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Studies on Genetic Variability Parameters for Yield, Quality and nutritional Traits in Basmati and Aromatic Rice (*Oryza sativa* L.)

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ABSTRACT: The present investigation was carried out to study genetic variability in thirty seven basmati and aromatic rice genotypes for sixteen characters which include yield, quality and nutritional traits. Analysis of variance (ANOVA) revealed significant differences among the genotypes for all the studied characteristics. Grain yield per plant, alkali spreading value, number of tillers per plant, iron content, length/breath ratio, zinc content, plant height, 1000 grain weight, grain length, kernel length had moderate to high phenotypic coefficients of variation (PCV) and genotypic coefficients of variation (GCV) estimates suggesting that these traits are under the influence of genetic control and less affected by the environment. In the present study, all the characters exhibited a high degree of heritability and high genetic advance indicating the presence of additive gene effect and hence selection based on phenotypic performance for these traits would be effective. Grain yield per plant, number of tillers per plant, iron content, zinc content, plant height, kernel length are important characters having high heritability, genetic advance as well as high coefficient of variation which should be considered while selecting for high yield. The results indicate the lesser influence of environment in expression of these traits and prevalence of additive gene action in their inheritance hence, amenable of simple selection.

Keywords: Basmati rice, GCV, PCV, genetic advance, heritability, Aromatic rice.

INTRODUCTION

Rice is a highly self-pollinating crop that originated in Southeast Asia and belongs to the gramineae family, producing edible starchy cereal grains. Oryza is a genus with two cultivated and twenty two wild species. *Oryza sativa* and *Oryza glaberrima* are the two cultivated species. Center of origin of *Oryza sativa* is South East Asia (Vaughan, 1994) and *Oryza glaberimma* is native to West Africa (Niger River delta). *Oryza sativa* is grown all over the globe, whereas *Oryza glaberrima* is only grown in a few places, such as West Africa. Rice, the world's second most widely cultivated cereal grain, is a staple food for more than half of the world's population, accounting for more than 20% of total calorie consumption. In India, rice is cultivated in 43.79 million hectares during 2020-21 with production of 117.94 million tones. The annual global rice production of 509 million tonnes was produced on an area of 158 million hectares in 2020-21.

Basmati is a Hindi term that combines two Hindi words: BAS, which means fragrant or scented, and MATI, which means QUEEN, resulting in the phrase "QUEEN OF FRAGRANCE". Basmati rice is distinguished by its extra long slender grain, lengthwise excessive elongation during cooking, soft and fluffy texture of cooked rice, and pleasant aroma (Archak *et al*., 2007; Nagaraju *et al*., 2002; Vemireddy *et al*., 2007).

Basmati rice has a lower glycemic index than any other rice species, according to a research released by the Diabetes Association of Canada (Foster *et al*., 2002) and are high in micronutrients, particularly iron and zinc (Gregorio *et al.*, 2002).

The development of new genotypes requires some knowledge about the genetic variability presents in the germplasm of the crop to build efficient breeding program. The knowledge about genetic variability can help to know if these variations are heritable or non-heritable. The magnitude of variation due to heritable component is very important because, it would be a guide for selection of parents for crop improvement (Dutta *et al.*, 2013). Therefore, selection for high yield requires knowledge about genetic variability. Genetic variability for agronomic traits is the key component of breeding program for broadening the gene pool of rice (Dutta *et al.*, 2013).

The success of breeding program depends upon the quantum of genetic variability available for exploitation and the extent to which the desirable characters are heritable (Tiwari *et al.*, 2011). Variability refers to the presence of differences among the individuals of plant population. Variation results due to difference either in genetic constitution of the individual of a plant population or in environment, they have grown. The existence of variability is essential for improvement of genetic material. Selection is also effective when there is significant amount of genetic variability among the individuals in breeding materials.

MATERIALS AND METHODS

Twenty-five days old seedlings of these germplasm lines were transplanted in Randomized Block Design with three replications having a plot size of $3m^2$/replication/genotype (3 rows each of 6.0 meter length) maintained with row to row spacing of 20 centimeter. Single plant per hill was planted maintaining hill to hill spacing of 15 centimeter. Recommended package of practices were followed for raising a good crop.

A total of 37 Basmati and Aromatic germplasm lines available with the Rice Breeding Project of Pantnagar as well collected variants of basmati rice were evaluated for yield, its attributes, quality and nutritional traits for identification of promising lines having excellent grain nutritional quality characteristics along with other traits. The description of germplasm lines is detailed in Table 1.

Table 1: Description of basmati and aromatic germplasm lines.

Sr. No.	Variety/Landrace	Parentage	Year
1.	Basmati Bahar	-	-
2.	Basmati-137	-	-
3.	Basmati-138	-	-
4.	Basmati-217	Selection from Local Basmati Collection	-
5.	Basmati-370	Pure line selection for Dehradun traditional basmati	1973
6.	Basmati-385	TN 1/Basmati 370 (introduction from Pakistan)	1992
7.	Basmati-386	Pure line selection from Karnalloca	1994
8.	Basmati-410	-	-
9.	Basmati-564	-	2015
10.	Basmati-6141	-	-
11.	Basmati-867	-	-
12.	Bindli	Landraces of Tarai region	-
13.	Govind Bhog	-	-
14.	Hansraj	Landraces of Tarai region	-
15.	Haryana Basmati-1	Sona/Basmati 370	1991
16.	Improved Pusa Basmati-1/PUSA 1460	Pusa Basmati1 /Pusa Basmati1/ IRBB 55)	2007
17.	Lal Basmati	Selection from local material	-
18.	Pant Basmati-1	Pusa Basmati-1/ IET-12603	2016
19.	Pant Basmati-2	UPRBS 9241 × IET 2268-5-1-5	2016
20.	Pant Sugandh Dhan-15	Basmati370/Sadri//Baharl/Muskan 41	2003
21.	Pant Sugandh Dhan-17	Pusa Basmati 1/UPRI 95-15	2004
22.	Pant Sugandh Dhan-21	Govind/BR 4698-17-1J/UPR B592-4/Haryana Basmati/ Pusa Basmati 1	2012
23.	Pant Sugandh Dhan-25	-	2015
24.	Pant Sugandh Dhan-27	UPR 1840-31-1-1 × Pusa Sugandh 2	2015
25.	Pusa 1121/Pusa Sugandh-4	Pusa 614-1-2/Pusa 614-2-4-3	2003
26.	Pusa 1509	Pusa basmati-1121/Pusa 1301	2013
27.	Pusa Basmati-1	Pusa150/Karnal Local	1989
28.	Pusa Sugandh-5 (PUSA 2511)	Pusa 3A/Haryana Basmati	2005
29.	Pusa Sugandh-6 (PUSA 1401)	Pusa Basmati-1/ Pusa 1121-92-8-2-7-1	2008
30.	Ranbir Basmati	Selection from Basmati 370	1995
31.	Sarbati	T(N)1/ Basmati 370//5*Basmati 370	-
32.	Sugandhmati	Pusa Basmati/IET 12603	-
33.	Super Basmati	IR662/Basmati 320	-
34.	Tapovan Basmati	Landraces of Tarai region	-
35.	Taraori Basmati	Selection from local Basmati Collection	1996
36.	Tilak Chandhan	Landraces of Tarai region	-
37.	Type-3	Selection from Basmati Deharadun	1978

Observations were recorded on various descriptors, yield, quality and nutritional traits *viz.*, days to 50% flowering, plant height (cm), panicle length (cm), number of tillers per plant, iron content (ppm), zinc content (ppm), 1000 grain weight (g), grain length (mm), grain breath (mm), hulling (%), milling (%), kernel length (mm), kernel breath (mm), length/breath ratio, alkali spreading value and grain yield per plant (g). Five plants per plot were randomly selected and tagged for recording the observations, while, observations on days to 50 % flowering were recorded on plot basis. After harvesting, the seeds of each genotype were dehulled for evaluation of the grain quality *viz*., kernel size (kernel length and breadth), kernel shape (kernel length breadth ratio) based on their dimension. Iron and zinc content were estimated by atomic absorption spectrphotometry method by Lindsay and Novell (1978), respectively.

Analysis of variance was calculated according to Cochran and Cox (1957). Heritability in broad sense (h^2b) was calculated and classified into low (below 30%), medium (30- 60%) and high (above 60%) according to Allard, 1960. Genetic advance in percent over mean (at 5%) were computed and categorized into low (0-10%), moderate (10-20%) and high (>20%) as given by Johnson *et al.* (1955). Estimates of PCV and GCV was calculated following Burton and De Vane (1953); Singh and Chaudhury (1977) and categorized into low (<10%), moderate (10-20%) and high (>20%) according to Sivasubramanian and Madhavamenon (1973).

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among 37 basmati and aromatic lines for all the traits studied *viz.*, days to 50% flowering, plant height (cm), panicle length (cm), number of tillers per plant, iron content (ppm), zinc content (ppm), 1000 grain weight (g), grain length (mm), grain breath (mm), hulling (%), milling (%), kernel length (mm), kernel breath (mm), length/breath ratio, alkali spreading value and grain yield per plant (g) at both 5% and 1% level of significance (Table 2) indicating presence of good amount of variability. Similar results were reported by Amod *et al*. (2020); Aarti and Jaiswal (2020); Akter *et al*. (2018); Allam *et al*. (2015) in basmati and aromatic lines.

The genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic advance as per cent of mean among 37 basmati and aromatic lines is presented in Table 3 and Graphical representation in Fig. 1 and 2.

Genotypic and Phenotypic coefficient of variation (%). For all of the characters, the phenotypic coefficient of variation (PCV) value was higher than the genotypic coefficient of variation (GCV) value, indicating a strong environmental impact on the expression of the characters. Highest genotypic and phenotypic coefficient of variation was observed for grain yield per plant (26.32, 29.07), alkali spreading value (20.77, 20.97) and number of tillers per plant (20.16, 20.68). Moderate GCV and PCV was observed in iron content (16.82, 17.63), length/ breath ratio (16.26, 16.63), zinc content (14.33, 15.38), plant height (13.36, 14.34), 1000 grain weight (11.95, 12.22), grain length (11.38, 11.71), kernel length (11.37, 11.63) and lowest GCV and PCV was observed for hulling (2.76, 3.81) and milling (4.78, 5.48). These results are in agreement with those reported by Amod *et al*. (2020) for hulling %, Krishna *et al*. (2020) for grain yield per plant, Dey *et al*. (2019) for number of tillers per plant, Allam *et al*. (2015) for alkali spreading value and grain yield.

Heritability h^2(bs) %. The results of the broad sense heritability revealed higher estimates for all the character tested, the value for heritability ranged from 52.50 to 98.10 %. High heritability was observed for alkali spreading value (98.10 %), days to 50% flowering (97.00 %), 1000 grain weight (95.60 %), kernel length (95.50 %), length/ breath ratio (95.50 %), number of tillers per plant (95.10 %), grain length (94.50 %), iron content (91.10 %), grain breath (91.00 %), zinc content (86.90 %), plant height (86.80 %), kernel breath (89.30 %) and grain yield per plant (81.90 %). Lowest heritability was recorded for hulling percentage (52.50 %) and panicle length (60.50 %).

Genetic Advance and Genetic Advance as % of mean. The estimates of genetic advance (GA) ranged from (31.59-0.33). High genetic advance was observed for plant height 31.59, iron content (17.18), days to 50% flowering (16.80), grain yield per plant (11.51), zinc content (6.34), 1000 grain weight (6.07), milling (%) (5.79), number of tillers per plant (5.21), panicle length (4.00), hulling (%) (3.22), grain length (2.39), alkali spreading value (2.16), kernel length (1.58), length/ breath ratio (1.20) and low for grain breath (0.45), kernel breath (0.33).

The genetic advance expressed as a percentage of mean ranged from (37.14 to 1.56). High advance as percentage of mean was observed for grain yield per plant (49.07), alkali spreading value (42.38), number of tillers per plant (40.49), iron content (33.08), length/ breath ratio (32.73), zinc content (27.52), plant height (25.65), 1000 grain weight (24.07), kernel length (22.88), grain length (22.80), grain breath (18.81), kernel breath (17.07), days to 50% flowering (16.86), panicle length (13.77) and low for hulling (%) (4.12), milling (%) (8.60).

Higher estimates of heritability with genetic advance as % of mean was for alkali spreading value, number of tillers per plant, length/ breath ratio, iron content, grain yield per plant, zinc content, plant height, kernel length, grain breath and grain length. These character are governed by additive gene action and selection will be rewarding. The results obtained are on par with those reported by Ahamed *et al*. (2021) for plant height, Krishna *et al*. (2020) for 1000 grain weight and kernel traits, Ashfaq *et al*. (2012) for number of tillers per plant in basmati and aromatic lines.

Table 2: Analysis of variance for yield, quality and nutritional traits in basmati and aromatic rice germplasm.

Source of Variation	Replications	Genotypes	Error	CD (0.05)	CV (%)
d.f	2	36	72		
Days to 50% flowering	5.793	207.907**	2.145	2.384	1.469
Plant Height (cm)	0.571	853.689**	41.055	10.429	5.203
Panicle Length (cm)	0.204	22.723**	4.065	3.282	6.949
Number of Tillers per Plant	0.229	20.502**	0.349	0.961	4.592
Iron Content (ppm)	3.819	236.436**	7.462	4.446	5.261
Zinc Content (ppm)	1.380	34.331**	1.645	2.087	5.569
1000 Grain Weight (g)	0.855	27.631**	0.413	1.046	2.550
Grain Length (mm)	0.091	4.356**	0.082	0.467	2.739
Grain Breath (mm)	0.001	0.164**	0.005	0.118	3.012
Hulling (%)	0.019	18.214**	4.225	3.346	2.629
Milling (%)	3.273	34.429**	3.262	2.940	2.681
Kernel length (mm)	0.037	1.868**	0.029	0.278	2.477
Kernel breath (mm)	0.003	0.087**	0.003	0.094	3.035
Length/Breath ratio	0.042	1.077**	0.017	0.209	3.518
Alkali Spreading Value	0.019	3.397**	0.022	0.239	2.880
Grain Yield Per Plant (g)	0.573	122.603**	8.394	4.716	12.356

* Significant at 5% level; **Significant at 1% level

Table 3: Variability parameters of genetic variability of yield and yield component traits.

Characters	Mean	RANGE		GCV	PCV	h^2 (Broad Sense)	Genetic Advance	Genetic Advance as % of Mean
		MAX	MIN					
Days to 50% flowering	99.67	123.33	85.33	8.31	8.44	97.00	16.80	16.86
Plant Height (cm)	123.15	162.32	91.42	13.36	14.34	86.80	31.59	25.65
Panicle Length (cm)	29.02	35.72	24.85	8.60	11.05	60.50	4.00	13.77
Number of Tillers per Plant	12.86	19.45	8.22	20.16	20.68	95.10	5.21	40.49
Iron Content (ppm)	51.93	72.03	35.53	16.82	17.63	91.10	17.18	33.08
Zinc Content (ppm)	23.03	29.44	16.82	14.33	15.38	86.90	6.34	27.52
1000 Grain Weight (g)	25.21	30.98	17.67	11.95	12.22	95.60	6.07	24.07
Grain Length (mm)	10.48	12.30	7.50	11.38	11.71	94.50	2.39	22.80
Grain Breath (mm)	2.41	3.10	2.00	9.57	10.04	91.00	0.45	18.81
Hulling (%)	78.20	82.07	72.06	2.76	3.81	52.50	3.22	4.12
Milling (%)	67.38	74.56	61.21	4.78	5.48	76.10	5.79	8.60
Kernel Length (mm)	6.89	8.85	5.16	11.37	11.63	95.50	1.58	22.88
Kernel Breath (mm)	1.91	2.40	1.63	8.77	9.28	89.30	0.33	17.07
Length/Breath ratio	3.66	4.92	2.27	16.26	16.63	95.50	1.20	32.73
Alkali Spreading Value	5.11	6.94	3.00	20.77	20.97	98.10	2.16	42.38
Grain Yield Per Plant (g)	23.45	35.31	15.12	26.32	29.07	81.90	11.51	49.07

GCV: Genotypic Coefficient of Variance; **PCV**: Phenotypic Coefficient of Variation; h^2: Heritability (Broad Sense)

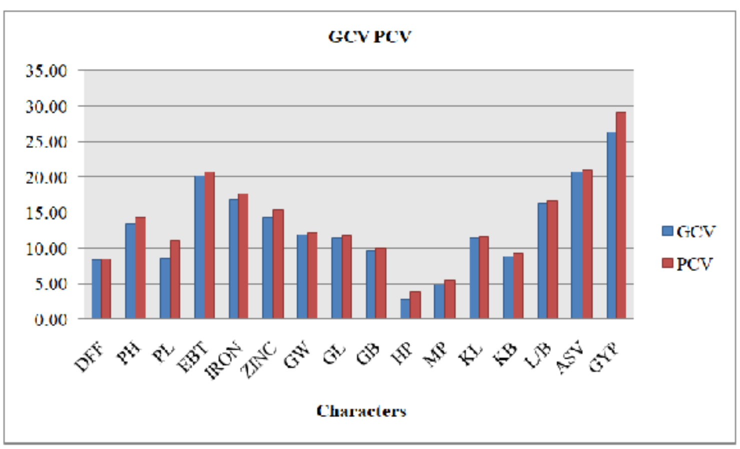

Fig. 1. Graphical representation of genotypic and phenotypic coefficient of variation.

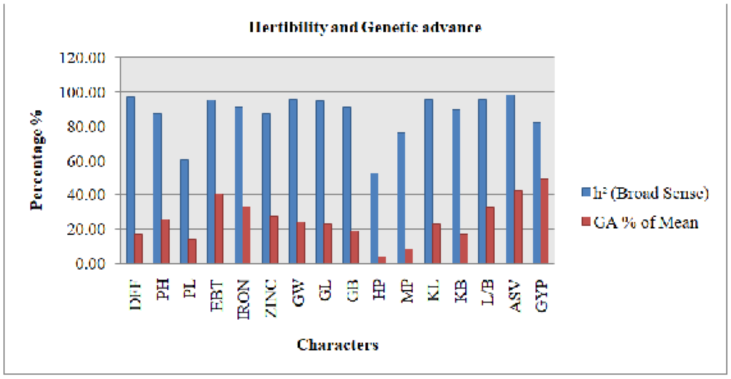

Fig. 2. Graphical representation of heritability, h^2 (broad sense) and genetic advance in % of mean.

CONCLUSION

From the present study, it is evident that genotypes studied may provide good source of material for further breeding programme. Therefore, the information on the genetic parameters such as coefficient of variation, heritability, genetic advance can help the breeder to evolve suitable basmati quality and nutritional cultivars. On the basis of results summarized above, it is concluded that the great deal of variability for the important characters studied even in highly selected lines under the present investigation. High heritability coupled with high genetic advance was observed for the characters alkali spreading value, number of tillers per plant, length/ breath ratio, iron content, grain yield per plant, zinc content, plant height, kernel length, grain breath and grain length indicated their due importance as the indicator characters and selection for these traits may be effective.

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Conflict of Interests. None.

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