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CONTENTS

Genetic variability studies for yield and its related traits in rice (*Oryza sativa* L.) genotypes

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ABSTRACT: Even though there are abundant rice genetic resources, only a fraction is used in breeding programs leading to a narrow genetic base for improved varieties. In order to develop superior cultivars, each crop breeding programme must have genetic variability. In the present investigation, fifty rice genotypes were used to estimate the genetic variability, heritability, and genetic advance for yield and yield-related traits. The experiment was conducted using RBD with two replications. In the current investigation, analysis of variance revealed significant difference among the 50 rice genotypes studied for various quantitative traits. Phenotypic coefficient of variation ranged from 7.66 to 23.01 %. Highest value obtained for number of effective tillers (23.01%) followed by leaf length (19.77%) and lowest value obtained for panicle length (7.66%). Genotypic coefficient of variation ranged from 3.69 to 19.47%. Highest value obtained for number of effective tillers (19.47%) followed by leaf length (18.27%) and plant height (13.23%). PCV is higher than GCV but there was a small difference between value of GCV and PCV which indicated low impact of environment. Heritability in broad sense ranged from 23.2 to 97.8 %. High heritability obtained for plant height (97.8%) followed by days to maturity (95.7%) and days to 50% flowering (94%) and lowest value was obtained for panicle length (23.2%) followed by yield per plant (30.3%). Genetic advance percentage of mean ranged from 3.66 to 34.80 %. Genetic advance percentage of mean was highest for leaf length (34.802 %) followed by number of effective tillers (33.94%) and plant height (26.96 %). In present investigation, high heritability coupled with high genetic advance obtained for plant height, days to 50% flowering, leaf length and number of effective tillers. This revealed presence of additive genetic variance and hence selection for above mention traits may be effective. Furthermore, genetic materials used in the current investigation exhibited adequate genetic variability which can be utilized in crop improvement programs.

Key words: Genotypes, heritability, genetic advanced, rice, variability

Oryza sativa is a staple meal for more than 50% of the world's population (Priya *et al*., 2019). It's an annual crop belongs to family poaceae and has diploid chromosome number (2n=24). It is cultivated on 167.13 million hectare area of the world and has production of 782.00 million tonnes (FAOSTAT, 2018). In India, it is cultivated on an area of 43.7 million hectare with production 116.4 million tonnes and has productivity 2659 Kg/ha (Annual report 2019-2020, DAC&FW). It can be grown in varied environmental conditions. Evolution of high yielding varieties with other beneficial agronomic characteristics is crucial to fulfill the growing demand for food. Yield is controlled by several components and constitutes a complex trait, thus it is more difficult to achieve genetic improvement in yield. Information about nature and magnitude of variation available in the genetic material is critical for breeding high-yielding cultivars. Presence of genetic variability and selection of useful genotypes are backbone of the breeding programme. Assessment of variability is based on valuable parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance (Hossain *et al.,* 2015). Heritability plays predictive role in determining the contribution of genotype to the phenotype (Bitew, 2016). Broad sense (H^2) or narrow sense (h^2) heritability of a trait is important in determining its response to selection. Heritability estimates the degree of transmissibility of the selected traits to the offspring during the breeding. Genetic advance and heritability share strong relationship. High heritability with high genetic advance is always desirable for selection of a trait (Larik *et al*., 2000). The objective of the present study was to estimate the GCV, PCV, heritability, genetic advance and to quantify the level of variation in a set of rice genotypes which would further help to determine the usefulness of the genetic material

for the crop improvement and selection of the most effective breeding strategies.

MATERIALS AND METHODS

Fifty rice genotypes which include advanced basmati breeding lines, basmati, scented and non basmati varieties were used in the present investigation to study variability parameters. Field experiment was conducted at the Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar during *Kharif* 2017. Field was laid in RBD with two replications. Twenty-one days old seedlings of each genotype were transplanted at a spacing of 20cm x 15 cm. Each plot consisted of three rows of 2.0 m length. Field was fertilized with N, P and K fertilizers at the rate 90, 60 and 60 kg/ha. Data on various quantitative traits was recorded from 10 randomly selected plants of each genotype in each replication *viz.*, plant height at maturity (cm), days to 50 per cent flowering, days to maturity, number of effective tillers per plant at maturity, leaf length (cm), leaf breadth (cm), panicle length (cm), thousand grain weight (g) and grain yield per plant (g). The data were analyzed as per the design to test the significance of difference among the genotypes for various characters. IBM SPSS Statistics 20.0 software for Windows was used for the data analysis.

RESULTS AND DISCUSSION

Presence of variability is the first and foremost requirement for initiating breeding programme. Hence, understanding the nature and distribution of genetic variability is the key to the success of crop improvement programme. Present investigation has been carried out to determine the variation among 50 rice genotypes for various quantitative traits. Analysis of variance revealed significant difference among the 50 genotypes used in the study (Table 1). This indicated the existence of ample amount of variability among the rice genotypes for the traits studied. Golam *et al*. (2011), Rahman *et al*. (2011) and Sohrabi *et al.* (2012) also reported high genetic variability in rice genotypes.

Mean performance of 50 genotypes of rice for nine quantitative traits has been provided in Table 2. Plant height ranged from 74.05 to 164.4 cm with general mean 117.23 cm. Highest value of plant height was exhibited by Basmati 370 (164.4cm) and lowest for TN1 (74.05cm). Value of days to 50% flowering ranged 70 to 108 days with mean value of 86 days. Highest value (108 days) was indicated by Taraori Basmati followed by Basmati 370 (107 days). Lowest value was revealed by UPR 4250-8-1-1-2 (70 days). Value of days to maturity ranged from 106.00 to 154.00 days with mean value 127.0. Highest value was exhibited by Basmati 370 (154 days) followed by Taraori Basmati (149 days). Lowest value exhibited by PTB 33 (106 days) followed by Suraksha (109) and UPR 4250-8-1-1-2 (111). Number of effective tillers ranged from 5 to15 with average of 10 tillers per plant. Highest value was shown by Pant Sugandh Dhan 25(15) followed by Pusa Basmati 1121(14) and lowest value shown by UPR 4222-7-1-1-2 (5). Flag leaf length ranged from 22.20 to 47.90cm with average of 34.85 cm per plant. Highest value obtained for Basmati 370 (47.9 cm) and lowest for UPR 4228-6-1-1-1 (22.02cm). Flag leaf breadth ranged from 1.15 to 1.95 cm with mean 1.50 cm. Highest value indicated by Pusa Sugandh 3 (1.95 cm) followed by UPR 4218-15-1-1-2 (1.85 cm). Lowest value exhibited by UPR 4222-7-1-1-1 (1.1 cm). Panicle length value ranged from 23.9 to

Table 1: Analysis of variance for yield and its component traits for basmati, scented and non basmati varieties of rice

SV	df	Plant height	Days to 50% flowering	Days to maturity	Number of effective tillers	Leaf length	Leaf width	Panicle length	Test weight	Grain yield per plant
Replicate	1	7.44	75.69	1.03	6.76	71.18	0.0064	8.41	1.09	23.13
Treatments	49	507.21**	167.28**	241.71**	12.30**	94.96**	0.0701**	9.14**	15.05**	15.39**
Error	49	11.06	10.09	10.43	3.49	13.82	0.0259	7.02	7.48	10.73

**Significant at 1% level

Table 2: Mean performance of 50 rice genotypes for nine quantitative traits

S. No.	*Genotypes*	*Plant height*	*Days to 50% flowering*	*Days to maturity*	*Number of effective tillers*	*Leaf length*	*Leaf width*	*Panicle length*	*Test weight*	*Grain yield/ plant*
1	*Taraor*i Basmati	152.25	108.00	149.50	8.00	36.60	1.65	24.66	23.75	25.50
2	Pant Basmati 1	109.81	98.00	132.50	13.00	36.60	1.50	27.00	23.63	22.70
3	Pant Basmati 2	124.65	81.00	138.50	11.50	26.50	1.15	26.00	25.00	21.35
4	UPR 4217-15-1-1-1	120.91	87.50	126.50	14.00	24.30	1.30	27.25	20.15	22.05
5	UPR 4217-15-1-1-2	114.40	92.00	131.50	12.00	23.95	1.35	23.90	23.95	22.20
6	UPR 4217-15-1-1-3	129.48	84.50	120.00	11.50	30.90	1.45	32.65	25.70	23.70
7	UPR 4218-15-1-1-1	105.10	76.00	113.50	14.00	37.20	1.30	28.35	22.05	20.60
8	UPR 4218-15-1-1-2	116.75	92.50	131.50	12.50	32.90	1.85	29.25	28.00	23.75
9	UPR 4218-15-1-1-3	117.19	76.00	119.50	8.50	45.50	1.25	30.85	24.85	25.70
10	UPR 4221-2-1-1-1	105.43	80.00	127.00	7.50	44.15	1.50	28.25	21.85	18.60
11	UPR 4222-7-1-1-1	103.15	83.00	125.50	8.00	26.95	1.15	26.60	28.05	23.85
12	UPR 4222-7-1-1-2	110.00	85.50	122.50	5.50	42.90	1.55	24.75	25.30	24.70
13	UPR 4222-7-1-1-3	119.20	81.00	123.00	14.50	22.90	1.70	28.90	21.35	17.75
14	UPR 4228-6-1-1-1	111.93	83.00	124.50	13.50	22.20	1.40	25.30	26.10	18.25
15	UPR 4246-9-1-1-1	112.90	84.50	116.00	9.50	29.95	1.40	28.30	27.65	20.85
16	UPR 4246-9-1-1-2	110.15	81.00	114.50	7.50	36.80	1.50	24.90	21.55	19.50
17	UPR 4246-9-1-1-3	107.95	72.50	113.00	9.50	28.10	1.60	28.70	20.80	29.95
18	UPR 4250-8-1-1-1	122.34	77.50	114.00	9.00	25.55	1.50	27.60	28.80	20.50
19	UPR 4250-8-1-1-2	115.10	70.50	111.50	11.00	27.85	1.80	28.80	20.70	24.10
20	UPR 4250-8-1-1-3	107.51	86.00	124.50	10.00	29.20	1.85	29.35	29.45	25.80
21	UPR 4257-8-1-1-1	135.00	84.50	123.50	7.00	38.10	1.25	29.15	28.00	19.10
22	UPR 4257-8-1-1-2	134.03	78.00	119.00	10.00	47.20	1.35	31.05	28.75	19.35
23	UPR 4257-8-1-1-3	117.85	79.50	118.00	13.00	40.00	1.35	30.00	27.30	21.20
24	UPR 4259-2-1-1-1	117.20	94.00	130.50	6.50	42.95	1.40	24.25	23.60	16.80
25	UPR 4259-2-1-1-2	118.25	90.50	129.50	13.50	23.90	1.65	29.35	16.40	21.05
26	UPR 4259-2-1-1-3	131.75	83.00	119.50	9.50	44.90	1.25	31.20	28.35	21.20
27	UPR 4259-9-1-1-1	118.75	86.50	128.00	8.00	39.60	1.35	26.00	25.10	24.95
28	UPR 4259-9-1-1-2	124.25	78.00	118.00	8.50	36.95	1.45	28.65	27.50	23.45
29	Pusa Basmati 1	90.24	94.00	134.50	12.50	31.68	1.60	27.50	22.70	21.00
30	Improved Pusa Basmati 1	95.23	103.50	133.50	13.50	33.20	1.35	28.20	25.78	24.63
31	Type 3	155.25	90.50	128.50	9.50	42.20	1.70	28.45	22.83	25.70
32	Basmati 386	159.16	103.00	149.43	11.50	36.55	1.35	24.40	21.90	24.00
33	Pusa sugandh 5	107.63	91.00	127.00	13.00	37.90	1.30	28.40	22.03	23.60
34	Pusa sugandh 3	104.63	86.50	124.50	12.50	36.00	1.95	30.75	26.95	23.25
35	Pant sugandh Dhan 15	115.87	84.50	138.50	9.50	27.00	1.55	28.65	23.65	25.90
36	Pant sugandh Dhan 17	113.50	95.00	135.50	11.00	43.30	1.50	28.05	25.00	24.10
37	Pant sugandh Dhan 21	112.35	93.50	135.50	13.50	36.95	1.55	30.40	23.81	18.50
38	Pant sugandh Dhan 25	117.73	96.50	128.00	15.50	27.65	1.65	26.15	23.85	24.75
39	Haryan Basmati 1	112.45	96.50	141.00	9.50	32.95	1.55	28.55	22.67	21.60
40	Punjab basmati 1	123.20	98.00	147.00	12.50	31.40	1.75	30.95	22.00	23.06
41	Punjab basmati 2	127.42	92.00	138.50	14.00	37.87	1.50	26.65	22.63	22.10
42	Pusa sugandh Dhan 2	101.05	84.00	127.50	10.50	39.45	1.20	29.30	25.03	22.40
43	BASMATI 385	136.29	94.00	140.00	9.50	37.75	1.60	24.95	25.07	24.15
44	Basmati 370	164.40	105.00	154.00	10.50	47.90	1.80	26.35	22.64	20.55
45	Pusa basmati 1121	111.70	99.50	137.00	14.50	32.50	1.45	26.75	29.25	27.25
46	RP 2068	113.80	74.00	114.50	8.50	28.45	1.50	25.83	25.09	19.40
47	PTB 33	100.95	74.00	106.00	10.50	39.15	1.65	24.85	24.29	24.20
48	MO 1	107.50	77.50	117.00	14.00	40.50	1.45	28.40	24.69	23.85
49	Suraksha	104.00	80.00	109.00	9.00	38.73	1.50	31.01	24.49	24.33
50	TN 1	74.05	77.00	120.50	7.50	38.85	1.55	28.56	21.57	16.85
	Mean	**117.23**	**86.87**	**127.04**	**10.78**	**34.85**	**1.50**	**27.88**	**24.43**	**22.23**
	Max	164.40	108.00	154.00	15.50	47.90	1.95	32.65	29.45	29.95
	Min	74.05	70.50	106.00	5.50	22.20	1.15	23.90	16.40	16.80
	C.V	2.79	3.65	2.54	17.34	10.67	10.77	9.50	11.19	14.57
	S.E	2.35	2.34	2.28	1.32	2.62	.11	1.87	1.93	2.31
	C.D%	6.68	6.38	6.49	3.75	7.47	0.32	5.3	5.49	4.6

Table 3: Estimates of variability parameters of 50 rice genotypes for 9 quantitative traits

Characters	GCV (%)	PCV (%)	h^2 (Broad Sense) (%)	Gen. Adv as % of Mean
Plant height	13.23	13.38	97.8	26.96
Days to 50% flowering	10.2	10.52	94	20.37
Days to maturity	8.46	8.65	95.7	17.05
Number of effective tillers	19.47	23.01	71.6	33.94
Leaf length	18.27	19.77	85.4	34.8
Leaf width	9.935	12.52	63	16.23
Panicle length	3.69	7.66	23.2	3.66
Test weight	7.96	11.22	50.3	11.63
Grain yield	6.79	12.34	30.3	7.7

32.65 cm with average of 27.88 cmper plant. Highest value exhibited by UPR 4217-15-1-1-3 (32.65cm) followed by UPR 4259-2-1-1-3 (31.2cm) and UPR 4257-8-1-1-2 (31.05cm). Test weight ranged from 16.40 to 29.45 g with average of 24.43 g per plant. Highest value exhibited by UPR 4250-8-1-1-3(29.45g) followed by Pusa Basmati 1121(29.25g) and UPR 4250-8-1-1-1(28.80 g). Lowest value revealed by UPR 4259-2-1-1-2 (16.4g). For yield, mean value ranged from 16.80 to 29.95 g with average of 22.47g yield per plant. Highest value of yield was exhibited by UPR 4246-9-1-1-3(29.95g) followed by Pusa Basmati 1121(27.25g) and Pant Sugandh Dhan 15(25.9g). Lowest value revealed by UPR 4259-2-1-1-2 (21.05 g). Quantitative characters such as plant height, days to 50% flowering, number of effective tillers, panicle length, test weight etc. plays important role in selection programme for development of a variety. Generally semi dwarf varieties are preferred as they escape lodging. Genotypes early in days to 50 % flowering will also exhibit early days to maturity. Early maturing varieties avoid risk of abiotic and biotic factors. Number of effective tiller and leaf architecture is positively associated with yield. Variety with more panicle length bears more number of grains and hence may results in good crop yield. Test weight plays important role in determining yield of the crop. Physical quality of grain is indicated by test weight. High test weight varieties can be used in crop improvement programme as a selection criterion.

Environment affects mainly quantitative characters of plants. This exhibits heritable and non-heritable variation, which can be calculated by the parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance. In the present investigation, phenotypic coefficient of variation ranged from 7.66 to 23.01 %. Highest value obtained for number effective of tillers (23.01%) followed by leaf length (19.77%) and lowest value obtained for panicle length (7.66%) (Table 3). Genotypic coefficient of variation ranged from 3.69 to19.47%. Highest value obtained for number of effective tillers (19.47%) followed by leaf length (18.27%) and plant height (13.23%). Lowest value obtained for panicle length (3.69%). From the above results, it was found that that PCV is higher than GCV for all the traits. There was a small difference between value of GCV and PCV. This showed that there was a little influence of environment on the traits studied in the current investigation. Selvaraj *et al*. (2011) and Bhadru *et al*. (2012) also reported similar results in their studies. Higher estimates of variability for number of effective tillers were reported by Bastia *et al*. (2008), Sabesan *et al.* (2009) and Selvaraj *et al*. (2011).

The value of heritability plays predictive role in expressing the reliability of phenotypic value. In the present study, the magnitude of heritability was categorized according to the Johnson *et al.*(1995) as low (0-30%), medium (30-60%) and high (above 60%). Heritability in a broad sense ranged from 23.2 to 97.8 %. High heritability obtained for plant height (97.8%) followed by days to maturity (95.7%) and days to 50% flowering (94%) and lowest heritability was obtained for panicle length (23.2%) followed by yield per plant (30.3%). Genetic advance as per cent of mean was grouped according to the Johnson *et al.* (1995) as low (less than 10 %) moderate (10-20 %) and high (more than 20 %). Genetic advance

percentage of mean ranged from 3.66 to 34.80. Genetic advance percentage of mean was highest for leaf length (34.802 %) followed by number of effective tillers (33.94%) and plant height (26.96 %). Lowest value obtained for panicle length (3.36%) (Table 3). High heritability explains less influence of the environment and effective selection of the plants. In present investigation, high heritability coupled with high genetic advance obtained for plant height, days to 50% flowering, leaf length and number of effective tillers. Similar results were obtained by Ajmera *et al*. (2017), Edukondalu *et al.* (2017) and Saha *et al.* (2019). The pattern of PCV, GCV, heritability and genetic advance obtained for various traits in the present study revealed presence of additive genetic variance. Hence, it is suggested that selection based on the above mentioned traits may be effective in the crop improvement programme.

CONCLUSION

The present study was aimed to determine the genetic variation among the 50 rice genotypes for various quantitative traits. Our result confirmed that 50 rice genotypes differ significantly for various quantitative traits studied. From the present investigation, it is clear that various traits such as plant height, days to 50% flowering, leaf length and number of effective tillers exhibited high values for PCV, GCV, heritability and genetic advance. Therefore, results of the present investigation indicated usefulness of these traits for selection in crop improvement programme.

REFERENCES

Ajmera, S., Kumar, S. S., and Ravindrababu, V. (2017). Evaluation of genetic variability, heritability and genetic advance for yield and yield components in rice genotypes. *International Journal of Current Microbiology and Applied Sciences*, 6(10): 1657-1664.

Annual Report 2019-20.Department of Agriculture, Cooperation and Farmers welfare. Government of India.

Bastia, D. K., Garnayak, L. M., and Barik, T. (2008). Diversification of rice (*Oryza sativa*) based cropping systems for higher productivity, resource-use efficiency and economics. *Indian Journal of Agronomy*, 53(1):22-26.

Bhadru, D., Rao, V. T., Mohan, Y. C., and Bharathi, D. (2012). Genetic variability and diversity studies in yield and its component traits in rice (*Oryza sativa* L.). *SABRAO Journal of Breeding and Genetics*, 44(1)129-137.

Bitew, J. M. (2016). Estimation of genetic parameters, heritability and genetic advance for yield related traits in upland rice (*Oryza sativa* L. and *Oryza glaberrima* Steud) genotypes in northwestern Ethiopia. *World Scientific News*, 47(2): 340-350.

Edukondalu, B., Reddy, R.V., Rani, S.T., Kumari, A.C. and Soundharya, B. (2017). Studies on variability, heritability, correlation and path analysis for yield and yield attributes in Rice (*Oryza sativa* L.). *International Journal of Current Microbiology and Applied Sciences*, 6(10): 2369-2376.

FAOSTAT, 2018. http://faostat.fao.org

Golam, F., Yin, Y. H., Masitah, A., Afnierna, N., Majid, N. A., Khalid, N., and Osman, M. 2011. Analysis of aroma and yield components of aromatic rice in Malaysian tropical environment. *Australian Journal of Crop Science*, 5(11): 1318-1325.

Hossain, S., Haque, M., and Rahman, J. (2015). Genetic variability, correlation and path coefficient analysis of morphological traits in some extinct local Aman rice (*Oryza sativa* L). *Rice Research: Open Access*.

Johnson, H.W., Robinson, H.F. and Comstock, R.E.(1955). Estimates of genetic and environmental variability in soybean. *Agronomy Journal*, 47 (7): 314-318.

Larik, A.S., Malik, S.I., Kakar, A.A. and Naz, M.A. (2000). Assessment of heritability and genetic advance for yield and yield components in *Gossypium hirsutum* L. *Scientific Khyber*, 13: 39-44.

Priya, T. R., Nelson, A. R. L. E., Ravichandran, K. and Antony, U. (2019).Nutritional and

functional properties of colored rice varieties of South India: a review. *Journal of Ethnic Foods*, 6(1):1-11.

Rahman, M. A. and Hasegawa, H. (2011). High levels of inorganic arsenic in rice in areas where arsenic-contaminated water is used for irrigation and cooking. *Science of the Total Environment*, 409(22): 4645-4655.

Sabesan, T., Suresh, R. and Saravanan, K. (2009). Genetic variability and correlation for yield and grain quality characters of rice grown in coastal saline lowland of Tamil Nadu. *Electronic Journal of Plant Breeding*, 1: 56-59.

Saha, S. R., Hassan, L., Haque, M. A., Islam, M. M. and Rasel, M. (2019). Genetic variability, heritability, correlation and path analyses of yield components in traditional rice (*Oryza sativa* L.) landraces. *Journal of the Bangladesh Agricultural University*, 17(1): 26-32.

Selvaraj, I. C., Pothiraj, N., Thiyagarajan, K., Bharathi, M. and Rabindran, R. (2011). Genetic parameters of variability, correlation and path coefficient studies for grain yield and other yield attributes among rice blast disease resistant genotypes of rice (*Oryza sativa* L.). *African Journal of Biotechnology*, 10 (17): 322 - 334.

Sohrabi, M., Rafii, M.Y., Hanafi, M.M., Siti, Akmar, A. and Latif, M.A. (2012). Genetic diversity of upland rice germplasm in Malaysia based on quantitative traits. *The Scientific World Journal,* 416291.

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