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Assessment of Genetic Variability and Inter-Character Association Studies in Rice Genotypes (*Oryza sativa* L.)

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A B S T R A C T

The present study was undertaken on twenty-nine genotypes of rice to determine, genetic variability, the nature of association among different yield attributes and their direct and indirect contribution towards yield. A high degree of variation was observed for all characters studied. Estimates of PCV and GCV were higher for the number of effective tillers per plant, flag leaf area, yields per plant and for test weight. Small differences between GCV and PCV were recorded for all the characters studied which indicated less influence of environment on these characters.The presence of high heritability with high genetic advance showed additive effects of the gene on the character and theyresponse to selection effectively as they are least affected by the environmental condition. Grain yield per plant showed the significant positive correlation number of effective tillers per plant, panicle length and test weight. The result of path analysis indicated number of effective tillers per plant had a highest positive direct effect on grain yield per plant followed by flag leaf area, days to maturity, panicle length and leaf length.

Introduction

Rice (*Oryza sativa* L.) belonging to the family of grasses Gramineae (Poaceae), is one of the important food crops among three major food crops in the world and forms the main diet of about more than half of the world's population. The area under rice cultivation is estimated to be 160.07 million hectares with global production 483.81 Million tons (USDA, 2017). Asia shares 90 percent production of rice alone and ranked first in production. Rice accounts for about 42 per cent of total food grain production and >55 per cent of diet in India. The production is very low in India due to non-availability of high yielding varieties.

A better understanding of the relationship between grain yield and its component traits becomes necessary for making an efficient selection for the development of new varieties with improved economically important traits (Kumar *et al.*, 2013). Development of high yielding varieties requires the knowledge of existing genetic variability. A critical estimate of genetic variability is pre-requisite for initiating appropriate breeding procedure in crop improvement programme. The Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are useful in detecting the amount of variability present in the germplasm. Heritability coupled with high genetic advance would be a more useful tool in predicting the resultant effect in the selection of the best genotypes for yield and its attributing traits (Singh *et al.,* 2011). Correlation (both phenotypic and genotypic) studies among yield and its component traits give a better insight towards the relationship between them (Jayasudha and Sharma, 2010). Genotypic correlation plays a key role in the development and execution of suitable breeding programs (Selvaraj *et al.,* 2011).

Path analysis provides a method of partitioning the correlation coefficient into direct and indirect effect and measures relative importance of causal factors involved (Dewy and Lu, 1959). With the above background information, the present investigation was undertaken to study the genetic parameters, correlation and path analysis among the twenty-nine rice genotypes.

Materials and Methods

The field experiments were carried out in two consecutive *kharif* season of 2014 and 2015 at Norman E Borlaug Crop Research Centre (NEBCRC) of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). The research materials for present study compromised of twenty-nine lines of rice genotypes which included Basmati and Non-basmati types. Twenty-nine lines of rice genotypes were grown in a randomized block design (RBD) with three replications. The test plot consisted of 3 rows of 6m length with a row to row and plant to plant spacing of 20 cm and 15 cm, respectively. Cultural practices like weeding, irrigation and recommended dose of fertilizer were applied to obtain a good crop growth. The observations were recorded on 5 randomly selected competitive plants in each plot for following characters: day to 50% flowering, days to maturity, no. of effective tillers per plant, panicle length (cm), leaf length (cm), leaf width (cm), flag leaf area (cm^2),test weight (g) and grain yield per plant (g).

Results and Discussion

The analysis of variance revealed that all the genotypes showed a significant difference for all the characters studied. The source of any kind of selection depends on the existence of the genetic variability. The presence of significant amount of variability in the initial breeding material assures the production of suitable recombinants for crop improvement. Previous studies in rice also found a significant variation for these traits The estimate of the mean, range, the phenotypic coefficient of variation (PCV), the genotypic coefficient of variation (GCV), heritability, genetic advance and genetic advance (as a percent of mean) were presented in table 1. Phenotypic coefficients of variation were higher than the corresponding genotypic coefficients of variation, indicating the considerable influence of the environment on the expression of the traits. Estimates of PCV and GCV were higher for the number of effective tillers per plant, flag leaf area, yields per plant and for test weight. Phenotypic coefficients of variation (PCV) and Genotypic coefficients of variation (GCV) ranged from 10.45%, 9.57 for panicle length to 48.62 %, 47.79 % for grain yield per plant. The similar finding also confirmed by (Tuwar*et al.,* 2013) for high GCV and PCV for the plant height number of tillers per plant, number of effective tillers per plant, grain yield per plant and 1000 grain weight. Bastia *et al.,* (2008) also reported high PCV and GCV in upland rice for grain yield per plant, number of effective tillers per plant and number of grains per panicle. The close association found between the phenotypic and genotypic coefficient of variation which is further supported by high values of heritability of the characters studied.

Table.1 General Mean (GM), Standard error, Range and variability parameters for yield and yield component characters

S. No	Characters	Mean	S.E	Range	PCV (%)	GCV (%)	h^2 (%)	GA (as % of mean)
1	**Days to 50% flowering**	111.95	1.22	71-139	18.27	18.17	98.93	37.23
2	**Days to maturity**	132.85	1.74	93-163	15.54	15.37	97.86	31.32
3	**Plant height (cm)**	126.00	2.59	91.32-174.10	19.55	19.22	96.67	38.93
4	**No. of effective tillers/ plant**	13.00	0.47	4-17	24.37	23.55	93.41	46.88
5	**Panicle length (cm)**	29.06	0.70	24.20-35.50	10.45	9.57	83.83	18.04
6	**Leaf length(cm)**	38.47	0.24	21.95-78.09	30.33	30.31	99.88	62.40
7	**Leaf width(cm)**	1.37	0.02	1.01-2.13	24.16	23.97	98.41	48.98
8	**Flag leaf area (cm2)**	32.04	2.55	17.05-68.19	35.57	32.78	84.94	62.24
9	**Grain yield/plant (g)**	15.38	0.80	9.68-39.40	48.62	47.79	96.60	96.76
10	**Test weight (g)**	13.31	0.27	6.78-24.35	39.29	39.11	99.08	80.19

Table.2 Inter character correlation coefficient between different characters at phenotypic and genotypic level in rice genotypes

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective tillers/ plant	Panicle length (cm)	Leaf length (cm)	Leaf width (cm)	Flag leaf area (cm2)	Grain yield/plant (g)	Test weight (g)
Days to 50% flowering	1.00	0.988**	0.548**	0.357**	0.078^{NS}	0.058^{NS}	0.065^{NS}	0.086^{NS}	-0.497**	-0.305**
Days to maturity	0.978**	1.00	0.625**	0.380**	0.098^{NS}	0.018^{NS}	0.099^{NS}	0.131^{NS}	-0.499**	-0.305**
Plant height (cm)	0.533**	0.603**	1.00	0.538**	0.259*	-0.287**	0.230*	0.207^{NS}	-0.457**	-0.364**
No. of effective tillers/ plant	0.336**	0.354**	0.520**	1.00	-0.279**	-0.345**	0.423**	0.313**	0.491**	0.494**
Panicle length (cm)	0.058NS	0.078NS	0.234*	-0.228	1.00	0.293**	-0.202^{NS}	-0.031^{NS}	0.038^{NS}	-0.127^{NS}
Leaf length(cm)	0.057NS	0.017NS	-0.282**	-0.332**	0.270*	1.00	-0.165^{NS}	-0.002^{NS}	0.192^{NS}	-0.035^{NS}
Leaf width(cm)	0.063NS	0.098NS	0.222*	0.411**	-0.188NS	-0.163NS	1.00	0.794**	-0.139^{NS}	-0.288**
Flag leaf area (cm2)	0.068NS	0.121NS	0.181NS	0.285**	-0.018NS	0.002NS	0.734**	1.00	0.019^{NS}	0.174^{NS}
Grain yield/plant (g)	-0.488**	-0.490**	-0.443**	0.461**	0.038NS	0.191NS	-0.140NS	0.019NS	1.00	0.307**
Test weight (g)	-0.303**	-0.302**	-0.356**	0.476**	0.117NS	-0.036NS	-0.285**	0.163NS	0.304**	1.00

Table.3 Path coefficient analysis showing the direct and indirect effect of characters on grain yield at phenotypic and genotypic level

Characters		Correlation with grain yield	Indirect effect via								
			Days to 50% flowering	Days to maturity	Plant height (cm)	No. of effective tillers/ plant	Panicle length (cm)	Leaf length (cm)	Leaf width(cm)	Flag leaf area (cm^2)	Test weight (g)
Days to 50% Flowering	P	-0.488**	**-0.300**	-0.299	-0.163	0.103	-0.018	-0.018	-0.019	-0.021	0.093
	G	-0.497**	**-0.581**	-0.574	-0.319	-0.210	-0.046	-0.033	-0.038	-0.050	0.177
Days to maturity	P	-0.490**	-0.070	**-0.072**	-0.043	0.026	-0.006	-0.001	-0.007	-0.009	0.022
	G	-0.499**	0.218	**0.220**	0.138	0.084	0.022	0.004	0.022	0.029	-0.067
Plant height(cm)	P	-0.443**	-0.005	-0.005	**-0.009**	-0.005	-0.002	0.003	-0.002	-0.002	0.003
	G	-0.457**	-0.004	-0.004	**-0.006**	-0.003	-0.002	0.002	-0.001	-0.001	0.002
No. of effective tillers/ plant	P	0.461**	-0.105	-0.110	-0.162	**0.311**	0.071	0.103	-0.128	-0.089	0.148
	G	0.491**	-0.142	-0.151	0.214	**0.397**	0.111	0.137	-0.168	-0.124	0.196
Panicle length (cm)	P	0.038^{NS}	-0.008	-0.010	-0.031	0.030	**0.133**	-0.036	0.025	0.002	0.015
	G	0.038^{NS}	-0.015	-0.019	0.050	0.053	**0.191**	-0.056	0.039	0.006	0.024
Leaf length (cm)	P	0.191^{NS}	0.007	0.002	-0.034	-0.039	0.032	**0.120**	-0.020	0.000	-0.004
	G	0.192^{NS}	0.006	0.002	-0.030	-0.036	0.030	**0.104**	-0.017	-0.001	-0.004
Leaf width(cm)	P	-0.140^{NS}	-0.008	-0.012	-0.028	-0.051	0.023	0.020	**-0.125**	-0.092	0.036
	G	-0.139^{NS}	-0.014	-0.021	-0.049	-0.089	0.043	0.035	**-0.211**	-0.168	0.061
Flag leaf area (cm^2)	P	0.019^{NS}	0.013	0.024	0.035	0.055	-0.004	0.000	0.142	**0.194**	-0.032
	G	-0.019^{NS}	0.024	0.037	0.059	0.089	-0.009	-0.001	0.226	**0.284**	-0.049
Test weight (g)	P	0.304**	-0.007	-0.007	-0.008	-0.011	-0.003	-0.001	-0.007	-0.004	**0.023**
	G	0.304**	0.01	0.010	0.012	0.016	0.004	0.001	0.010	0.006	**0.033**

The estimates of heritability help the plant breeder in selection of elite genotypes from diverse genetic population, hence prior knowledge about the heritability of the traits is a prerequisite for the selection programme (Singh *et al.,* 2011). The broad sense heritability estimates for the traits observed are leaf length (99.88%), test weight (99.08%), days to 50% flowering (98.93%), leaf width (98.41%), days to maturity (97.86%) and least for panicle length (83.83%). These results are in collaboration with the results obtained by Abdourasmane *et al.,* (2016) and Akinwale *et al.,* (2011) for days to heading, days to maturity, plant height, grain yield and number of grains per panicle, panicle weight, and panicle length Kundu *et al.,* (2008) for grain yield per plant and 1000 grain weight in tall indicaaman rice and Singh *et al.,* (2007) for days to 50% flowering, grains per panicle and plant height. The presence of high heritability with high genetic advance showed additive effects of the gene on the character and theyresponse to selection effectively as they are least affected by the environmental condition.

The correlation analysis was done to reveal the association between yield and its component traits. Table 2 presents the phenotypic and the genotypic correlation between yield and its associated traits. The values below the diagonal indicate the phenotypic correlation coefficients of the traits while the values above the diagonal represent the genotypic correlation coefficients of the traits. Genotypic correlations found higher than phenotypic correlations for all the character studied. The direction of phenotypic and genotypic correlations was almost the same for most of the character combinations. Grain yield per plant showed the significant positive correlation number of effective tillers per plant, panicle length and test weight these observations were supported by the results of Baloch *et al.,* (2016), Sravan *et al.,* (2016). Plant height significant positive correlation with a number of effective tillers per plant, panicle length and leaf width. A number of effective tillers per plant showed significant positive correlation with leaf length, leaf width and yield per plant. Thus improvement in yield can be enhanced by indirect selection for effective tillers per plant and leaf width. The results are in conformity with Mohammed *et al.,* (2007) for the number of panicles per plant, Mathure *et al.,* (2011) for the length of panicle and Al-tahir *et al.,* (2014) reported flag leaf length correlation with panicle length.

The path coefficient analysis carried out at phenotypic and genotypic levels showed similar trends for the majority of the traits (Table 3). Path analysis revealed direct and indirect effects on grain yield via yield component traits. At phenotypic level number of effective tillers per plant, panicle length, leaf length, flag leaf area and test weight showed direct positive effect whereas at genotypic level days to maturity, the number of effective tillers per plant, panicle length, leaf length and flag leaf area showed positive direct effect on grain yield per plant. Shankar *et al.,* (2016) reported the positive direct effects coupled with positive correlation coefficients with panicle length and test weight. Hence, selection of the above traits would result in improvement of grain yield in rice. The similar finding also reported by Solanki and Tiwari (2013) and Islam *et al.,* (2015) for days to 50% flowering, 100 seed weight, panicle length and leaf length had a direct positive effect on grain yield per plant and that will be effective to enhance the grain yield.

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