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Genetic variability studies for qualitative and quantitative traits in rice (*Oryza sativa* L.)

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Abstract
The experiment was consisted of nineteen rice germplasm *viz*; IET26383, DRR Dhan-49, R-RHZ-1B-80, R-RH-2-M1-93, CGZR-1/IET 23824, Samba mahsuri, DRR Dhan 48, CR Dhan 311, R-RHZ-SM-14, MI 127, R-RHZ-1H-82, IR 64, CGZR-2(IET23824), Zinco rice(IET25477), CR Dhan-310(IET 24780), R-RHP-MI-30(IET 25461), MI156, CR2818-1-11-1-B-1-1-2-B-1 and DRR Dhan 45. The analyses of variance revealed that mean sum of squares were highly significant for all the traits for rice genotypes. Genetic variability, phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV), heritability in broad sense and genetic advance in percent of mean were analyzed. High variability was observed in case of plant height cm, grain width and total spikelets. High estimates of heritability were observed for biological yield/plant. The magnitude of phenotypic correlation was higher than the genotypic correlation. Grain yield/plant showed highly significant and positive correlation with panicle length and grain width.

Keywords: Genetic advance, Genetic variability, Heritability and Rice

Introduction
Rice is an ancient staple food cereal crop of the world's and feeding the variety of dishes and dietary needs of people living in the tropics and subtropics. The introduction of high yielding heterotic hybrids under commercial agriculture has resulted in a quantum leap in rice yield enhancement. However, because rice is the country's basic food, increasing its productivity has become critical (Subbaiah *et al*., 2011) [17]. For genetic inhencement, understanding the nature and extent of genetic variation influencing the inheritance of quantitative traits like yield and its components is critical. A thorough examination of genetic diversity is required before beginning any crop improvement effort or using appropriate selection procedures. India is not self-sufficient in food grain production, but also the world's second largest producer and exporter of high-quality rice (Sreedhar *et al*., 2005) [16]. Rice is a vital crop that feeds nearly half of the world's population, accounting for more than half of their daily calorie intake (Maclean *et al*., 2002) [9]. Magnesium, thiamin, niacin, phosphorus, vitamin B6, zinc, and copper are all found in it. Iron, potassium, and folic acid are all present in some kinds. White rice is one of the least protein-dense grains; yet, some enhanced types may deliver 14 gm of protein per 100 gm. Rice contains a variety of energy-dense substances such as carbohydrates, lipids, protein, and a moderate quantity of calcium and riboflavin (Juliano *et al*., 1993) [7]. Humans consume the majority of rice. *Oryza sativa* is a cattle feed with a variety of industrial and non-industrial uses, in addition to providing a major share of the daily calorie and protein intake for half of the world's population. Correlation is a great tool for studying character associations, and it was thus highly beneficial in determining a selection strategy for improving a character without compromising gains in other qualities. Correlation and route analysis reveal the magnitude of the relationship between grain yield and its components, as well as the relative importance of their direct and indirect impacts, providing a clear picture of their relationship with grain yield (Babu *et al*. 2012) [2]. Rice possesses the world's biggest collection of genetic diversity, and India is home to a wide range of rice cultivars, landraces, and many lesser-known types that have been cultivated by farmers for centuries. The evaluation of genetic diversity is a fundamental principle in crop improvement breeding, which involves the transfer of beneficial features to other genotypes Sasaki (2005) [12] and Varshney *et al*. (2008) [19]. Evaluation of locally adapted germplasm is the first stage in breeding for a specific characteristic, and land races are an excellent starting point for breeders looking to develop crop varieties with desirable traits (Shimelis and Laing 2012).

Materials and Methods

The experimental material for the present study consisted of 19 rice genotypes were evaluated in RCBD design in three replications at CRS (Crop Research Station), Masodha, Unit iii, Achraya Narandra Deva University of Agriculture and Technology, Kumarganj Ayodhya. During the *Kharif* season of 2020-2021. The data were recorded on 5 randomly selected plants from each replication for 15 quantitative characters studied were *viz*., Days to 50% flowering (days), Plant height (cm), Productive tillers, Panicle length(cm), Total spikelets, Filled spikelets, Spikelet fertility (%), Grain length, Grain width, L:B ratio, Biological yield/plant (g), Harvest index (%), Zinc content, Iron content and Grain yield / plant (g). Mean values were subjected to analysis of variance to test the significance for each character as per methodology advocated by Panse and Sukhatme (1967) [11]. Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) were calculated by the formula given by Burton (1952) [4], heritability in broad sense (h2) by Burton and De Vane (1953), and genetic advance i.e. the expected genetic gain were calculated by using the procedure proposed by Johnson *et al* (1955) [6].

Results and Discussion

▪ Variability parameters

Greater variability in the initial breeding material ensures better chances of producing desired forms of a crop plant. Thus, the primary objective of germplasm conservation is to collect and preserve the genetic variability in indigenous collection of crop species to make it available to present and future generations. The analysis of variance indicated the existence of significant differences among all the hybrids for all the traits studied. The results of analysis of variance are presented in Table 1. This indicates that the rice germplasm utilised in this study has a lot of variation. The estimates of phenotypic (PCV) and genotypic (GCV) coefficients of variation for fifteen rice genotype characteristics. For all of the characteristics, the magnitudes of the phenotypic coefficient of variability (PCV) were larger than the genotypic coefficient of variability (GCV).Plant height (15.79) had the highest phenotypic coefficient of variation, followed by grain yield/plant (9.21), biological yield/plant (8.53), iron content (8.45), spikelet fertility (8.08), L:B ratio (7.65), zinc content (6.78), panicle length (6.77), filled spikelets (6.66), total spikelets (6.51), harvest index (5.01).

Plant height (15.12) had the highest genotypic coefficient of variation, followed by grain yield per plant (8.63), biological yield per plant (8.37), iron content (7.65), spikelet fertility (7.41), L:B ratio (7.00), panicle length (6.23), filled spikelets (5.98), zinc content (5.05), total spikletes (4.65), days to 50% flowering (4.02), productive tillers (3.53), grain length (3.35), grain width (3.35), grain length (3 (2.11). Selvaraj *et al*., (2011) [13], O.T *et al*., (2017) [18], and Sumanth *et al*., (2017) [18] have all previously shown substantial variability for the above characteristics in rice. Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for all the traits studied indicating that the characters were less influenced by the environment. Therefore, selection on the basis of phenotype alone can be effective for the improvement of these traits.

▪ Heritability

The estimates of heritability act as predictive instrument in expressing the reliability of phenotypic value. Therefore, high heritability helps in effective selection for a particular character. Heritability estimations varied from 71.37 percent (harvest index) to 96.18 percent (biological yield/plant) in a wide sense. Biological yield/plant (96.18 percent), productive tillers per plant (96.11 percent), days to 50% flowering (94.68 percent), grain length (93.58 percent), plant height (91.69 percent), iron content (89.34 percent), grain yield/plant (87.74 percent), panicle length (84.71 percent), spikelets fertility (84.08 percent) all had high heritability estimates in the broad sense (71.37 percent). High heritability indicates the scope of genetic improvement of these characters through selection. The findings of the current study in terms of heritability and genetic progress are largely consistent with those of prior researchers such as Anbanandan *et al*., (2009) [1], Dhurai *et al*., (2014) [5], Khatun *et al*., (2015) [8], and Bitew *et al*., (2016) [3].

▪ Genetic advance

The genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. Heritability in conjunction with genetic advance would give a more reliable index of selection value (Johnson *et al.* 1955) [6]. Plant height (29.82 percent) and biological output per plant (>15 percent) were the features with the highest estimations of genetic progress in percent of mean (16.90 percent). Spikelet fertility (14.00%), L:B ratio (13.21%), grain yield/plant (12.87%), panicle length (11.81%), filled spikelets (11.06%), days to 50 percent flowering (8.06%), zinc content (7.73%), productive tillers (7.12), total spikelets (6.84), iron content (6.78 percent). In the instance of harvest index, the lowest value of genetic progress in percent of mean (5%) was discovered (1.84 percent). Anbanandan *et al*., (2009) [1], Dhurai *et al*., (2014) [5], Khatun *et al*., (2015) [8], Bitew (2016) [3], and Singh *et al*., (2016) [15] found that the estimates of heritability and genetic advance observed in this study agree with the available literature in rice.

Table 1: Analysis of variance for 15 characters in rice germplasm

Characters	Source of variation		
	Replications	**Treatments**	**Error**
Degree of freedom	2	18	36
Days to 50% Flowering	0.278	31.986**	0.588
Plant Height cm	52.341	676.248**	19.788
Productive Tillers	0.278	44.233**	0.588
Panicle Length cm	0.410	9.938**	0.697
Total Spikelets	13.888	614.170**	36.394
Filled Spikelets	0.126	1.657**	0.055
Spikelet Fertility	0.012	9.507**	0.004
Grain Length	2.233	19.737**	1.440
Grain Width	0.262	10.748**	0.648
L:B Ratio	37.55	23.57**	2.61
Biological Yield/Plant	0.409	22.259**	2.625
Harvest Index	0.001	5.665**	0.006
Zn Content	0.052	0.62**	0.54
Iron Content	0.286	0.60**	0.207
Yield/ Plant	0.850	10.478**	1.137

*, ** Significant at 5 (%) and 1 (%) probability levels, respectively.

Table 2: Estimates of range, grand mean, coefficients of variation (%), heritability and genetic advance for 15 characters in rice germplasm

Characters		Range Lowest-Highest	Grand Mean (X)	Coefficient of variation		Heritability in broad sense (%)[$h^2_{(bs)}$%]	Genetic advance in percent of mean (G %)
				PCV (%)	GCV (%)		
1	Days to 50% Flowering	63.67-79.00	71.33	4.13	4.02	94.68	8.06
2	Plant Height cm	86.33-131.79	109.06	15.79	15.12	91.69	29.82
3	Productive Tillers	9.67-12.13	10.90	3.6	3.53	96.11	7.12
4	Panicle Length cm	21.07-30.91	25.99	6.77	6.23	84.71	11.81
5	Total Spikelets	187.81-224.20	206.00	6.51	4.65	81.55	6.84
6	Filled Spikelets	155.97-178.2	167.05	6.66	5.98	80.63	11.06
7	Spikelet Fertility	74.28-91.03	79.57	8.08	7.41	84.08	14
8	Grain Length	8.23-11.20	9.71	3.46	3.35	93.58	6.67
9	Grain Width	1.23-2.10	1.68	3.11	2.8	80.9	5.19
10	L:B Ratio	4.64-7.34	5.99	7.65	7	83.86	13.21
11	Biological Yield/Plant	27.33-53.16	40.24	8.53	8.37	96.18	16.9
12	Harvest Index	5.09-19.61	12.35	5.01	2.11	71.37	1.84
13	Zn Content	23.00-32.40	27.70	6.78	5.05	73.24	7.73
14	Iron Content	41.23-53.04	47.13	8.45	7.65	89.34	6.78
15	Grain yield/ Plant	9.3-14.8	12.05	9.21	8.63	87.74	12.87

Summary and Conclusions

The analysis of variance revealed that mean sum of squares due to treatment were highly significant for all the traits among the nineteen genotypes of rice. Indicated presence of sufficient variability among rice genotypes under study. The estimates of phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV) for all the traits. High magnitudes of variability were observed in case of plant height (cm), grain yield/plant and biological yield/plant showed highest phenotypic coefficient of variation. High estimates of heritability in broad sense was found for biological yield/plant, productive tillers per plant, days to 50% flowering, grain length, plant height, iron content, grain yield/plant, panicle length, spikelets fertility, L:B ratio, total spikelets, grain width and filled spikelets, whereas, medium estimates of heritability were observed for zinc content and harvest index. The high value of genetic advance in per cent of mean was found in plant height, while lowest value was noted for harvest index.

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