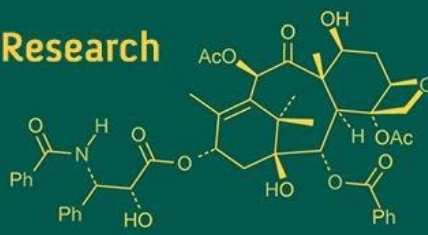


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Estimation of genetic variability parameters for agro-morphological and grain quality traits in rice (*Oryza sativa* L.) mutants and parents

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Abstract

For the variability study of the rice (*Oryza sativa* L.) among fifty eight genotypes, nineteen characters were used. In genetic variability study phenotypic coefficient of variation is greater than genotypic coefficient of variation indicating the that effect of environment is very negligible where, plant height, panicle length, flag leaf length, sterile grain per plant, stem thickness, stem length, number of panicles per plant, 1000 grain weight, decorticated grain breadth, decorticated grain length breadth ratio and grain yield per plant had high genotypic coefficient of variation. Heritability is the heritable portion of phenotypic variance and it is a good index of the transmission of characters from parents to the offspring. The present study reveals that stem length is highly heritable character among all the characters and plant breeder can select the long stem length genotypes, as the character is highly heritable followed by plant height, panicle length, flag leaf length, time of maturity and 1000 weight per plant etc. Most of the traits showed high value of GA as % mean, genotypes with high genetic advance are governed by additive genes and selection for these traits will be useful in improving grain yield.

Keywords: Correlation coefficient, genetic variability, genetic advance, heritability, path coefficient

Introduction

Rice (*Oryza sativa* L.) (2n=24) is a major self- pollinating cereal crop belonging to genus *Oryza* of family Poaceae and subfamily Oryzoidea. It is one of the most important food crops, feeding more than one-third of the world's population. To meet the food demand created by a growing population, the development of high yielding rice varieties is critical. Grain yield is affected by many yield-attributing traits that are influenced by the environment. A successful breeding program requires genetic variability of yield contributing traits, as well as their interrelationship and relationship with yield, (Guru *et al.*, 2017) [8].

Rice is undoubtedly the most important stable food grain in the world. Demand of the rice in India is projected at 128 million tones by the year 2012, which requires increase in productivity to at least 3 t/ha from the present i.e2 t/ha, (Anonymous, 2012) [3].

Rice mutants are produced by the mutation breeding also called variation breeding the method that uses physical radiation or chemical means to induce spontaneous genetic variation in plants to develop new crop varieties. "mutation" is the source of most genetic variation. Every mutant rice shows difference in one or two characters from parents genetically it is known as genetic variability.

Magnitude of genetic variability governs the inheritance of quantitative characters like yield and its components which are essential for effective genetic improvement. So, to observe those genetic variation and to compare those qualities of mutant varieties from their parents DUS characterization is the method which means is a way of determining whether a newly bred variety differs from existing varieties within the same species and also useful for identification of varieties, for varietal information system and classification of varieties into different groups and for genetic resources.

Materials and Methods

Fifty eight mutants and parents of rice were grown in a randomized complete block design with two replications at the Research cum Instructional Farm, Department of Genetics and Plant Breeding, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh state located between 17° 14' and 24° 45' N latitude and 79°16' and 84°15' E longitudes whereas, Raipur lies at 21°16' N and 81°36' E with a height of 289.60 m above the mean sea level., India. The material was grown in a complete randomized block design with five checks in two replications during *Kharif* 2022. Each entry was sown in two rows of 2 m length at spacing of 20 cm between rows and 15 cm between plants.

The data were collected on five randomly selected plants from each accession. Recommended cultural practices were used for growing rice crop throughout the experiment.

Results and Discussion

Range and Mean performance of different characters

Days to 50% flowering varied from early (71-90 days) to late (111- 130 days), 19 genotypes showed early days to 50% flowering and 17 showed medium and 22 showed late days to 50% flowering. The days to 50% flowering ranged from 76 (Sanchuriya Mutant-6) to 123 days (Mai Dubraj) with a mean value of 102.138 days. Plant height ranged from 69.33 cm (Jhilli Mutant-13-2) to 197.5 cm (Alsakar Parent) with a mean height of 124.592 cm. Five categories of panicle length were found i.e. very short (<16), short (16-20 cm), medium (21-25 cm), long (26-30 cm) and very long (>30 cm). Very short panicle length was shown by 4 genotypes, Short panicle length was shown by eight genotypes, medium length by 33, long length by 10 and very long panicle length by three genotypes. Panicle length ranged from 12.35 cm (Alsakar Mutant-3) to 48 cm (Laicha Mutant-13) with a mean value of 23.639 cm. Three category of leaf length were found i.e. short (< 30 cm), medium (30-45 cm) and long (> 45 cm), 24 genotypes showed short leaf length, 28 showed medium leaf length and 6 showed long leaf length. Leaf length varied from 19.83 cm (Alsakar Mutant-8) to 50.33 cm (Mai Dubraj) with a mean value of 32.87 cm. Leaf width of 53 genotypes were found medium (1-2 cm) in width and 5 were narrow. The range of variation for leaf width was 0.625 cm (Chaptijurmatiya Mutant-4) to 1.395 cm (Danighoda Parent) with mean value of 1.036 cm. Out of 58 genotypes sterile grains were present in all the genotypes. The range of variation for leaf sterile grain was four (Danighoda Mutant-6) to 75 (Maharaji Mutant-10) with mean value of 29.267. Three category of stem thickness were found i.e. thin (<0.40), medium (0.40-0.55) and thick (>0.55), 12 genotypes showed thin thickness, three showed medium and 43 were thick. The range of variation for stem thickness was 0.031 cm to 0.394 cm with mean value of 0.154 cm. Three category of stem length were found i.e. very short (<91), short(91-110), medium (111-130) and long(131-150).37 genotypes showed very short stem length,7 showed short, nine showed medium and 5 genotypes showed long stem length. The range of variation for stem length was 43.165 cm (Maharaji Parent) to 142 cm (Safri-17 Parents) with mean value of 88.735 cm. Panicle number per plant varied from few (<11) to many (>20), few panicle number was shown by 19 genotypes 36 showed medium panicle number and three showed many panicle numbers. It ranged from seven (Jhilli Mutant-13-2) to 32.5

(Danighoda Mutant-6) with a mean value of 13.259. Time of maturity varied from early (101-120 days) to late (141-160 days), eight genotypes showed early time maturity, 22 medium and 28 genotypes showed late time maturity. Time of maturity ranged from 111.5 (Alsakar Mutant-3) to 158.5 days (Jawaphool Parent) with a mean value of 137.353 days. Thousand grain weight ranged from 15.08 g (Samundchini-S-49 (grassy)) to 48.115 g (Chaptijurmatiya Parent) with a mean value of 31.53 g. Grain length varied from very short (<0.6 mm) to very long (>12 mm), very short grain length was shown by five genotypes, 31 showed short grain length, 20 showed medium and two long. Grain length showed variation from 5.05 mm (Dhaniyadhan Parent) to 10.105 mm (Safri-17-2) with a mean value of 8.096 mm. Grain width showed variation i.e. narrow (2.1-2.5 mm), medium (2.6-3.0 mm) and broad (3.1-3.6 mm). Very narrow grain breadth was shown by four genotypes, narrow by 35, medium grain breadth by 15 and four by broad grains. Grain breadth observed variation from 1.855 mm (Maharaji Mutant-11) to 3.475 mm (Dhaniyadhan Parent) with a mean value of 2.545 mm. Grain length breadth ratio ranged from 1.54 (Dhaniyadhan Mutant-1) to 5.01 (Maharaji Mutant-11) with a mean value of 3.271. Decorticated grain length ranged from 3.05 mm (Samundchini-S-50) to 8 mm (Tilkormel Parent) with a mean value of 5.428 mm. Decorticated grain width ranged from 1 mm (Luchai Parent) to 2.3 mm (Alsakar Mutant-3) with a mean value of 1.25 mm. Decorticated grain l/b ratio ranged from 1.525 (Dhaniyadhan Mutant-1) to 8 (Tilkormel Parent) with the mean value of 4.735. Hulling percentage varied from 48.81% (Chaptijurmatiya Mutant-4) to 84.465% (Mai Dubraj) with a mean value of 68.566%. The grain yield per plant varied from 5.83 g (Gathuwan Mutant-6) to 29.89 g (Safri-17-2-48) with a mean value of 17.657 g.

Phenotypic and genotypic coefficient of variation

The result showed that the phenotypic coefficient of variation (PCV) was higher in magnitude than the genotypic coefficient of variation (GCV) for all the quantitative characters studied in the experiment. This reveals that observed variations are result of both genotype and influence of environment.

Among the characters studied, highest genotypic coefficient of variation (>20%) was shown by plant height (26.334), panicle height (21.617), flag leaf length (25.486), sterile grain (53.626), stem thickness (49.915), stem length (27.198), number of panicles (34.982), 1000 seed weight (25.518), decorticated grain width (29.912), decorticated grain length breadth ratio (32.67), grain yield (35.002). Moderate genotypic coefficient of variation was recorded for grain length breadth ratio (19.998), grain breadth (15.336), grain length (14.652), flag leaf width (11.251), days to 50% heading (13.248) and hulling percentage (11.25). Low magnitude of genotypic coefficient of variation (<10%) in present study was recorded only for time of maturity (9.975).

High magnitude of phenotypic coefficient of variation (PCV) was recorded for plant height (26.391), panicle height (21.703), flag leaf length (25.554), sterile grain (62.669), stem thickness (61.023), stem length (27.23), number of panicles (37.179), 1000 seed weight (25.586), decorticated grain width (30.565), decorticated grain length breadth ratio (34.15), grain yield (35.323), grain length breadth ratio (22.033). Medium magnitude of PCV was

recorded for grain breadth (17.36), grain length (15.014), flag leaf width (12.367), days of 50% flowering (13.28) and hulling percentage (11.332), decorticated grain length (19.468). Low magnitude of genotypic coefficient of variation (<10%) in present study was recorded only for time of maturity (10.003)

The presence of high magnitude of genotypic coefficient of variation indicates the high genetic variability in the population. In present investigation phenotypic coefficient of variation was in general higher than the GCV, but the difference was very low, indicating less environmental influence on expression of different traits. Similar findings were also reported by Vyas *et al.* (2021) [13], Noatia *et al.* (2021) [11], Sharma *et al.* (2021) [12]. Moderate genotypic coefficient of variation and phenotypic coefficient of variation and low estimates of GCV and PCV were reported by Donker *et al.* (2021) [6], Lakshmi *et al.* (2021) [10], Ahamed *et al.* (2021) [1].

Heritability (Broad sense)

The high heritability estimates (>70%) were observed stem length (99.769), followed by plant height (99.563%), days to 50% flowering (99.522), 1000 seed weight (99.474), flag leaf length (99.466), time of maturity (99.445), panicle length (99.21), hulling percentage (98.556), grain yield (98.186), decorticated grain width (95.773), grain length (95.242), decorticated grain length breadth ratio (91.518), number of panicles (88.53), flag leaf width (82.764), grain length breadth ratio (82.211), decorticated grain length (79.549), grain breadth (78.048), sterile grain (73.22).

Genetic advance

The highest genetic advance as percentage of mean were recorded for the characters sterile grain (94.531), stem

thickness (84.377), grain yield (71.446), number of panicles (67.804), hulling percentage (64.383), decorticated grain width (60.302), stem length (55.964), plant height (54.128), 1000 seed weight (52.429), flag leaf length (52.36), panicle length (44.355), grain length breadth ratio (37.532), decorticated grain length (31.902). Similar type of results were reported by Ali *et al.* (2018) [2], Bhargavi *et al.* (2021) [5], Bhor *et al.* (2020) [4], Gupta *et al.* (2020) [7], Lakshmi *et al.* (2021) [10]

The moderate genetic advance as percentage of mean was recorded by grain length (29.457), grain breadth (27.91), days to 50 % flowering (27.226), decorticated grain length breadth ratio (23.007), leaf breadth (21.085), time of maturity (20.491).

Since broad sense heritability includes both additive and epistatic effects it will be reliable only when accompanied by high genetic advance. Heritability estimates along with genetic advance is more useful than heritability alone in predicting the effectiveness of selection (Johnson *et al.* 1955) [9]. In the present study the characters which showed high heritability associated with high genetic advance are sterile grain, stem thickness, grain yield, number of panicles, hulling percentage, decorticated grain width, stem length, plant height, 1000 seed weight, flag leaf length, panicle length, grain length breadth ratio, decorticated grain length. This indicates that heritability in these characters are governed by additive gene effects and direct selection for these traits which are fixable in nature may lead to development of desirable rice plant.

High heritability with moderate genetic advance as percentage of mean was observed for grain length, grain breadth, days to 50% flowering, decorticated grain length breadth ratio, leaf breadth, time of maturity.

Table 1: Genetic parameters of variation for yield and quality traits

S. No.	Characters	Mean	Range		GCV (%)	PCV (%)	h ² (bs) (%)	GA	GA as % of mean
			Min	Max					
1	Days of 50% flowering (days)	102.13	76.5	123.6	13.24	13.28	99.52	27.80	27.22
2	Plant height (cm)	124.59	69.33	197.5	26.34	26.39	99.56	67.44	54.12
3	Panicle length (cm)	23.63	12.35	48	21.61	21.70	99.21	10.53	44.35
4	Flag leaf length (cm)	32.87	19.83	50.33	25.48	25.55	99.46	17.21	52.36
5	Flag leaf width (cm)	1.036	0.62	1.39	11.25	12.36	82.76	0.21	21.08
6	Sterile grains/ panicle	29.26	4	75	53.62	62.69	73.24	27.66	94.53
7	Stem thickness (cm)	0.15	0.03	0.39	49.99	61.02	67.12	0.13	84.37
8	Stem length (cm)	88.73	43.16	142	27.19	27.23	99.76	49.65	55.96
9	Number of panicles/plant	13.25	7	32.5	34.98	37.17	88.53	8.99	67.80
10	Time of maturity (days)	137.35	111.5	158.5	9.97	10.00	99.45	28.14	20.49
11	1000 seed weight (g)	31.53	15.08	48.15	25.51	25.58	99.47	16.53	52.42
12	Grain length (mm)	8.09	5.05	10.10	14.65	15.01	95.24	2.38	29.45
13	Grain breadth (mm)	2.54	1.85	3.47	15.33	17.36	78.04	0.71	27.91
14	Grain l/b ratio	3.27	1.54	5.01	19.98	22.05	82.21	1.22	37.35
15	Decorticated grain length (mm)	5.42	3.05	8	17.36	19.46	79.54	1.73	31.90
16	Decorticated grain width (mm)	1.25	1	2.3	29.91	30.56	95.73	0.75	60.30
17	Decorticated grain l/b ratio	4.73	1.52	8	32.67	34.15	91.51	3.04	64.38
18	Hulling %	68.56	48.81	84.46	11.25	11.32	98.55	15.75	23.00
19	Grain yield/ plant (g)	17.65	5.83	29.89	35.00	35.32	98.18	12.61	71.44

Conclusion

The analysis of variance indicated that the mean sum of squares due to genotype were significant for all the yield and quality characters. This indicates the presence of considerable variability among the 58 rice genotypes for the traits taken into consideration. The high genotypic and phenotypic coefficient of variation was recorded for all the

traits. The high magnitude of genotypic coefficient of variation revealed the presence of high amount of genetic variability for the characters studied in the population and thus offers scope for genetic improvement through selection for this character. The relatively less differences between genotypic coefficient of variation and phenotypic coefficient of variation were recorded for all the characters, indicating

less environmental influence in the expression of these attributes.

High heritability coupled with high genetic advance as percent of mean was observed for days to 50% flowering, number of panicles per plant, plant height, panicle length, 1000 seed weight, grain yield per plant, flag leaf length, flag leaf width, sterile grain per Panicle, stem thickness, stem length, time of maturity, grain l/b ratio, decorticated grain length, decorticated grain l/b ratio and Hulling percentage, suggesting that these characters are governed by additive genes and selection for these traits will be useful in improving grain yield.

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New knowledge is produced through research. To achieve something good with light patience, vigour, and dedication on the part of the individual, research requires the close cooperation of friends and colleagues as well as the direction of specialists in the field. These remarks serve as extremely thanks, never quite compensating them for their invaluable assistance and collaboration. New knowledge is produced through research. To achieve something good with light patience, vigour, and dedication on the part of the individual, research requires the close cooperation of friends and colleagues as well as the direction of specialists in the field. These remarks serve as a extremely thanks, never quite compensating them for their invaluable assistance and collaboration. New knowledge is produced through research. To be successful, research requires the intimate assistance of friends, colleagues, and subject-matter specialists.

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