



Short Communication

## Studies on gene action and combining ability for yield and its component traits in rice (*Oryza sativa* L.)

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The knowledge of combining ability is useful to assess the nicking ability of parents and at the same time elucidate the nature and magnitude of gene action involved for trait of interest. The main aim of this investigation was to study the gene action governing the inheritance of grain yield and yield components and to identify good general and specific combiners among blast resistant low temperature tolerant lines/varieties suitable for hill ecology

Half diallel set of  $F_1$  crosses generated from crossing eight diverse varieties/elite lines of hill rice possessing blast resistance and tolerance to low temperature viz., IR 9202, VL Dhan 16, Pant Dhan 6, VHC 1253, VL Dhan 221, VRS 1000-1, NR 10073, HPU 856. Thirty-days old seedlings of eight parents and 28  $F_1$  crosses were transplanted in a well-puddled field using randomized block design with three replications. Standard agronomic practices were used to raise good crop. Observations were recorded on days to flowering, plant height (cm), panicle bearing tillers/plant (PBT/plant), panicle length (cm), grain weight/panicle (g), fertile, sterile and total spikelets/panicle, 1000-grain weight, primary and secondary branches/panicle, length and width of flag leaf and grain yield/ plant using Standard Evaluation System of rice proposed by International Rice Research Institute, Manila, Philippines [1]. The estimates of combining ability and variances were estimated following method 2, model 1 of Griffing [2].

The analysis of variance revealed highly significant differences among the treatments for all the characters under study indicating the suitability of material. Combining ability analysis revealed significance of mean squares due to *gca* (except for flag leaf width) and *sca* effects for all the traits suggesting thereby the importance of both additive and non-additive gene actions in the inheritance of these traits.

Preponderance of non-additive gene action was evident from less than unity ratio between  $\sigma^2_{gca}$  and  $\sigma^2_{sca}$  for days to flowering, plant height, panicle length, PBT/plant, grain weight/panicle, fertile and sterile

spikelets/panicle, primary and secondary branches/panicle and grain yield/ plant while preponderance of additive gene action was indicated by more than unity ratio between  $\sigma^2_{gca}$  and  $\sigma^2_{sca}$  for total spikelets/panicle and 1000-grain weight. Several workers reported preponderance of non-additive gene effects for grain yield, days to flowering, plant height, panicle length, PBT/plant, grain weight/panicle, grains or fertile spikelets/panicle, grain yield/plant [3-5] flag leaf length, flag leaf width [6] and preponderance of non-additive gene action for 1000-grain weight [3]. Preponderance of non-additive genetic effects offers good scope for exploitation of hybrid vigour in improving these traits. When additive effect forms the principal factor for genetic variance, use of pedigree method or transgressive breeding could be desirable in improving the targeted traits.

The estimates of *gca* effects (Table 1) revealed wide differences among the parents. The parental lines IR 9202, Pant Dhan 6 and HPU 856 had highly significant and positive *gca* effects for grain yield/plant. In addition, IR 9202 and HPU 856 also showed positively significant *gca* effects for fertile spikelets/panicle, total spikelets/panicle and secondary branches/panicle. Similarly, IR 9202 and Pant Dhan 6 possessed significant positive *gca* effects for plant height and panicle length. IR 9202 also turned out to be good combiners for days to flowering, PBT/plant and flag leaf length. Both VL Dhan 16 and VHC 1253 emerged as desirable combiners for sterile spikelets and total spikelets/panicle. Similarly VL Dhan 221 and VRS 1000-1 for sterile spikelets/panicle; VRS 1000-1 and NR 10073 for secondary branches/panicle; VHC 1253 and NR 10073 for days to flowering and VRS 1000-1 for primary branches/panicle possessed significant *gca* effects in desired direction. The result also revealed that none of parental line found good general combiners for all the traits. Overall assessment of *gca* effects of parental lines suggested that IR 9202, HPU 856, Pant Dhan 6 and VL Dhan 16 emerged superior to rest of parental lines. It may be suggested that a crossing programme

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**Table 1.** General combining ability effects for grain yield and its component traits in rice

Parents	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	PBT/plant	Grain weight/panicle (g)	Fertile grains/panicle	Sterile grains/panicle	Total grains/panicle	1000-grain weight (g)	Primary branches/panicle	Sec. branches/panicle	Flag leaf length (cm)	Flag leaf width (cm)	Grain yield/plant (g)
1. IR 9202	2.86**	5.68**	1.22**	0.84*	0.42**	7.13*	7.37**	14.50**	-0.79	-0.04	2.37**	3.52**	0.02	6.72**
2. VL Dhan 16	0.76*	1.75	0.79*	-0.23	0.02	-4.47	-2.70*	-7.17*	1.33**	-0.21	0.73	0.82	0.01	-2.07*
3. Pant Dhan 6	-0.68	7.35**	0.44	0.43	-0.24	-1.93	0.83	-1.10	1.18*	0.59**	-0.63	-0.25	0.03	3.95**
4. VHC 1253	-3.38**	-0.32	-0.26	0.45	0.18	0.57	-5.70**	-5.13	1.42**	-0.37*	-3.08**	-0.81	-0.02	-0.94
5. VL Dhan 221	0.69	-5.38**	-1.01**	-0.63*	-0.65**	-14.80	6.97**	-7.83*	0.43	0.06	-1.60*	-0.65	-0.01	-5.18**
6. VRS 1000-1	0.66	-0.92	-0.16	0.38	0.08	2.90	-2.80**	0.10	-1.14*	0.49**	1.53*	0.70	0.01	-0.91
7. NR 10073	-2.84**	-6.08**	-1.52**	-1.19**	-0.08	-7.37*	-3.47**	10.83**	0.16	-0.74**	-2.63**	-2.05**	-0.02	-5.83**
8. HPU 856	1.92**	-2.08	0.51	-0.05	0.28	17.97**	-0.50	17.47	-2.60**	0.23	3.23**	-1.27*	-0.01	4.26**
SE gi	0.349	1.1947	0.286	0.263	0.152	2.940	0.867	3.155	0.458	0.169	0.637	0.584	0.019	0.649
SE gi-gj	0.529	1.806	0.432	0.398	0.230	4.445	1.311	4.770	0.693	0.255	0.982	0.884	0.028	0.982

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

involving these parents, coupled with rigorous selection for desired traits in the segregating generations should be taken up to develop high yielding rice cultivars for hill ecology.

Six crosses viz., Pant Dhan 6 × HPU 856, VL Dhan 16 × VL Dhan 221, Pant Dhan 6 × VRS 1000-1, IR 9202 × VRS 1000-1, VHC 1253 × VL Dhan 221 and VHC 1253 × NR 10073 were identified as the good specific combinations for grain yield per plant. In addition to grain yield, these crosses exhibited significantly specific combining ability for different component characters also. VL Dhan 16 × VL Dhan 221 and Pant Dhan 6 × VRS 1000-1 for fertile spikelets/panicle, total spikelets and days to flowering; VHC 1253 × VL Dhan 221 for days to flowering, sterile spikelets/panicle, 1000-grain weight; Pant Dhan 6 × HPU 856 for primary branches/panicle; VL Dhan 16 × VL Dhan 221 for grain weight/panicle, PBT/plant and sterile spikelets/panicle and IR 9202 × VRS 1000-1 for days to flowering, plant height and flag leaf length showed significant *sca* effects in desirable direction.

The perusal of total 92 crosses with significant *sca* effects and *gca* effects of their respective parents involved revealed that 55 crosses (*i.e.*, 60%) involved at least one parent with good general combining ability. This indicated the presence of additive × additive and/or additive × dominance genetic interaction in sizeable amount in these crosses. The remaining 40% crosses involved average or poor general combiners as their parents. Other workers like Sharma *et al.*, [7] also reported the similar findings. It appears that high *sca* effects of any crosses does not necessarily dependent upon the *gca* effects of the parents involved in crosses. The superiority of these crosses may be due to complementary type of gene action, which can be exploited in the subsequent generation. In such crosses where non-additive gene effects played a predominant role in association with additive components the recurrent

selection or reciprocal recurrent selection may be used. The perusal of results indicates no correspondence between the *per se* performance of parents and crosses with *gca* effects of parents and *sca* effects of crosses. These results are in agreement with the finding of several researchers who have also suggested that *per se* parental or hybrid performance did not necessarily correspond with *gca* and *sca* effects. Singh and Gupta [8] observed that it is possible that favoured direction of the expression of a character is due to complex interaction among genes, which may express recessively in certain background and dominantly in others. Dick and Shattuck [9] opined that epistatic gene action might result upon hybridization, responsible for the F<sub>1</sub> performance.

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