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Assessment of genetic variability, heritability and genetic advance for yield and quality traits in basmati (*Oryza sativa* L.) genotypes of Himachal Pradesh

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Abstract

The genetic parameters were studied to generate information on genetic variability, heritability and genetic advance among thirty basmati genotypes including three checks at research farm of the Rice and Wheat Research Centre Malan, Himachal Pradesh during *Kharif* 2013. Significant difference among the genotypes was revealed through the analysis of variance. Phenotypic and genotypic co-efficient of variation were high only for gelatinization temperature. Moderate PCV and GCV were recorded for grains per panicle, spikelets per panicle, tillers per plant, amylose content and grain yield per plant which indicated the presence of sufficient variability ensuring ample scope for improvement through selection. High heritability coupled with high genetic advance as percentage of mean was recorded for spikelets per panicle, grains per panicle and gelatinization temperature which suggested the presence of additive gene action and thereby these traits could be considered as reliable indices for selection.

Keywords: genetic variability, heritability, genetic advance, basmati

Introduction

Rice (*Oryza sativa* L.) is the world's leading cereal crop as more than half of the world's population is dependent on rice as their staple food. Around the globe, it is cultivated on an area of 160.82 million hectares with annual production of 486.78 million metric tones. It is one of the major food crops of the most Asian countries like China, India, Pakistan, Bangladesh Vietnam and Korea. In India rice was grown on an area of 43.19 million hectares with a production of 110.15 million tonnes (FAO, 2017) [2]. In Himachal Pradesh rice is grown over a limited area of 72.5 thousand hectares with a production of 125.2 thousand tones and productivity of 17.3 q/ha (Anonymous 2016) [3]. Basmati rice has been grown for thousands of years at the foot hills of Himalayan mountain ranges in India and its cultivation is confined to north and northwestern states like Punjab, Haryana, Uttarakhand and Uttar Pradesh, Jammu Kashmir, Delhi and Rajasthan. Rice grown elsewhere, other than its place of origin cannot be called basmati as it will not have the combined characteristics of aroma and post cooking elongation because of soil and weather conditions. Basmati rice is a special type of aromatic rice which is known for its extra long grains and pleasant and distinct aroma. Traditional Basmati rice is not only in demand in the domestic markets but also have a worldwide billion-dollar export market. However productivity of aromatic rice is low as compared to their demand in the world market. Hence, they are sold at premium pocket price as compared to other rice types. Therefore efforts are made to enhance the productivity with keeping grain quality as top priority. Increase in production can be achieved by improved agronomic techniques and developing the adopting high yielding varieties (Thakare *et al* 2013) [17].

The presence of genetic variability for morphological and yield related traits is of utmost importance for identification and development of desirable genotypes as improvement in any trait is depends on the amount of genetic variability present in the experimental material of that trait. Besides genetic variability, heritability and genetic advance are useful parameters on which selection efficiency depends upon. Heritability is an index of transmissibility of the characters from the parents to offspring and has a predictive role in crop breeding programme. However estimates of heritability alone fail to indicate the response to selection. Therefore estimates of genetic advance along with heritability estimates takes into account for genetic improvement of the selected genotypes over the parental populations for various traits. Thus, the genetic advance has an advantage over heritability and helps breeders in various selection programmes. The genetic advance for the studied traits is dependent on the extent of genetic variability, heritability and selection intensity.

Relatively high heritability and genetic advance values for the traits under study favor the possibility of selection of desirable genotypes. The present study was, therefore, undertaken to estimate the extent of genetic variation, heritability and genetic advance in basmati genotypes and to identify best genotypes for cultivation under hilly regions of Himachal Pradesh.

Material and Methods

The present investigation was carried out at Rice and Wheat Research Centre Malan, CSK Himachal Pradesh Krishi Vishvavidyalaya, Kangra, Himachal Pradesh situated at an elevation of 950 m above the mean sea level with 32°07' N latitude and 76°23' E longitude during *Kharif*, 2013. Thirty genotypes of Basmati rice including three checks T-23, Hassan Serai and Kasturi were laid out in a randomized block design with three replications. The net plot size was 3m×1m with 20cm and 15cm spacing between rows and plants respectively. All recommended cultural practices were followed to raise the experiment. Five plants from each genotype were taken at random from each replication for recording data on the following characters *viz.*, plant height (cm), tillers per plant (no), panicle length (cm), spikelets per panicle (no.), grain per panicle (no.), fertility %, 1000-grain weight (g), grain yield per plant (g). The observations on days to 50 per cent flowering were recorded on plot basis. Observations were also recorded to study grain quality characters viz., grain length (mm), grain breadth (mm), length/breadth (L/B) ratio, grain length after cooking, grain elongation ratio, amylose content (%) and gelatinization temperature. data were compiled by taking mean value over randomly selected plants from all the replications and subjected to the statistical analysis for randomized block design as per Panse and Sukhatme 1984. Genetic parameters such as genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability and genetic advance were computed as per Burton and De Vane, 1953 and Johnson *et al.*1955 [5, 10]

Results and Discussion

The extent of variability with respect to nine agro-morphological and seven quality characters in thirty basmati genotypes were measured in terms of, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance as per cent of mean.

Analysis of variance

Analysis of variance (Table 1.) revealed significant differences among genotypes for all yield attributing and quality traits indicating the presence of adequate variability among the genotypes.

Phenotypic and genotypic coefficient of variation

The estimates of mean, range, phenotypic coefficient of variation (PCV), genotypic coefficients of variation (GCV), heritability in broad sense (h^2) and expected genetic advance as per cent of mean (GAM) are presented in Table 2. In general, the values of PCV were higher than the values of GCV indicating that the apparent variation is not only due to genotypes but also due to influence of environment. A close difference between phenotypic and genotypic co-efficient of variation revealed that there was a little influence of environment on the expression of the characters studied. The estimates of PCV and GCV were classified as high (>30%), (moderate 15-30%) and low (<15%). PCV and GCV were found to be high only for the gelatinization temperature (52.25; 49.47). However estimates of PCV and GCV were moderate for grain yield per plant (17.82; 15.32), grains per panicle (29.59; 29.04), spikelets per panicle (27.79; 27.28), tillers per plant (21.97; 17.19) and amylose content (20.16; 19.90) indicating that all these characters are amenable for further improvement. Similar results are found by Vanaja and Babu (2006) [19], Shobha Rani *et al*. (2001), Subbaiah *et al.* (2011) [22] and Patel *et al.*, (2014). Lower degree of PCV and GCV for the traits *viz.*, days to 50% flowering, plant height, panicle length, fertility, 1000-grains weight, grain length, grain breadth, L:B ratio, grain length after cooking and elongation ratio. Similar findings were reported by Subbaiah *et al*. (2011) [22], Ravindra *et al*. (2012) [4] and Srujana *et al*. (2017) [7] for days to 50% flowering, plant height, panicle length, fertility, 1000-grains weight, grain length, grain breadth, L:B ratio and elongation ratio indicates that these characters are under genotypic control and improvement of such traits is very limited, however these traits can be improved through hybridization.

Heritability and genetic advance

High heritability (broad sense) estimates (>80%) were observed for almost all the traits *viz.*, days to 50 per cent flowering (91.68), plant height (89.96), panicle length (81.84), spikelets per panicle (96.41), grain per panicle (96.31), fertility (82.75), 1000-grain weight (94.15), grain length (88.95), grain breadth (96.08), L:B ratio (89.18), grain length after cooking (95.86), grain elongation ratio (99.33), amylose content (97.42), gelatinization temperature (89.65). Present results were in accordance with the findings of Mishra *et al*. (1996) [12], Panwar (2005) [14], Chand *et al*. (2005), Yumnam *et al*. (2011) [23], Dhanwani *et al*. (2013) [6], Hossain *et al*. (2015) and Srujana *et al*. (2017) [7] indicating that the variation observed was mainly under genetic control and less influenced by environment and hence selection will be effective for these traits. However tillers per plant (61.22) and grain yield per plant (73.95) showed moderate heritability (50-80%) indicating the characters are influenced by environmental effects and selection for improving can be misleading. Since the estimates of heritability are in broad sense selection based on heritability alone is misleading hence estimate of genetic advance as per cent of mean is used for better prediction of characters under study. The genetic advance indicates the progress that can be expected for a trait as result of selection. The values of genetic advance as per cent of mean were high (>50%) for characters like gelatinization temperature (96.49), grains per panicle (58.69) and spikelet per panicle (55.18), while moderate (25-50%) for characters like amylose content (40.45), grain yield per plant (27.14) and tillers per plant (29.18). Estimates of genetic advance as per cent of mean were low (<25%) for rest of the traits *viz*., days to 50% flowering, plant height, panicle length, fertility, 1000-grains weight, grain length, grain breadth, L:B ratio, grain length after cooking and elongation ratio. Similar results were reported by Kole *et al*. (2008) [11], Babu *et al*. (2012), Paikhomba *et al*. (2013) [13], Swarker and Senapati (2014) [16] and Venkanna *et al*. (2014) [21]. Heritability alone fails to indicate the response to selection and a character having high heritability may not necessarily give high genetic advance. Therefore Heritability should be always considered along with genetic advance as per cent of mean to arrive at a more reliable conclusion (Johnson *et al*., 1955) [10]. High heritability coupled with high genetic advance as per cent of mean was observed for spikelets per panicle, grains per panicle and gelatinization temperature which indicated the presence of additive gene action and thereby these traits could be considered as reliable indices for selection. These results are in agreement with the results obtained by Thakur *et al*. (1999) [18], Gupta *et al*. (1999) [8], Satish *et al*. (2003) [15], Gyanendrapal *et al*. (2011) [9], Vanisree *et al*. (2013) [20] and Allam *et al*. (2015) [1]. High heritability coupled with moderate genetic advance as per cent of mean was observed for amylose content indicating character is governed by additive genes though influenced by environment. High heritability coupled with low genetic advance as per cent of mean is observed for the rest of traits indicating non-additive gene action, high heritability is due to the favorable environment rather than genotype therefore selection of such traits may not be rewarding.

Table 1: Analysis of variance for morphological and quality traits in basmati rice

Sources of variation	Replication	Genotypes	Error
df	2	29	58
Days to 50% flowering	1.3	56.80*	1.67
Plant height	41	365.28*	13.1
Tiller/ plant	1.68	7.39*	1.29
Panicle length	37.4	17.84*	1.22
Spikelets/panicle	102.01	6851.63*	83.97
Grain/panicle	64.75	4847.55*	61
Fertility	8.84	233.81*	15.19
1000-grains weight	0.33	16.61*	0.33
Grain yield per plant	35.59	23.77*	2.5
Grain length (L)	0.308	0.486*	0.017
Grain breadth (B)	0.001	0.036*	0.001
Length breadth ratio (L:B)	0.061	0.176*	0.007
Grain length after cooking	0.047	1.504*	0.021
Elongation ratio	0.015	0.0270*	0.0007
Amylose content (%)	0.035	54.760*	0.479
Gelatinization temperature	0.0777	2.720*	0.101

* Significant at 5% level of significance

Table 2: Estimates of parameters of variability for different characters in basmati genotypes.

Traits	Mean	Range	PCV (%)	GCV (%)	h^2b (%)	Genetic advance as per cent of mean
Agro-morphological traits						
Days to 50 per cent flowering	91.87	85-103	4.87	4.66	91.68	9.20
Plant height (cm)	102.75	88-132.73	11.11	10.55	89.96	20.60
Tillers per plant (cm)	8.29	5.6-11.20	21.97	17.19	61.22	29.18
Panicle length(cm)	25.53	20.57-29.50	10.19	9.22	81.84	17.17
Spikelet per panicle	174.09	68.67-283.87	27.79	27.28	96.41	55.18
Grains per panicle	137.56	57.20-238.53	29.59	29.04	96.31	58.69
Fertility (%)	79.29	57.51-90.70	11.83	10.77	82.75	20.17
1000-grains weight(g)	22.61	18.50-28	10.62	10.30	94.15	20.59
Grain yield per plant(g)	17.34	12.94-23.78	17.82	15.32	73.95	27.14
Quality traits						
Grain length (mm)	7.65	6.66-8.43	5.45	5.16	88.95	10.09
Grain breadth (mm)	4.13	1.61-2.05	6.01	5.88	96.08	11.89
Grain L/W ratio	4.14	3.62-4.71	6.08	5.74	89.18	11.17
Grain length after cooking (mm)	10.57	9.07-12.32	6.79	6.65	95.86	13.41
Elongation ratio	1.38	1.22-1.67	7.09	6.80	91.88	13.42
Amylose content (%)	21.37	12.83-31.41	20.16	19.90	97.42	40.45
Gelatinization temperature	1.89	1-5.67	52.25	49.47	89.65	96.49

Conclusion

On the basis of results summarized above, it is concluded that wide range of genetic variability was found among genotypes for all the traits studied and which means there is ample scope of selection for these traits for further improvement. High PCV and GCV was observed only for gelatinization temperature and for rest of the traits PCV and GCV was moderate to low. The study revealed that heritability in broad sense was high for all the traits except for tillers per plant and grain yield per plant (moderate heritability) indicating that the variation observed was mainly under genetic control and less influenced by environment and hence selection will be effective for these traits. High heritability coupled with high genetic advance was observed for spikelets per panicle, grains per panicle and gelatinization temperature which indicated the presence of additive gene action and thereby these traits could be considered as reliable indices for selection

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