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

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Genetic variability, genotypic and phenotypic coefficients of variation, heritability and genetic advance for eleven characters in one hundred and fifty genotypes including five check varieties of rice were studied. The analysis of variance revealed that there were highly significant differences for all the characters except leaf width and 100-seed weight 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 panicle length. Heritability and genetic advance were high for all the characters except days to 50% flowering and panicle length, which had moderate genetic advance along with high heritability indicating the involvement of additive type of gene action 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 tonnes 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 sub-specific 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. 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 145 genotypes of rice collected from 13 villages in Lohandiguda, 7 villages in Bakawand, 5 villages in Darba, 3 villages in Tokapal, 10 villages in Bastanar, 2 villages in Pharasgaon, 2 villages in Kondagaon, 11 villages in Keskal and 5 villages in Baderajpur blocks of Chhattisgarh along with five check varieties Jaya, Mandya Vijaya, Prasanna, Rasi and Vasumathi in a Randomized Block Design with three replications. Thirty days old seedlings were transplanted with a spacing of 20 cm and 15 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), leaf length (cm), leaf width (cm), total tillers per plant, productive tillers per plant, panicle length, grains per panicle, spikelet fertility and single plant yield. Days to 50% flowering were computed on plot basis. Seed weight (g) was recorded by weighing 100 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 (1957). 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 (1952) and Johnson *et al*. (1955).

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

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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 except leaf width and 100-seed weight (Table 1). A wide range of variation was observed in the rice germplasm for all the quantitative characters and yield (Table 2). However, widest range of variability was recorded for grains per panicle (73.81 to 297.23) followed by plant height (78.33 to 155.43 cm). The range of variation obtained for leaf width (0.68 to 1.45 cm) and 100-seed weight (1.42–3.60 g) was least when compared to all the other characters.

Grains per panicle and plant height exhibited high genotypic and phenotypic variances, followed by spikelet fertility and days to 50% flowering. Similar results were obtained earlier by Sawant *et al*. (1994) and Deb Choudhary and Das (1998).

Coefficients of variation studies indicated that the estimates of PCV were slightly higher than the corresponding GCV estimates for plant height, leaf length, days to 50% flowering, grains per panicle and spikelet fertility 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 magnitude of PCV was higher than the corresponding GCV for the characters like leaf width, total tillers per plant, productive tillers per plant, panicle length, 100-seed weight and single plant yield suggesting the influence of environment on the expression of these traits.

Table 1. Analysis of variance for different traits in rice germplasm

S. No.	Character	Mean sum of squares		
		Replications (d.f.=2)	Treatments (d.f.=149)	Error (d.f.=258)
1.	Days to 50% flowering	1.78	206.12**	1.02
2.	Plant height (cm)	6.98	568.60**	1.81
3.	Leaf length (cm)	7.16	87.86*	2.58
4.	Leaf width (cm)	0.014	0.07	0.01
5.	Total tillers per plant	5.17	22.95**	1.89
6.	Productive tillers per plant	3.19	11.69**	1.07
7.	Panicle length (cm)	8.43	15.05**	1.05
8.	Grains per panicle	8.86	3440.24**	7.14
9.	Spikelet fertility (%)	5.62	329.87**	0.59
10.	100-grain weight (g)	0.29	0.40	0.02
11.	Single plant yield (g)	4.61	50.76**	1.01

** Significant at 1 per cent level
* Significant at 5 per cent level

The characters like total tillers per plant, productive tillers per plant, grains per panicle and single plant yield showed high PCV and GCV estimates. Sinha *et al.* (2004) also recorded similar observations for total tillers per plant, productive tillers per plant and single plant yield. Low PCV and GCV estimates were obtained for days to 50% flowering and panicle length. These results are in conformity with those obtained for days to 50% flowering by Sinha *et al*. (2004) and panicle length by Patil *et al*. (2003).

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 62.56 to 99.46 % (Table 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 17.34 to 49.54 and the important characters like productive tillers per plant (49.54), single plant yield (46.87) and grains per panicle (45.74) recorded higher estimates.

Based upon variability and heritability estimates, it could be concluded that improvement by direct selection in rice is possible for traits like productive tillers per plant and grains per panicle. In general, the character that shows high heritability with high genetic advance are controlled by additive gene action (Panse and Sukatme, 1957) and can be improved through simple or progeny selection methods. 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. In the present investigation, high heritability along with high genetic advance was noticed for all the traits except panicle length and days to 50% flowering, which had moderate magnitude of genetic advance. 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 (Samadia, 2005).

In the present study, eleven superior genotypes, *viz.*, IC114085, IC114126, IC114341, IC114612, IC114847, IC115114, IC115208, IC5738, IC5743, IC115757 and IC115909 were found to be potential enough to be used as parents in heterosis breeding. These genotypes recorded highest values for one or the other yield contributing

Table 2. Range, mean, genotypic and phenotypic variance components, coefficient of variability, heritability and genetic advance for different traits in rice germplasm

S. No.	Character	Range	Mean	Variance components		Coefficient of variability		Heritability (%)	Genetic advance	Genetic advance as per cent of mean
				Genotypic	Phenotypic	Genotypic	Phenotypic			
1.	Days to 50% flowering	69.0-113.0	89.83	68.37	69.39	9.20	9.27	98.52	16.91	18.82
2.	Plant height (cm)	78.33-155.43	115.70	188.93	190.74	11.88	11.94	99.05	28.18	24.35
3.	Leaf length (cm)	26.02-50.35	38.86	28.43	31.01	13.72	14.33	91.66	10.52	27.05
4.	Leaf width (cm)	0.68-1.45	1.15	0.02	0.03	12.52	15.83	62.56	0.23	20.40
5.	Total tillers per plant	7.30-20.21	13.14	7.02	8.91	20.17	22.73	78.72	4.84	36.85
6.	Productive tillers per plant	3.23-13.36	6.86	3.54	4.61	27.44	31.31	76.82	3.40	49.54
7.	Panicle length (cm)	17.13-28.87	23.17	4.67	5.72	9.32	10.33	81.54	4.02	17.34
8.	Grains per panicle	73.81-297.23	151.88	1144.37	1151.51	22.27	22.34	99.38	69.47	45.74
9.	Spikelet fertility (%)	52.39-97.35	86.18	109.76	110.35	12.16	12.19	99.46	21.52	24.97
10.	100-grain weight (g)	1.42-3.60	2.46	0.13	0.15	14.66	15.70	87.21	0.69	28.20
11.	Single plant yield (g)	6.19-26.17	17.37	16.58	17.60	23.44	24.15	94.21	8.14	46.87

characters and hence their utilization in combination breeding may help in generating high yielding varieties/ hybrids by pyramiding all the favourable genes.

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