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Correlation, Heritability and Genetic Advance Analysis of Rice (*Oriza sativa* L.) Genotypes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was conducted at Seed Testing Laboratory of Seed Technology Section, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The study was based on the germplasm evaluation of 45 germplasm including three checks viz., NDR-2065, BPT 5204 and Sambha sub1. The high estimates (> 40 %) of phenotypic (PCV) and genotypic (GCV) coefficients of variation was registered in case of shoot length (PCV=18.1129 %, GCV=17.1129 %). The magnitude of heritability in broad sense varied between 0.7947 per cent in case of seedling length to 0.9567 per cent in case of vigour index-I. The high estimates of h^2 (>0.8564**)** were noted for vigour index-I (0.9567) followed by root length (0.8845), speed of germination (0.8749), seed weight (0.8596). Vigour index-I noticed highly significant and positive correlation with shoot length (0.454), root length (0.419), seedling dry weight (0.333), germination per cent (0.319), seed weight (0.315), seedling length (0.312), seed width (0.308), root length (0.292), speed of germination (0.281) and L/B ratio (0.216).

Keywords: Correlation Coefficient; evolution; laboratory; Oriza sativa L.

1. INTRODUCTION

One of the most significant crops in the world, rice (*Oryza sativa* L.) comes in second position in terms of yearly output behind wheat. With an annual global production of over 700 million tonnes and a harvest area of almost 165 million hectares, rice is the staple diet of over half of the world's population. It also supplies over 80% of calories and 75% of protein for people living in a large portion of Asia 1]. It is unavoidable that food will rise as the world's population grows in order to fulfil everyone's nutritional demands. Increasing food output per unit area is the key to resolving such inconsistencies and is the primary means of rescuing humanity from poverty and hunger [2].

The seed's underlying endurance and performance potential allow it to function properly when sown. Low-vigor seeds will result in less field establishment or stand, which will affect yields. Low seed vigour is thought to be the cause of an annual five percent crop loss. The only way to fully reap the benefits of an upgraded variety and its full genetic potential is to sow very strong seed. When a high-yielding variety incorporates link-wise seed vigour, the poor seed germ inability issue in tropical regions will be significantly reduced. The ability of a seed lot to perform well in terms of field establishment is mostly reliant on the seed's ability to germinate and establish under less-than-ideal field conditions. The seeds are suited to perform well after planting because of their performance potential, or hidden stamina. "Seed plays an important role for the success of any crop and it is the most important input for the success of any crop production programme. Seed vigour is an important factor that affects seedling establishment. Seeds low in vigour generally produces weak seedlings that are susceptible to environmental stresses. High vigour in seeds is expected to provide the growing seedlings the competitive advantage against various environmental stresses" [2].

"The important seed quality attributes are genetic purity, physical purity, germination, moisture, health and vigour. In addition to above quality seed should be of uniform size and should possess good. Germination capacity of quality seed lot should be high for obtaining the desired crop stand in the field. Using seed of low germination will reduce the field establishment or stand and thus the yields will be lowered" [3]. "Seed germination is affected by a variety of factors which are imposed to the seed during its formation, maturation, and ripening, such as infection with the paste and pathogen. Sub-optimal condition of nutrients and water supply and untimely rains or frost at the maturity stage. In addition, post-harvest operations and handling of the seed lots during marketing or distribution are also responsible for affecting the seed quality. The performance potential of a seed lot concerning field establishment is very such dependent on the capacity to germinate emerge and establish under sub-optimal field conditions" [4].

2. MATERIALS AND METHODS

The experiment was conducted in a Completely Randomized Block Design with three replications. The observations were recorded on five randomly selected competitive seedlings of a genotype in a germination test in each replication for twelve characters in the experiment. The mean values of observations recorded on five plants of each line were used for analysis. Laboratory observations were recorded as per ISTA rules. The observations for different characters were recorded as follows: 1000-grain weight (g), Seed length (mm), Seed breadth (mm), L/B ratio, Germination (%), Speed of germination, Root length (cm), Shoot length (cm), Seedling length (cm), Seedling dry weight (g), Vigour Index-I, Vigour Index-II. The experimental data were compiled by taking the mean of 5 selected plants for each germplasm. The data collected for the characters mentioned above will be subjected to statistical analysis as follows:

1. Estimation of coefficient of variation [3].
2. Estimation of heritability [4] and genetic advance [5].
3. Estimation of correlation coefficients [6].

3. RESULTS AND DISCUSSION

3.1 Coefficient of Variation

The estimates of phenotypic (PCV) and genotypic (GCV) coefficients of variation for 12 seed quality characters of rice genotypes are presented in Table 1. The magnitude of phenotypic coefficients of variation (PCV) was higher than corresponding genotypic coefficients of variation for all seed quality traits.

The high estimates (> 40 %) of phenotypic (PCV) and genotypic (GCV) coefficients of variation was registered in case of shoot length (PCV=18.1129 %, GCV=17.1129 %). Moderate estimates (> 20% %) of PCV and GCV were noted for seedling length (PCV=18.1284 %, GCV=16.1603 %) , root length (PCV=24.6124 %, GCV=23.1470 %) and 1000- seed weight (PCV=22.2979 %, GCV=20.6729 %), whereas the low estimates (< 20%) of phenotypic and genotypic coefficients variation were observed for decorticated seed width (PCV=19.4250 %, GCV=17.6901 %), germination per cent (PCV=16.2090 %, GCV=14.7667 %) and seedling length (PCV=17.9611 %). GCV=16.0234 %), seedling dry weight (PCV=20.7137 %, GCV=19.1684%), seed L/B ratio (PCV=19.4100 %, GCV=17.7350 %), speed of germination (PCV=22.4805 %, GCV=21.0274 %), vigour index-I (PCV=42.9603 %, GCV=42.0199 %) and vigour index-II (PCV=21.0187 %, GCV=19.4734 %). The same type work was done at different crops by some workers Jan and Kashyap, Saha et al. and Rishabh 2019 [7,8,9].

3.2 Heritability and Genetic Advance

Heritability in broad sense (h^2b) and genetic advance in per cent of mean (Gs %) for all the 12 seed quality traits estimated and finding are given in Table 1.

The magnitude of heritability in broad sense varied between 0.7947 per cent in case of seedling length to 0.9567 per cent in case of vigour index-I. The high estimates of h^2 (>0.8564**)** were noted for vigour index-I (0.9567) followed by root length (0.8845), speed of germination (0.8749), seed weight (0.8596). Vigor index-II (0.8584), Moderate estimates of heritability (>0.8293<0.8564), L/B ratio (0.834), germination per cent (0.8300), shoot length (0.8298) and seed width (0.8293) showed low heritability (<0.7959).

The genetic advance in per cent, mean range from 0.0232 per cent in case seedling dry weight to 24.8204 in case of germination per cent. The very high estimates of (>8.4680) genetic advance were reregistered for (24.8204) in case of germination percentage, vigour index-I (22.2826), seed weight (8.6994), seed width (0.8914) exhibited high. Moderate genetic advance (>0.8592<2.8592) were recorded for root length (6.4273) and shoot length (4.5634), whereas vigour index-II (2.1552), L/B ratio (1.1931) and seedling dry weight (0.0232) possessed low genetic advance. Some of these characters have also been reported to exhibited high estimate of heritability with genetic advance in percent of mean was observed for germination percentage, vigour index, root length showed high heritability with vigour index at genotypic and phenotypic level by earlier workers Jan and Kashyap**,** Rishabh et al., Akshitha et al. and Singh et al. [7,9,10,11].

3.3 Correlation Coefficients

The phenotypic and genotypic correlation coefficients computed among 12 seed quality characters under study are presented in Table 2 and 3. Respectively in general, the values of genotypic correlation coefficients were similar in sign or nature but slightly higher in magnitude than the corresponding phenotypic correlation coefficients for all the characters. Some of the character had non-significant and negative correlation coefficient either at genotypic or phenotypic level.

Table 1. Estimates of ranges, grand mean, phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability in broad sense (h2b) and genetic advance in per cent of mean (GA) for 12 characters in rice genotypes

Characters	Range	Grand mean	PCV (%)	GCV (%)	Heritability (h^2b %)	Genetic advance in per cent of mean (Ga %)	C. V.	GA % M
Seedling dry Weight (g)	0.46-0.077	0.065	20.7137	19.1684	0.8564	36.5410	7.8505	36.5410
1000 seeds weight (g)	14.17-28.66	22.49	22.2979	20.6729	0.8596	8.6994	8.3563	39.4826
Seed length (mm)	7.33-11.23	9.91	16.0234	16.0234	.7959	29.4472	8.1149	29.4472
Seed width (mm)	1.55-3.03	2.74	19.4250	17.6901	0.8293	0.8914	8.0245	33.1868
L/B ratio	2.58-4.73	3.65	19.4100	17.7350	0.8349	1.1931	7.8880	33.3812
Germination (%)	81.00-98.00	91.42	16.2090	14.7667	0.8300	24.8204	6.6841	27.7125
Speed of germination	12.15-19.07	21.43	22.4805	21.0274	0.8749	8.4680	7.9513	40.5164
Root length (cm)	10.50-31.20	14.63	24.6124	23.1470	0.8845	6.4273	8.3659	44.8438
Shoot length (cm)	11.40-18.60	14.51	18.7856	17.1129	0.8298	4.5634	7.7490	32.1137
Seedling length (cm)	22.60-33.70	28.89	18.7856	16.1603	0.7947	8.3980	8.2147	29.6763
Vigour index-I	23.30-9027.00	2686.66	42.9603	42.0199	0.9567	2228.2677	7.81	84.6661
Vigour index-II	4.10-7.45	5.92	21.0187	19.4734	0.8584	2.1552	7.9101	37.1661

Table 2. Estimates of phenotypic correlation coefficient between different characters in rice

Characters	Seed length (mm)	Seed width (mm)	L/B ratio	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling dry Weight (g)	Vigour index-I	Vigour index-II
1000 seed weight (g)	0.747**	0.674**	0.452**	0.539**	0.325*	0.422**	0.702**	0.67**	0.435**	0.451**	0.315*
Seed length (mm)		0.819**	0.713**	0.756**	0.506**	0.388*	0.662**	0.653**	0.482**	0.4528**	0.262
Seed width (mm)			0.411**	0.729**	0.428**	0.460**	0.686**	0.668**	0.456**	0.456**	0.308*
L/B ratio				0.769**	0.601**	0.451**	0.492**	0.532**	0.577**	0.528**	0.216
Germination (%)					0.720**	0.535**	0.711**	0.693**	0.646**	0.681**	0.319*
Speed of germination						0.299	0.545**	0.505**	0.572**	0.557**	0.281
Root length (cm)							0.532**	0.547**	0.517**	0.479**	0.292
Shoot length (cm)								0.846**	0.554**	0.567**	0.419**
Seedling length (cm)									0.705**	0.705**	0.454**
Seedling dry weight (g)										0.849**	0.312*
Vigour index-I											0.3331

Table 3. Estimates of genotypes correlation coefficient between different characters in rice

Character	Seed length (mm)	Seed width (mm)	L/B ratio	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling dry Weight (g)	Vigour index-I	Vigour index-II
1000 seed weight (g)	0.796	0.746	0.482	0.606	0.369	0.489	0.831	0.768	0.506	0.484	0.315
Seed length (mm)		0.833	0.703	0.818	0.557	0.470	0.821	0.833	0.577	0.553	0.276
Seed width (mm)			0.295	0.732	0.423	0.513	0.841	0.844	0.528	0.550	0.331
L/B ratio				0.785	0.627	0.502	0.605	0.669	0.665	0.638	0.226
Germination (%)					0.732	0.573	0.832	0.878	0.763	0.816	0.373
Speed of germination						0.251	0.554	0.607	0.663	0.647	0.316
Root length (cm)							0.505	0.643	0.593	0.554	0.325
Shoot length (cm)								0.969	0.659	0.678	0.477
Seedling length (cm)									0.705	0.705	0.524
Seedling dry Weight (g)										0.941	0.349
Vigour index-I											0.3407

The vigor index-I exhibited a highly significant and positive correlation coefficient with seedling dry weight (0.849), seedling length (0.705), germination per cent (0.681), shoot length (0.567), speed of germination (0.557), L/B ratio (0.528), root length (0.479), seed width (0.456), seed length (0.452) and seed weight (0.451), the character showed positive and significant correlation with this seed quality parameter. The correlation coefficients of this character with the rest of the traits were non-significant. Vigour index-I noticed highly significant and positive correlation with shoot length (0.454), root length (0.419), seedling dry weight (0.333), germination per cent (0.319), seed weight (0.315), seedling length (0.312), seed width (0.308), root length (0.292), speed of germination (0.281) and L/B ratio (0.216). The correlation coefficients of vigour index-II with all characters were registered as significant.

Seedling dry weight noted highly significant and positive correlation with seedling length (0.705), germination per cent (0.646), L/B ratio (0.577), speed of germination (0.572), shoot length (0.554), root length (0.517), seed length (0.482), seed width (0.456) and seed weight (0.435). The correlation coefficient of seedling dry weight with all seed characters was registered as significant. Seedling length noted a highly significant and positive correlation with shoot length (0.846), germination per cent (0.693), seed weight (0.671), seed width (0.668), seed length (0.653), L/B ratio (0.532), root length (0.547) and speed of germination (0.505), Shoot length highly significant and positive correlation with germination per cent (0.711), seed weight (0.702), seed width (0.686), seed length (0.662), root length (0.532) and L/B ratio (0.492) the correlation coefficient of shoot length with all seed characters are noted significant. Root length highly significant and positive correlation with germination per cent (0.535) seed width (0.460), L/B ratio (0.451), seed weight (0.422), seed length (0.388) and speed of germination (0.299).

Speed of germination highly significant and positive correlation with germination per cent (0.720), L/B ratio (0.601), seed length (0.506), seed width (0.428) and seed weight (0.325), The correlation coefficient of speed of germination with all seed characters are significant. Germination per cent and positive correlation with L/B ratio (0.769), seed length (0.756), seed width (0.729) and seed weight (0.539) were highly significant. Positive correlation with seed length (0.713), seed weight (0.452) and seed width (0.411) correlation coefficient of L/B ratio with all seed characters are significant.

Seed width is highly significant and positive correlation with seed length (0.819), and seed weight (0.672). The correlation coefficient of seed width was significant. Seed length is highly significant and positively correlated with seed weight (0.747). The correlation coefficient of seed length was significant with all seed characters. The existing showed a high and significant positive association with seed vigour index at both genotypic and phenotypic levels by earlier workers in rice [12,13,7,9,10,11].

4. CONCLUSION

A broad range of diversity was seen in the seed features for 45 rice genotypes. Vigor Index-I showed a high magnitude of genotypic and phenotypic coefficients of variation, suggesting that these traits have a significant amount of room for improvement following hybridization and subsequent selection. For vigor index-I, root length, germination speed, 1000-seed weight, one or both parameters, moderate estimates of GCV and PCV were recorded, suggesting the possibility of getting a decent improvement by selection. The high estimate of heritability with high genetic advance in per cent of mean was observed for vigour index-I, root length and high germination percentage. The three previously indicated qualities have strong genetic progress in percent of mean and heritability, making them attractive traits for selection-based improvement. In general, the genotypic correlation was more similar to the matching phenotypic correlation coefficient and had a larger value.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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