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Genetic Variability, Heritability and Other Quantitative Characters Studies in Leading Varieties and Landraces of Rice (*Oryza sativa* L.)

Varsha Gayatonde, Prudhvi Raj Vennela, Mahadevu

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Abstract Thirty eight varieties and 43 landraces of rice of Southern Karnataka were evaluated for ten quantitative characters. Heritability in broad sense was very high for chaffyness percent followed by number of tillers and productive tillers in released varieties. Among landraces plant height had highest heritability followed by productive tillers, germination percentage and seed length. PCV estimates were higher than GCV for majority of the characters. The study signified high heritability coupled with high GAM for seeds per panicle and grain yield in both released and traditional varieties. Landraces such as Sannaki, Bilidoddibudda, Karigajivele, Jeerigesanna and Marabatta found to be promising as short duration potential donors where, Sannamullare, Kichadi samba, Gandha sale, Karidoddi, Kanadatumba, Mugadsugandha, Adikane, Karigajivele could be exploited for developing dual purpose rice varieties.

Keywords GCV, PCV, GAM, Heritability, Variability.

V. Gayatonde*[1], Prudhvi Raj Vennela[2], Mahadevu[3]
[1 2] Students, Research Scholars, Department of Genetics and Plant Breeding, BHU, Varanasi, India
[3]Research Guide, Associate Professor, A. C. College, Mandya, UAS, Bangalore, Karnataka, India
e-mail: varshapanchu@gmail.com
*Correspondence

Introduction

Rice is a staple for nearly half of the world's seven billionpeople. However, more than 90% of this rice is consumption is in Asia, where it is a staple for a majority of the population, including the region's 560 million hungrypeople [1]. Rice occupies a pivotal place in Indian agriculture as it is a staple food for more than 70% of population and a source of livelihood for about 120 to 150 million rural households [2]. It accounts for about 43% of food grain production in the country. At the current rate of population growth, which is 1.8%, rice requirement by 2020 would be around 140 million tons [3].

To meet the food demand of the growing population and to achieve food security in the country, the present production levels need to be increased by 1.8-2 million tons every year [2] which is possible through heterosis breeding and other innovative breeding approaches. To increase the present levels of heterosis for yield, there is a need to identify and utilize genetically divergent parents for in crossing program which could be selected from landraces and leading varieties. A systematic evaluation and characterization of rice accessions helps in identification of superior, genetically divergent landraces and varieties and also provides information on the utility of the genetic resources [3]. Characterization of accessions provides the informantion on morphological and agronomic aspects of the material that is essential for the gene bank management [4]. The development of varieties is a continuous process and effectiveness of selection depends primarily upon the magnitude of genetic variability in thebreeding material at hand. Keeping in view on the importance of varietal improvement rice, therefore, the present investigation was undertaken to study the genetic variability, heritability and other quantitative characters studies in leading varieties and landraces of southern Karnataka.

Materials and Methods

A field experiment was conducted during *kharif* of 2013, at zonal agricultural research station, Mandya, Karnataka, India. Situated at 12⁰00 ´N latitude, 76⁰00´N longitude and altitude of 696 m above mean sea level located in southern dry zone with 38 varieties and 43 landraces. Traits were laid out in an augmented design with a spacing of 20 × 15 cm and 30 days old seedlings were transplanted in standard plot size with one seedling per hill. Standard agronomic practices and plant protection measures were taken as per schedule. The data were collected on ten phenotypic characters viz., days to 50% flowering, plant height (cm), number of tillers, number of productive tillers, panicle length (cm), test weight (g), percent healthy seeds, percent chaffynes, seeds per panicle and grain yield per plant (g). Analysis of variance for all the characters was carried out by Windows stat and SPSS software and the genetic parameters such as PCV and GCV, heritability broad sense (h^2) were calculated [5], and genetic advance in percent of mean (genetic gain) were work out.

Results and Discussion

The 10 quantitative traits studied were categorized into growth traits and grain yield traits. The variability parameters such as mean, range, standardized range, PCV, GCV, h^2 (broad sense) and genetic advance of % mean (GAM) both in varieties and landraces are given in Tables 1 and 2 respectively. Differences among the traits justified by taking the significant differences (ANOVA).

Exploitation of natural genetic variability help to meet short-term objectives as very often breeders are forced to meet immediate requirement of the farmers, consumers and end-users. Selection by farmers and/ or plant breeders has resulted in significant genetic improvement in crop productivity. However, continued crop genetic improvement to meet medium and/ long-term requirements requires availability of variability induced through deliberately planned crosses among the genotypes harboring desired combination of traits. Highly significant mean squares suggested substantial variability among varieties for all the traits among the varieties and landraces evaluated in a season, *kharif* of 2013.

Considering the rice varieties, per cent chaffy seeds showed the larger variation among the growth traits as indicated by standardized range (3.47), followed by grain yield (1.88), seeds per panicle (1.64) and lowest in days to 50% flowering. Panicle length (0.41). Estimates of GCV were higher for chaffy grains percentage (28.98). Moderate GCV with high heritability (100%) and GAM was noticed for productive

Table 1. Descriptive statistics and study of variability for growth and yield traits in rice varieties.

Parameters	Mean ± SE	Sd	Range	Standardized range	Min	Max	GCV	PCV	h^2 % (broad swense)	GAM%
Days to 50% flowering	96 ± 1.5	8.77	30.00	0.31	85.00	115.00	7.70	8.40	84.47	14.61
Plant height	114±3.2	18.85	85.36	0.75	70.44	155.80	14.28	15.06	89.83	27.88
No. of tillers	8 ± 0.32	1.91	7.20	0.90	6.20	13.40	19.31	21.40	81.00	36.00
Panicle length	7 ± 0.31	1.85	7.80	1.11	4.20	12.00	18.90	21.40	77.90	34.50
Productive tillers	22 ± 0.30	1.73	8.59	0.39	17.21	25.80	5.52	7.35	56.60	8.55
Seeds per panicle	192 ±14.36	83.74	314.78	1.64	88.15	402.93	39.49	39.00	99.30	81.34
Test weight	23 ± 0.83	4.85	25.20	1.10	6.60	31.80	20.00	24.08	50.00	39.70
Per cent healthy seeds	90 ± 1.18	6.92	31.26	0.35	64.78	96.04	6.96	6.99	40.00	6.50
Per cent chaffy seeds	9 ± 1.18	6.92	31.26	3.47	3.96	35.22	67.00	66.50	98.00	89.30
Grain yield (g/plant)	58.7 ± 3.32	19.41	67.80	1.14	28.80	96.60	28.82	30.23	90.00	56.60

Table 2. Descriptive statistics and study of variability for growth and yield traits in landraces.

Sl. No.	Particulars	Mean ± SE	Standard deviation	Range	Standardized range	Min	Max	GCV	PCV	H^2 (broad sense) %	GAM%
1	Days to 50% flowering	102 ± 0.77	5.080	24	0.24	91	115	4.58	4.58	98	9.45
2	Plant height	122 ± 1.80	11.86	56.64	0.46	85.16	141.80	8.95	8.95	98	18.43
3	No. of tillers	8 ± 0.36	2.40	10.60	1.33	5.2	15.80	25.10	25.12	99	51.70
4	Panicle length	21 ± 0.31	2.06	8.60	0.41	17.90	26.50	7.06	9.12	59.98	11.27
5	No. of productive tillers	7 ± 0.28	1.90	8.60	1.23	5	13.60	23.20	23.28	99	47.64
6	Seeds per panicle	169 ± 9.60	63.22	282.16	1.67	55.36	337.52	20.67	20.69	95.30	42.80
7	Test weight	21± 0.74	4.91	21.80	1.04	10	31.80	33	34.67	90.59	64.71
8	Healthy seeds %	84 ± 2.90	19.46	88.20	1.05	8.08	96.29	21.26	21.27	98.30	43.77
9	Chaffy seeds %	15 ± 2.96	19.46	88.20	5.88	3.71	91.92	96.80	97.33	99.30	98.33
10	Grain yield	150.3 ± 31.70	31.70	238	1.88	26.18	240	53.30	60.30	19.80	5.00

tillers. High heritability was also observed in days to 50% flowering. Among the 10 traits no significant results were found in days to 50% flowering, panicle length and test weight. More significant differences were found in traits like per cent chaffy grains and productive tillers.

In landraces among the 10 traits, per cent chaffy grains showed highest variability (5.5) followed by grain yield (1.89), and test weight. Lowest variability found in days to 50% flowering. High PCV was observed in per cent chaffy grains and also narrow difference between the PCV and GCV was noticed for the same trait. Moderate GCV with high heritability (99%) was found in number of tillers indicates additive genetic action is ruling the trait per cent chaffy grains and number if productive tillers. Among the 10 traits no significance differences were found in panicle length. Significant differences were found in traits like per cent chaffy grains and productive tillers.

A wide range of variability as indicated by the occurrence of an extreme varieties was evident for, chaffynes and productive tillers and number of tillers during *kharif* season and the same trend is reflected in comparison of landraces and released varieties also. However, occurrence of traits such as panicle length, plant height, days to 50% flowering and chaffyness was pronounced in *kharif*, both in released varieties and landraces. One deviation from this trend was observed for grain yield per plant which showed high variability in comparison of released to landraces. A rather lower variability for panicle length (0.41) and days to fifty per cent flowering among the released varieties indicates that, not many useful accessions are available in the collection for the improvement of grain yield. However, advanced breeding lines and some landraces such as Sannaki, Bilidoddibudda, Karigajivele, Jeerigesanna and Marabatta for short duration could be utilized for breeding short duration rice cultivars in high yielding background.

Landraces with a better ability to produce large number of productive tillers such as Sannamullare, Kichadi samba, Gandha sale, Karidoddi, Kanadatumba, Mugadsugandha, Adikane and Karigajivele could be exploited for developing dual purpose rice varieties. However released varieties are always known for their high yielding ability. Higher per cent chaffyness is not a desirable trait in any cultivars. But due to the neck blast infection during plant reproductive stage chaffyness was pronounced in many of the varieties, but comparing the two groups released varieties were having more chaffyness which indicates though landraces are low yield but have better resistant response.

In general, a higher PCV than GCV coupled with narrow difference indicates less environmental impact on majority of traits. Eg. Seeds per panicle and chaffyness. Similar observations were reported by Hasib [6]. Number of tillers showed higher heritability in varieties and panicle length, productive tillers plant^{-1}, chaffy panicle^{-1}, and 1000 grain weight were highly heritable in landraces. Moderate heritability was recorded for panicle length and number of tillers during *kharif.* Low heritability was noticed for healthy seeds. Heritability is a function of genotypic and phenotypic variation. These results are in conformity with those reported by Ganapathy et al. [7].

High expected GAM for percent chaffyness, seeds per panicle; moderate expected GAM for grain yield and low GAM for in number of productive tillers. These results are in conformity with those reported by Kuldeep et al. [8]. High heritability coupled with high expected genetic advance indicated the effectiveness of selection for productive tillers and number of tillers. Similar reports were observed by Mall et al. [9] and Ganapathy et al. [7] Moderate heritability coupled with moderate genetic advance was observed for grain yield plant^{-1}. The traits such as chaffy spikelet panicle^{-1},test weight and grain yield plant^{-1} exhibited low heritability with moderate genetic advance indicating influence of non-additive gene effects in the inheritance of these characters.

Conclusion

Substantial variability among the genotypes for these traits considered in the study is expected as they have evolved through the combination of natural and artificial selection operated on the variation created by mutational events and reshuffled by recombination. Selection pressures exerted by varying crop management practices under different production constraints and farmers preferences have further led to the differentiation of the varieties that differed from place to place, with each characterized by a higher level of adaptation to a given environment [10]. The variation in quantitative traits is the reflection of variation in human selection pressures driven by target environment-specific preferences and requirements. As rice is predominantly a self-pollinated crop, the landraces are a mixture of pure-lines, each of which possess a slightly different combination of traits and hence are better adapted to different production environment and / or a combination of production environments. Productivity increase and stability cannot be achieved from single traits but rather from different combinations of traits under unpredictable and unfavorable environments in the face of inevitable climate change. Through increased use of released varieties and landraces that harbor time tested traits, it is possible to develop rice cultivars that are suitable for adaptation to environment production constraints, especially of abiotic stresses whose occurrence are expected to vary in timing, intensity, duration and crop growth stage.

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