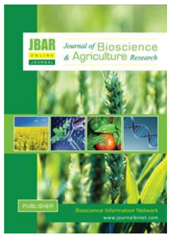
Journal BiNET
Scientific Publication

Published with Open Access at Journal BiNET
Vol. 28, Issue 02: 2389-2398
Journal of Bioscience and Agriculture Research
Journal Home: www.journalbinet.com/jbar-journal.html



Analysis of genetic variability and character relationship in rice (*Oryza sativa* L.) seed and seedling traits

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Article received: 01.08.2021; Revised: 30.11.2021; First published online: 31 December, 2021.

ABSTRACT

Eight rice genotypes with different genetic backgrounds were evaluated for grain length, grain width, grain length width ratio, grain thickness, 1000 grain weight, seed germination percent, shoot length, root length and root shoot ratio. The genetic variance ($\delta^2 g$), phenotypic variance ($\delta^2 p$), phenotypic covariance (PCV), genotypic coefficient of variation (GCV), heritability (h_b^2), genetic advance (GA), genetic advance in percent of mean (GA %) and correlation coefficient were all calculated. The experiment was conducted using a Randomized Block Design with three replications in a controlled environment in the laboratory of Department of Agriculture at Bangabandhu Sheikh Mujibur Rahman Science and Technology University Gopalganj in June 2021. For all of the studied characters, analysis of variance revealed a significant difference in genotypes. PCV values greater than GCV were found in all of the characteristics, indicating that they were influenced by non-additive gene action rather than environmental factors and that selection for improving these traits would be beneficial. The PCV (41.33) and GCV (41.70) estimates for the root shoot ratio were both high, indicating a wide range of variability for the two component characteristics, shoot length and root length. PCV and GCV values were moderate for grain length width ratio, seed germination percent, shoot length, and root length. The PCV and GCV of most grain characters were low. All of the characters had high heritability, ranging from 90.77 percent to 99.81 percent, except for 1000 grain weight (46.91 percent). Seed germination percent (36.03), shoot length (40.03), root length (35.16) and root shoot ratio (35.16) all had high heritability and high genetic advance in percent of mean (79.25). Grain thickness (8.68) and seed germination percent had the lowest GA% (8.71). Grain length with grain length width ratio, grain width with root shoot ratio, 1000 grain weight with grain width, grain thickness, root length and root shoot ratio were all found to have positive and significant correlations in a character association study. At the genotypic level, the highest positive significant correlation was found between 1000 grain weight and root shoot ratio (r_g= 0.908) and grain length and grain width ratio (r_p=0.900). According to genetic variability and correlation analysis, grain length, grain length width ratio, 1000 grain weight, root length and root shoot ratio could be used as selection indices for further improvement of seed and seedling characters of rice genotypes.

Key Words*: Genetic variability, Variance component, Heritability, Character association and Rice.*

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EISSN: 2312-7945,

Cite Article: Hoque, N., Islam, M. Z., Zarin, F., Mahmud, N., Rahman, M. and Biswas, B. (2021). Analysis of genetic variability and character relationship in rice (*Oryza sativa* L.) seed and seedling traits. Journal of Bioscience and Agriculture Research, 28(02), 2389-2398.
Crossref: https://doi.org/10.18801/jbar.280222.290

I. Introduction

Rice is one of the most important cereal crops globally, accounting for more than 21% of global food production and up to 76% of Southeast Asia's caloric intake (Fitzgerald et al., 2008; Miura et al., 2011). According to previous projection, Rice production will need to expand by 40% by 2030 to fulfill the predicted demand of the world's growing population and consumer preference (Khush, 2005, Unnevehr, 1992; Juliano and Villareal 1993; Custodio et al., 2019). Rice is Bangladesh's agriculture's lifeblood; in Bangladesh, as in most other countries, 'food security' is almost entirely dependent on 'rice security' (Brolley, 2015); it accounts for roughly 4.5 percent of GDP (BBS, 2020). Different strategies have been proposed for improving grain quality and rice yield. One of the most effective, sustainable and economical approaches for increasing rice productivity is improving and using superior rice varieties (Rosegrant and Cline, 2003). High grain yield potential, enhanced grain shape, nutritional value, disease resistance and stress tolerance are the most desirable qualities in a superior rice cultivar. Yield of rice influenced by three characteristics, i.e. number of panicles per plant, number of grains per panicle and the grain weight.

Rice varieties differ greatly in seed quality, which influences the growth stages, quality and yield of rice. Quick emergence and rapid growth are generally preferred in commercial rice varieties, particularly those designed for direct seeding. Grain weight is the most consistent trait, measured as 1000-grain weight. According to Tan et al. (2000), grain weight positively correlates with grain shape. Grain shape is determined and characterized by a combination of grain length, grain width, grain length width ratio and grain thickness. Grain shape contributes to grain yield and itself an important physical quality of rice grain that has a most critical impact on the market values of grain products. Seedling vigour is an ability of a plant to emerge rapidly from soil or water, where it grows (Heydecker, 1960). Seedling vigour is affected by shoot and root systems, this system reciprocally benefit each other as a result of the relationship between water and nutrient absorption and carbohydrate production in a different growth stage. Strong shoots and roots are beneficial for rice growth in the medium to late growth periods and obtain stable yield due to worldwide water crisis and physical damage during rice transplanting. Strong shoots of rice seedlings are pre-requisite for higher energy utilization efficiency and more photosynthates for survival. Plants can change the root-shoot mass ratio in changing soil conditions and stress environments (Rich and Watt, 2013; Xu et al., 2015). The vigour of the root system is essential in rice (*Oryza sativa* L.) and other higher plants for water uptake, nutrient uptake, canopy structural support and sensing environmental factors (Coudert et al., 2010; Orman-Ligeza et al., 2013).

Most of the research work has been done on plant height and yield. On the other hand, studies of shoot length and shoot weight were overlooked. The measurements of root length, root thickness and root weight characteristics were considered as most challenging (Li et al., 2005; Price et al., 2002). Rice cultivars have substantial genetic variation to improve different characters (Redona and Mackill 1996a), where genetic basis of seedling characteristics and its improvement are possible through conventional and molecular breeding. Seed and seedling characters have been used in rice genetic studies (Li and Rutger, 1980) and screening breeding lines from different genetic backgrounds (McKenzie et al., 1994). Seedling vigour is correlated with crop growth and yield (Ellis, 1992) therefore high seedling vigour or rapid growth of seedling is a major breeding target in rice and other crops (Karrel et al., 1993; Redoña and Mackill, 1996a).

Multiple genes control most agronomically important characters (Tan et al., 2000). Improvement of grain shape, 1000-grain weight, seedling vigour and seedling characteristics are essential and fundamental objectives for success in any breeding program (Xing and Zhang, 2010; Sakamoto et al., 2006). In rice, most yield contributing characters are dependent on each other to take along grain yield. Furthermore, most yield components are quantitative and the variability's are both heritable

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and non-heritable (Stuber, 1987). Therefore the information on nature and magnitude of the genetic variation present in a crop species for the character to improve is essential for the success of any breeding program (Hub, 2011). While selection is made based on yield contributing characters, where heritability and genetic advance are two important factors for selection. Heritability estimates combined with genetic advances are more useful in predicting selection gain than heritability estimates alone for quantitative character (Paul et al., 2006). High broad sense heritability coupled with high genetic advance can precisely determine the role of environmental factors on the expression of genotype and the consistency of characters (Babu et al., 2012).

There are two types of variability: additive and non-additive. To gain an explicit knowledge of the pattern of variations, the phenotypic variance has been partitioned into genotypic and phenotypic. In crop improvement programs, a thorough examination of genetic variability parameters such as genotypic coefficient of variability (GCV), phenotypic coefficient of variability (PCV), heritability and genetic advance of various characters with economic importance is mandatory. Information on correlation coefficient between yield and its component characters is very important for elucidating the direct and indirect effect of characters and selecting traits for crop improvement (Kishore et al., 2015). The objectives of this study were to find out the underlying genetic variability, heritability, genetic advance and association of characters related to seed and seedlings in some rice genotypes to aid information for selecting rice genotypes for developing future varieties with superior characters for higher yield and tolerance to biotic and abiotic stress.

II. Materials and Methods

Seeds of *Indica* rice (*Oryza sativa* L.) variety: BRRIdhan52, BRRIdhan67, BRRIdhan71, BRRIdhan75, BRRIdhan81, BRRIdhan86, BRRIdhan87 and BRRIdhan92 were used in this study, which were collected from Bangladesh Rice Research Institute (Table 01). The laboratory study was conducted in December 2021 in the laboratory of Department of Agriculture, Bangabandhu Sheikh Mujibur Rahman Science and Technology University Gopalganj. The germination test was performed using the petridish method with three replicates of 100 seeds. Seeds were sterilized with 2% sodium hypochlorite for 20 min, washed extensively with distilled water to remove excessive chemicals attached with seeds and then germinated in petri dishes with wetted filter paper at 24±2°C in the dark. Seeds were soaked in distilled water for 36h at room temperature and placed on Whatman filter paper no.1. The petridishes were observed every day and the numbers of germinated seeds were recorded at 24h interval up to 14 days from set up of the test. Seeds with uniform germination were selected and sand cultured in a natural medium with 1:1 (Organic matter: Sand). Rice seedlings were raised in controlled environment with the LED lighting system set at 20±2°C and 24±2°C for day and night respectively and 70 ±2% relative humidity under a 6h photoperiod and 18h dark. The growth experiment was laid out in randomized complete block design with three replications. Five seedlings for each replication were randomly selected for growth analysis.

Table 01. Information of the rice varieties used in the experiment collected from Bangladesh Rice Research Institute, Gopalgonj Regional station

Rice variety	Used in this study as	Season	Phenotypic description with special feature
BRRIdhan52	(V1)	Aman	Submergence tolerant
BRRIdhan67	(V2)	Boro	Salinity tolerant
BRRIdhan71	(V3)	Aman	Drought tolerant
BRRIdhan75	(V4)	Aman	Uptake twenty five percent less nutrient
BRRIdhan81	(V5)	Boro	Protein rich, premium quality grain
BRRIdhan86	(V6)	Boro	Lodging resistant, long grain, export quality
BRRIdhan87	(V7)	Aman	Somaclonal variant
BRRIdhan92	(V8)	Boro	Drought tolerant and derived from rice wheat cross

BRRI – Bangladesh Rice Research Institute, V - Variety

Data collection:

Length, width, thickness and thousand grain weight

The length *L* (mm), width *W* (mm) and thickness *T* (mm) of the rice grains were measured by using digital slide calliper with an accuracy of 0.01mm. Rice grains were randomly selected and each of their

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dimension was measured 10 times on each variety. The 1000 grain weight was measured by random selection of one thousand grains of each variety and carefully weighed on digital scale, followed by estimation of the final weight in grams with an accuracy of 0.001g. The procedure was repeated three times and average values were recorded (Varnamkhasti et al., 2008).

Germination and Germination percent

Seed germination was considered complete once the radicle protruded about 2 mm in length. The germination experiment was continued for 14 days and recorded daily (Ellis and Roberts, 1981). A seed was considered to be germinated as seed coat ruptured, plumule and radicle came out and were >2mm long. Germination count was expressed in percentage and calculated using the following formula (International Seed Testing Association, 2006).

Germination (%) = (Number of seed germinated)/(Total number of seed for test) × 100

Measurement of shoot length, root length and root shoot ratio

Randomly selected five seedlings were taken from each variety to measure shoot length, root length and root shoot ratio after 21 days from initiation of the experiment (kouio, 2003). It was measured with a measuring scale and expressed in centimetres.

Measures of genetic parameters

Variability parameters like genotypic variance $(\delta^2 g)$, phenotypic variance $(\delta^2 p)$, were estimated according to the formula given by Johnson et al. (1955). Genotypic coefficient of variations (GCV) and phenotypic coefficient of variations (PCV) were estimated according to Burton (1952) and Singh and Chaudhary (1985). Heritability in broad sense (h^2b) was estimated according to the formula suggested by Johnson et al. (1955) and Hanson et al. (1956). Heritability was classified in three categories as low (below 30%), medium (30-60%) and high (above 60%), as suggested by Johnson et al. (1955). Estimating genetic advance and genetic advance in the percentage of mean (GA%) were done following the formula of Johnson et al., 1955; Allard, 1960 and Comstock and Robinson, 1952. Genetic advance estimates were categorized as high, medium and low as suggested by Johnson et al. (1955). The coefficient of genotypic and phenotypic variation were categorized as proposed by Sivasubramanian and Madhavamenon (1973). Furthermore, genotypic correlation coefficients (r_g) and phenotypic correlation coefficients (r_p) were estimated according to Johnson et al. (1955); Singh and Chaudhary (1985) to find out the interrelation of the studied characters.

Data analysis

All data were tested for significance using analysis of variance (ANOVA) followed by the least significant difference (LSD) test at the $P < 0.05$ level (Gomez and Gomez, 1984). Randomized Complete Block Design was used to test the variation in rice varieties. All statistical analyses were conducted using MSTAT-C (Statistical analysis software) computer package program.

III. Results and Discussion

Mean performance of the genotypes

Analyses of variance (ANOVA) revealed significant variation among the genotypes regarding all quantitative characters under study (Table 02). The variation for grain length ranged from 8.25 mm to 10.32 mm, with an average of 9.377 mm. The longest grain was found in BRRIdhan86 and shortest in BRRIdhan52. Rice grain width ranged from 2.12 mm to 2.42 mm with an average of 2.283 mm. BRRIdhan52 had the highest grain width, while BRRIdhan81 had the lowest. Grain length width ratio ranged from 3.40 to 4.69 with an average of 4.12. Highest grain length width ratio was found in BRRIdhan81 and lowest in BRRIdhan52. Grain thickness ranged from 1.61 mm to 1.84 mm with an average of 1.77 mm. BRRIdhan71 had the highest and BRRIdhan75 had the lowest grain thickness. Variation in 1000 grain weight ranged from 21.00 g to 26.33 g with an average of 23.70 g. Highest 1000 grain weight was found in BRRIdhan92 and lowest in BRRIdhan75. Seed germination percentage ranged from 62 to 98 percent, with an average of 88 percent.

The highest germination was found in BRRIdhan71, while the lowest was found in BRRIdhan81. The length of the shoots ranged from 4.56 cm to 8.93 cm on average, with an average of 7.50 cm.

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BRRIdhan81 had the longest shoot length, while BRRIdhan92 had the shortest. The average root length was 4.271 cm, ranging from 2.80 cm to 5.39 cm. BRRIdhan71 had the longest root and BRRIdhan67 had the shortest. The root shoot ratio ranged from 0.31 to 1.13, with 0.62 being the average. The highest root shoot ratio was BRRIdhan67, while the lowest was BRRIdhan92.

Table 02. Mean performance of 8 rice genotypes based on seed and seedling characters

Variety	Grain length (mm)	Grain width (mm)	Grain length width ratio	Grain thickness (mm)	1000 grain weight (g)	Seed germination (%)	Shoot length (cm)	Root length (cm)	Root shoot ratio
V1	8.25 g	2.42 ab	3.40 f	1.83 a	24.67 ab	66 cd	6.38 b	4.49 c	0.73 b
V2	8.61 f	2.27 c	3.79 d	1.82 a	22.67 bc	95 a	8.68 a	2.80 e	0.31 d
V3	9.07 e	2.47 a	3.67 e	1.84 a	25.00 ab	98 a	6.93 b	5.39 a	0.79 b
V4	9.23 d	2.24 c	4.12 c	1.61 e	21.00 c	68 c	6.96 b	3.64 d	0.53 c
V5	9.94 b	2.12 d	4.69 a	1.72 d	23.33 bc	62 d	8.93 a	4.38 c	0.50 c
V6	10.32 a	2.22 c	4.66 a	1.76 c	24.33 ab	97 a	8.92 a	4.18 c	0.48 c
V7	9.65 c	2.13 d	4.54 b	1.78 b	22.33 bc	94 ab	8.67 a	4.33 c	0.50 c
V8	9.97 b	2.40 b	4.15 c	1.83 a	26.33 a	90 b	4.56 c	4.94 b	1.13 a
$LSD_{(0.05)}$	0.055	0.056	0.078	0.018	2.716	4.592	0.600	0.433	0.078
SE(±)	0.14	0.027	0.094	0.015	0.436	3.078	0.312	0.164	0.05
SD	0.687	0.131	0.459	0.076	2.136	15.081	1.529	0.803	0.246
CV (%)	0.39	1.15	1.17	1.07	6.54	3.13	4.55	5.79	7.88

Estimation of variability parameters

Seed and seedling characters were evaluated for genotypic variances, phenotypic variances, genotypic co-efficient of variation, phenotypic co-efficient of variation, heritability, genetic advance and genetic advance as percent of mean (Table 03). The result of ANOVA for all the characters was highly significant (not presented) revealed that genotype possess inherent genetic variation among them for the studied characters. Higher value of phenotypic variance than the genotypic variances for all the characters indicated the influence of environment. Environmental influence on different yield contributing characters of rice also reported by Devi et al. (2006), Prajapati et al. (2011), Islam et al. (2016) and Akter et al. (2018).

Table 03. Estimation of genetic parameters of 8 rice genotypes based on seed and seedling characters

Characters	Phenotypic variance ($\delta^2 g$)	Genotypic variance ($\delta^2 p$)	PCV (%)	GCV (%)	Heritability (%) ($h^2 b$)	GA	GA (%)
Grain length (mm)	0.517	0.516	7.67	7.66	99.81	1.41	15.06
Grain width (mm)	0.019	0.018	6.04	5.88	94.74	0.26	11.20
Grain length width ratio	0.230	0.228	11.62	11.57	99.13	0.94	22.71
Thickness (mm)	0.0061	0.0060	4.39	4.36	98.35	0.15	8.68
1000 grain weight (g)	4.53	2.13	8.98	6.15	46.91	2.06	8.71
Seed germination (%)	247.25	240.38	18.76	18.49	97.22	30.20	36.03
Shoot length (cm)	2.55	2.43	21.28	20.79	95.41	3.01	40.03
Root length (cm)	0.66	0.60	19.04	18.14	90.77	1.50	35.16
Root shoot ratio	0.066	0.064	41.33	40.70	96.95	0.49	79.25

Here, $\delta^2 g$= Genotypic variance, $\delta^2 p$= Phenotypic variance, GCV= Genotypic coefficient of variance, PCV= Phenotypic coefficient of variance, $h^2 b$ = Heritability in broad sense, GA = Genetic advance, GA% = Genetic advance in percent of mean

The magnitude of genotype variation expressed as phenotypic and genotypic co-efficient of variation. Estimates of phenotypic co-efficient of variation (PCV) were higher than the corresponding genotypic co-efficient of variation (GCV) for all the characters, indicating that seed and seedling characters interacted with environments to some extent. Interaction of different characters of rice with environment was also reported by Bhadru et al. (2012) and Akter et al. (2018). A wide range of phenotypic co-efficient variation (4.39 % to 41.33 %) and genotypic co-efficient of variation (4.36% to 40.70%) was observed for seed and seedling characters. Root shoot ratio had high phenotypic and genotypic co-efficient of variation, indicating little environmental influence and presence of high genetic variability for the characters in the genotype. Hence, selection based on phenotype in these genotypes will be effective for improving root character. Mishra and Verma (2002) and Rasel et al. (2018) also reported high PCV coupled with high GCV for shoot and root character. The present study found moderate phenotypic and genotypic co-efficient of variation for grain length width ratio, seed

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EISSN: 2312-7945,

germination percent, shoot length and root length. Islam et al. (2020) also found moderate PCV and GCV values for rice grain length width ratio. Low phenotypic and genotypic co-efficient of variation were observed for grain length, grain width, grain thickness and 1000 grain weight in the present study indicating low variability in the characters and less possibility of improvement for these characters.

Estimation of heritability

Estimation of heritability helps predict the consistency of the phenotypic value of characters in a crop improvement program. All the characters: grain length, grain width, grain length width ratio, grain thickness, seed germination percent, shoot length, root length and root shoot ratio in the studied genotypes showed high heritability except 1000 grain weight (Table 03). Islam et al. (2020) also observed high heritability for grain length, grain width, grain thickness and grain length width ratio. High heritability values estimated in the characters indicate less influence of environment in character expression. High heritability also helps in effective selection based on phenotypic expression of these characters following selection methods generally used in rice breeding program.

Genetic advance

Genetic advance ranged from 0.26 to 30.20, while the genetic advance in percent of mean ranged from 8.68 to 48.06. Seed germination percentage showed highest genetic advance (30.20). Grain width and thickness showed very low genetic advance (Table 03). Islam et al. (2015) reported the lowest genetic advance for grain width. For root shoot ratio, shoot length, root length, seed germination percentage, and grain length width ratio, the genetic advance in percent of mean was high (>20 percent). There was a moderate genetic advance (10-20%) in percent of mean for grain length and width. Islam et al. (2015) found a moderate genetic advance for grain length. Grain thickness and 1000 grain weight showed low genetic progress in the mean (0-10%). Rasel et al. (2018) also reported a high heritability with a high genetic advance in percent of mean for shoot length. The combination of heritability and advances in genetics would result in a more reliable index of selection value (Johnson et al., 1955).

Characters with high heritability and genetic progress indicated that additive gene action was dominant in controlling the characters, which could be improved through selection. The non-additive gene action for the expression of the character was indicated by high heritability and low genetic advance in the characters. The favourable influence of environment rather than genotype is responsible for a character's high heritability. Characters of this type are not always effective. Additive gene effects result in low to moderate heritability in character, which is also influenced by environment and direct selection will be rewarding in improving this character.

Correlation among character

Genotypic and phenotypic Correlation co-efficient were estimated for different characters in 8 rice genotypes (Table 04). Grain length had a positive and significant genotypic and phenotypic relationship with grain length width ratio, as well as a negative non-significant relationship with grain width and grain thickness. The 1000 grain weight, seed germination percent, shoots length, root length and root shoot ratio had a positive non-significant correlation with grain length. Grain width had a positive genotypic correlation with 1000 grain weight but was non-significant at the phenotypic level, whereas grain thickness and root shoot ratio had both genotypic and phenotypic correlations. Grain width had a non-significant but positive genotypic and phenotypic relationship with germination percent and root length. Grain width had a negative significant genotypic correlation with grain length width ratio, but a non-significant phenotypic correlation and a negative significant genotypic correlation with shoot length at both levels. Grain length width ratios correlated positively with seed germination percentage and shoot length but negatively with grain thickness, 1000 grain weight, root length and root shoot ratio. Grain thickness had a significant positive correlation with 1000 grain weight at the genotypic level but was non-significant at the phenotypic level, whereas seed germination percent, root length and root shoot ratio had non-significant positive correlations.

Shoot length had a negative non-significant genotypic and phenotypic correlation with grain thickness. There was a positive significant correlation with root shoot ratio and root length at the genotypic level, but not at the phenotypic level, whereas there was a positive significant correlation with seed germination percent at both levels. A positive non-significant genotypic and phenotypic correlation

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EISSN: 2312-7945,

with seed germination percent was found in 1000 grain. Grain length, grain width, length-to-width ratio, and grain thickness have shown a positive correlation with grain weight in rice, though the degree of correlation has varied between studies by different researchers.

Table 04. Genotypic (G) and phenotypic (P) correlations among seed and seedling characters in 8 rice genotypes

Characters		Grain width	Grain width ratio	Grain thickness	1000 grain weight	Seed germination percent	Shoot length	Root length	Root shoot ratio
Grain length	r_g	-0.486^{ns}	0.900*	-0.277^{ns}	0.169^{ns}	0.213^{ns}	0.168^{ns}	0.261^{ns}	0.116
	r_p	-0.484^{ns}	0.895*	-0.494^{ns}	0.084^{ns}	0.210^{ns}	0.164^{ns}	0.249^{ns}	0.114^{ns}
Grain width	r_g		-0.824*	0.604^{ns}	0.795*	0.182^{ns}	-0.766*	0.484^{ns}	0.698*
	r_p		-0.319^{ns}	0.740*	0.565^{ns}	0.175^{ns}	-0.730*	0.448^{ns}	0.668*
Grain length width ratio	r_g			-0.475^{ns}	-0.279^{ns}	0.032^{ns}	0.503^{ns}	-0.047^{ns}	-0.272^{ns}
	r_p	*		-0.433^{ns}	-0.189^{ns}	0.032^{ns}	0.489^{ns}	-0.044^{ns}	-0.267^{ns}
Thickness	r_g				0.834*	0.517^{ns}	-0.282^{ns}	0.349^{ns}	0.408^{ns}
	r_p				0.599^{ns}	0.505^{ns}	-0.274^{ns}	0.330^{ns}	0.128^{ns}
1000 grain weight	r_g					0.314^{ns}	-0.695*	0.767	0.908*
	r_p					0.212^{ns}	-0.465^{ns}	0.497^{ns}	0.595^{ns}
GERMP	r_g						0.082^{ns}	0.073^{ns}	0.048^{ns}
	r_p						0.079^{ns}	0.069^{ns}	0.047^{ns}
Shoot length	r_g							-0.489^{ns}	-0.914*
	r_p							-0.456^{ns}	-0.879*
Root length	r_g								0.756*
	r_p								0.709*

Here, r_g= Genotypic correlation coefficients, r_p= phenotypic correlation coefficients; *Indicate significant at $p \leq 0.05$ level. Ns: Not significant at (n-2) df.

In some studies conducted by Rui and Zhao (1983); Shi and Shen (1985), grain length contributed more to grain weight than other grain shape characters. There was a positive non-significant correlation between germination percent and shoot length, root length and root shoot ratio at both levels. At both levels, there is a negative significant correlation between shoot length and root shoot ratio, as well as a negative non-significant correlation between root length and shoot length. Root length had a significant positive relationship with root shoot ratio. The genotypic correlation coefficients in this study were higher than their phenotypic correlation coefficients, indicating a strong inherent association between the traits and a dominating effect of the environment on phenotypic expression, lowering the phenotypic correlation value. Rasel et al. (2018) also observed environmental effects on rice character association. In some cases, the phenotypic correlation coefficient was higher than their genotypic correlation coefficients, suggesting the equal effect of genotype and environment on character expression ultimately at the phenotypic level. The greater value of genotypic correlation co-efficient than phenotypic correlation co-efficient value for different characters in rice reported earlier by Bai et al. (1992), which explain the expression of characters and higher value of correlation co-efficient value at phenotypic level with genotype environmental effect in reverse direction.

IV. Conclusion

Genetic variation in rice genotypes for seed and seedling characteristics, which are essential for crop development, were revealed in this study. There was a greater genetic variance in grain length, 1000 grain weight, seed germination percent and shoot root characteristics. Due to additive gene effects, phenotypic qualities may be further improved by hybridization and pedigree selection of specified characters, as demonstrated by genetic variability. Selection for characters with high heritability and moderate genetic advance may be ineffective because of the influence of the environment. Grain length, grain length width ratio, 1000-grain weight, root length and root shoot ratio can be used as selection indices to improve rice seed and seedling characteristics, according to the results of the character association study.

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HOW TO CITE THIS ARTICLE?

Crossref: https://doi.org/10.18801/jbar.280221.290

MLA

Hoque, N. et al. "Analysis of genetic variability and character relationship in rice (*Oryza sativa* L.) seed and seedling traits". Journal of Bioscience and Agriculture Research, 28(02), (2021): 2389-2398.

APA

Hoque, N., Islam, M. Z., Zarin, F., Mahmud, N., Rahman, M. and Biswas, B. (2021). Analysis of genetic variability and character relationship in rice (*Oryza sativa* L.) seed and seedling traits. *Journal of Bioscience and Agriculture Research*, 28(02), 2389-2398.

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Hoque, N, Islam, MZ, Zarin, F, Mahmud, N, Rahman, M and Biswas, B. Analysis of genetic variability and character relationship in rice (*Oryza sativa* L.) seed and seedling traits. Journal of Bioscience and Agriculture Research, 2021 December, 28(02): 2389-2398.

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