

Variability, Heritability and Genetic Advance for Agro-Morphological and Grain Quality Parameters in Landraces of Rice (*Oryza sativa* L.)

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Abstract The landraces maintained by farmers are endowed with wide genetic variability, which provides tremendous scope for further genetic improvement of the rice crop. Therefore, the present investigation was carried out to assess the variability, heritability and genetic advance in seventy landraces of rice for sixteen agro-morphological and grain quality parameters. The analysis of variance revealed the presence of significant variability among the landraces of rice under study. Variability studies indicated that the estimates of phenotypic coefficient of variation were slightly higher than genotypic coefficient of variation for all the traits, indicating

less influence of environment. Among all the characters under study, total number of grains per panicle exhibited highest PCV (35.94) and GCV (35.85), whereas lowest PCV (4.59) and GCV (4.28) were recorded for spikelet fertility. All the characters under study except spikelet fertility and panicle length exhibited high heritability coupled with high genetic advance as a per cent of mean, which indicated the preponderance of additive gene action in controlling these traits. Hence direct selection of these characters would be effective in improving the seed yield. Emphasis should be given on these characters, while selection is made to improve yield potential, quality and nutritional status of crop, to develop the hidden hunger free world.

Keywords Genetic advance, Heritability, Landraces, Rice and Variability.

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Introduction

Among cereals, rice is undoubtedly the most important cereal of the world, which is the staple food for more than half of the world's population. It has shaped the cultures, diets and economies of billions of people living in Asia where it has a long history of

cultivation and is deeply ingrained in the daily lives of Asian people. Landraces of rice harbor a great deal of useful traits and played a very important role in the local food security and sustainable development of agriculture, in addition to their significance as genetic resource for the improvement of rice cultivars.

The success of plant breeding depends on the extent of genetic variability present in a crop. Knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential for genetic improvement. A critical analysis of genetic variability present in the germplasm of a crop and its estimation is a pre-requisite for initiating any crop improvement program as well as adopting appropriate selection techniques.

Partitioning of observed variability into heritable and non-heritable components is very much essential to get a true indication of the genetic coefficient of variability as a useful measure of the magnitude of genetic variance present in the population. It is very difficult to judge whether observed variability is heritable or not. Heritability indicates the extent of transmissibility of a character into future generations. Moreover, knowledge of heritability is also essential for selection of component traits for yield improvement.

Again the heritable portion of the total variation might not be always due to additive gene action. Thus estimates of heritability alone will not give a clear indication of the associating genetic progress that would result from selecting the best plants. It is also essential to find out the relative magnitude of additive and non-additive genetic variances with regard to the characters of concern. Therefore it should be combined with information on genetic advance. Thus a character possessing high heritability along with high genetic advance will be valuable in the selection program. Keeping in view the importance of aforesaid aspects, the present investigation was undertaken to study the genetic variability, heritability and genetic advance among the landraces of rice for agro-morphological and grain quality parameters.

Materials and Methods

The field experiment was conducted during *kharif* 2013 at Directorate of Rice Research Farm, ICRISAT campus, Patancheru, Hyderabad, India, situated at 17.53° N latitude, 78.27° E longitude and altitude of 545 m above mean sea level. Seventy landraces of rice, collected from various places were sown separately in raised bed nursery. Thirty days old seedlings of each genotype were transplanted in 5 rows of 3 m length by adopting a spacing of 20 cm between rows and 15 cm between plants with in a row in randomized block design replicated thrice. All the necessary precautions were taken to maintain uniform plant population of each genotype per replication. All the recommend package of practices was adopted besides providing necessary prophylactic plant protection measures to raise a good crop.

Data were recorded on a total of sixteen metric characters. Among them seven agro-morphological characters viz., stem length, total number of tillers per plant, number of productive tillers per plant panicle length, total number of grains per panicle, spikelet fertility and single plant yield were recorded on five randomly selected plants in each plot. Time of heading (50% plants with heads) was recorded on plot basis. 100-grain weight was recorded per replication in each genotype. Grain quality and nutritional traits including decorticated grain length, width, L/B ratio, amylose content, gel consistency, grain iron concentration and grain zinc concentration (EDXRF, model-X-supreme 8000) were also recorded as per the standard procedures. The data collected on all the characters were subjected to standard methods of analysis of variance, phenotypic and genotypic coefficient of variation, heritability (broad sense), genetic advance and genetic advance as a percent of mean.

Results and Discussion

Genetic variability

The analysis of variance revealed the existence of significant differences among the genotypes for all the traits (Table 1), indicating the presence of considerable genetic variability among the experimen-

Table 1. ANOVA for agro-morphological and grain quality parameters in different landraces of rice. ** Significant at 1 percent level of significance. * Significant at 5 % level of significance.

Sl. No.	Character	Replications (df=2)	Mean sum of squares	
			Treatments (df=69)	Error (df=138)
1.	Time of heading (50% of plants with panicles)	0.171	374.34**	1.862
2.	Stem length (excluding panicle) (cm)	1.459	590.82**	3.735
3.	Total number of tillers per plant	0.067	14.43**	0.869
4.	Number of productive tillers per plant	0.457	13.96**	0.797
5.	Panicle length (cm)	1.672	19.86**	1.075
6.	Total number of grains per panicle	12.078	11789.45**	19.349
7.	Spikelet fertility (%)	0.641	47.89**	2.268
8.	Single plant yield (g)	0.385	93.63**	2.108
9.	100-grain weight (g)	0.007	0.77**	0.003
10.	Decorticated grain length (mm)	0.004	1.37**	0.004
11.	Decorticated grain width (mm)	0.0002	0.08**	0.001
12.	Decorticated grain : L/B ratio	0.001	1.06**	0.011
13.	Amylose content (%)	0.674	76.89**	0.435
14.	Gel consistency (mm)	5.233	629.62**	5.040
15.	Grain iron concentration (mg/kg)	0.381	7.54**	0.547
16.	Grain zinc concentration (mg/kg)	0.945	34.84**	1.033

tal material under study. Thus there is ample scope for improvement of different quantitative and qualitative traits through selection. The mean values, genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic advance as per cent of mean (Table 2) of seventy landraces were calculated for yield and its contributing traits and grain quality parameters.

For all the characters under study, phenotypic coefficient of variation values are slightly higher than the genotypic coefficient of variation values indicating that the characters were less influenced by the environment. Therefore, response to direct selection may be effective in improving these traits.

The characters studied in the present investigation exhibited low (less than 10%), moderate (10-20 %) and high (more than 20 %) phenotypic and genotypic coefficients of variation. High phenotypic and genotypic coefficients variations were observed for six traits namely total number of grains per panicle (35.94/35.85), gel consistency (35.63/35.21), single plant yield (24.07/23.28), 100- grain weight (22.30/22.16), number of productive tillers

per plant (21.88/20.13) and amylose content (20.61/20.44). These results are in confirmity with the findings Padmaja et al. [1] and Vanisree et al. [2] for number of productive tillers per plant and single plant yield, Basavaraja et al. [3] for number of grains per panicle and amylose content Parikh et al. [4] for 100-grain weight and Dhanwani et al. [5] and Shejul et al. [6] for gel consistency. The estimates of phenotypic (4.59) and genotypic (4.28) coefficients of variation were found to be low for spikelet fertility. These findings are in accordance with those of Saidaiah et al. [7] and Pandey et al. [8].

Phenotypic and genotypic coefficients of variation were moderate for total number of tillers per plant (19.92/18.24), grain zinc concentration (18.33/17.54), grain iron concentration (17.54/15.78), L/B ratio (16.23/15.99), stem length (15.10/14.96), decorticated grain length (12.24/12.19), time of heading (11.94/11.85), panicle length (11.29/10.43) and decorticated grain width (10.93/10.69). These results are in trend with the findings of Bekele et al. [9] for time of heading and decorticated grain length Parray and Shikari [10] and Dhanwani et al. [5] for total number of tillers per plant and panicle length and Veerabathiran et al. [11] for decorticated grain width and L/B ratio.

Table 2. Estimation of variability, heritability and genetic advance for agro-morphological characters and grain quality parameters in landraces of rice. Min-Minimum, Max-Maximum, PCV-Phenotypic Coefficient of variation; GCV-Genotypic coefficient of variation; GA-Genetic advance.

Sl. No.	Character	Mean	Range		Pheno- typic variance	Geno- typic variance	PCV (%)	GCV (%)	Heritability in broad sense (h ²)		GA as percent of mean
			Min	Max					GA	GA	
1.	Time of heading (50% of plants with panicles)	93.77	70.00	120.00	125.36	123.49	11.94	11.85	98.51	22.72	24.23
2.	Stem length (cm)	93.54	52.65	122.44	199.43	195.69	15.10	14.96	98.13	28.55	30.52
3.	Total no. of tillers per plant	11.66	8.33	19.61	5.39	4.52	19.92	18.24	83.88	4.01	34.41
4.	No. of productive tillers per plant	10.41	6.50	17.68	5.19	4.39	21.88	20.13	84.63	3.97	38.14
5.	Panicle length (cm)	23.99	19.35	34.75	7.34	6.26	11.29	10.43	85.35	4.76	19.85
6.	Total no. of grains per panicle	174.70	75.22	499.33	3942.72	3923.37	35.94	35.85	99.51	128.72	73.68
7.	Spikelet fertility (%)	91.15	79.98	96.58	17.48	15.21	4.59	4.28	87.02	7.49	8.22
8.	Single plant yield (g)	23.73	12.58	36.71	32.62	30.51	24.07	23.28	93.54	11.01	46.38
9.	100-grain weight (g)	2.28	1.02	3.33	0.26	0.26	22.30	22.16	98.81	1.04	45.38
10.	Decorticated grain : length (mm)	5.53	3.41	8.18	0.46	0.46	12.24	12.19	99.11	1.38	25.00
11.	Decorticated grain : width (mm)	1.51	1.13	1.86	0.03	0.03	10.93	10.69	95.64	0.33	21.53
12.	Decorticated grain : L/B ratio	3.70	1.99	6.57	0.36	0.35	16.23	15.99	97.01	1.20	32.44
13.	Amylose content (%)	24.70	6.32	32.72	25.92	25.48	20.61	20.44	98.32	10.31	41.75
14.	Gel consistency (mm)	40.98	22.00	92.33	213.23	208.19	35.63	35.21	97.64	29.37	71.67
15.	Grain iron concentration (mg/kg)	9.67	5.97	12.9	2.88	2.33	17.54	15.78	80.99	2.83	29.26
16.	Grain zinc concentration (mg/kg)	19.14	8.97	25.1	12.30	11.27	18.33	17.54	91.60	6.62	34.59

Heritability and genetic advance

All the characters under investigation expressed high estimates of heritability in broad sense ranging from 80.99 to 99.51%. Among all agronomic characters, highest heritability was recorded for total number of grains per panicle (99.51%) followed by 100-grain weight (98.81%), while decorticated grain length (99.11%) and amylose content (98.32%) among the grain quality parameters exhibited, highest heritability estimates.

High heritability for quantitative characters indicates the scope of genetic improvement of these characters through selection. All quality characters also exhibited high degree of broad-sense heritability, which revealed that these characters are less influenced by environment and there could be greater correspondence between phenotypic and breeding values.

Genetic advance as a per cent of mean is classified as low (less than 10%), moderate (10-20%) and high (more than 20%). Among the metric charac-

ters spikelet fertility exhibited low (8.22%) genetic advance as a per cent of mean, panicle length had moderate (19.85%) genetic advance as a per cent of mean. Remaining all the traits exhibited high estimates of genetic advance as a per cent of mean, among them total number of grains per panicle acquired highest value (73.8%). However all the grain quality parameters exhibited high values of genetic advance as a per cent of mean, among which gel consistency recorded the highest (71.67%) value.

Among all the characters studied, spikelet fertility exhibited high heritability coupled with low genetic advance as a per cent of mean. Similar results were obtained earlier by Madhavi et al. [12]. High heritability coupled with low genetic advance as a per cent of mean indicates that the expression of the trait is under the control of non-additive type of gene action, and its response to selection would be poor. In such case hybridization program is rewarded.

Panicle length expressed high heritability coupled with moderate genetic advance as a per cent

of mean, which is in accordance with the reports of Singh et al. [13] and Sankar et al. [14]. High heritability coupled with moderate genetic advance as per cent of mean, suggested that the expression of this trait was mostly influenced by additive type of gene action. Hence its response to selection would be effective in improving the seed yield.

All the remaining metric characters expressed high heritability coupled with high genetic advance, which indicated the preponderance of additive gene action in controlling the traits. Hence direct selection of such characters would be effective in improving the yield. Similar results were observed by Gangashetty et al. [15] for time of heading, Kumar et al. [16] for plant height, total number of tillers per plant and productive tillers per plant, Singh et al. [17] and Jaiswal et al. [18] for total number of grains per panicle and single plant yield and Padmaja et al. [1] and Parikh et al. [4] for 100-grain weight.

All the quality parameters exhibited high heritability coupled with high genetic advance as a per cent of mean. These results are in accordance with the findings of Amudha and Thiyagarajan [19] for decorticated grain length and width. Veerabhadhiran et al. [11] reported similar results for decorticated grain width and L/B ratio Sankar et al [14] also obtained same results for decorticated grain L/B ratio and for grain iron and zinc concentration Amudha and Thiyagarajan [19] recorded similar results for amylose content and gel consistency.

Conclusion

A perusal of genetic parameters viz., phenotypic and genotypic coefficients of variation revealed less influence of environment on the characters under study. Therefore, response to direct selection may be effective in improving these traits. All the characters under study except spikelet fertility and panicle length exhibited high heritability coupled with high genetic advance as a per cent of mean, which indicated the preponderance of additive gene action in controlling these traits. Hence direct selection of the these characters would be effective in improving the seed yield. Panicle length had high heritability coupled with moderate genetic advance

as per cent of mean suggesting that the expression of this trait was mostly influenced by additive type of gene action. Hence its response to selection would be effective in improving the seed yield. While, spikelet fertility had high heritability coupled with low genetic advance as per cent of mean indicating that the expression of this trait was under the control of non-additive type of gene action, hence its response to selection would be poor.

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