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Studies on genetic variability in rice (*Oryza sativa* (L.) genotypes under aerobic condition

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Abstract
The present study was carried out at Anbil Dharmalingam Agricultural College and Research Institute, Trichy under aerobic conditions. The experimental material comprised forty-nine rice genotypes, which were laid out in randomized complete block design. Observations were recorded for ten quantitative characters, and the data were analyzed for biometric characters *viz*., phenotypic coefficient of variation (PCV), genotypic co-efficient of variation (GCV), heritability (h^2), and genetic advance as percent of the mean (GAM). High heritability and high genetic advance were observed for all the characters except grain yield per plant, indicating the presence of high variability among the rice genotypes. High heritability coupled with genetic advance as per cent of mean was observed for all the characters except days to maturity it may be due to additive effects and selection may be effective for those characters with high heritability and genetic advance.

Keywords: Rice genotype, heritability, PCV, GCV, genetic advance

Introduction

Rice is an important cereal crop, which is mainly grown under submerged conditions, but there is a need for a strategy for growing under aerobic conditions to decrease water use in rice production. Aerobic cultivation requires fifty percent or less of the water used by lowland rice. Aerobic rice cultivation is most likely to be of interest to farmers in environments with limited or unreliable irrigation and moderate drought tolerance, particularly during the sensitive reproductive stage (Amudha and Thiyagarajan, 2011) [3]. Thus, to reduce water use in rice production and to maintain rice productivity in a water-short rice environment, there is an immediate need to accelerate the genetic improvement of rice under aerobic conditions. High-yielding rice varieties that are bred for lowland ecosystems generally perform poorly in aerobic condition. Hence, there is a need to study the variability of rice varieties/genotypes under aerobic condition. Hence, the present study was formulated to evaluate the genetic variability of rice varieties/landrace prevailing in Tamil Nadu.

Materials and methods

The present investigation was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Trichy, under aerobic conditions with 49 rice genotypes comprising 34 rice varieties, 10 rice landraces, and 6 advanced breeding lines. The experiment was laid out in a randomized block design with two replications. The observations were recorded from five randomly selected plants in each genotype for ten characters *viz*., days to 50% flowering, plant height, number of tillers per plant, number of productive tillers per plant, panicle length, number of grains per panicle, spikelet fertility, grain yield per plant, straw yield per plant and harvest index. The data were subjected to analysis of variance according to the method recommended by Panse and Sukhatme (1985) [23]. Phenotypic and genotypic co-efficient of variation were computed according to the method suggested by Burton (1952) [5]. Heritability on broad sense was calculated as per formula given by Allard (1960) [2]. Genetic advance was expressed by using the formula suggested by Johnson *et al.* (1955) [13].

Result and discussion

Analysis of variance revealed that the mean sum of squares due to genotypes was highly significant for all the characters under study (Table 1). It indicates that the rice genotypes tested were highly variable. The variations in rice genotypes were also reported by Dhurai *et al*. (2014) [8], Konate *et al.* (2016) [15] and Singh *et al.* (2023) [29]. The estimates of mean, range, phenotypic coefficient of variation (PCV), genotypic co-efficient of variation (GCV), heritability (h2), and genetic advance as percent of the mean (GAM) were presented in Table 2.

The highest PCV and GCV were observed for panicle length (45.83% and 46.28%) followed by number of productive tillers per plant (37.76% and 40.48%), number of tillers per plant (33.71% and 35.11%), grain yield per plant (31.95% and 41.50%), straw yield per plant (28.99% and 34.88%), harvest index (24.67% and 25.31%), grains per panicle (23.01% and 34.15%) and plant height (20.17% and 23.80%). Hence, these characters are more suitable for direct selection. Similar findings were reported by Nayak *et al*. (2002) [20], Habib (2005) [12], Deepa Sankar *et al*. (2006) [7] and Faysal *et al.* (2022) [11]. The authors Williams *et al.* (2021) [32] for the number of productive tillers per plant and grain yield per plant,) Nikhitha *et al*. (2020) [22], Fatima *et al*. (2021), Bhargava *et al*. (2021) [4] and Singh *et al*. (2021) [30] reported for plant height, number of productive tillers per plant, and number of grains per panicle while Lakshmi *et al.* (2021) [17] and Mounika *et al.* (2022) [19] reported for the trait number of grains per panicle.

Moderate PCV and GCV were recorded for days to 50% flowering (19.38% and 19.95%) and spikelet fertility (15.50% and 19.55%). The results were in accordance with Nayak *et al*. (2003) [21], Patil *et al*. (2003) [24], and Sarkar *et al*. (2007) [26]. Divya and Pandey (2020) [9], Sudeepthi *et al.* (2020) [31], Sadhana *et al*. (2022) [25] for grain yield per plant, and Manjunatha and Kumara (2019) [18] for the number of grains per panicle. The moderate and low values of PCV and GCV, restrict the scope for the selection of genotypes based on these characters.

The rice genotypes under study showed high heritability for all the characters except grains per panicle and grain yield per plant. The highest heritability was recorded for panicle length (98.07%) followed by harvest index (95.06%), days to 50% flowering (94.30%), number of tillers per plant (92.19%), number of productive tillers per plant (86.98%), plant height (71.86%), straw yield per plant (69.09%), and spikelet fertility (62.86%). Heritability estimates were more than 60% for these characters which indicates that these characters were less influenced by environmental conditions and phenotypic selection would be effective for these characters.

It is a difference between the mean genotypic value of selected lines and the mean genotypic value of the population before selection. The highest value of genetic advance was recorded for panicle length (93.50%) followed by the number of productive tillers per plant (72.54%), grain yield per plant (50.68%), straw yield per plant (49.65%) harvest index (49.56%), days to 50% flowering (38.77%), plant height (35.24%), number of grains per panicle (31.97%) and spikelet fertility (25.32%).

The heritability and genetic advance are important selection parameters. The heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection (Johnson *et al*., 1955) [13]. High heritability and high genetic advance were recorded for all the characters except grain yield per plant and grains per panicle. The direct selection for these characters would be effective as heritability and genetic advance are high due to additive gene interaction. Similar results of high heritability and high genetic advance were obtained by Nayak *et al*. (2002) [20], Chaudhary and Motiramani, (2003) [6], Deepa Sankar *et al*. (2006) [7], Akinwale *et al*. (2011) [1], Kavyashree *et al*. (2022) [14], Fatima *et al*.(2021), Bhargava *et al*. (2021) [4] and Sheena and Lavanya (2023) [28] for plant height, number of productive tillers per plant, number of grains per panicle and grain yield per plant. Nikhitha *et al*. (2020) [22], and Singh *et al*. (2021) [30] reported for plant height. Lakshmi *et al*. (2021) [17] for spikelet fertility and grains per panicle, Shankar *et al*. (2016) [27] reported for grain yield per plant.

Conclusion

Higher values of PCV and GCV for the characters panicle length, number of productive tillers per plant, number of tillers per plant, grain yield per plant, straw yield per plant, harvest index, grains per panicle, and plant height indicate higher variability among these characters. The estimates of high heritability and high genetic advance were observed for all the characters taken except grain yield per plant and grains per panicle. The direct selection for these characters would be effective which might be due to the presence of additive gene controlling these characters.

Table 1: Analysis of variance of RBD for different traits

character	Mean sum of squares		
	Replication	Genotype	error
Degrees of freedom	1	48	48
Days to 50% flowering	1.23	398.58**	4.67
Plant height	74.42	1217.16**	199.25
Number of tillers per plant	255.38	291.85**	227.78
Number of productive tillers per plant	5.92	73.72**	5.12
Panicle length	20.29	266.40**	2.58
Number of grains per panicle	1062.60	2281.53**	856.83
Spikelet fertility	15.68	375.42**	85.60
Grain yield per plant	47.32	392.47**	71.74
Straw yield per plant	1.77	216.28**	55.27
Harvest index	0.0005	0.0192**	0.0005

**- significance at 1% level

Table 2: Variability parameters for yield and other component traits in rice

Character	Mean	Range	GCV (%)	PCV (%)	Heritability	GA (%)
Days to 50% flowering	71.76	46.00-112.00	19.38	19.95	94.30	38.77
Plant height	112.70	47.80-162.05	20.17	23.80	71.86	35.24
Number of tillers per plant	117.83	8.20-90.70	33.71	35.11	92.19	21.15
Number of productive tillers per plant	15.61	7.00-38.20	37.76	40.48	86.98	72.54
Panicle length	25.04	16.35-101.60	45.83	46.28	98.07	93.50
Number of grains per panicle	114.96	64.40-212.80	23.01	34.15	45.41	31.95
Spikelet fertility	78.04	25.70-95.51	15.50	19.55	62.86	25.32
Straw yield per plant	43.66	17.70-82.50	28.99	34.88	69.09	49.65
Grain yield per plant	28.07	12.20-55.50	31.95	41.50	59.29	50.68
Harvest index	0.39	0.19-0.73	24.67	25.31	95.06	49.56

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