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GENETIC VARIABILITY AND CHARACTER ASSOCIATION OF QUANTITATIVE TRAITS IN JHUM RICE GENOTYPES

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ABSTRACT

Thirty jhum rice genotypes of hilly origin were studied for genetic variability, correlation and path analysis under medium high land of Bangladesh Rice Research Institute, Gazipur, Bangladesh. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications for the period of March to July (Aus season), 2016. Analysis of variance revealed significant difference among the genotypes for all the characters studied. The PCV values were greater than GCV, revealing little influence of environment in character expression. High values of heritability along with high genetic advance were observed for filled grain and plant height. Such outcomes suggested predominance of additive gene action in gene expression for these characters. Grain yield showed positive association with number of effective tiller and thousand grain weight at genotypic in conjunction with phenotypic level. Most of the traits had significant genetic variability besides, plant height and panicle length exhibited positive direct effect together with positive correlation with yield. Thousand grain weight possessed negative direct effect but highest positive significant correlation with yield.

Keywords: Correlation, variability, genetic advance, heritability, path co-efficients, rice, yield, yield components.

INTRODUCTION

Rice is a food grain crop of global importance with special preference in Asian countries (Sahu et al., 2017). Rice is life for majority of the residents of this sub-continent. Rice landraces play a vital role for food and nutritional security besides resistance to diseases and pests and resilience to climate changes which is essential for the survival of mankind facing the unpredictable climate change on earth. Jhum

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rice is a unique kind of plant genetic resource which is cultivated through hilly areas mostly by tribal people of Bangladesh. The local farmers usually grow low yielding local landraces. More than 300 local jhum rice landraces have been collected from various hilly districts of Bangladesh and conserved in Bangladesh Rice Research Institute (BRRI) genebank (Source: BRRI genebank accession book). This collection is an invaluable genetic resource that can be used for varietal development.

Breaking yield ceiling is the key breeding objective of rice breeding program with the noble intend to feed the ever increasing population. For that reason, knowledge on the nature and magnitude of the genetic variation leading the inheritance of quantitative characters like yield and its components is crucial for effective genetic improvement. The success of breeding program depends upon the quantum of genetic variability available for exploitation and the extent to which the desirable characters are heritable (Tiwari et al., 2011).

Genetic variability of promising genotypes of certain crop is like a directory of their genetic vitality. Variability has two components such as additive and non-additive. To obtain a clear understanding of the pattern of variations, the phenotypic variance has been partitioned into genotypic and phenotypic variance. A critical analysis of the genetic variability parameters, namely, Genotypic Coefficient of Variability (GCV), Phenotypic Coefficient of Variability (PCV), heritability and genetic advance for different traits of economic importance is a major pre-requisite for any plant breeder to work with crop improvement pogrammes. Further, information on correlation co-efficients between grain yield and its component characters is essential for yield improvement, since grain yield in rice is a complex entity and is highly influenced by several component characters (Kishore et al., 2015). Role of environmental attributes on the expression any genotype and reliability of characters can be determined precisely by high broad sense heritability united with high genetic advance (Babu et al., 2012).

Moreover, knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations. Knowledge of correlation between yield and its contributing characters are basic and for most endeavor to find out guidelines for plant selection. Partitioning of total correlation into direct and indirect effect by path analysis helps in making the selection more effective. Comprehending the above facts, the present investigation was undertaken to know variability and correlation among yield and its contributing characters using 30 jhum rice genotypes under direct seeded condition in a medium high land.

MATERIALS AND METHODS

A total of 30 jhum rice landraces (Table 1) were collected from Rangamati district of Bangladesh. The collected landraces (code: J1-J30) have been conserved at short term storage of the BRRI Gene bank for safe keeping. Local names and place of collection of the studied jhum rice are listed in table1.

Table 1. Information on local name and place of collection of the Jhum rice landraces

Sl. No.	local name	Code	Upazilla	Sl. No	name	Code	Upazilla
01	Kobrok-1	J1	Rangamati Sadar SaSSadar	16	Chorui	J16	Rangamati Sadar
02	VanguriJhum	J2	,,	17	Pattiki	J17	,,
03	Amey-1	J3	,,	18	Amey-2	J18	,,
04	Horinbinni	J4	,,	19	Guri	J19	,,
05	Bairi	J5	,,	20	Kamarang-2	J20	,,
06	Lonkaparabinni	J6	,,	21	Suri	J21	,,
07	Turni	J7	,,	22	Kamarang-3	J22	,,
08	Vangurivalo	J8	,,	23	Amey-3	J23	,,
09	Bandornokbinni	J9	,,	24	Badoi	J24	,,
10	Kamarang-1	J10	,,	25	Turki	J25	Kaptai
11	Lokkhibinni	J11	,,	26	Kangbui	J26	,,
12	Gonda	J12	,,	27	Kongcho	J27	,,
13	Kangbui	J13	,,	28	Bidi	J28	,,
14	Koborok-2	J14	,,	29	Kobrok	J29	,,
15	Galong	J15	,,	30	Mongkhoi	J30	,,

The experiment was conducted following a Randomized Complete Block design with three replicates for each treatment at the experimental field of BRRI, Gazipur, during March to July (Aus season), 2016. Geographically, the place is located at about 24.00° N latitude and 90.25°E longitude with an elevation of 8.4meters from the sea level and is characterized by subtropical climate. The soil of the experimental site was clay loam in texture.

Twenty days-old seedlings from each entry were transplanted using single seedling per hill in 2.4 m^2 plot with 25cm and 20cm space between rows and plants, respectively.

Fertilizers were applied @ 80:60:40:12kg N: P: K: S per hectare. However, except N, the other fertilizers were applied at final land preparation. Nitrogen was applied in three equal splits, at 15 days after transplanting (DAT), at 35 DAT, and just before flowering. Intercultural operations and pest control measures were done as and when necessary.

Data were collected on culm diameter (mm), flag leaf angle, plant height (cm), days to flowering, days to maturity, effective tiller number (ET), panicle length (cm), number of filled grains per panicle, grain length (mm), grain breadth(mm), grain length breadth ratio,1000grain weight (g) and grain yield per hill (g). Kernels were classified on the basis of length (size) and for *LB* ratio (shape) following classification described by Cruz and Khush (2004).

Statistical analysis

Genotypic and phenotypic co-efficient of variation were calculated following the methodology delineated by Burton (1952), while the estimates of heritability and genetic advance were computed as per the procedures elaborated by Burton and Devane (1953), and Johnson et al. (1955), respectively. Normal Pearson's correlation and path coefficient analysis was undertaken using R software (version 3.2.1). Furthermore, Genotypic and phenotypic correlation coefficients were calculated with META-R software.

RESULTS AND DISCUSSION

Agronomic traits are quantitative in nature, and interact with the environment under study, so partitioning the traits into genotypic, phenotypic, and environmental effects is essential to find out the additive or heritable portion of variability. The mean, range, genotypic and phenotypic variance (Vg, Vp) and coefficient of variation (GCV, PCV), h^2_b, genetic advance (GA) and genetic advance in percent of mean (GAPM) are presented in table 2.

Table 2. Estimation of genetic parameters of different quantitative characters in 30 Jhum rice landraces

Character	Mean	Range	V_p	V_g	PCV	GCV	h^2_b	GA (5%)	GAPM
Flag leaf angle (cm)	50.10	30.62-67.40	75.60	72.72	17.36	17.02	96.18	13.21	26.38
Culm Diameter(mm)	4.80	3.48-6.52	0.44	0.31	13.76	11.68	72.12	0.75	15.68
Plant Height (cm)	119.65	90.59-144.37	186.91	186.17	11.42	11.40	99.60	21.52	17.98
Effective Tiller	6.97	4.00-10.00	3.34	2.97	19.78	18.65	88.95	2.57	27.79
Panicle Length (cm)	28.81	23.69-33.87	6.31	5.86	8.72	8.40	92.85	3.69	12.79
Days to Flowering	91.33	74.00-113.00	65.52	65.08	8.89	8.86	99.32	12.70	13.95
Days to Maturity	118.00	104.00-141.00	62.53	62.06	6.70	6.67	99.26	12.40	10.50
Filled Grain	105.40	81.71-137.25	221.26	220.38	14.11	14.08	99.60	23.41	22.21
Grain Length (mm)	9.07	5.89-12.69	2.20	1.79	16.32	14.75	81.67	1.91	21.06
Grain Breadth (mm)	3.37	2.05-4.68	0.38	0.06	18.19	7.08	15.16	0.15	4.36
LB ratio	3.15	1.65-4.48	0.47	0.24	21.90	15.43	49.63	0.54	17.18
1000 grain wt.(g)	23.30	13.88-31.54	16.33	15.99	17.34	17.16	97.92	6.25	26.83
Yield (g)	5.14	2.52-9.28	2.47	2.31	30.57	29.54	93.33	2.32	45.08

V_p= Phenotypic variance, V_g =Genotypic variance, PCV = Phenotypic Coefficient of variation, GCV = Genotypic coefficient of variation, h^2_b = Heritability (Broad sense), GA = Genetic advance, GAPM = Genetic advance in percent of mean

The range of variation was much pronounced for all the traits in the study. The highest genotypic and phenotypic variances were observed for filled grain. Plant height and flag leaf angle exhibited high genotypic and phenotypic variances indicating the presence of the wide range of variability for the traits under study and had greater scope of selection for the improvement of jhum rice. Moderate genotypic and phenotypic variances were obtained from days to flowering and days to maturity, hence these traits might be considered for the improvement of jhum rice genotypes.

In this study, most of the growth traits showed higher PCV compared to yield and yield component traits. However, lower PCV belonged to days to maturity (6.70%) while yield (30.57%) was recorded with higher value. Length breadth ratio (21.90%), effective tiller (19.78%) and grain breadth (18.19%) were recorded with higher values of PCV. Panicle length (8.72%) and days to flowering (8.89%) were found with lower values. The higher GCV was associated with yield (29.54%) and the value was fairly low in case of days to maturity (6.67%).Heritability ranged from 15.16 to 99.60%. The highest amount of heritability was recorded at filled grain and plant height whereas, the lowest value was found at grain breadth. The results were in conformity with that of Anjaneyulu et al. (2010), Idris et al. (2012) and Sandhya (2014). Flag leaf angle, panicle length, days to flowering, days to maturity, 1000 grain wt. and yield were highly heritable all with an estimated H^2> 0.90 whereas other characters showed relatively low heritability. Characters with high values of GCV and heritability indicating that they might transmit to their progenies and therefore, phenotypic selection based on these characters would be effective. Similar results have been reported by Akand et al. (1997), Sabesan et al. (2009) and Jayasudha and Sharma (2010). Genetic advance (GA) ranged from 0.15% for grain breadth to 23.41% for filled grain. The genetic advance as percent of mean (GAPM) ranged from 4.36% for grain breadth to 45.08% for yield.

Pearson’s correlation coefficient was computed among 13 quantitative traits of 30 accessions of jhum rice genotypes (Table 3).

Table 3. Pearson correlation analysis among yield and its contributing characters in jhum rice genotypes

	Culm Diameter	Plant Height	Effective Tiller	Panicle Length	Days to Flowering	Days to Maturity	Filled Grain	Grain Length	Grain Breadth	LB ratio	1000 grain wt.	Yield
Flag leaf angle	0.255	0.225	-0.429**	0.426**	0.310*	0.264	0.136	-0.266	-0.092	-0.099	-0.098	-0.135
Culm Diameter		0.075	-0.37*	0.080	0.531**	0.519**	0.420**	0.191	-0.207	0.303	-0.105	-0.017
Plant Height			0.053	0.696***	0.204	0.221	0.146	-0.307	-0.145	-0.158	-0.522	0.245
Effective Tiller				-0.130	-0.154	-0.148	0.135	-0.291	-0.145	-0.130	-0.364*	0.446**
Panicle Length					0.236	0.234	0.030	-0.244	-0.109	-0.115	-0.416**	0.119
Days to Flowering						0.992***	0.036	0.173	-0.486**	0.441**	-0.331*	-0.055
Days to Maturity							0.015	0.191	-0.457**	0.434**	-0.321*	-0.063
Filled Grain								-0.390*	-0.077	-0.189	-0.443**	0.209
Grain Length									-0.185	0.793***	0.565***	-0.476**
Grain Breadth										-0.735***	0.387*	-0.337*
LB ratio											0.133	-0.123
1000 grain wt.												-0.542**

*, **,***Significant at 5%, 1% and 0.1% levels, respectively

Flag leaf angle was significantly and positively correlated with panicle length but negatively correlated with effective tiller. Culm diameter showed significant positive correlation with days to flowering (0.531**), days to maturity (0.519**) and filled grain (0.420**). On the other hand, panicle length and filled grain showed negative association with 1000 grain wt. Effective tiller was positively correlated with yield. Mirza et al. (1992) reported positive correlation of number of panicles/m2 and grain yield with number of tillers/plant. However, plant height was found significantly correlated with panicle length (0.696**). Days to flowering was highly significant and positively correlated with days to maturity (0.992**) and LB ratio (0.441**). Again, grain length showed positive and highly significant correlation with LB ratio (0.793**) and 1000 grain wt. (0.565**).

The genotypic and phenotypic correlations for yield and yield components are showed in table 4. Effective tiller possessed highly negative association with flag leaf angle followed by culm diameter. Panicle length showed highly significant and positive correlation with plant height (Rangare et al., 2012) and significant positive correlation with flag leaf area both at genotypic and phenotypic level. Days to maturity showed significant positive correlation with culm diameter and days to flowering. Moreover, days to flowering and filled grain also has positive association with culm diameter at genotypic as well as phenotypic level.

Grain breadth has negative but significant association with both days to flowering and maturity.

Effective tiller and 1000 grain weight showed significant positive correlation with yield, but negatively significant association with grain length at genotypic along with phenotypic level. Hence, effective tiller and 1000 grain weight should be given prior attention in rice improvement program because of their major influence on yield. This finding was in accordance with Hasan et al. (2010), Manikyaminnie et al. (2013) and Adilakshmi and Girijarani (2012).

Path coefficient analysis was done to partition the direct and indirect effects of different yield contributing traits on yield of rice. Path coefficient analysis (Table 5) revealed that effective tiller (-0.238) possessed negative direct effect on yield but made the indirect effect positive and significant. This indicates that more number of effective tiller is the highly reliable component of grain yield (Garg et al., 2010). Another important character with high direct effect is length-breadth ratio, which showed the highest positive direct effect (0.352) on yield but had negative indirect effect on total correlation. Hence, direct selection based on length-breadth ratio would not be effective for improvement of yield. Moreover, negative direct effect was observed for flag leaf angle, days to flowering, grain length and grain breadth. On the other hand, plant height and panicle length exhibited positive direct effect along with positive correlation with yield. Furthermore, 1000 grain weight possessed negative direct effect and highest positive significant correlation with yield.

The residual effect of the present study was 0.368, indicated that 63.2% of the variability was accounted for 13 yield contributing traits included in the present study. The rest amount of variability might be controlled by other yield contributed traits that was not included in the present investigation.

Table 4. Genotypic (G) and phenotypic (P) correlations among yield and yield contributing characters in jhum rice genotypes

Traits		Flag leaf angle	Culm Diameter	Plant Height	Effective Tiller	Panicle Length	Days to Flowering	Days to Maturity	Filled Grain	Grain Length	Grain Breadth	LB ratio	1000 grain wt.
Culm diameter	G	0.235											
	P	0.231											
Plant Height	G	0.225	0.029										
	P	0.227	0.0005										
Effective Tiller	G	-0.462**	-0.390*	0.024									
	P	-0.454**	-0.382*	0.013									
Panicle Length	G	0.376*	0.009	0.700***	-0.089								
	P	0.378*	-0.014	0.675***	-0.104								
Days to Flowering	G	0.336	0.520**	0.210	-0.251	0.241							
	P	0.337	0.499**	0.189	-0.258	0.216							
Days to Maturity	G	0.279	0.502**	0.202	-0.234	0.224	0.987***						
	P	0.280	0.477**	0.174	-0.244	0.194	0.984***						
Filled Grain	G	0.099	0.492**	0.272	0.074	0.293	0.207	0.168					
	P	0.101	0.466**	0.228	0.060	0.245	0.177	0.127					
Grain Length	G	-0.322	0.184	-0.205	-0.294	-0.234	0.118	0.158	-0.267				
	P	-0.329	0.123	-0.280	-0.304	-0.312	0.072	0.103	-0.386*				
Grain Breadth	G	-0.464**	-0.692***	-0.210	0.131	-0.318	-0.817***	-0.753***	-0.249	-0.318			
	P	-0.289	-0.406*	-0.102	0.060	-0.167	-0.493**	-0.448**	-0.104	-0.163			
LB ratio	G	-0.227	0.245	-0.244	-0.109	-0.127	0.381*	0.380*	0.053	0.715***	-1.000***		
	P	-0.228	0.196	-0.329	-0.122	-0.201	0.321	0.307	-0.074	0.560***	-0.614***		
1000 grain wt.	G	0.021	-0.063	-0.391*	-0.158	-0.409*	-0.254	-0.244	-0.459**	0.304	0.352*	-0.050	
	P	0.022	-0.040	-0.369*	-0.147	-0.387*	-0.237	-0.223	-0.434**	0.371*	0.191	0.028	
Yield	G	-0.086	0.040	0.289	0.431**	0.163	-0.045	-0.068	0.276	-0.592***	0.036	-0.112	0.425**
	P	-0.084	0.042	0.290	0.431**	0.161	-0.046	-0.069	0.287	-0.592***	0.022	-0.115	0.426**

*, **,***Significant at 5%, 1% and 0.1% levels, respectively

Table 5. Partitioning of genotypic correlation into direct (bold phase) and indirect components of 30 genotypes of jhum rice

	Flag leaf angle	Culm Diameter	Plant Height	Effective Tiller	Panicle Length	Days to Flowering	Days to Maturity	Filled Grain	Grain Length	Grain Breadth	LB ratio	1000 grain wt.	Yield
Flag leaf angle	**-0.471**	0.064	0.010	0.102	0.002	-0.117	0.020	-0.029	0.268	0.036	-0.035	0.014	-0.135
Culm Diameter	-0.120	**0.252**	0.003	0.088	0.000	-0.201	0.039	-0.091	-0.193	0.081	0.107	0.015	-0.018
Plant Height	-0.106	0.019	**0.046**	-0.013	0.004	-0.077	0.017	-0.031	0.309	0.057	-0.056	0.076	0.245
Effective Tiller	0.202	-0.093	0.002	**-0.238**	-0.001	0.058	-0.011	-0.029	0.292	0.157	-0.046	0.053	0.347**
Panicle Length	-0.201	0.020	0.032	0.031	**0.006**	-0.089	0.018	-0.007	0.246	0.043	-0.041	0.061	0.119
Days to Flowering	-0.146	0.134	0.009	0.037	0.001	**-0.378**	0.074	-0.008	-0.174	0.190	0.155	0.048	-0.056
Days to Maturity	-0.125	0.131	0.010	0.035	0.001	-0.375	**0.075**	-0.003	-0.192	0.179	0.153	0.047	-0.063
Filled Grain	-0.064	0.106	0.007	-0.032	0.000	-0.013	0.001	**-0.216**	0.392	0.030	-0.067	0.065	0.209
Grain Length	0.125	0.048	-0.014	0.069	-0.001	-0.065	0.014	0.084	**-1.006**	0.072	0.279	-0.083	-0.477**
Grain Breadth	0.043	-0.052	-0.007	0.035	-0.001	0.183	-0.034	0.017	0.186	**-0.392**	-0.259	-0.057	-0.337*
LB ratio	0.047	0.076	-0.007	0.031	-0.001	-0.167	0.033	0.041	-0.797	0.288	**0.352**	-0.020	-0.123
1000 grain wt.	0.046	-0.026	-0.024	0.087	-0.002	0.125	-0.024	0.096	-0.568	-0.152	0.047	**-0.146**	0.543**

*, **,*** Significant at 5% and 1% levels, respectively

Residual Effect, R = 0.3685925

CONCLUSION

The experiment reveals the significant genetic variability among the yield contributing traits of jhum rice genotypes. Higher mean values of plant height and days to maturity are evidence of their superiority in contribution of variation. Moreover, considering the results of character association and path analysis it is well understood that 1000-grain weight and the number of effective tiller works as a selection criteria for yield improvement. Such kind of characters could be used in rice breeding strategy and biotechnological research for further yield and quality improvement.

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