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Genetic Variability for Grain Yield and Character Association Studies in Upland Rice (*Oryza sativa* L.) Germplasm

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Abstract

An investigation including 45 upland rice genotypes was conducted during *kharif* of 2007 to study genetic variability, correlation and component analysis for grain yield and nine other yield contributing characters. Genotypes, R 1830 RF 4, NDR 105441, CRR 614, IR 74371 and HUG SG 1076 recorded high mean performance for grain yield. High genotypic coefficient of variation was observed for number of panicles/hill and high phenotypic coefficient of variation for number of panicles/hill and number of tillers/hill whereas plant height, number of tillers/hill, panicle length, flag leaf length and test weight showed high estimates of heritability. Number of panicles/hill and number of tillers / hill showed high genetic advance as percent of mean. Characters like number of tillers / hill, number of spikelets / panicle and number of panicles / hill showed positive significant correlation with grain yield / hill at both genotypic and phenotypic levels. Path coefficient analysis indicated that number of tillers / hill and number of spikelets / panicle had maximum direct effect on grain yield / hill at both genotypic and phenotypic levels.

Key words : Genetic variability, Genotypic coefficient of variation, Phenotypic coefficient of variation, Heritability, Correlation.

Rice is the major cereal crop that is consumed almost exclusively through out world. But, water is necessary for the cultivation of rice and now-a-days water is increasingly becoming scarce. The per capita availability of fresh water resources declined by 40—60% in many Asian countries between 1990—1995 and it is expected to decline further by another 15—54% during the next 15—20 years. Water security will be a threat to food security in this region. Future rice production will, therefore, depend primarily on developing and adopting strategies that will use water more efficiently in irrigation schemes. There are only a few upland rice varieties / cultivars of good yield potential coupled with good quality characteristics. To meet the food demands of ever increasing population, it is necessary to improve the productivity of this fragile ecosystem. Keeping in view these perspectives, the present experiment was conducted to study genetic variability for grain yield and character association in short duration upland rice.

Methods

The experimental material comprised 43 upland rice genotypes, grown in randomized complete block design with three replications at the Central Research Farm, Department of Genetics and Plant Breeding, SHIATS, Allahabad during *kharif* of 2007. Each

Table 1. Analysis of variance for 10 characters in upland rice germplasm. * and ** significant at 5 and 1% levels of significance, respectively.

	Characters	Mean sum of square Replication	Treatment	Error
	df	2	44	88
1	Days to 50% flowering	33.96	312.72**	3.84
2	Plant height	104.18	880.86**	20.42
3	No. of tillers/hill	5.06	28.85**	2.40
4	No. of panicles/hill	9.50	22.07**	2.26
5	Panicle length	5.42	12.31**	1.01
6	Flag leaf length	24.45	38.07**	2.93
7	Flag leaf width	0.06	0.05*	0.01
8	Spikelets/panicle	375.61	913.09**	162.54
9	Test weight	4.81	14.02**	0.21
10	Grain yield/hill	0.99	19.29*	4.29

Table 2. Estimates of genetic parameters for 10 quantitative characters in upland rice germplasm.

	Characters	Coefficient of variation (%) PCV	GCV	Heritability (%) (bs)	GA as percent of mean
1	Days to 50% flowering	11.75	11.54	66.4	13.34
2	Plant height	18.42	17.80	93.4	35.43
3	No. of tillers/hill	22.44	19.89	78.6	36.32
4	No. of panicles/hill	24.22	20.90	74.5	37.16
5	Panicle length	9.61	8.53	78.8	15.60
6	Flag leaf length	13.77	12.32	80.0	22.69
7	Flag leaf width	9.84	8.05	66.9	13.56
8	Spikelets/panicle	14.41	11.22	60.6	17.99
9	Test weight	10.16	9.94	95.7	20.03
10	Grain yield/hill	17.56	12.89	53.8	19.48

genotype was grown in 5 × 2 m plot with inter and intra-row spacing of 20 × 15 cm, respectively. Data on days to 50% flowering, plant height (cm), number of tillers/hill, number of panicles/hill, panicle length (cm), flag leaf length (cm), flag leaf width (cm), number of spikelets/panicle, test weight (g) and grain yield / plant (g) were recorded on five randomly selected plants in each replication. The mean values are used for calculating genotypic and phenotypic coefficient of variation (1). Heritability (broad sense) and expected genetic advance (as percent of mean) (2), correlation coefficient (3) and path coefficient analysis (4) were estimated.

Results and Discussion

Analysis of variance for grain yield and nine other yield contributing characters revealed that the 45 genotypes differed significantly, indicating the presence of enormous variability among the genotypes for all characters studied (Table 1). The wide spectrum of variability noticed in these characters would offer scope for selection to evolve promising lines. The higher magnitude of GCV and PCV were recorded for number of panicles/hill, number of tillers / hill, plant height and grain yield / hill, suggesting the possibility of yield improvement through selection for these characters (Table 2). Sinha et al. (5) reported significant variation for plant height, number of tillers/ plant and number of panicles / plant.

Table 3. Estimates of genotypic and phenotypic correlation coefficients of component characters with grain yield in upland rice germplasm. * and ** significant at 5 and 1% levels of significance, respectively.

	Characters		Plant height	No. of tillers/hill	No. of panicles/ hill	Panicle length	Flag leaf length
1	Days to 50% flowering	r_g	– 0.491**	0.226	0.201	0.186	– 0.217
		r_p	– 0.490**	0.184	0.146	0.133	– 0.195
2	Plant height	r_g		– 0.387**	– 0.356**	0.360*	0.478**
		r_p		– 0.301*	– 0.259	0.358*	0.455**
3	No. of tillers/hill	r_g			0.970**	0.078	– 0.219
		r_p			0.952**	0.097	0.189
4	No. of panicles/hill	r_g				0.136	– 0.177
		r_p				0.144	– 0.140
5	Panicle length	r_g					0.431**
		r_p					0.365*
6	Flag leaf length	r_g					
		r_p					
7	Flag leaf width	r_g					
		r_p					
8	Spikelets/panicle	r_g					
		r_p					
9	Test weight	r_g					
		r_p					

Table 3. Continued.

	Characters		Flag leaf width	Spike-lets/ panicle	Test weight	Grain yield/ hill
1	Days to 50% flowering	r_g	0.388**	– 0.080	0.238	0.064
		r_p	0.301*	– 0.121	0.229	0.054
2	Plant height	r_g	–0.098	0.011	– 0.283	0.173
		r_p	–0.080	0.092	– 0.267	0.106
3	No. of tillers/hill	r_g	–0.233	0.152	– 0.068	0.776**
		r_p	–0.168	0.097	– 0.048	0.435**
4	No. of panicles/hill	r_g	–0.346	0.103	– 0.129	0.435**
		r_p	–0.211	0.092	– 0.096	0.405**
5	Panicle length	r_g	0.056	0.059	– 0.023	0.144
		r_p	0.163	– 0.052	– 0.004	0.112
6	Flag leaf length	r_g	0.158	0.055	– 0.276	0.078
		r_p	0.205	0.088	– 0.224	0.067
7	Flag leaf width	r_g		– 0.043	0.115	0.327*
		r_p		– 0.038	0.087	0.224
8	Spikelets/panicle	r_g			– 0.161	0.511**
		r_p			– 0.117	0.582**
9	Test weight	r_g				0.140
		r_p				0.116

Heritability is a measure of the extent of phenotypic variation caused by the action of genes. In the present investigation, high heritability estimates were obtained for test weight (95.7%), plant height (93.4%) and flag leaf length (80.0%) (Table 2). Medium heritability was observed for number of tillers / hill (78.6%) and number of panicles / hill (78.8%), suggesting that selection would be more meaningful if genetic

Table 4. Direct (Diagonal) and indirect effects of component characters on grain yield at genotypic and phenotypic levels.

	Characters		Days to 50% flowering	Plant height	No. of tillers/ hill	No. of panicles/ hill	Panicle length	Flag leaf length	Flag leaf width	Spikelets/ panicle	Test weight	Grain yield/ hill
1	Days to 50%	G	**0.043**	–0.021	0.010	0.009	0.008	– 0.009	0.017	– 0.003	0.010	0.064
	flowering	P	**0.068**	0.033	– 0.013	–0.010	–0.009	0.013	–0.020	0.008	– 0.016	0.054
2	Plant height	G	– 0.156	**0.317**	– 0.123	–0.113	0.114	0.151	–0.031	0.003	– 0.089	0.073
		P	– 0.077	**0.158**	– 0.048	–0.041	0.056	0.072	0.013	0.015	– 0.042	0.106
3	No. of till-	G	0.220	–0.376	**0.672**	0.543	0.076	–0.213	–0.227	0.147	– 0.066	0.776
	ers/hill	P	0.036	–0.059	**0.195**	0.186	0.019	–0.037	–0.033	0.019	– 0.009	0.435
4	No. of pani-	G	– 0.166	–0.294	0.800	**0.325**	–0.113	0.146	–0.285	– 0.08	0.107	0.435
	cles/hill	P	– 0.021	0.039	0.140	**0.147**	0.021	0.021	0.031	0.014	0.014	0.405
5	Panicle length	G	– 0.037	0.071	0.015	–0.027	**0.197**	–0.085	–0.011	0.012	0.005	0.144
		P	– 0.002	–0.005	– 0.001	–0.002	**0.123**	–0.005	–0.001	– 0.001	0.006	0.112
6	Flag leaf	G	– 0.011	0.024	– 0.011	0.009	0.021	**0.049**	0.008	0.003	– 0.014	0.078
	length	P	– 0.001	0.010	– 0.001	–0.001	0.001	**0.062**	0.001	0.004	– 0.001	0.067
7	Flag leaf	G	0.068	–0.017	0.041	0.060	0.010	– 0.028	**0.174**	– 0.007	0.020	0.327
	width	P	0.059	–0.016	– 0.033	–0.041	0.004	0.041	**0.185**	0.008	0.017	0.224
8	Spikelets/	G	– 0.042	0.006	0.079	0.054	–0.031	0.029	–0.022	**0.522**	– 0.084	0.511
	panicle	P	– 0.058	0.044	0.046	0.044	0.025	0.042	0.019	**0.476**	– 0.056	0.582
9	Test weight	G	0.024	–0.029	0.007	0.013	–0.002	0.028	0.012	– 0.016	**0.102**	0.139
		P	0.022	–0.026	– 0.005	0.009	0.001	0.022	0.008	– 0.011	**0.096**	0.116

advance is also taken into consideration simultaneously. High genetic advance as per cent of mean estimates were obtained for number of panicles/hill (37.16), number of tillers / hill (36.32) and plant height (35.43).

High heritability combined with high genetic advance is desirable for the selection-based genetic improvement of a character (2). High heritability coupled with high genetic advance as per cent of mean observed for plant height, indicating that this character predominantly governed by additive gene action (6, 7). This character could be improved by mass selection and other breeding methods based on progeny testing. High heritability associated with moderate genetic advance as per cent of mean was observed for test weight and flag leaf length, suggesting the involvement of additive and non-additive type of gene action in their inheritance. The results are in agreement with Muthuswamy and Kumar (8).

The correlation among various yield and yield contributing characters revealed that grain yield per plant was significantly and positively correlated with number of tillers / hill (0.776**, 0.435**) and spikelets per panicle (0.511**, 0.582**) and number of panicles / hills (0.435**, 0.405**) at both genotypic and phenotypic levels (Table 3). It suggests that top priority should be given to these characters while making selection for yield improvement. Monalisa et al. (9) and Shankar et al. (6) also reported that grain yield was positively correlated with spikelets per panicle, number of tillers, test weight, harvest index and biological yield.

Identification of important yield components and information about the association with yield and among characters is necessary in developing efficient breeding strategy for evolving improved genotypes. Among the other characters, positive significant correlation was recorded at both genotypic and phenotypic levels between number of tillers / hill and number of panicles/hill (0.970**, 0.952**), plant height and panicle length (0.360*, 0.358*), plant height and flag leaf length (0.478**, 0.455**) and panicle length and flag leaf length (0.431**, 0.365*) whereas flag leaf width positively and significantly correlated with days to 50% flowering (0.388**, 0.301*) and grain yield / hill (0.327*), suggesting the inter-dependency of these characters and due consideration should be given in selection program. However, plant height showed negative significant association with days to 50% flowering and (–0.491**, –0.490**) and number of tillers / hill (–0.387**, –0.301*) at genotypic and phenotypic levels. Component analysis is a tool to partition the observed correlation coefficient into direct and indirect effects of yield component characters on grain yield to provide more clear understanding of character association for formulating effective selection strategy. Perusal of these results obtained from component analysis (Table 4) revealed that the characters, no. of tillers / hill (0.672, 0.195), no. of spikelets/ panicle (0.522, 0.476), no. of panicles / hill (0.325, 0.147) and plant height (0.317, 0.158) exhibited high positive direct effect on grain yield / hill at both genotypic and phenotypic paths. This provides an indication of inter-relationship of these characters with the yield per plant and direct selection of these characters may be rewarding for yield improvement. These results were in consonance with Monalisa et al. (9) and Shankar er al. (6). High positive genotypic correlation between number of tillers / hill and grain yield per plant was due to its hig+**h direct effect (0.672, 0.195) and positive indirect effects of number of panicles / hill (0.543, 0.186) and number of spikelets / panicle (0.147, 0.019). Likewise, high significant positive correlation of number of spikelets / panicle with grain yield / plant was due to its high direct effect.

The genetic architecture of grain yield is based on the balance or overall net effect produced by various yield components interacting with one another. Based on the studies on correlation and path analysis, it may be concluded that no. tillers per hill, spikelets per panicle, no. of panicles / hill and plant height being easily observable characters at field level, appeared to be primary yield contributing characters and could be relied upon these characters for selection of genotypes to improve the genetic yield potential of rice.

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