Short Communication

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Estimation of Heterosis and Heterobeltosis for Some Allogamic Traits in *Oryza sativa L.*

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Many researchers have reported varying degree of heterosis in different crops but little or no information is available about the estimation of heterosis regarding allogamic traits in rice. Natural cross pollination is less than 1 % in *Oryza sativa* L. The occurrence of cytoplasmic male sterility, an essential prerequisite to hybrid development has been reported in rice [2,4,9], but the amount of out crossing oven on male sterile lines is very low [3, 10]. Oka and Morishima [8] reported 20 to 100 % out crossing in wild rice *Oryza perennis* Moench and observed that pollen number was positively correlated with anther length. Increased length of anther could improve out crossing not only through its influence on stigma exertion but also by directly increasing the number of pollengrain available for pollination [12]. Ali *et al.* [1] also reported additive type of gene action for pollen grain size in some early studies on rice.

Our objective was to collect some information about the genetic mechanism involved in the inheritance of these floral traits and to identify genotypes with improved floral traits that may be used in hybrid rice breeding programe for the development of a potential source of outcrossing. Four parents Basmati 370, Basmati 385, Basmati 198 and 4048 (a long grain recently developed cultivar) alongwith their six F_1 hybrids were grown at Rice Research Institute, Kala Shah Kaku during Khrif 1991 in single rows (2.5 m long) in a randomized complete block design with three replications. The rows were spaced 35 cm apart and plant within the rows were 25 cm apart. Four floral characteristics anther length (mm), 100-anther weight (mg), pollen grain size (microns) and percent filled spikelets were measured. A binacular micro scope was used to measure anther length and pollen grain size. For 100-anther weight on electronic balance Mettler H-18 was used. Fifty observations were made on each of five randomly selected plants from each replicate of each of the ten genotypes. Percent filled spikelets was obtained by dividing the number of grains per panicle by the number of spikelets per panicle and then multiplying by 100. Standard analysis of variance technique was applied to determine the significance of mean differences [5]. Magnitude of heterosis and heterobeltosis was calculated as the percentage increase (+) or decrease (-) compare to the respective mid and better parental values. Griffing's [6] approach, Methods 2, Model 2, was used to estimate variance components and gene action. A ratio of genotypic to phenotypic variances was used to estimate heritability in broad sense.

Only two hybrids showed significant heterosis for anther length and this was in the positive direction only for 4048 x Basmati 198, estimated at 4.08% (Table 1). The combining ability analysis (Table.2) indicated predominantly additive gene action for anther length. High heritability also confirm these results. Similar results were observed previously in rice [1, 7, 12] and barley (11). For 100 anther weight only 3 of 6 hybrids showed significant heterosis and only two of them in a positive direction (Basmati 370 x Basmati 385 and Basmati 370 x 4048) at 15.9% and 22.6% respectively. Neither of them exhibited significant heterobeltosis. Additive gene action was observed for this trait due to high estimates of additive variance and heritability (Table 2).

Significant and positive heterosis for pollen grain size

TABLE 1. ESTIMATES OF HETEROSIS (HT%) AND HETEROBELTOSIS (HBT%) FOR ALLOGAMIC TRAITS IN F_1 HYBRIDS OF 4 X 4 DIALLEL CROSS EXPERIMENT ON RICE.

Cross combinations	Anther length (mm)		100 Anther weight (mg)		Pollen grain size (micron)		Percent filled spikelets	
	Ht%	Hbt%	Ht%	Hbt%	Ht%	Hbt%	Ht%	Hbt%
Bas.370 x Bas.385	-0.41	-6.56**	+15.9*	+1.86	-0.02	-0.76	+3.92*	+3.85*
Bas.370 x 4048	-6.52**	-8.12**	+22.6**	-6.86	-1.61	-4.63	-12.23**	-12.41**
Bas.370 x Bas.198	+0.41	-5.10**	+0.25	-24.81**	+1.61	+0.05	-3.71	-5.15
Bas.385 x 4048	-1.62	-9.65**	-13.95*	-27.45**	-2.31	-5.98	-8.54*	-8.79*
Bas.385 x Bas.198	+1.95	+1.16	+0.80	-16.32**	+5.75*	+3.38	-15.88**	-17.20**
4048 x Bas 198	+4.08*	+0.12	+7.98	+5.94	+10.83**	+9.08**	-10.03**	-11.20**

Where: *, ** = Significant at 0.05% and 0.01% probability levels, respectively.

was observed in Basmati 385 x Basmati 198 and 4048 x Basmati 198, and 4048 x Basmati 198 also showed significant and positive heterobeltosis indicating an overdominance type of gene action (Table 1). Ali *et al.* [1] have reported single dominant gene for the inheritance of pollen grain size. The combining ability analysis (Table 2) also indicated predominantly dominance type of gene action for pollen grain size. For percent filled spikelets only Basmati 370 x Basmati 385 indicated positive heterosis and heterobeltosis at 3.92 % and 3.85% respectively, thus indicating overdominance type of gene action. Dominant type of gene action was identified (Table 2).

TABLE 2. ESTIMATION OF VARIANCE COMPONENTS FOR ANTHER LENGTH, ANTHER WEIGHT AND PERCENT FILLED SPIKELETS IN RICE GENOTYPES.

Variance	Anther length (mm)	100-Anther weight (mg)	Percent filled spikelets
2GCA	0.0085	1.3539	-5.1039
2SCA	0.0083	0.8461	48.7358
2g	0.0253	3.539	38.528
2p	0.267	3.7246	43.3524
2e	0.0014	0.1707	4.8244
2A	0.0170	2.7078	-10.2078
2D	0.0083	0.8461	48.7358
h^2B.S.	94.76	95.42	88.87

2GCA = General combining ability variance, 2 SCA = Specific combining ability variance, 2g = Genetic variance, 2p = Phenotypic variance, 2e = Environmental variance, 2A = Additive variance, 2D = Dominance variance, h^2B.S. = Heritability in broad sense.

Conclusion

Several crosses were identified in this study that result in either positive heterosis or heterobeltosis for the allogamic traits studied. High heritabilities, and predominantly additive gene action for two of the four traits, suggest that rice breeding for allogamic traits may be feasible. The conclusion is not novel [7,10,11,12], but confirms existance of sufficient genetic variance in current breeding material.

Key words: Allogamic, Additive, Heterosis, Heritability and *Oryza sativa* L.

References

1. S.S. Ali, S.J.H. Jafri, M.G. Khan and M.A. Butt, IRRN, **17** (5), 6 (1992).
2. D.S. Athwal and S.S. Virmani, *Cytoplasmic Male Sterility and Hybrid Breeding in Rice*. (International Rice Research Institute, Los Banos, Philippines, 1972), pp. 615-620.
3. H.L. Carnahan, J.R. Erickson, S.T. Tseng and J.N. Rutger, *Outlook for Hybrid Rice in the U.S.A.* (International Rice Research Institue, Los Banos, Philippines, 1972), pp. 603-607.
4. J.R. Ericson, Agron. Abstr, **6** (1969).
5. R.A. Fisher, *Statistical Methods for Research Workers* (Oliver and Boyd., London, 1958), 13th ed., pp.248-298.
6. J.B. Griffing, Aust.J.Bio. Sci., **9**, 463 (1956).
7. Y. Muraoka, M. Kawatake, I. Yamakawa, I. Kato and R. Kasima, Agr. Hort., **17**, 1143 (1942).
8. H.I. Oka and H. Morishima, Evolution, **21**, 249 (1967).
9. S.S. Pradhan, S.N. Ratho and P.J. Jachuck, IRRN, **17** (5), 8. (1992).
10. T.W. Stansel and J.P. Craigmiles, Rice J., **69**(5), 14 (1966).
11. C.A. Suneson, Breeding Techniques - Composite Crosses and Hybrid Barely, Proc. First Int. Barely Genet. Symp., **1**, 303 (1963).
12. S.S. Virmani and D.S. Athwal., Crop Sci., **13** (1), 66 (1973).