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Exploring Genetic Variability Among Aromatic Rice (*Oryza sativa* L) Landraces in Odisha

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ABSTRACT: A total of 108 aromatic rice landraces were evaluated to assess genetic variability, broad-sense heritability, and genetic advance concerning yield and rice blast disease response. Across seasons, variations were noted in the estimated genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). Generally, PCV values exceeded GCV values for the parameters studied. Notably, GCV was moderate for the number of tillers per plant and low for plant height, while grain yield per hill, 100 grain weight, and rice blast PDI showed high GCV values. Plant height exhibited moderate heritability alongside low genetic advance, whereas the number of tillers per plant, 100 grain weight, and rice blast PDI displayed high heritability coupled with high genetic advance. These observations provide valuable insights for breeding improved aromatic rice genotypes.

Keywords: Aromatic rice, Landraces, Genetic variability, Heritability, yield.

INTRODUCTION

Rice (*Oryza sativa* L.), the fundamental food crop worldwide, serves as the main livelihood for many Asians. Aromatic rice, recognized since ancient times, holds a prominent status due to consumers' preference for its distinctive aroma, alongside other desirable quality traits. Short-grain aromatic rice types have been grown throughout India, mainly on a small scale within specific regions, for religious observances, festivals, hosting guests, and daily consumption. Several states boast themselves on their distinctive collection of aromatic short-grain rice varieties. The depletion of these invaluable resources following the green revolution raises concerns regarding germplasm preservation. Considering that rice landraces, situated as an intermediate group between cultivated and wild varieties, possess exceptional genetic potential for uncovering new traits and the genes or alleles responsible for them, the systematic characterization of these resources across various collections holds paramount importance (Pusadee *et al.,* 2009). Nevertheless, because of insufficient research attention and comprehensive characterization, numerous outstanding genotypes within these landraces remain untapped. There exists ample opportunity for enhancing the productivity of this crop through varietal improvement and hybrid development. The foremost consideration in facilitating genetic improvement of a crop is the exploration of genetic variability. A thorough understanding of the inheritance patterns of quantitative traits and knowledge about the heritability of grain yield, its components, and susceptibility to diseases are crucial for devising an effective breeding strategy (Chakravorty *et al.,* 2013). Heritability serves as an indicator of the transmission of traits from parents to their offspring and holds significance in the selection process within plant breeding. Genetic advance offers insights into the anticipated gains resulting from the selection of superior individuals. Both heritability and genetic advance serve as crucial selection parameters aiding in the prediction of gains under selection. The current study aimed to assess the extent of variability and heritability concerning yield-contributing traits and susceptibility to rice blast disease, focusing on aromatic landraces from Odisha.

MATERIAL AND METHODS

A. Experimental material

A total of one hundred and eight aromatic landraces of Odisha were obtained from the National Gene Bank at

ICAR National Rice Research Institute, Cuttack. The evaluation of these landraces for their yield performance was conducted at the Experimental Farm of ICAR NRRI, Cuttack. During the rabi season of 2022, the genotypes were cultivated using an augmented design. Crop cultivation followed the standard agronomic practices recommended by the Odisha University of Agriculture and Technology. Observations were made on various quantitative traits, including plant height, number of tillers per plant, 100-grain weight, grain yield per hill, and disease reaction to rice blast across the genotypes.

B. Statistical analysis

The agro-morphological data were statistically analysed through analysis of variance (ANOVA) using R Version 4.3.1 software. Subsequently, the data were subjected to further analysis within the R software package to compute the Genetic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), Heritability (broad sense) expressed as a percentage, Genetic Advance, and Genetic Advance as a percentage of the mean. Additionally, heritability in broad sense was determined according to the ratio of genotypic variance to total variance in a non-segregating population, following the classification by Hanson *et al.* (1956), where low heritability ranges from 0 to 30%, moderate heritability ranges from 30 to 60%, and high heritability exceeds 60%.Expected genetic advance values for various traits were also categorized into low, moderate, and high based on thresholds proposed by Johnson *et al*. (1955): Low genetic advance (0 - 10%), moderate genetic advance (10 - 20%), and high genetic advance (> 20%).

RESULTS AND DISCUSSION

A. Assessment of genetic variance components

Understanding the genetic diversity among genotypes is paramount for the success of breeding initiatives, as it forms the basis for effective selection. The examination of variance has unveiled noteworthy differences among genotypes across all studied traits, underscoring the considerable variability inherent in the genetic material. Agronomic traits and yield characteristics, being primarily quantitative in nature, are subject to the influence of both genetic makeup and environmental conditions. The variance analysis revealed significant differences among genotypes for all studied traits, indicating substantial variability within the material. Table 1 presents the general mean and estimates of variability, including the Genetic coefficient of variation (%), Phenotypic coefficient of variation (%), Heritability (%) (broad sense), and Genetic Advance as a percentage of the mean. Notably, for three traits—plant height, no. of tillers/ plant and grain yield/hill—Phenotypic coefficients of variation (PCV) values exceeded Genotypic coefficient of variation (GCV). However, the observation of closer values between Phenotypic coefficient of variation (PCV) and Genotypic coefficient of variation (GCV) for 100 grain weight and rice blast PDI suggests that these traits are minimally influenced by environmental factors. These findings suggest that selecting based on these traits is likely to produce favorable outcomes in future breeding programs. Similar results were reported in a study conducted by Roy and Shil (2020). Significant genotypic coefficients of variation were noted for traits such as 100-grain weight, grain yield per hill, and PDI, indicating their potential for improvement through selective breeding. The phenotypic and genotypic coefficients of variation were moderate for 100-grain weight and PDI. Notably, high PCV values were observed for grain yield per hill and PDI. The genotypic coefficient of variation ranged from 6.08% (plant height) to 38.65% (PDI), while the PCV varied from 7.96% (plant height) to 38.73% (PDI). Very similar findings were reported by Gyawali *et al.* (2018). The mean plant height among the genotypes ranged from 182.00 to 106.00 cm, while the number of tillers per plant ranged from 3 to 13, with a mean value of 7.5. Similar variation was also observed concerning rice blast PDI, grain yield per hill, and 100-grain weight.

B. Heritability and genetic advance as percent of mean

The broad-sense heritability, as highlighted by Bisen *et al.* (2019), underscores the combined influence of phenotypic and genotypic variations in the parameters under investigation, playing a pivotal role in selection processes. The heritability estimates ranged widely, from 49.00% for Grain yield/hill to 99.59% for rice blast PDI. Notably high heritability was observed for No. of tillers/plant (65.03%), 100 grain weight (98.00%), and rice blast PDI (99.59%), suggesting a significant presence of additive genetic control, consistent with findings by Hossain *et al.* (2018) in rice genotypes. Moderate heritability was recorded for Grain yield/hill (49.00%) and plant height (58.00%), possibly attributable to environmental influences on phenotypic traits. These observations resonate with those made by Naveenkumar *et al.* (2021) in their study involving 192 rice landraces.

Genetic advance serves as a crucial metric indicating the potential progress attainable through population selection, as emphasized by Islam *et al.* (2015). Across traits, the genetic advance exhibited significant variability, ranging from 0.75% for 100 grain weight to 55.62% for rice blast PDI. Notably, one trait, plant height, showed a relatively low genetic advance as a percentage of the mean, standing at 9.58%. Conversely, traits with high genetic advance as a percent of mean (GAM) suggest a predominant influence of additive gene action, thus indicating their suitability for genetic enhancement through selection. In this study, traits such as No. of tillers/plant (30.26%), 100 grain weight (49.99%), Grain yield/hill (35.26%), and rice blast PDI (79.46%) exhibited high GAM. This finding aligns with results reported by Ajmera *et al.* (2017); Demeke *et al.* (2022) for the above mentioned traits.

Understanding both heritability and genetic advance together provides deeper insights than solely examining heritability, as emphasized by Amegan *et al.* (2020). In their study, traits showing high heritability along with high genetic advance as a percentage of mean (GAM) included the number of tillers per plant (65.03%, 30.26%), 100-grain weight (98.00%, 49.99%), and rice blast PDI (99.59%, 79.46%). This indicates a substantial influence of additive genes on these traits, with minimal impact from non-additive genes (Table 1). Consequently, these traits are likely to be responsive to improvement through direct selection processes. Similarly, Demeke *et al.* (2022) observed comparable trends for the number of tillers per plant and grain weight across 68 hybrid rice genotypes.

Table 1: Variability, heritability and genetic advance for quantitative traits in aromatic rice landraces.

Characters	Mean	Range		GCV	PCV	Heritability (H^2) %	Genetic Advance	Genetic Advance as percentage of mean
		Maximum	Minimum					
Plant Height (cm)	138.78	182.00	106.00	6.08	7.96	58.00	13.30	9.58
No. of tillers/ plant	7.50	13.00	3.00	18.21	22.59	65.03	2.27	30.26
100 grain weight (g)	1.50	2.98	0.90	24.39	24.51	98.00	0.75	49.99
Grain yield/ hill (g)	13.83	32.25	4.20	24.36	34.68	49.00	4.87	35.26
Rice blast Percent Disease Index(PDI)	70.00	100.00	6.53	38.65	38.73	99.59	55.62	79.46

CONCLUSIONS

Higher heritability estimates suggest that these traits were relatively less influenced by environmental factors, indicating that their phenotypes accurately reflect genotypes and are therefore crucial for selecting superior genotypes based on phenotypic performance. Conversely, traits with lower heritability may benefit from pedigree, sib, or progeny tests for genetic improvement. The moderate heritability estimates for traits such as yield and plant height suggested a dominance of non-additive variance for yield in the studied material. Traits exhibiting high heritability along with high genetic advance indicated that additive gene action primarily governed their heritability. Similarly, traits with moderate to high heritability coupled with high to moderate genetic advance implied that additive gene action contributed to their heritability. This suggests that such traits could undergo further improvement through selective breeding in subsequent generations.

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Conflicts of interest. None.

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