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Gene action and combining ability for yield and its component traits of rice in upland condition of Himachal Pradesh

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Abstract

Research was carried out to determine the study of gene action and combining ability in rice. The material consisted of F_1 population of 33 crosses developed by crossing 11 genotypes with three testers. The crosses were made at RWRC, Malan during *kharif* 2018 and during *kharif* 2019 the (33) $F_{1's}$ materials along with parental lines (11) + testers (3) were evaluated in RBD with three replications at RWRC, Malan. Magnitude of dominance genetic variance σ^2D was found to be higher than that of additive genetic variance σ^2A for plant height, total tillers/plant, effective tillers/plant, panicle length, spikelets/panicle, grains/panicle, spikelet fertility, grain yield/plant, 1000-grain weight. Average degree of dominance was observed more than one for all the traits studied except days to 50% flowering, days to maturity, grain length, grain breadth and L:B ratio.

Key words: *Oryza sativa*, Gene action, General combining ability, Specific combining ability.

The nature and magnitude of gene action involved in expression of quantitative traits is important for successful development of crop varieties. The correct choice of parents for hybridization is crucial for development of cultivars. Combining ability analysis provides such information so as to frame the breeding programme effectively. This analysis helps in identification of parents with high general combining ability (GCA) and parental combinations (cross) with high specific combining ability (SCA). In order to combine desirable attributes along with high yield, the most appropriate approach is recombinant breeding. Breeding strategies based on selection of hybrids require expected level of specific combining ability (SCA). Combining ability analysis is one of the powerful tools available to estimate the combining ability effects and aids in selecting the desirable parents and crosses for the exploitation of heterosis (Muhammad *et al*. 2007). The performance of parents may not necessarily reveal it to be a good or poor combiner. Therefore, gathering information on nature of gene effects and their expression in terms of combining ability is necessary.

The success of any breeding programmne depends upon the knowledge of the nature and magnitude of genetic effects of different quantitative traits. The common approach of selecting parents or the basis of *per se* performance, adaptation and diversity does not necessarily lead to the fruitful results. Therefore, the present study was taken up for selection of the best parents for hybridization based on the knowledge of combining ability of the parents.

Materials and Methods

The experimental materials used for the present investigation consisted of F_1 population of 33 crosses developed by crossing genotypes of rice *viz*., HPR 2410, HPR 2652, HPR 2703, HPR 2842, HPR 2869, HPR 2874, HPR 2876, HPR 2881, HPR 2883, LGP 26 and LGP 123 with three diverse testers viz., HPR 1156, HPR 2656 and HPR 2795. All the lines used as female parents were crossed to each of the testers by hand pollination using the standard procedure of emasculation in a line X tester mating design at RWRC Malan, during kharif, 2018. During kharif 2019 the F_1's (33) materials along with parental lines were evaluated in RBD with three replications at RWRC, Malan. In each replication entries (F_1's and parents) were grown in single row of 2m length. The data was recorded on five random competitive plants in each replication for all the traits studied except days to 50% flowering and days to maturity which were recorded on plot basis. The statistical analysis as per the design for analysis of variance as per Panse and

Sukhatme (1985), Line × tester analysis was carried out following the method of Kempthorne (1957) and estimation of additive and dominance variance components, average degree of dominance was calculated as per line x tester mating design.

Results and Discussion

Magnitude of σ^2A was found to be higher than that of σ^2D for days to 50% flowering, days to maturity, grain length, grain breadth and L: B ratio whereas, magnitude of ó^{2}D was found to be higher than that of σ^2A for plant height, total tillers/plant, effective tillers/plant, panicle length, spikelets/panicle, grains/panicle, spikelet fertility, grain yield/plant, 1000-grain weight (Table 1). Average degree of dominance was observed more than one for all the traits studied except days to 50% flowering days to maturity, grain length, grain breadth and L:B ratio. The highest average degree of dominance value observed among top 5 traits were 1000-grains weight (4.1884), grain yield (3.1215), effective tillers/plant (3.0454), total tillers/plant (2.8517) and plant height (1.6906). Karthikeyan *et al*. (2009) found that the ratio between the estimates of additive and dominance variances indicated preponderance of non-additive gene action for the characters namely plant height, no. of tillers/plant, panicle length, grain weight/panicle and grain yield/plant. Shikari *et al*. (2009) also reported similar types of findings. Utharasu and Anandakumar (2013) reported similar results and also found that σ^2D higher than σ^2A for days to 50% flowering, plant height, productive tillers/plant, panicle length, grains/panicle, 100-grain weight and grain yield/plant.

In present study estimation of general combining ability (GCA) and specific combining ability (SCA) for all the traits studied which showed that out of 11 lines HPR 2652 is good general combiner for total tillers/plant, effective tillers/plant and grain fertility, HPR 2869 is good general combiner for plant height, panicle, length, spikelets/ panicle, grains/ panicle, grain yield/plant, HPR 2842 is good general combiner for total grain length, L:B ratio and LGP 123 is good general combiner for 50% flowering and HPR 2410 is good general combiner for 1000-grain weight, days to maturity Among crosses HPR 2881 X HPR 2656 is good specific combination for plant height and panicle length and the cross HPR 2652 X HPR 2656 is good specific combination for spikelets/panicle, grains/panicle, total tillers/plant, effective tillers/plant. The cross HPR 2869 X HPR 1156 is good specific combination for 50% flowering, L: B ratio. The cross LGP 26 X HPR 1156 is good specific combination for grain yield/plant, 1000-grain weight, grain fertility and grain breadth. The cross HPR 2876 X HPR 2656 is good specific combination for grain length and cross HPR 2703 X HPR 2795 is good specific combination for days to maturity.

Combining ability analysis helps in identifying potential parents either to be used in heterosis breeding or for isolation of transgressive segregents in the development of pure lines. The general and specific combining abilities were significant for all the characters, indicating the importance of both additive and non-additive genetic components. It was found that there was a predominance of the non-additive genetic components for expression of different traits. These results were in accordance with the findings of Muhammad *et al*. (2007) and Hossain *et al*. (2009) emphasized grain yield per plant has high specific combining ability (SCA) variance suggesting the presence of non-additive genetic variance.

The major role of non-additive gene effects in the manifestation of all the traits was confirmed by higher values of SCA variance than for GCA variance, the ratio of (σ^2gca/ σ^2sca) being less than one, and the degree of dominance being greater than one. These results indicate the preponderance of non-additive gene action within the expression of all the traits studied and suggest the feasibility of exploitation of non-additive genetic variation for traits through hybrid breeding. The importance of non-additive genes for expression of yield and its components have also been previously reported (Dalvi and Patel 2009; Saidaiah *et al*. 2010 and Selvaraj *et al*. 2011). Further, for grain quality parameters higher estimates of SCA variances than GCA variances has also been revealed by Vanaja *et al*. (2003) and Thakare *et al*. (2010). Investigation of GCA effects revealed that among lines and testers were good general combiners for grain yield and the other traits. Hence these good general combiners of males and females may be used in future for hybrid rice breeding programme. The cross LGP 26 X HPR 1156 is good specific combination for grain yield/plant and the other cross combination is LGP 26 X HPR 1156 followed by HPR 2703 X HPR 2795, HPR 2652 X HPR 2656, HPR 2881 X HPR 2656, HPR 2876 X HPR 1156 and HPR 2869 X HPR 2656 showed high heterosis over standard check for grain yield/plant.

Conflict of interest: The authors declare that they have no conflict of interest in this paper.

Table 1. Estimates of additive (σ^2A) and dominance ($ó^2D$) variance, average degree of dominance ($(\sigma^2D/\sigma^2A)^{½}$) for yield, physiological, phenological and grain quality traits

Traits/Source of variation	Mean sum of squares		
	Additive variance	Dominance variance	Average Degree of Dominance
Yield traits & physiological traits			
Plant height	2.5596	7.3163	1.6906
Total tillers/plant	0.1678	1.3646	2.8517
Effective tillers/plant	0.1142	1.0592	3.0454
Panicle length	0.0920	0.1977	1.4659
Spikelets/panicle	119.110	133.1327	1.0572
Grains/panicle	46.3606	56.2291	1.1012
Spikelet fertility	9.8314	11.7380	1.0926
Grain yield/plant	0.6572	6.4038	3.1215
1000-grain weight	0.0563	0.9877	4.1884
Phenological traits			
Days to 50% Flowering	5.3094	-0.5683	-
Days to maturity	11.7558	1.6458	0.3047
Grain quality traits			
Grain length [L]	0.0354	0.0332	0.9684
Grain breadth [B]	0.0022	-0.0019	-
L:B ratio	0.0308	-0.0051	-

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