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Short Communication

Combining ability for grain yield and its components in lowland rice (*Oryza sativa* L.)

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Rice (*Oryza sativa* L.) is the most important food-crop of India, occupying 44.5 m.ha. with a total production of 85.5 m.t. (2000-2001) with an average productivity of 1.9 t/ha. Of the total area 13.0 m.ha. (35%) is under rain-fed lowlands, where the average yields are around 1.2 t/ha. Under this situation farmers are some times forced to go for late planting due to unpredicted rainfall. Hence, there is a need to develop varieties with high yield and also suitable for late planting. The success of a plant breeding program largely depends on the choice of parents for hybridization and identification of superior recombinants in the segregating generations. The combining ability analysis developed by Griffing [1] provides useful information on selection of different parents, which in turn helps the plant breeder to identify most promising crosses for further use in breeding program. The present investigation has been, therefore undertaken to study combining ability for grain yield and its components in lowland rice under normal and late planting situations.

A set of diallel crosses (excluding reciprocals) were made with eight lowland rice genotypes *viz.*, Gayatri, Sabita, Lunishree, Utkalprabha, Manoharsali, OR 1334-8, CN 1035-59 and CN 718-8-21-10 during the wet season 1996. A part of F_1 seed and parents were grown in 1997 wet season to get F_2 seed. The final experiment comprising of 8 parents, 28 F_1s and 28 F_2 bulks was grown in a randomized block design with three replications under two planting situations i.e. normal (last week of July) and late (first week of September) during the wet season, 1998 at Central Rice Research Institute, Cuttack. There were 6 rows of 4.5 m length in F_2 bulks and one row of parents and F_1s. Plant to plant and row to row distances were maintained at 15 and 20 cm respectively. Recommended agronomic practices were followed to raise the crop.

Data were collected on 5 plants selected randomly from parents and F_1s. While in F_2 bulk, data were collected from 30 plants for grain yield/plant and its components *viz.*, biological yield/plant, 100-grain weight, panicle weight, no. of filled grains/panicle, panicle length, no. of effective panicles/plant and plant height. Plot means were used for statistical analysis. The combining ability effects and variances were calculated for F_1 and F_2 genrations according to Griffing [1]. The predictability ratio ($2\sigma^2 g/2\sigma^2 g + \sigma^2 s$) was calculated as suggested by Baker [2] for fixed effect model, where σ^2 g and σ^2 s are the equal components of GCA and SCA respectively.

Analysis of variance for grain yield and its components showed significant differences for all the characters studied among the 28 F_1s and 28 F_2 bulks under both normal and late planting situations. The analysis of variance for combining ability revealed that the general as well as specific combining variances were found significant in both F_1 and F_2 generations for grain yield and its component traits studied indicating thereby the importance of both additive and non-additive genetic variance in the inheritance of these traits in lowland rice. The predictability ratio is near to unity for 100-grain weight suggesting the greater importance of additive genetic variance for this trait. Low values for grain yield/plant, biological yield/plant, no. of filled grains/panicle, panicle weight and no. of panicles/plant indicated the predominant role of non-additive gene effects in controlling these traits. For plant height nearly equal importance of additive and non-additive gene effects was observed. Similar results were also reported by earlier workers [3-5] for different characters in rice.

The magnitude and direction of combining ability effects provide guidelines for selecting parents and their utilization. In the present study significant *gca* effects were recorded in all the characters studied. However, none of the parents was a good combiner for all the characters. The best parents identified were Lunishree and Utkalprabha, which showed significant positive *gca* effects for grain yield and most of the component characters. Among rest of the parents Sabita was found to be good combiner for panicle weight, grain number, and 100-grain weight. While CN 718-8-21-10 was found to be good combiner for panicle weight, 100-grain weight, no. of filled grains/panicle and plant height. On the other hand, two parents Manoharsali and CN1035-59 were found to be poor combiners for most of the attributes in both F_1 and F_2 generations under normal planting. Whereas, under late planting OR 1334-8 and Gayatri were found to be good combiners for grain yield/plant (Table 1). In majority of the cases, good general combiners showed better *per se* performance, which indicated that parents may be selected either on the basis of *gca* or *per se* performance or in combination [6].

Table 1. Estimates of *gca* effects for grain yield under normal and late planting situations in lowland rice

Parents	Generation	Grain yield/plant	
		Normal Planting	Late Planting
Gayatri	F_1	−0.03	0.55*
	F_2	−0.88**	0.66
Sabita	F_1	0.66	0.01
	F_2	0.62*	0.29
Lunishree	F_1	1.56*	0.04
	F_2	0.60*	−0.34
Utkalprabha	F_1	1.65**	−0.84**
	F_2	−0.06	−0.12
Manoharsali	F_1	−2.54**	−0.80**
	F_2	−0.72**	−0.99**
OR 1334-8	F_1	0.44	1.46**
	F_2	1.44**	1.16**
CN 1035-59	F_1	−1.83**	0.11
	F_2	−0.86**	−0.12
CN 718-8-21-10	F_1	0.50	−0.53
	F_2	−0.12	−0.54
S.E. (gi)	F_1	0.50	0.28
	F_2	0.67	0.37

*, ** Significant at 5% and 1% level respectively.

The magnitude of *sca* effects is of vital importance in selecting the cross combinations with higher probability of obtaining desirable transgressive segregants. Among the 28 crosses only eleven *viz.*, Gayatri/Sabita, Gayatri/ Lunishree, Sabita/CN 1035-59, Lunishree/ Utkalprabha, Lunishree/OR 1334-8, Utkalprabha/Manoharsali, Utkalprabha/OR 1334-8, Utkalprabha/CN 718-8-21-10, Manoharsali/OR 1334-8, OR 1334-8/CN 718-8-21-10 and CN 1035-59/CN 718-8-21-10 showed significant positive *sca* effects for grain yield under normal planting. Among these 11 crosses only two crosses OR 1334-8/CN 718-8-21-10 and CN 1035-59/CN 718-8-21-10 also showed significant positive *sca* effects in F_2 generation. Whereas, under late planting out of the 28 crosses only nine *viz.*, Gayatri/Lunishree, Gayatri/ Manoharsali, Gayatri/OR 1334-8, Sabita/ Manoharsali, Lunishree/OR 1334-8, Utkalprabha/CN 718-8-21-10, OR1334-8/CN 1035-59, OR 1334-8/CN 718-8-21-10 and CN 1035-59/CN 718-8-21-10 showed significant positive *sca* efects for grain yield/plant. These results indicated that the crosses with superior *sca* effects involving high × low *gca* parents could be exploited to yield positive heterosis in higher frequencies. It is also evident from the present results, among the different component traits, biological yield/plant played an important role in improving the grain yield/plant in lowland rice both under normal and late planting situations.

On the basis of combining ability effects five cross combinations (Table 2) *viz.*, Gayatri/Lunishree, Utkalprabha/CN 718-8-21-10 OR 1334-8/CN 718-8-21-10, Lunishree/OR 1334-8 and CN 1035-59/CN 718-8-20-10 which showed significant *sca* effects for grain yield and some of its component characters and having one of the parents a good general combiner both under normal and late planting situations could be exploited in future breeding program to improve grain yield in lowland rice.

Table 2. Estimates of *sca* effects in five best crosses for grain yield under normal and late planting situations in lowland rice

Cross combination	Generation	Grain yield/plant	
		Normal planting	Late planting
Gayatri/Lunishree	F_1	7.99**	1.49*
	F_2	0.72	−0.26
CN 1035-59/ CN 718-8-21-10	F_1	5.35**	1.60*
	F_2	2.62**	0.35
Utkalprabha/ CN 718-8-21-10	F_1	4.78**	1.85*
	F_2	−1.28	−1.35
OR 1334-8/ CN 718-8-21-10	F_1	3.49**	1.65*
	F_2	2.22**	0.87
Lunishree/ OR 1334-8	F_1	3.03*	3.28**
	F_2	−0.20	−0.33
SE (Sij.)	F_1	1.32	0.74
	F_2	0.71	0.98

*, ** Significant at 5% and 1% levels respectively

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