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Elucidating Components of Genetic Variation for Yield and Yield Attributing Traits in Rice (*Oryza sativa* L.) Germplasm Lines

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ABSTRACT: Evolving high yielding cultivars is one of the prime objectives of breeding and such cultivars can be evolved by hybridizing dissimilar parents. Therefore, identification of such parents is the prerequisite and until and unless components of genetic variation are not worked out such parents cannot be identified. The present study was carried out during *Kharif* 2022 with an aim to elucidate components of genetic variation for yield and yield attributing traits in rice germplasm lines. The experiment was conducted at two locations *viz.*, Experimental area of Division of Plant Breeding and Genetics and Regional Agriculture Research Station (RARS) Rajouri in which twenty-six rice germplasm lines were evaluated in Randomized Complete Block Design (RCBD) in three replications having a plot size of 5m^2. Data on yield and yield attributing traits *viz.*, number of days to 50 per cent flowering, plant height, total number of tillers per plant, number of effective tillers per plant, days to maturity, panicle length, 1000 grain weight and grain yield per plant were recorded following standard procedures and was statistically analysed using appropriate software. Analysis of variance revealed significant variation among the germplasm lines for all the traits studied indicating presence of sufficient variation in the experimental material. Estimates of components of genetic variation revealed that traits like days to 50 per cent flowering and plant height were found to have high heritability coupled with high genetic advance indicating the effectiveness of selection in improving these traits.

Keywords: Genetic variation, rice, heritability and genetic advance.

INTRODUCTION

Rice (*Oryza sativa* L.), a member of the Poaceae family, holds a pivotal role as the most crucial staple cereal globally, sustaining over 50 percent of the world's population, particularly in Asia (Thapa and Bhusal 2020). It contributes significantly to global nutrition, providing 23 percent of the world's calorie intake with a staggering 92 percent of rice production and consumption cantered in Asia, where it plays a crucial role in the lives of countless people across the continent (Basnet, 2008). Rice also commands a vital position in Indian agriculture, thriving in diverse soil and climatic conditions. Its cultivation spans regions from below sea level, exemplified by the Kuttanad area in Kerala, to elevations reaching up to 2000 meters in the Union Territory of Jammu & Kashmir. As regards statistics in India during *kharif* 2022 rice was raised over an area of 45.07 million hectares with net produce and productivity of 122.27 million tonnes and 2.71 tonnes per hectare respectively (Anonymous, 2022a). In UT of Jammu and Kashmir during *kharif* 2021 it was raised over an area of 267.58 thousand hectares with net produce and productivity of 5186 thousand quintals and 21.74 quintals per hectare respectively (Anonymous, 2022b).

Although with the help of technological interventions coupled with high yielding cultivars production has increased substantially over time but it is still inadequate to subsist with the increasing global demand (Sasaki and Burr 2000; Thapa and Bhusal 2020). To meet the rising demand it is imperative to search diverse lines so that they can be exploited in hybridization programmes. This involves a comprehensive understanding of the genetic variability of traits contributing to yield, their interrelationships as well as their overall impact on yield. Such knowledge is essential for the development of effective breeding programme as highlighted by Nayak *et al*. (2016). Additionally, it is crucial to characterize diverse rice germplasm lines across various agro-climatic zones in the Jammu region of the Union Territory of Jammu & Kashmir for their possible use in breeding programmes.

Among various components of genetic variation heritability serves as a valuable tool for plant breeders, aiding in the prediction of traits in the next generation, facilitating appropriate selections, and quantifying the extent of genetic improvement achievable through selection, as emphasized by Khatun *et al.* (2015).

Therefore, the primary objective of this study was to assess genetic variability among rice germplasm lines so that promising lines can be exploited in future hybridization programmes thereby contributing to increased rice production so as to meet the growing global demand.

MATERIALS AND METHODS

The present study was carried out at Experimental Area of Division of Plant Breeding and Genetics, FoA, Chatha and Regional Agriculture Research Station (RARS), Rajouri SKUAST-J during *kharif* 2022. Chatha is located in the sub-tropical region of the Union Territory of J&K about elevation around of 293 metres above the mean sea level coordinates 32.6529° N, 74.8071° E while, RARS, Rajouri is located at an elevation of 915 meters above mean sea level having average temperature of 29ºC during summer and 16ºC during winter. The experimental material consists of 26 germplasm lines (Table 1) collected from three districts of Jammu region *viz*., Rajouri, Poonch and Udhampur along with germplasm lines/released varieties maintained by Division of Plant Breeding and Genetics, SKUAST-Jammu.

Table 1: Details of rice germplasm lines used as experimental material in the present study.

Sr. No.	Description of germplasm lines	Nomenclature allocated	Sr. sNo	Description of germplasm lines	Nomenclature allocated
1.	Collected from Budhal area of Distt. Rajouri	GP-1	14	Collected from Dalogra area of Distt. Rajouri	GP-14
2.	Collected from Budhal area of Distt. Rajouri	GP-2	15	Collected from Manjakote area of Distt. Rajouri	GP-15
3.	Collected from Budhal area of Distt. Rajouri	GP-3	16	Germplasm line available at division of Plant Breeding and Genetics	GP-16
4.	Collected from Budhal area of Distt. Rajouri	GP-4	17	Chenab course rice variety released by SKUAST-K	GP-17
5.	Collected from Gulpur area of Distt. Poonch	GP-5	18	Collected from Chaktroo area of Distt. Poonch	GP-18
6.	Collected from Barmeen area of Distt. Udhampur	GP-6	19	Collected from Jhullas area of Distt. Poonch	GP-19
7.	Collected from Barmeen area of Distt. Udhampur	GP-7	20	Collected from Ajote area of Distt. Poonch	GP-20
8.	Collected from Barmeen area of Distt. Udhampur	GP-8	21	Collected from Khanetar area of Distt. Poonch	GP-21
9.	Collected from Sankari area of Distt. Rajouri	GP-9	22	Collected from Qazi Motah area of Distt. Poonch	GP-22
10.	Collected from Khanetar Bela area of Distt. Poonch	GP-10	23	GIZZA-14 variety available at division of PBG	GP-23
11.	Collected from Chandaki area of Distt. Poonch	GP-11	24	Jaya variety available at division of PBG	GP-24
12.	Collected from Rehan area of Distt. Rajouri	GP-12	25	K-39 variety available at division of PBG	GP-25
13.	Collected from Kalar area of Distt. Rajouri	GP-13	26	K-448 variety available at division of PBG	GP-26

The seeds of the germplasm lines were sown in nursery during the month of June, 2022 at both the location viz., Rajouri and Chatha and 25 days old healthy seedlings were transplanted in Randomized Complete Block Design with three replications each with a plot size of $5m^2$ (1m × 5m) having spacing of 20 × 15 cm during the month of July, 2022. Single seedling was transplanted per hill and recommended package and practices were followed for the optimum growth at both the locations. Yield and yield attributing trait observations were recorded by randomly choosing 5 plants from each germplasm line from each replication i.e., 5 plants each from 3 replications for the traits like plant height (cm), total number of tillers per plant, number of effective tillers per plant, panicle length (cm) were recorded. The traits like number of days to 50 per cent flowering and number days to maturity were observed by counting the days from the date of sowing of nursery till the advent of the characters. The post-harvest characters like 1000, spikelets per panicle and seed coat colour were recorded after harvesting, threshing and drying the seeds. The data collected on each character was subjected to the statistical analysis *viz*., ANOVA (analysis of variance). genotypic variance, phenotypic variance, genotypic coefficient of variation, phenotypic coefficient of variation, heritability in broad sense, genetic advance and genetic advance as per cent of mean.

RESULTS AND DISCUSSION

Analysis of variance (Table 2) indicated presence of significant variation in the germplasm lines for yield and yield attributing traits thereby, revealing that the germplasm lines under the present study were distinct from one another with respect to all traits recorded. Mean performance of germplasm lines (Table 3) revealed that days to 50 per cent flowering ranged from 72.33 to 108.33 with an overall mean of 85.69 days at Chatha, while it ranged from 82.66 to 110.00 days with an overall mean of 92.64 days at Rajouri. GP-26 and GP-8 exhibited minimum days to 50 per cent flowering respectively at Chatha and Rajouri whereas, GP-19 took maximum days to flower at both the locations. Total number of tillers per plant ranged from 5.95 to 17.13 with an average of 8.81 tillers per plant at Chatha, while, at Rajouri it ranged from5.86 to 17.46 tillers per plant with an average of 8.82. GP-20 and GP-1 recorded minimum total number of tillers per plant respectively at Chatha and Rajouri while, GP-15 recorded maximum total number of tillers per plant at both the locations. Number of effective tillers per plant varied from 4.73 to 15.93 with an average of 7.69 at

Chatha, while it ranged from 5.14 to 14.45 with an average of 7.49 effective tillers per plant at Rajouri location. GP-20 and GP-21 recorded minimum number of effective tillers per plants respectively at Chatha and Rajouri whereas, GP-15 recorded maximum effective tillers per plant at both the locations. Plant height among the germplasm lines varied greatly ranging from 87.64 cm to 154.37 cm with an overall mean height of 110.42 cm at Chatha while, at Rajouri it ranged from 89.16 cm to 152.86 cm with an overall mean height of 109.71 cm. GP-23 recorded minimum height while, GP-6 recorded maximum height at both the locations. Panicle length varied from 20.04 cm to 32.11 cm with an average of 26.04 cm at Chatha, while, it ranged from 19.50 cm to 30.77 cm with an average length of 25.90 cm at Rajouri. GP-23 recorded minimum, whereas GP-18 recorded maximum panicle length at both the locations. Number of days to maturity ranged from 102.66 to 135.33 days with an overall mean of 121.19 at Chatha, while it ranged from 109.33 to 141.33 days with average mean of 127.32 days at Rajouri. GP-4 took minimum and GP-13 took maximum days to attain maturity at both the locations. 1000 grain weight varied from 18.06 g to 30.86 g with an average mean weight of 23.58 g at Chatha, while, it ranged from 18.20 g to 30.12 g with an average weight of 23.36 g at Rajouri. The minimum 1000 grain weight was recorded in GP-19 and the maximum was recorded in GP-4 at both the locations, *viz.,* Chatha and Rajouri. Grain yield per plant was observed to vary from 8.73 g to 28.01 g with a overall mean of 17.12 g at Chatha, whereas, it varied from 9.46 g to 29.66 g with a mean of 18.52g at Rajouri. Minimum yield per plant was observed in GP-23 at both the location while maximum yield per plant was recorded in GP-16 and GP-24 at Chatha and Rajouri respectively. Components of genetic variation (Table 4) revealed that phenotypic variance was observed to be ranging from 4.95 to 140.34 whereas, genotypic variance was observed to be ranging from 4.72 to 132.47 at Chatha, while at Rajouri phenotypic variance was observed to be ranging from 4.11 to 131.92 whereas, genotypic variance was observed to be ranging from 3.81 to 126.76. The highest phenotypic and genotypic variance was observed for plant hight followed by days to 50 per cent flowering, days to maturity, grain yield per plant, panicle length, total number of tillers per plant while, the least were observed for number of effective tillers per plant at both the locations *viz.,* Chatha and Rajouri. Results and conclusions of similar kind were also reported by Htwe *et al.* (2019), Lingaiah *et al.* (2020); Demeke *et al.* (2022). Genotypic coefficient of variance was observed to be ranging from 6.82 per cent to 29.44 per cent at Chatha, while it ranged from 6.72 per cent to 27.45 per cent at Rajouri location. The highest genotypic coefficient of variance was observed in grain yield per plant followed by number of effective tillers per plant, total number of tillers per plant, 1000 grains weight, panicle length, days to 50 per cent flowering, plant height while, the least was observed in days to maturity at both the locations. Results of similar kind were also reported by Lingaiah *et al.* (2020); Demeke *et al.* (2022). Phenotypic coefficient of variance was observed to be ranging from 6.86 per cent to 29.84 per cent at Chatha, while, at Rajouri it ranged from 6.75 per cent to 27.90 per cent. The highest phenotypic coefficient of variance was observed in grain yield per plant followed by number of effective tillers per plant, total number of tillers per plant, 1000 grain weight, panicle length, days to 50 per cent flowering and plant height while, least was observed in days to maturity at both the locations. Results of similar kind were also reported by Dey *et al.* (2019); Lingaiah *et al.* (2020); Demeke *et al*. (2022). PCV estimates were found to be higher than GCV estimates but lower differences between PCV and GCV revealed that expression of characters is mainly due to genotype itself. Similar results were reported by Lingaiah *et al.* (2020); Demeke *et al*. (2022). Traits studied showed high estimates of heritability in broad sense ranging from 88.80 per cent to 99.54 per cent at Chatha, while heritability estimate ranged from 87.5 per cent to 99.64 per cent at Rajouri. The highest heritability was observed in number of days to 50 per cent flowering followed by number of days to maturity, grain yield per plant while, lowest estimate was recorded in 1000 grain weight at both the locations. Results of similar kind were reported by Demeke *et al.* (2022); Hasan *et al.* (2022). Genetic advance was observed to be ranging from 4.37 to 23.03 at Chatha, while, at Rajouri it ranged from 3.87 to 22.73. The highest estimate of genetic advance was observed in plant height, days to 50 per cent flowering, days to maturity, grain yield per plant, panicle length, 1000 grain weight, total number of tillers per plant while, the least was observed in number of effective tillers per plant at both the locations. High heritability coupled with high genetic advance provides reliable results of presence of additive genetic effects. High heritability coupled with high genetic advance was observed in characters *viz.,* days to 50 per cent flowering and plant height. Results of similar kind were reported by Srujana *et al.* (2017); Sandeep *et al.* (2018). Genetic advance as percent of mean was observed to be ranging from 13.97 to 59.86 per cent at Chatha, while it ranged from 13.80 to 55.66 per cent at Rajouri. Highest genetic advance as percent of mean was observed in grain yield per plant at both the locations while, lowest genetic advance as per cent of mean was observed in days to maturity at both the location.). High heritability coupled with high genetic advance as percent of mean was observed for traits *viz.,* days to 50 per cent flowering, number of effective tillers per plant, plant height, panicle length, 1000 grain weight and yield per plant. Results of similar kind were observed by Khatun *et al.* (2015); Singh and Verma (2018); Lipi *et al.* (2020) in their respective studies.

Table 2: Analysis of variance for traits recorded in the present study at Chatha and Rajouri locations.

Source of variation	df	Days to 50 per cent flowering		Total Number of tillers per plant		Number of effective tillers per plant		Plant hight (cm)		Panicle length (cm)		Days to maturity		1000 grain weight (g)		Grain yield per plant (g)	
		Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri
Replications	2	2.46	1.87	1.05	1.13	1.19	1.25	6.50	7.73	2.10	1.25	2.92	2.85	2.63	2.79	1.78	1.39
Treatments	25	303.65**	242.18**	17.55**	17.45**	14.86**	12.33**	421.02**	395.77**	37.02**	32.92**	207.68**	221.90**	33.39**	32.34**	78.35**	80.18**
Error	50	1.40	0.87	1.38	0.84	0.68	0.88	23.61	15.48	1.24	1.02	2.52	1.72	1.34	1.46	2.04	2.51

**represents significance level at1 per cent

Table 3: Mean performance of germplasm lines w.r.t various traits recorded at Chatha and Rajouri.

Germplasm lines	Days to 50 per cent flowering		Total number of tillers per plant		Number of effective tillers per plant		Plant hight (cm)		Panicle length(cm)		Days to maturity		1000 grain weight (g)		Grain yield per plant(g)	
	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri
GP-1	84.66	90.00	6.10	5.86	5.57	5.23	103.95	104.62	23.00	23.27	118.66	123.00	20.38	19.60	11.76	14.15
GP-2	80.33	93.33	7.81	7.91	7.66	6.93	102.15	102.59	21.91	22.30	118.00	123.00	21.80	21.55	14.11	15.77
GP-3	82.33	86.00	8.44	8.53	8.22	7.32	105.39	107.80	21.35	20.56	119.66	124.33	24.23	24.14	11.55	14.83
GP-4	76.00	84.33	9.16	9.60	8.10	8.46	116.07	115.10	24.95	24.91	102.66	109.33	30.86	30.12	23.66	25.50
GP-5	101.33	109.66	7.30	7.40	6.36	6.20	99.85	97.57	27.52	28.16	135.00	141.31	24.40	23.16	18.80	19.76
GP-6	80.00	84.33	6.73	6.83	6.60	5.98	154.37	152.86	30.95	30.34	117.33	122.00	27.52	27.16	17.62	20.73
GP-7	75.00	83.66	7.13	7.33	6.96	6.57	104.80	105.45	21.21	21.75	117.66	122.66	24.10	24.20	10.12	12.90
GP-8	73.33	82.66	7.96	7.41	6.16	6.07	101.86	99.56	25.16	23.98	121.33	125.00	27.27	27.74	16.56	15.17
GP-9	76.66	85.00	9.030	9.05	7.91	7.58	114.86	116.29	25.16	24.35	116.66	119.66	26.83	27.16	17.73	19.46
GP-10	83.66	91.00	11.66	10.89	9.39	9.29	111.61	110.58	21.92	23.53	113.66	122.66	28.66	28.70	16.78	18.12
GP-11	83.66	88.66	9.38	9.22	8.81	8.56	121.51	120.00	28.22	29.03	119.00	123.66	20.43	20.40	17.16	18.70
GP-12	100.00	105.00	8.36	8.38	7.06	7.50	107.31	106.87	26.52	26.94	133.00	136.00	21.23	21.93	23.57	24.48
GP-13	101.33	105.33	6.64	6.58	6.20	5.54	105.00	104.01	24.98	25.56	135.33	141.33	26.51	26.70	18.28	21.42
GP-14	89.00	97.66	8.35	8.31	7.30	7.23	108.39	110.75	27.8	27.37	128.66	134.33	21.12	20.74	22.24	23.99
GP-15	93.00	96.33	17.13	17.46	15.93	14.45	126.45	124.30	29.04	28.47	125.66	132.00	19.76	19.86	10.85	10.83
GP-16	100.33	108.33	8.02	8.13	6.53	6.56	109.71	108.17	26.78	27.02	131.33	138.33	26.08	25.33	28.01	25.86
GP-17	76.00	85.33	8.73	8.56	7.31	7.45	110.02	105.39	24.98	24.26	113.66	123.33	25.16	24.90	12.68	14.92
GP-18	86.00	93.00	8.20	8.45	6.44	6.91	113.73	110.68	32.11	30.77	129.66	136.33	19.46	19.67	20.12	22.54
GP-19	108.33	110.00	11.75	11.49	9.94	10.22	109.85	108.77	21.71	22.42	129.66	137.33	18.06	18.20	11.20	12.16
GP-20	82.33	87.66	5.95	6.12	4.73	5.16	101.39	102.21	30.49	30.29	117.66	127.00	20.26	20.33	16.72	12.13
GP-21	83.33	87.00	7.22	7.60	5.73	5.14	103.11	101.66	30.78	30.74	115.66	124.00	24.70	21.13	16.58	17.88
GP-22	84.33	93.00	8.96	8.85	7.70	7.84	111.89	107.72	30.97	30.17	123.66	131.33	20.90	21.66	22.18	23.08
GP-23	85.33	91.00	6.00	6.20	5.13	5.29	87.64	89.16	20.04	19.50	124.66	132.33	20.03	20.10	8.73	9.46
GP-24	95.33	103.00	10.39	10.41	8.50	8.66	107.62	108.52	29.23	28.42	124.00	132.00	22.36	22.04	26.69	29.66
GP-25	74.00	84.00	11.10	10.83	9.65	9.53	114.44	114.32	24.49	24.21	109.33	118.66	26.77	26.66	17.49	20.43
GP-26	72.33	83.33	11.70	12.01	10.23	9.16	117.93	117.50	25.76	25.17	109.33	109.34	24.21	24.1	14.01	17.76
Mean	**85.69**	**92.64**	**8.81**	**8.82**	**7.69**	**7.49**	**110.42**	**109.71**	**26.04**	**25.90**	**121.19**	**127.32**	**23.58**	**23.36**	**17.12**	**18.52**
C.V.	1.38	1.00	13.34	10.43	10.74	12.52	4.40	3.58	4.27	3.90	1.31	1.04	4.91	5.18	8.35	8.56
C.D.	1.97	1.53	1.93	1.51	1.35	1.54	7.97	6.45	1.82	1.65	2.60	2.17	1.90	1.98	2.34	2.60

CONCLUSIONS

The germplasm lines under present study were found to be distinct w.r.t agro-morphological, yield and yield attributing traits. Traits like Days to 50 percent and plant height showed high heritability with genetic advance estimates, which suggested additive gene may be present and selection might be effective and hence can be utilized in future breeding programmes.

Table 4: Estimates of genetic parameters observed among germplasm lines under study at Chatha and Rajouri.

Characters	Genotypic variance (σ^2_g)		Phenotypic variance (σ^2_p)		Genotypic coefficient of variance (per cent)		Phenotypic coefficient of variance (per cent)		Heritability (h^2 bs) (per cent)		Genetic advance		Genetic advance as per cent of mean (per cent)	
	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri	Chatha	Rajouri
Days to 50 per cent flowering	100.74	80.43	101.21	80.72	11.71	9.68	11.74	9.69	99.54	99.64	20.62	18.44	24.07	19.9
Total number of tillers per plant	5.38	5.53	5.85	5.81	26.31	26.64	27.42	27.32	92.10	95.14	4.58	4.72	52.03	53.54
Number of effective tillers per plant	4.72	3.81	4.95	4.11	28.23	26.06	28.9	27.04	95.39	92.85	4.37	3.87	56.80	51.73
Plant height (cm)	132.47	126.76	140.34	131.92	10.42	10.26	10.72	10.46	94.39	96.09	23.03	22.73	20.86	20.72
Panicle length (cm)	11.91	10.63	12.34	10.97	13.26	12.58	13.48	12.78	96.65	96.90	6.99	6.61	26.85	25.52
Days to maturity	68.38	73.38	69.22	73.96	6.82	6.72	6.86	6.75	98.79	99.21	16.93	17.57	13.97	13.80
1000 grain weight (g)	10.68	10.29	12.20	11.75	13.85	13.73	14.70	14.67	88.80	87.50	6.44	6.18	26.90	26.46
Grain yield per plant (g)	25.43	25.88	26.11	26.72	29.44	27.45	29.84	27.90	97.39	96.86	10.25	10.31	59.86	55.66

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Conflict of Interest. None.

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