR 118. Parents Sasyashree, MPR7 1 and NDR 118 were good general combiners for volume expansion.

In general, parent Sasyashree was a good general combiner for days to maturity (Y2), test weight and volume expansion. NDR 359 was a good general combiner for grain yield per plant and number of effective tillers per plant. It was evident from the present findings that it was not necessary for the best general combiners to exhibit positive correspondence with their *per se* performance for most of the characters. The present result with respect to *gca* effect and *per se* performance is in a close agreement with the findings of rice workers, Ali and Khan (1995), Ganesan *et al.* (1997) and Punitha *et al.* (2004), who had also reported that *per se* performance of the parent or hybrid may not necessarily correspond with the *gca* effect. Thus, it may be concluded that *per se* performance of the parent might not always serve as an index of their genetic nicking ability. The favored direction of the expression of a trait may be due to complex interaction among the genes

Table 2. Estimates of σ^2*gca,* σ^2*sca,* σ^2A and σ^2D in respect of nine traits in partial diallel crosses in rice (pooled over two years)

Character		Estimate				
		$\sigma^2 gca$	$\sigma^2 sca$	σ^2A	σ^2D	$\sqrt{\frac{\sigma^2 D}{\sigma^2 A}}$
PH		43.342	136.101	84.681	136.103	1.27
NETP		00.047	03.001	00.094	03.003	5.65
NGP		336.912	220.602	637.821	220.600	0.59
GY		00.169	07.391	00.338	07.391	4.66
WUN		155.451	261.560	310.901	261.56	0.92
ADV		00.063	00.659	00.126	00.659	2.29
VE		00.047	00.427	00.094	00.427	2.13
DM	Y1	24.041	31.971	48.082	31.972	0.82
	Y2	43.890	17.851	87.781	17.852	0.45
TW	Y1	00.019	00.719	00.038	00.719	4.35
	Y2	00.024	00.571	00.048	00.571	3.45

PH = Plant height; NETP = Number of effective tillers / plant; NGP = Number of grains / panicle; GY = Grain yield / plant; DM = Days to maturity; TW = Test weight; WUN = Water uptake number; ADV = Alkali digestion value; VE = Volume expansion Y1 = *kharif*-2001, Y2 = *kharif*-2002

which may express recessively in certain background and dominantly in others; this may influence the direction of F_1 expression. Further, more epistatic gene action may become operative upon hybridization thereby causing unpredictable F_1 performance (Dick and Shattuck, 1990).

Combining ability variances and components of genetic variance

Estimate of variances due to general and specific combining ability ($\sigma^2 gca$ and $\sigma^2 sca$), additive genetic variance (σ^2A) and non-additive genetic variance (σ^2D) for various traits under study are presented in Table 2. The magnitude of $\sigma^2 sca$ was higher than the $\sigma^2 gca$ for all the characters except number of grains per panicle and test weight (Y2). The magnitude of additive genetic variance was relatively smaller than non-additive genetic variance for most of the characters except days to maturity, number of grains per panicle and water uptake number. The average degree of dominance

$$\sqrt{\frac{\sigma^2 D}{\sigma^2 A}}$$ indicated preponderance of non-additive gene action for most of the characters. The qualitative traits namely, water uptake number exhibited partial to complete dominance,

where as, partial dominance was exhibited by number of grains per panicle. The magnitude of additive and non additive components of genetic variance in the inheritance of various characters in the present set of parental materials revealed that non-additive genetic variance was more important than additive for most of the characters. Similar observations were also reported by rice workers, Roy and Mandal (2001), for number of tillers, number of grains per panicle and grain yield. Munhot *et al.* (2000) reported performance of non-additive gene action for volume expansion and water uptake number. On the other hand, Kalamani and Sundaram (1988) reported inheritance of additive genetic variance compared to non-additive genetic variance for number of effective tillers, grains per panicle, test weight and grain yield. The importance of both the kinds of genetic variance (σ^2A and σ^2D) was reported by Reddy (2002) and Verma *et al.* (2004) for plant height and grain yield per plant in rice. The characters exhibiting importance of non additive gene action may be successfully exploited through the production of hybrid rice. For the improvement and exploitation of the characters exhibiting greater role of additive gene action in their inheritance, single plant selection should be employed in segregating populations derived from crossing of multiple parents with desirable genes. Since crossing of multiple parents expected to accumulate and exploit both additive and non-additive types of fixable gene effects. Simultaneous exploitation of both additive and non-additive gene action can be achieved if some forms of recurrent selection in segregating population are made feasible.

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