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Variability and Correlation Study of different Seed Vigour Parameters in Rice (*Oryza sativa* L.)

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ABSTRACT: Rice is a staple cereal crop of Asia as well as India. In India unavailability of quality seed is still a problem. Quality seed with good physiological performance with respect to seed vigour is an important input to get higher yield. Quality seed with good stand establishment and seed vigour not only leads to good stand establishment but also shows tolerance to adverse climatic condition. In the present investigation we have used 120 rice landraces from different places of India and they were examined for six traits contributing seed vigour *viz.*, germination Percentage (G%), root length (RL), shoot length (SL), seedling dry weight (SDW), seed vigour index I (SVI I) and seed vigour index II (SVI II). From the 120 genotypes 12 genotypes for SVI I and 15 genotypes for SVI II are recorded very high values. High variability in all the traits with good heritability (H^2), PCV, GCV and genetic advance (GA) were recorded. A significant and positive correlation was found with seed vigour I and II with G%, RL, SL, SDW. In principal component analysis PC1 found with Eigen value 3.889 fond to contribute highest to the population (64.81%). The genotypes with high seed vigour can be used as in future breeding programs.

Keywords: Seed vigour index, Germination percentage, seedling dry weight, root length.

INTRODUCTION

Rice holds the status of being one of the most essential foods in the world and a staple for the majority of Asians. Around 426 million tonnes of rice is produced a year on 154 million hectares of cultivated land worldwide, with an average yield of 2.76 t ha-1. In India, rice is grown year-round in various regions across 43.8 million hectares of varied ecologies, where 85.3 million tonnes were produced, with an average productivity of 1.94 t ha^{-1} (Jagtap *et al.*, 2012). Global food consumption is predicted to quadruple by 2050 due to the growing human population, which presents a significant problem given the negative consequences of climate change. In addition to guaranteeing a high yield, high-quality seed is also regarded as a key component in raising agricultural production (Pradhan *et al.*, 2019a; Hunter *et al.*, 2017; Chauhan *et al.*, 2015; Vijaylaxmi *et al.*, 2022). India's agricultural sector still faces a number of opportunities and challenges, though, including meeting the country's demand for and ability to afford certain crops, increasing the nutritional value, productivity, and quality of its agricultural produce, lowering the cost of production and the negative effects of farming on the environment, and managing the effects of climate change on agriculture. Adopting novel varieties with superior physiological qualities would help achieve this. Using high-quality seed is the key to unlocking a plant variety's genetic potential and is often regarded as the most important and fundamental input in crop production. One of the most crucial factors in determining the quality of seeds is their vigour, which provides the yield and genetic potential of the seed and guaranteeing uniformity in seedling growth, germination of seed, field establishment, and resistance to unfavourable environmental conditions. This directly affects crop productivity (Ventura *et al.*, 2012; Rajarau *et al.*, 2012). Furthermore, strong seed vigour is similarly crucial for direct sowing as it promotes early field establishment and yields robust seedlings that can outcompete weeds (Panda *et al.*, 2021a; Anandan *et al.*, 2021; Mahender *et al.*, 2015; Yamauchi and winn, 1996; Parul *et al*. 2022). It is still difficult to breed with stronger seeds as doing so can increase crop resilience against the adverse impacts of meteorological change and biotic barriers to agricultural yields, in addition to being necessary to increase yield (Daniel *et al.*, 2017). Since rice is the main crop, increasing its production requires a supply of high-quality seeds of types that are appropriate for the agro-climatic conditions. In the present investigation, 120 germplasm of rice have been tested for the variability study with respect to the physiological parameters of seed including germination percentage, seed vigour index II, seed vigour index I, shoot length, root length and seedling dry weight. The result will reveal genotypes with high stand establishment and robustness which can be used in further breeding programmes.

MATERIAL AND METHODS

In the present investigation, 120 rice genotypes from different states of India including Gujarat, Maharashtra, Tamil Nadu, Assam, Manipur and Odisha which have been stored and collected from the gene bank of NRRI, Cuttack. The landraces from Odisha have been collected from the Jeyporetract of Odisha which is known as the secondary centre of origin for rice and has broad diversity in the genetic constitution of the landraces. All the germplasms were grown in the wet season of 2020 at OUAT, Bhubaneswar. The freshly harvested were treated with 2% KNO_3 solution to overcome the dormancy and then used for the estimation of different seed vigour parameters. To study the variability six physiological seed quality parameters were recorded such as germination percentage, shoot length, root length, seed vigour index II and seed vigour index I. Top-of-paper method was adopted where three replications of hundred seeds were germinated in a petri-dish and placed in incubator (Rao *et al.*, 2006).

For estimation of growth parameters, ten seedlings from each replication were evaluated and mean data is taken as value for each replication. The germination % (GP) is the percentage of normal seedlings on the final count day which was the 14th day and is the final germination percentages calculated. For root and shoot length estimation seedlings were observed on the final count day and measured including the cotyledonary node and expressed in cm. First the cotyledons were removed and the seedlings were dried at 85°C for 24 hours and an average of 10 seedlings were taken and expressed in mg (Kleyer *et al.*, 2008).

Seed vigour indices (SVI I and SVI II) were calculated by multiplying germination percentage with seedling length and seedling dry weight respectively (Abdul-Baki and Anderson 1973). Crop-stat software 7.0 was used to estimate the analysis of variance (ANOVA) for each characteristic, as well as the coefficient of variation (CV %), mean and range. A correlation matrix heat map was created by analysing Pearson's correlation coefficients, which were based on the mean values of the 120 genotypes and were used to determine the link between the various physiological variables. For this investigation, the mean estimates of the six physiological parameters were divided into four groups: low, medium, high and very high value containing germplasm lines.

RESULT AND DISCUSSION

Among the 120 landraces eight germplasm namely Bilijaya, Badra, Gouri, Malbar, Pandya, Sona-masuri, Lusai, and Pk-21 showed 100% germination. The lowest amount of germination is found at Bharati, Phoaujarangbele, Uttarbangalocal 9. Manavari shows the highest root as well as shoot length along with along with Malavar and Tulasi. Germplasms like Mikirahu, Joha, and Uttarbanglocal 9 showed the lowest shoot length. Landraces like Basmati, Johaand Gochi are found to havethe lowest Root length. The seedling dry weight was found highest at Bilipandya, Turnaiangaanba, and Chaokhao-simple, whereas landraces like Palinadhan, Mahamaga and Shyam are recorded with the lowest value. Germplasms like Pandya, Bilipandya and Tulasi are found to have the highest value for both Seed Vigour II and Seed Vigour I. Landraces like Bharati, Joha, Mikirahu, Palinadhan-1, and Lalimunduria are observed to be the least vigorous. All the parameters were recorded to have a wide range of variability. Collections of landraces from the states where previous research had indicated the presence of substantial genetic variation in rice were utilised in this variability analysis. (Pandit *et al.*, 2020; Vanlalsanga and Singh 2019; Latha *et al.*, 2013).

The GCV percentage of various genotypes varied from 35.36% to 82.89 %. Among the traits, four traits showed GCV % more than 40% *viz.*, Germination (49.27%), Shoot length (41.88%), Seed vigour index I (69.53%) and Seed vigour II (82.89%). The lowest GCV was found for the trait root length which was 35.36%. The PCV range of all the traits varied from 36.97 to 76.46. A similar trend was found for PCV in all the traits. Four parameters showed PCV of more than 40%. The highest GCV was found for Seed vigour index II and the lowest was recorded for root length. The heritability of all the traits was more than 90%. The highest heritability was observed for the trait seed vigour index II (97%), followed by shoot length (96%), Seed vigour index I(95%), Germination (94%),Root length(91%) and the lowest was 78% which was observed for Seedling dry weight. The Genetic advance for all the characters varied from 1.13 to 942.01. The highest GA was recorded for seed vigour index II, followed by seedling dry weight (62.56) and Germination percentage (51.62). Three traits showed genetic advance less than 10, *viz.*, shoot length (5.22), Root length (4.12), and seed vigour index II (1.13).

To ascertain if selection for one characteristic would impact selection for another, the correlation between traits is important. Table 3displays the simple correlation coefficient derived from the aggregated data. Significant correlations were found between all the vigour determining parameters, according to correlation coefficients calculated over the 120 rice genotypes for six seedling vigour characteristics. Germination % showed a significant and positive correlation with Seed vigour index I (0.849), followed by Seed vigour index II(0.65), Root length (0.347), Shoot length (0.343) and Seedling dry weight (0.235). Significant positive correlation was recorded in between seedling dry weight and Seed vigour Index II (0.806), followed by Shoot length

(0.681). Root length and Shoot length were found to have a positive correlation with seed vigour index I, which were 0.701 and 0.699 respectively. In direct-seeded rice, seedling vigour is a crucial characteristic for improved crop establishment, and related qualities are quantitatively inherited (Wing *et al.*, 1995; Panda *et al.*, 2021b).

Based on the mean data of seed vigour among the 120 genotypes, fifteen germplasms showed very high vigour, eighteen at high vigour, forty-four with medium and 40 germplasms with low seed vigour were recorded. Sujay (2007) observed similar type of results was obtained for different physiological parameters. The seedling vigour traits such as total dry weight, germination rate, maximum root length, root dry weight and shoot dry weight were found to significantly correlate with one another (Panda *et al.*, 2021b; Cui *et al.*, 2002,) Variations in the vigour test results suggested that, when stored in the same circumstances, seeds with lower vigour will become less viable sooner than those with higher vigour. Previous results indicate that when preserved under the same conditions, low vigorous seeds lost their viability more quickly than substantially higher vigour seeds (Black and Halmer 2006; Richman *et al.*, 2006). Although high-vigor seeds create early and consistent stands that provide developing seedlings with strong resilience against a variety of environmental pressures, low-vigor seeds result in weak seedlings that are prone to environmental stresses (IRRI, 2009). In PCA analysis out of the 6 principal components, only PC_1 was recorded to have an Eigen value more than 1 i.e. 3.889 contributing 64.816% of the variation in the population. Out of all the 6 parameters in PC1 SVI I contributed the highest (22.792), followed by SVI II(20.755) and Root length(15.781). For construction of genotype-by-trait bi-plot graph for the six vigour characteristics that were calculated from the 120 genotypes, the scatter diagram was plotted using the first two main components. In the illustration, landraces with greater physiological parameter values are circled. Most genotypes with high estimations of the physiological parameters under study were found in the top right (1st quadrant) and (2nd quadrant) at the bottom right corner. Most of the landraces with intermediate value were retained in the third quadrant (bottom left), while in the (top left) fourth quadrant the majority of low-value bearing genotypes were accommodated.

Table 1: Estimation of variability of different seed vigour indices of 120 germplasms.

Traits	Range	Mean	SD	CD(5%)	CV(%)	GCV	PCV	h^2bs	GA
Germination percentage (%)	8-100	52.2	51.96	9.592	0.98	49.27	50.58	0.94	51.62
Root length (cm)	2.28-13.5	5.92	7.12	1.029	1.21	35.36	36.97	0.91	4.12
Shoot Length (cm)	2.28-16.83	6.17	2.60	0.813	0.42	41.88	42.67	0.96	5.22
Seedling Dry Weight (mg)	0.001-0.04	0.01	0.006	0.002	0.60	35.93	38.94	0.78	62.56
Seed Vigour Index–I	45.44-2183.33	672.85	871.5	162.81	1.29	69.53	71.14	0.95	942.01
Seed Vigour Index-II	0.02-3.29	0.54	0.56	0.158	1.03	82.89	76.46	0.97	1.13

SD- Standard Deviation, CD- Critical difference, GCV- Genotypic Covariance, PCV- Phenotypic Covariance, $\mathbf{h^2_{bs}}$ **–** Broad sense heritability, GA- Genetic Advance

Table 2: ANOVA of different seed vigour contributing traits of 120 rice germplasms.

Traits	Genotype Means Sum of squares (d.f-119)	Replication Means Sum of squares (d.f–2)	Error
Germination percentage	20.10*	20.21	35.56
Root length	13.5647**	0.934	0.409
Shoot Length	20.2894**	0.074	0.255
Seedling Dry Weight	3.404^{-5}*	1.20^{-5}	0.59^{-5}
Seed Vigour Index–I	666937**	25218	10245
Seed Vigour Index-II	0.94821**	0.0q382	0.01

* Significant at 0.05 ** Significant at 0.01 level

Table 3: Eigen value of different principal components and contribution of different seed vigour contributing traits.

Variables	PC1	PC2	PC3	PC4	PC5	PC6
G%	13.335	48.162	2.538	0.052	24.429	11.485
RL	15.781	7.148	19.185	53.606	0.271	4.01
SL	14.765	4.327	30.57	45.67	0.637	4.032
SVI.1	22.792	9.747	1.399	0.019	4.687	61.356
SVI.2	20.755	0.208	19.488	0.305	45.012	14.232
SWD	12.573	30.409	26.82	0.348	24.964	4.885
Prin_comp	**Eigenvalue**	**Percentage of variance**				
PC1	3.889	64.816				

G%- Germination percentage, RL- Root length, SL- Shoot length, SDW- Shoot Dry Weight, SVI-I- Seed Vigour Index–I, SVI-II- Seed Vigour Index–II

Table 4: Correlation matrix of different seed vigour contributing traits among the 120 rice germplasms.

	G%	RL	SL	SDW	SVI -I	SVI-II
G%	1					
RL	0.347**	1				
SL	0.343**	0.681**	1			
SDW	0.235**	0.491**	0.423**	1		
SVI -I	0.849**	0.701**	0.699**	0.446**	1	
SVI-II	0.65**	0.548**	0.505**	0.806**	0.797**	1

*, ** Significant at 0.05 and 0.01 levels, respectively G%- Germination percentage, RL- Root length, SL- Shoot length, SDW- Shoot Dry Weight, SVI-I- Seed Vigour Index–I, SVI-II- Seed Vigour Index–II

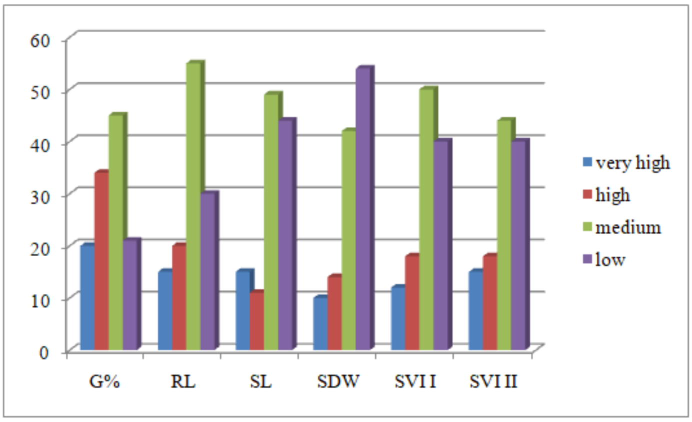

Fig. 1. Distribution frequency of 120 rice germplasms for each seed vigour contributing traits.

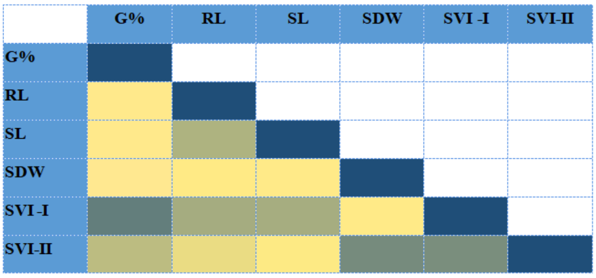

Fig. 2. Heat map of different seed vigour traits based on their correlation.

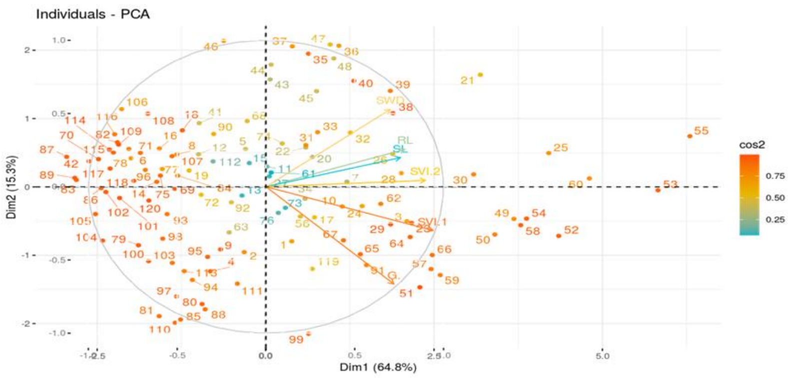

Fig. 3. Trait by genotype bi-plot of different seed vigour traits in 120 rice germplasms.

CONCLUSIONS

The present investigation focuses on variability study and correlation analysis of seed vigour-related traits by using 120 genotypes collected from different states of India. With regard to every aspect of seed quality, a great deal of variation is seen among the landraces and a positive correlation was observed between seed vigour index I and II with traits like shoot length, root length, germination percentage and seedling dry weight.

FUTURE SCOPE

All the genotypes found to be highly vigorous with high germination percentage can be used as donors for variety development in a breeding program

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Conflict of interest. None.

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