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Estimation of genetic variability, heritability and genetic advance for yield and quality traits in some indigenous Basmati rice (*Oryza sativa* L) genotypes

UMESH, HK JAISWAL, T SRAVAN, SHOWKAT A WAZA and RAHUL BHARDWAJ*

Department of Genetics and Plant Breeding, Institute of Agricultural Sciences Banaras Hindu University, Varanasi 221005 Uttar Pradesh, India
***Department of Plant Breeding and Genetics, Rajasthan Agricultural Research Institute (SKNAU), Durgapura 302018 Rajasthan, India**
Email for correspondence: umesh7155@gmail.com

ABSTRACT

The present investigation was carried out on 24 rice genotypes to study different genetic parameters viz range, coefficient of variation (CV), heritability and genetic advance for yield attributing and quality characters. The data indicated the existence of genetic variability for all the traits varying from lower to higher coefficients of variance. The genotypic coefficient of variation (GCV) for characters like spikelets/panicle and alkali spread value were 28.23 and 21.77 respectively whereas phenotypic coefficient of variation (PCV) values for these characters were 28.68 and 21.83 respectively. Small differences between GCV and PCV were recorded for all the characters. Amylose content (0.66) recorded lesser influence with environment and highest was recorded with flag leaf width (12.33) in agronomic traits. Thus it can be concluded that the quality characters are less influenced than the agronomic traits by environmental factors. The heritability values for various yield and quality traits ranged from 27.61 (spikelet fertility) to 99.43 per cent (alkali spread value). The genetic advance values ranged from 0.19 (kernel breadth) to 70.33 (spikelets/panicle) for different yield and quality traits.

Keywords: Range; genetic advance; variability; heritability; rice

INTRODUCTION

Rice belongs to genus *Oryza* (2n= 24) of family Poaceae. The genus *Oryza* includes 10 genomic types (AA, BB, CC, BBCC, CCDD, EE, FF, GG, HHJJ and HHKK) of which 22 are wild and only two namely *Oryza sativa* and *O glaberrima* are cultivated (Watanabe 1997). *O sativa* consists of 2 major varietal groups of indicia (Hsein) and japonica (Kang) that have been recognized in China since ancient times. Subsequent studies using SSRs and SNPs distinguished five genetically defined groups that roughly corresponded to the isozyme groups identified by Glaszmann (1987): indicia, aus, temperate japonica, tropical japonica and aromatic. Basmati rice has been cultivated at the foot of the Himalayan mountain ranges in India for thousands of years. Even archeological excavations at Ahar village near Udaipur railway station revealed remains (2000 BC-1600 BC) of long grained rice considered as possible ancestor of Basmati (Randhawa 1980). Rice is the most important staple food in Asia. More than 90 per cent of the world's rice is grown and consumed in Asia where 60 per cent of the world's population lives. Rice accounts for between 35-60 per cent of the caloric intake of three billion Asians (Guyer et al 1998). Yield improvement has been achieved in rice with the development of high yielding heterotic hybrids under commercial cultivation. However being the staple food of the population in India, improving its productivity has become of crucial importance (Subbaiah et al 2011). Basmati rice is a special type of aromatic rice known world over for its extra long grains and pleasant and distinct popcorn like aroma. Component 2-acetyle-l-pyrroline has been reported as an important flavor component of several aromatic varieties (Dhulappanavar et al 1975). Traditional Basmati rice is not only in demand in the domestic markets but is also seen in the menu of connoisseurs worldwide creating a billion-dollar export market. A paradigm shift in the rice breeding strategies from quantity centered approach to quality oriented effort was inevitable since India has not only become self-sufficient in food grain production but also is the second largest exporter of quality rice in the world (Sreedhar et al 2005). Breaking of yield barriers in cereal crops including rice has become hard task to breeders. Plateauing of rice yield coupled with shrinking natural resources mainly land and water has caused major challenges to breeders for increasing rice production by at least 3 MT each year to maintain self-sufficiency in rice production (Siddiq et al 1997). Therefore efforts to enhance rice productivity with keeping grain quality must receive top priority. Increasing rice production can be achieved by application of improved agronomic techniques and developing and adopting high yielding varieties (Thakare et al 2013). Selection is also effective when there is genetic variability among the individuals in a population. Hence insight into the magnitude of genetic variability present in a population is of paramount importance to a plant breeder for starting a judicious breeding programme (Vivek et al 2005). Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are helpful tools in detecting the amount of variability present in the germplasm. Knowledge of heritability and genetic advance of the character indicate the scope for the improvement through selection. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection.

MATERIAL and METHODS

A field experiment was conducted during Kharif 2013 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, UP. The seed material for the present investigation consisted of twenty four genotypes of rice and details are furnished in Table 1. The experiment was laid in randomized block design with three replications. Each replication consisted of twenty four genotypes randomized and replicated within each block. Twenty seven days old seedlings were transplanted 20 cm apart between rows and 15 cm within the rows. All the recommended packages of practices were followed along with necessary prophylactic plant protection measures to raise a good crop. Five representative plants in each replication were randomly selected to record observations on the quantitative characters under study. Observations were recorded on eleven yield attributes viz days to 50 per cent flowering, days to maturity, plant height (cm), flag leaf length (cm), flag leaf width (mm), main panicle length (cm), effective tiller per plant (number), spikelets per panicle (number), filled grains per panicle (number), spikelet fertility (%), 100-seed weight (g) and yield per plant (g) of five randomly selected plants in each entry under each replication. Observations were also recorded to study grain quality characters viz kernel length (mm), kernel breadth (mm), kernel length after cooking (mm), alkali spread value and amylose content. The data were compiled by taking mean value over randomly selected plants from all the replications and subjected to the statistical analysis such as analysis of variance (Panse and Sukhatme 1961), genotypic and phenotypic coefficient of variation (Burton 1952) and heritability (Lush 1940) and genetic advance as per cent of mean (Johnson et al 1955).

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 results of analysis of variance of the present investigation are presented in Table 2 and 3. A wide range of phenotypic coefficient of variation (PCV) was observed for traits ranging (Table 4) from 3.48 per cent (spikelet fertility) to 28.68 per cent (spikelets/panicle) among yield traits. For quality traits PCV ranged from 5.64 per cent (amylose content) to 21.83 per cent (alkali spread value). Genotypic coefficient of variation (GCV) had the range of 1.83 per cent (spikelet fertility) to 28.23 per cent (spikelets/panicle) among yield traits and 5.50 per cent (gelatinization temperature) to 21.77 per cent (alkali spread value)

Table 1. List of Basmati varieties under study

Variety	Parentage	Origin
Taroari Basmati	Pure line selection from local Basmati	Haryana
Basmati-370	Pure line selection from local agro commercial group	Punjab
Kasturi Basmati	Basmati 370/CR 88-17-1-5	DRR, Hyderabad
Sanowal Basmati	-	Jammu & Kashmir
Type-3	Selection from Dehradooni Basmati	Uttar Pradesh
Ranbir Basmati	Selection from Bas 370-90-95	Jammu & Kashmir
PB2517-2-51-1	-	IARI, New Delhi
Pusa Basmati-1	Pusa 167/Kernal local	IARI, New Delhi
HUBR 10-9	-	BHU
HPB-1S-97	Selection from Pusa Basmati-1	BHU
Pusa-44	IARI 5901-2/IR-8	IARI, New Delhi
Pusa Sugandh-3	-	IARI, New Delhi
Pusa Sugandh-5	Pusa 3A/Haryana Basmati	IARI, New Delhi
HUBR 2-1	HBR 92/Pusa Basmati-1/Kasturi	BHU
Vasumati	-	-
Mugadh Sugandh	-	-
Pusa Sugandh-2	-	-
Pusa 1460	Improved Pusa Basmati-1	IARI, New Delhi
Majhera Db-1	-	Uttrakhand
Majhera Db-2	-	Uttrakhand
Majhera Db-3	-	Uttrakhand
PRH-10	-	IARI, New Delhi
Mahi Sugandha	BK 79/Basmati 370	Rajasthan
Yamani	Selection from Taroari Basmati	-

among quality traits. The difference between PCV and GCV suggests that these characters are under major influence of genetic control and less due to environmental factors. High phenotypic variations were composed of high genotypic variations and less of environmental variations which indicated the presence of high genetic variability for different traits and less influence of environment. Therefore selection on the basis of phenotype alone can be effective for the improvement of these traits. Similar results were observed by Pathak and Sharma (1996), Sarvanan and Senthil (1997), Rather et al (1998), Satya et al (1999), Shivani and Reddy (2000), Iftekharudduala et al (2001), Sao (2002), Hasib (2005) and Panwar (2005). Low estimates of PCV and GCV were observed

Table 2. Analysis of variance for eleven yield attributing characters in 24 genotypes of Basmati rice, *Oryza sativa* L

Source	df	Days to 50% flowering	Days to maturity	Flag leaf length (cm)	Flag leaf width (mm)	Plant height (cm)	Main panicle length (cm)	Effective tillers/plant	Spikelets/ panicle	Spikelet fertility (%)	Grain yield/ plant (g)	100-seed weight (g)
Replication	2	5.0139	15.264	2.146	0.739	6.5588	2.7987	0.1351	15.8748	2.4552	1.0757	0.002179
Treatment	23	142.4197**	148.854**	83.041**	7.3936**	827.8819**	16.3530**	14.8201**	3649.2366**	12.451022**	36.665**	0.175052**
Error	46	3.1298	7.510	3.095	2.1296	4.2926	3.5684	0.1934	39.0378	5.8069	1.225405	0.001388

*Significant at P= 0.01, **Significant at P= 0.05

Table 3. Analysis of variance for quality characters in 24 genotypes of basmati rice, *Oryza sativa* L

Source	df	Kernel length (mm)	Kernel breadth (mm)	Kernel length after cooking (mm)	Alkali spread value	Gelatinization temperature	Amylose content
Replication	2	0.005935	0.003004	0.002235	0.002110	1.764572	0.028101
Treatment	23	1.14852**	0.03087**	5.06523**	4.77328**	44.30071**	5.70664**
Error	46	0.010491	0.001768	0.021736	0.009049	0.938872	0.026659

*Significant at P= 0.01, **Significant at P= 0.05

Table 4. General mean, range of variation, CD value and genotypic, phenotypic and error variance of different characters contributing to yield in Basmati rice, *Oryza sativa* L

Character	PVC (%)	GCV (%)	ECV (%)	Heritability	Genetic advance		GA (%) of mean	
					5%	1%	5%	1%
Days to 50% flowering	7.06	6.84	1.77	93.68	13.59	17.41	13.63	17.47
Days to maturity	5.70	5.29	2.11	86.25	13.13	16.83	10.13	12.98
Flag leaf length (cm)	13.52	12.80	4.36	89.59	10.07	12.90	24.96	31.98
Flag leaf width (mm)	16.65	11.18	12.33	45.17	1.83	2.35	15.49	19.85
Plant height (cm)	13.66	13.55	1.69	98.46	33.87	43.40	27.71	35.51
Main panicle length (cm)	9.91	7.31	6.69	54.43	3.14	4.02	11.11	14.24
Effective tillers/plant	25.23	24.74	4.93	96.18	4.46	5.72	49.99	64.07
Spikelet/panicle	28.68	28.23	5.08	96.68	70.33	90.13	57.23	73.35
Spikelet fertility (%)	3.48	1.83	2.96	27.61	1.61	2.06	1.89	2.53
Grain yield/plant (g)	23.63	22.49	7.24	90.60	6.74	8.64	44.10	56.51
100-seed weight (g)	10.74	10.61	1.64	97.66	0.49	0.63	21.60	27.68
Kernel length (mm)	8.16	8.05	1.34	97.31	1.25	1.60	16.36	20.96
Kernel breadth (mm)	6.24	5.73	2.45	84.58	0.19	0.24	10.86	13.92
Kernel length after cooking	9.91	9.85	1.12	98.72	2.65	3.40	20.16	25.83
Alkali spread value	21.83	21.77	1.64	99.43	2.59	3.32	44.72	57.71
Gelatinization temperature	5.67	5.50	1.40	93.90	7.59	9.73	10.98	14.07
Amylose content	5.64	5.60	0.66	98.61	2.81	3.61	11.45	14.67

for the characters days to maturity and spikelets fertility per cent suggesting that the direct selection for these traits may not be rewarding. Similar results were also reported by Kaw et al (1999).

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 is classified as low (below 30%), medium (30-60%) and high (above 60%). The characters studied in the present investigation expressed low to high heritability estimates ranging from 27.61 to 99.43 per cent. High heritability (in broad sense) was noted (Table 4) for plant height (98.46%) and 100-seed weight (97.66%) and all yield traits except for spikelet fertility (27.61%) and moderate for main panicle length (54.43%) and flag leaf width (45.17%). For quality traits all characters showed high heritability. Similar findings were reported by Panwar et al (1997), Sarawgi et al (2000), Gannamani (2001) and Sao (2002) in various studies on heritability in Basmati rice. A character associating with high heritability may not necessarily give high genetic advance (Gandhi et al 1964). Johnson et al (1955) and Gandhi et al (1964) suggested that high heritability should be accompanied by high genetic advance to arrive at a more reliable conclusion. The breeder should be cautious in making selections based on heritability as it includes both additive and non-additive gene effects. Therefore heritability should be considered along with genetic advance for reliable assessment.

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). The genetic advance (Table 4) values for various yield traits ranged from 0.49 (100-seed weight) to 70.33 (spikelets/panicle) and for quality traits from 0.19 (kernel breadth) to 7.59 (gelatinization temperature). The genetic advance for all quality traits was very low as percentage of mean was highest for spikelets/panicle (57.33%) and lowest for spikelet fertility (1.89%) among yield traits and for quality traits it was highest for alkali spread value (44.72%) and lowest for kernel breadth (10.86%) followed by gelatinization temperature (10.98%). These results are in agreement with the results obtained by Gyanendrapal et al (2011) for grain yield per plant, spikelets per panicle, effective tillers per plant and days to 50 per cent flowering; Krishna et al (2010) for number of total spikelets per panicle and number of filled spikelets per panicle; Kundu et al (2008) for grain yield per plant and 1000-grain weight in tall *indica* aman rice and Singh et al (2007) for days to 50 per cent flowering, grains per panicle and plant height. Other characters showed high heritability along with moderate or low genetic advance which can be improved by intermating superior genotypes of segregating population developed from combination breeding (Samadia 2005). These characters indicate the predominance of additive gene effects in their expression and would respond to selection effectively as they are least influenced by environment.

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