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Genetic variability, heritability and genetic advance analysis for seed yield and its physiological quality parameters in rice (*Oryza sativa* L.)

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Abstract
The present investigation was carried out to study genetic parameters for eleven seed yield and its physiological quality contributing characters in thirty rice genotypes with three check varieties during *Kharif* 2016. Analysis of variance showed significant differences among all the characters under study. The phenotypic coefficient of variance was slightly higher in magnitude than that of genotypic coefficient of variance for seed yield and its physiological contributing characters indicating very less environmental influence on the expression of these traits. Higher genotypic coefficient of variation was recorded for seeds per panicle (24.22) followed by seed yield per plant (22.14) and vigour index (18.31). Heritability in broad sense estimates were higher for days to 50% flowering followed by seedling dry weight, days to maturity, plant height, vigour index and seed yield per plant. High expected genetic advances were observed for characters *viz.*, seed yield per plant, seeds per panicle, vigour index, plant height, days to 50% flowering and seedling dry weight. High heritability along with high genetic advance as percent of mean was registered for days to 50% flowering, seedling dry weight, plant height, vigour index and seed yield per plant, this suggest that these traits can be taken as selection parameters to select elite genotypes.

Keywords: Genetic variability, heritability, genetic advance and rice (*Oryza sativa* L.)

Introduction
Rice (*Oryza sativa* L.) is one of the most important staple cereal crop belongs to family Graminaea (Poaceae) having chromosomes 2n = 2x = 24 and is central to lives of billions of people around the world. Rice grain contains 75 to 80% starch, 12% water and 7% protein (Oko *et al*., 2012; Hossain *et al*., 2015) [10, 6]. However, more than 90% of this rice is produced and consumed in Asia, where it is a staple for a majority of the population, including the region's 560 million hungry people. Cultivation of rice is important for the food security of Asia. India has a long history of rice cultivation and stands first in rice area and second in rice production, after China.

The success of any breeding programme mainly depends on the quantum of genetic variability available for exploitation and the extent to which the desirable characters are heritable (Tiwari *et al.*, 2011) [15]. Variability refers to the presence of differences among the individuals of plant population. Variation results due to difference either in genetic constitution of the individual of a plant population or in environment, they have grown. The existence of variability is essential for improvement of genetic material. Selection is also effective when there is significant amount of genetic variability among the individuals in breeding materials. For efficient selection it becomes essential to know about heritable portion of total variability in the germplasm for different traits. Heritability and genetic advance are the direct selection parameters, so correct knowledge of heritability and genetic advance is much more essential in formulation of selection strategy. Taking these facts under consideration the present investigation was carried out to estimate extent of genetic variability, heritability and genetic advance for seed yield and its physiological quality parameters in rice (*Oryza sativa* L.).

Materials and Methods
The present investigation was carried out at the Crop Research Station (CRS) Masodha, Ayodhya and physiological qualities of the seed were tested in Seed Testing Laboratory of the Seed Technology Section, Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.).

The experimental materials for the present investigation consisted of thirty genotypes and three check varieties of rice *viz.*, Shusksamrat, Narendra 359 and Narendra 2064. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Each replication consisted of thirty genotypes and three check varieties. Twenty eight days old seedlings were transplanted 20 cm apart between rows and 15 cm within the row. All the recommended cultural practices were followed to raise a good crop. Observations were recorded randomly on five competitive normal looking plants from each treatment in each replication to record the observations *Viz.*, Days to 50% flowering, Days for maturity, Plant height (cm), Panicle length (cm), Seeds/panicle, 1000-seed weight (g), Seed yield/plant (g), Seed germination (%), Seedling dry weight (mg), Germination index and Vigour index. Phenotypic and genotypic coefficient of variation was calculated by the method suggested by Burton and De vane (1953) [3]. Heritability was estimates by the formula given by Hanson *et al*., (1956) [5] and genetic advance was estimated by the formula suggested by Johnson *et al.* (1955) [7].

Results and Discussion

The experimental results obtained from the present study are as follows. The results of combined analysis of variance for all the characters are shown in Table 1. The analysis of eleven traits was carried out to partition the total variation into genotypic variation and phenotypic variation. Analysis of variance was based on the mean values of eleven quantitative traits in 33 rice genotypes. Significant effects of genotype were observed for all the characters under study. The results pertaining to phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (broad sense) and genetic advance expressed as percent of mean for all the characters under study are presented in Table 2.

Genotypic coefficient of variation (GCV) measures the range of variability in crop and also enables to compare the amount of variability present in different characters. The phenotypic coefficients of variation (PCV) estimates were slightly higher than their corresponding genotypic coefficients of variation (GCV) for all the characters under study, indicated very less environmental influence on the expression of these characters. PCV was recorded higher for seeds per panicle (28.20) followed by seed yield per plant (22.68) and vigour index (18.69). Low magnitude of PCV was exhibited by seed germination per cent (4.08) followed by germination index (8.31) and panicle length (8.97). The remaining traits exhibited medium values of PCV. Similar findings were observed by Singh *et al.* (2008) [12] and Raut *et al*. (2009) [11].

Similarly, GCV was also high for seeds per panicle (24.22) followed by seed yield per plant (22.14) and vigour index (18.31). Whereas, low magnitude of GCV was exhibited by seed germination per cent (3.92) followed by germination index (6.61) and panicle length (7.52).The differences between the values of PCV and GCV were small for almost all the traits indicating less influence of environment in expression of these traits.

Heritability gives the information on the magnitude of inheritance of characters, while genetic advance is helpful in formulating suitable selection procedures. In the present study, heritability (broad sense) ranged from 99.29% to 63.36%. The highest heritability was found in days to 50% flowering (99.29) followed by seedling dry weight (99.22), days to maturity (98.36) and plant height (97.00). This indicated that selection of these traits would be more effective as compared to others. Similar results were obtained by Mahto *et al.* (2003) [9], Singh *et al.* (2007) [13], Chouhan *et al.* (2014) [4], Lingaiah (2015) [8] and Singh *et al.* (2018) [14] in rice genotype they studied. Other traits showed intermediate heritability.

Heritability and the genetic advance are important selection parameters. Johnson *et al.* (1955) [7] suggested that high heritability estimates along with the high genetic advance is more helpful in predicting gain under selection than heritability estimates alone. The estimates of genetic advance can help to understand the type of gene action of various polygenic characters. Genetic advance (GA) under selection refers to the improvement of characters in genotypic value for the new population compared with the base population under one cycle of selection at a given selection intensity (Wolie *et al.*, 2013) [16]. Expected genetic advance as percent of mean had a general range between 44.54 % for seed yield per plant and 7.77% for seed germination per cent. Among the characters high values of GAM (>20%) were recorded for days to 50% flowering, day to maturity, seeds per panicle, plant height, 1000 seed weight, seedling dry weight, vigour index and seed yield per plant. It was moderate (10 to 20%) for days to panicle length and germination index and low (<10%) for seed germination per cent. Similar findings were also observed by Anjaneyulu *et al.* (2010) [2] and Tiwari *et al.* (2011) [15].

Table 1: Analysis of variance for 11 characters of rice genotypes

Characters	Source of variation		
	Replications	Treatments	Error
Degree of freedom	2	32	64
Days to 50% flowering	2.939	552.801**	1.314
Days to maturity	2.212	666.278**	3.681
Plant height (cm)	70.175	935.997**	9.376
Panicle length (cm)	0.212	9.794**	1.202
Seed/panicle	480.576	2368.938**	250.763
1000-seed weight (g)	0.054	33.332**	0.715
Seed germination (%)	2.758	34.063**	0.914
Seedling dry weight (mg)	6.030	3861.631**	10.030
Germination index	0.016	8.950**	1.446
Vigour index	197.735	158294.5**	2150.1
Seed yield/plant (g)	1.286	48.544**	0.776

*,** significant at 5.0% and 1.0% probability level, respectively.

Table 2: Estimates of range, Mean, Coefficients of variation (%), heritability and genetic advance for 11 characters in rice germplasm

S. No.	Characters	Range (Lowest-Highest)	Mean	Coefficient of variation		Heritability in broad sense [$h^2_{(bs)}$%]	Genetic advance in per cent of mean (GA %)
				PCV (%)	GCV (%)		
1.	Days to 50% flowering	67.00-120.00	91.27	14.90	14.85	99.29	30.49
2.	Days to maturity	89.00-146.00	115.70	12.95	12.84	98.36	26.24
3.	Plant height (cm)	57.37-127.70	96.81	18.42	18.15	97.00	36.84
4.	Panicle length (cm)	18.67-27.00	22.48	8.97	7.52	70.44	13.01
5.	Seeds/panicle	66.00-175.00	109.67	28.20	24.22	73.79	42.87
6.	1000-seed weight (g)	16.36-30.29	23.09	14.74	14.28	93.83	28.49
7.	Seed germination (%)	81.00-93.00	84.67	4.08	3.92	92.36	7.77
8.	Seedling dry weight (mg)	180.00-324.00	241.91	14.86	14.81	99.22	30.39
9.	Germination index	19.15-27.16	23.92	8.31	6.61	63.36	10.84
10.	Vigour index	881.50-1824.24	1245.69	18.69	18.31	96.03	36.97
11.	Seed yield/plant (g)	12.18-28.49	18.02	22.68	22.14	95.35	44.54

Conclusion

On the basis of present investigation and earlier report it could concluded that the characters such as days to 50% flowering, seedling dry weight, plant height, vigour index and seed yield per plant, showing the high heritability and genetic advance may be utilized as efficient selection parameters.

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