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Studies on Variability, Heritability and Genetic Advance for Quantitative Characters in Rice (*Oryza sativa* L.) Germplasm

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ABSTRACT

Genetic variability, genotypic and phenotypic coefficients of variation, heritability and genetic advance for nine characters in seventy genotypes of rice were studied. The analysis of variance revealed that there were highly significant differences for all the characters among the genotypes. The estimates of genotypic and phenotypic coefficients of variation (GCV and PCV) were high for all the characters except days to 50% flowering and Days to maturity. Heritability and genetic advance were high for all the characters except days to 50% flowering and Days to maturity, which had moderate genetic advance along with high heritability indicating the involvement of additive and non-additive type of gene action respectively in controlling these characters.

Key words: *Rice, Genetic variability, Heritability, Genetic advance.*

INTRODUCTION

Rice is the staple food for 65% of the global population and forms the cheapest source of food, energy and protein. In India, rice is cultivated by different methods under diverse environmental conditions. To meet the food demand of the growing population and to achieve food security in the country, the present production levels need to be increased by 2 million tones every year, which is possible through heterosis breeding and other innovative breeding approaches. To increase the present levels of heterosis for yield, there is a need to identify and utilize genetically divergent parents for inter and intra subspecific crosses in rice. A systematic evaluation and characterization of germplasm lines not only helps in identification of superior and genetically divergent germplasm lines but also provides information on the utility of the genetic resources.

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Characterization of accessions provides the information on morphological and agronomic aspects of the material that is essential for the gene bank management. Therefore, the present investigation was undertaken to study the genetic variability for yield and its component characters in various rice germplasm lines.

MATERIALS AND METHODS

A field experiment was conducted with 70 genotypes of rice collected from different parts of the country in a Randomized Block Design with three replications. Twenty five days old seedlings were transplanted with a spacing of 30 cm and 20 cm between rows and plants, respectively. Five representative plants for each genotype in each replication were randomly selected to record observations on plant height (cm), Days to 50% flowering, total tillers per plant, productive tillers per plant, panicle length(cm), No.of filled grains per panicle, Days to maturity, 1000-grain weight(g) and single plant yield(g). Days to 50% flowering and days to maturity were recorded on plot basis. Test weight (g) was recorded by weighing 1000 grains of each cultivar. The mean data after computing for each character was subjected to standard methods of analyses of variance following Panse and Sukatme[5] Phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (broad sense) and genetic advance as percentage of mean were estimated by the formulae suggested by Burton[1] and Johnson *et al*.[4].

RESULTS AND DISCUSSION

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 highly significant differences among genotypes for all the characters studied (Table 1). A wide range of variation was observed in the rice germplasm for all the quantitative characters and yield (Table 3). However, widest range of variability was recorded for grains per panicle (47.13-146.40) followed by plant height (71.50-145.40cm). The range of variation obtained for total number of tillers (7.27-20.13) and 1000-grain weight (13.42-32.09 g) was least when compared to all the other characters(Table 2).Number of filled Grains per panicle and plant height exhibited high genotypic and phenotypic variances, followed by Days to maturity and days to 50% flowering. Similar results were obtained earlier by Sawant *et al*.[9] and Deb Choudhary and Das[3].Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for days to 50% flowering, plant height, number of tillers per plant, number of productive tillers per plant, panicle length, number of filled grains per panicle, number of unfilled grains per panicle, days to maturity, 1000 grain weight, grain yield per plant(Fig 1) 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. The characters like total tillers per plant, No. of productive tillers per plant, No. of filled grains per panicle and single plant yield showed high PCV and GCV estimates. Patel *et al*.[6] also recorded similar observations for total tillers per plant, No. of productive tillers per plant and single plant yield. Low PCV and GCV estimates were obtained for days to 50% flowering and Days to maturity. These results are in conformity with those obtained for days to 50% flowering by Sinha *et al*.[10] and Days to maturity by Chanbeni *et al*.[2].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. In the present study, all the characters exhibited high heritability, which ranged from 82.00 to 96.80 % (Table 4 and Fig 2). The genetic advance is a useful indicator of the progress that can be expected as a result of exercising selection on the pertinent population. The genetic advance

expressed as a percentage of mean ranged from 15.782-60.750 and the important characters like single plant yield (60.75), No. of productive tillers per plant (45.913) and No. of filled grains per panicle (44.031) recorded higher estimates(Table 4 and Fig 2).Based upon variability and heritability estimates, it could be concluded that high heritability coupled with high genetic advance as per cent of mean was observed for grain yield per plant, followed by number of productive tillers per plant, number of filled grains per panicle, number of tillers per plant and plant height (cm). This indicated that these traits were controlled by additive type of gene action in the inheritance of these characters[5]. These characters can be further improved by following simple selection procedure. Selection for the traits having high heritability coupled with high genetic advance is likely to accumulate more additive genes leading to further improvement of their performance. The high estimates of heritability coupled with moderate genetic advance as per cent of mean for days to 50 per cent flowering and days to maturity indicated the presence of non-additive gene effects, in addition to influence of environment to some extent. The characters showing high heritability along with moderate or low genetic advance can be improved by intermating superior genotypes of segregating population developed from combination breeding[8].Percentage Contribution of different traits towards genetic variability in 70 genotypes of rice presented in table 5. The genetic variability was contributed by number of filled grains per panicle was highest towards genetic divergence (35.07%), followed by 1000 grain weight (16.52%), number of tillers per plant (14.65%), panicle length (14.20%), plant height (13.00%), days to maturity (3.14%), days to fifty per cent flowering (2.60%), number of productive tillers per plant (0.41%), grain yield per plant (0.37%). The characters number of filled grains per panicle, 1000 grain weight, number of tillers per plant, panicle length together contributed 80.44% towards total divergence. Therefore, these characters should be given importance during selection indices.In the present study, fourteen superior genotypes, *viz.*, IC-217954, IC-217992, IC-75756, IC-75783, IC-75775, IC-75738, IC-75786, IC-75773, IC-758443, IC-75779, IC-75748, IC-75747, IC-75772 and IC-75782were found to be potential enough to be used as parents in various breeding programmes. These genotypes recorded highest values for one or the other yield contributing characters and hence their utilization in combination breeding may help in generating high yielding varieties/ hybrids by pyramiding all the favourable genes.

Table 1: ANOVA for yield and yield contributing characters in rice genotypes

S.No.	Character	Mean sum of squares		
		Replications (d.f.=2)	Treatments (d.f.=69)	Error (d.f.=138)
1	Days to 50% Flowering	18.233	229.62**	15.66
2	Plant Height (cm)	41.403	800.73**	16.40
3	No. of tillers/ plant	0.662	24.26**	0.62
4	No. of productive tillers/plant	0.092	19.51**	0.46
5	Panicle length(cm)	1.873	35.27**	0.87
6	No. of filled grains/panicle	11.872	1393.51**	15.10
8	Days to maturity	3.986	360.88**	18.63
9	Grain yield/plant(g)	18.262	168.91**	6.27
10	1000 grain weight(g)	1.023	36.33**	0.86

****** Significant at 1% level * Significant at 5% level

Table 2: Range, Mean for different traits in rice Germplasm

Characters	Range	Mean
Days to 50 per cent Flowering	83-116.3	99.82
Plant height (cm)	71.50-145.40	105.26
No. of tillers/ plant	7.27-20.13	12.86
No. of productive tillers/plant	5.33-18.0	10.90
Panicle length(cm)	14.17-29.53	22.37
No. of filled grains/panicle	47.13-146.40	98.67
Days to maturity	100.00-156.67	121.83
Grain yield/plant(g)	11.34-44.63	23.63
1000 grain weight(g)	13.42-32.09	23.35

Table 3: Genotypic and Phenotypic variance components, coefficient of variability for different traits in rice germplasm

Characters	Phenotypic Variance	Genotypic Variance	PCV (%)	GCV (%)
Days to 50 per cent Flowering	86.979	71.321	9.343	8.460
Plant height (cm)	277.844	261.442	15.836	15.361
No. of tillers/ plant	8.502	7.881	22.675	21.831
No. of productive tillers/plant	6.820	6.345	23.995	23.106
Panicle length(cm)	12.335	11.466	15.697	15.134
No. of filled grains/panicle	474.572	489.470	22.077	21.723
Days to maturity	132.714	114.081	9.456	8.767
Grain yield/plant(g)	60.482	54.214	32.149	31.149
1000 grain weight(g)	12.681	11.824	15.250	14.725

Table 4: Heritability and Genetic Advance for different traits in rice germplasm

Characters	Heritability in broad sense(h^2) (%)	Gen. Adv as per cent of Mean (at 5%)
Days to 50 per cent Flowering	82.00	15.782
Plant height (cm)	94.10	30.696
No. of tillers/ plant	92.70	43.299
No. of productive tillers/plant	93.00	45.913
Panicle length(cm)	93.00	30.059
No. of filled grains/panicle	96.80	44.031
Days to maturity	86.00	16.745
Grain yield/plant(g)	89.60	60.750
1000 grain weight(g)	93.20	29.291

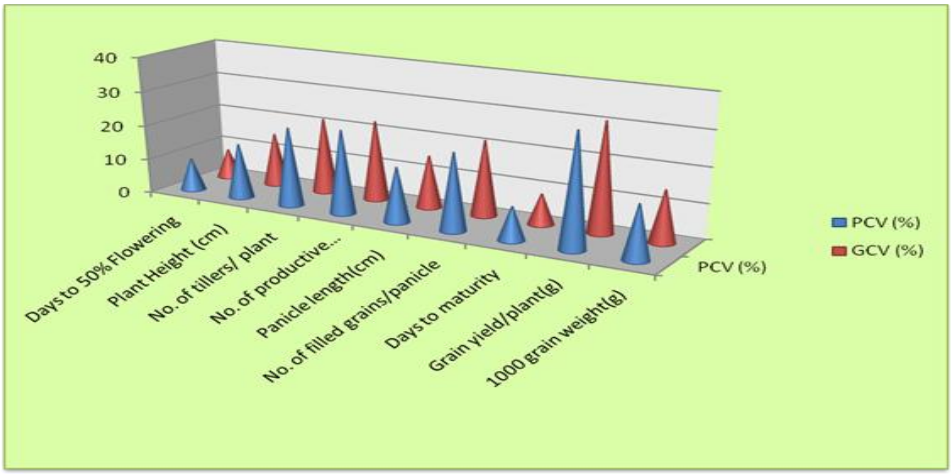

Fig. 1: Graphical representation of PCV and GCV

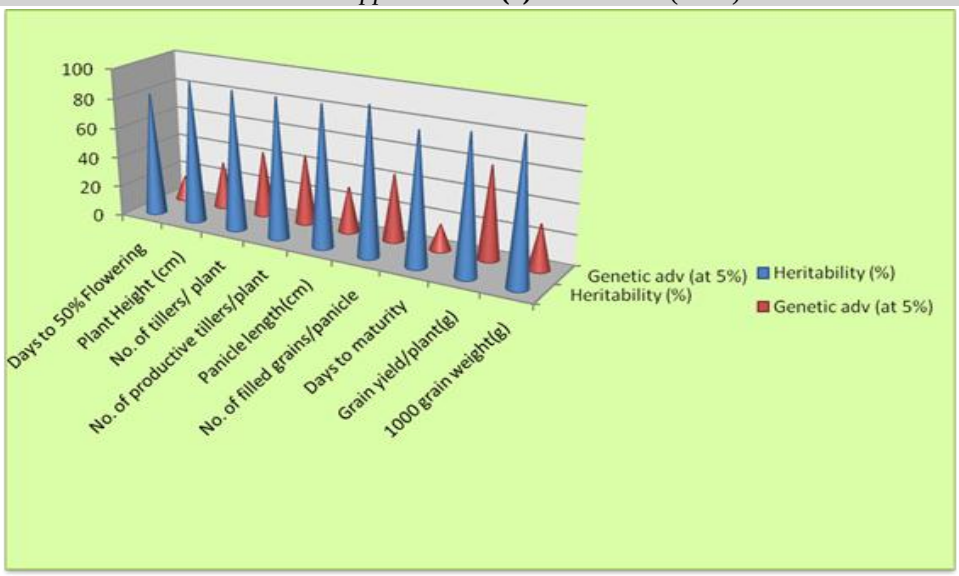

Fig. 2: Graphical representation of h^2 and Genetic advance (5%)

Table 5: Relative contribution of different characters to genetic variability in rice genotypes

S. No	Characters	Times ranked first	Contribution (%)
1.	Days to 50% Flowering	63	2.60
2.	Plant Height (cm)	314	13.00
3.	No. of tillers/ plant	354	14.65
4.	No. of productive tillers/plant	10	0.41
5.	Panicle length(cm)	343	14.20
6.	No. of filled grains/panicle	847	35.07
7.	Days to maturity	76	3.14
8.	Grain yield/plant(g)	9	0.37
9.	1000 grain weight(g)	399	16.52

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