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Assessment of Genetic Variability, Heritability and Genetic Advance for Heat Tolerance in Rice (*Oryza sativa* L.)

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ABSTRACT
The genetic parameters were studied to generate information on genetic variability, heritability and genetic advance among fifty rice genotypes at the experimental farm of Genetics and Plant Breeding of Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu. Significant difference among the genotypes was revealed through the analysis of variance. Moderate PCV and GCV were recorded for hundred grain weight, panicle length , plant height at maturity and total number of productive tillers per plant indicating that all these characters are amenable for further improvement. High heritability coupled with moderate genetic advance as per cent of mean was observed for panicle length, plant height at maturity and 100 grain weight which indicated that these characters are governed by additive genes though influenced by environment.
Key words: Rice, Heritability, Genetic Advance and Heat stress

INTRODUCTION

High temperature (heat) stress is considered to be one of the major environmental factors limiting crop growth and yield. This stress induces many biochemical, molecular, and physiological changes and responses that influence various cellular and whole plant processes that affect crop yield and quality. Heat stress (increase in above-optimum air temperature) often occurs, but they can have very different effects on various physiological growths, development, and yield processes. The rise in atmospheric temperature causes detrimental effects on growth, yield, and quality of the rice crop by affecting its phenology, physiology, and yield components [8, 9]. The sensitivity of rice to high temperature varies with growth phase, an increase in day/night temperature and genotype [5].The growth of a rice plant can be broadly divided into three phases: vegetative, reproductive and ripening or grain filling. The vegetative phase culminates with panicle initiation (PI), the reproductive phase with anthesis (flowering)and grain-filling at grain maturity. The genotype of the rice plant largely defines the characteristics of each phase, although the growth environment of the plant also contributes to the overall source-sink dynamics of the plant [6]. The impact of increased temperature has an accumulative effect on the later phases of plant development; changes in the vegetative and ripening phase will alter the grain-filling phase and thus, the grain quality of the rice. Rice has been cultivated under a wide range of climatic conditions. Almost 90% of the world's rice is grown and consumed in Asia, where 50% of the population depends on rice for food. However, the rice crop during the sensitive flowering and early grain-filling stages is currently exposed to temperatures higher than the critical threshold of 33 oC in South Asia and Southeast Asia [7].
Rice exhibits a good amount of variability for various characters. Co-efficient of variation is useful in the assessment of genetic variability for the particular characters Heritability is an index of transmission of characters from parents to their offspring (Falconer, 1989). Heritability denotes the proportion of phenotypic variation repeatable and is due to genes and thus helps the breeders to select the elite variety for a character. High heritability alone is not enough to make efficient selection, unless information is accompanied by substantial amount of genetic advance [3]. Genetic advance denotes the improvement in the mean values of selected families over the base population [4] and thus helps the breeder to select the progenies in the earlier generation itself.

MATERIALS AND METHODS

The present investigation was conducted at the experimental farm of Genetics and Plant Breeding of Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu (Latitude: 11º 24‟ N; Longitude: 79º44‟ E; Altitude: +5.79 Mtrs), India. Fifty rice genotypes were evaluated in a randomized block design with three replications. The net plot size was 3m×1m with 20cm and 15cm spacing between rows and plants respectively. All recommended cultural practices were followed to raise the experiment. Observations on days to first flowering, total number of tillers per plant, total number of productive tillers per plant , panicle length, pollen fertility), total number of spikelets per panicle , total number of filled spikelets per panicle, plant height at maturity , spikelet fertility , 100 grain weight , grain yield per plant were recorded on five randomly selected plants in each replication. The analysis was done as per the procedure laid by Panse and Sukhatame [1],Burton and De Vane [2] and Johnson et al.,[3].

RESULTS AND DISCUSSION

Analysis of variance (Table 1.) revealed significant differences among genotypes for all the traits indicating the existence of inherent genetic variability among the genotypes that can be exploited for improvement. The estimates of mean, range, phenotypic coefficient of variation (PCV), genotypic coefficients of variation (GCV), heritability in broad sense (h^2) and expected genetic advance as per cent of mean are presented in Table 2. In general, the values of PCV was higher than the values of GCV indicating that the apparent variation is not only due to genotypes but also due to influence of environment. A close difference between phenotypic and genotypic co-efficient of variation revealed that there was a little influence of environment on the expression of the characters studied. The estimates of PCV and GCV were classified as high (>30%), (moderate 15-30%) and low (<15%).In the present investigation estimates of PCV and GCV were moderate for hundred grain weight (25.80; 23.07), panicle length (22.90; 22.68), plant height at maturity (20.61; 20.58) and total number of productive tillers per plant (19.57; 18.66) indicating that all these characters are amenable for further improvement.. Lower degree of PCV and GCV for the traits *viz.,* spikelet fertility (3.72; 1.24), days to first flowering (8.67; 8.54) and pollen fertility (11.15; 11.10). indicates that these characters are under environmental control and improvement of such traits is very limited, however these traits can be improved through hybridization.

High heritability (broad sense) estimates (>80%) were observed for almost all the traits *viz.,* plant height at maturity (99.65), pollen fertility (99.04), panicle length (98.06), total number of spikelets per panicle (97.67), total number of filled spikelets per panicle (97.36), days to first flowering (97.20), total number of tillers per plant (92.06), total number of productive tillers per plant (90.88) indicating that the variation observed was mainly under genetic control and less influenced by environment and hence selection will be effective for these traits(Table 2.). Hundred grain weight (79.90) showed moderate heritability (50-80%) indicating the characters are influenced by environmental effects and selection for improving the desired objective can be misleading. Since the estimates of heritability are in broad sense selection based on heritability alone is misleading hence estimate of genetic advance as per cent of mean is used for better prediction of characters under study. The genetic advance indicates the progress that can be expected for a trait as result of selection. The values of genetic advance as per cent of mean were moderate (25-50%) for characters like plant height at maturity (40.00), total number of spikelet per panicle (36.76) and total number of filled spikelets per panicle (35.78). Estimates of genetic advance as per cent of mean were low (<25%) for rest of the traits *viz*., Spikelet fertility (0.75), hundred grain weight (0.78), grain yield per plant (2.97), total number of productive tillers per plant (6.39), total number of tillers per plant (6.44), panicle length (10.47), days to first flowering (12.17) and pollen fertility (19.44).. Heritability alone fails to indicate the response to selection and a character having high heritability may not necessarily give high genetic advance. Therefore Heritability should be always considered along with genetic advance as per cent of mean to arrive at a more reliable conclusion.High heritability coupled with moderate genetic advance as per cent of mean was observed for panicle length, plant height at maturity and 100 grain weight which indicated that these characters are governed by additive genes.. High heritability coupled with low genetic advance as per cent of mean is observed for the rest of traits indicating the effect of non-additive gene action.

On the basis of results summarized above, it is concluded that wide range of genetic variability was found among genotypes for all the traits studied and which means there is ample scope of selection for these traits for further improvement. Most of the traits hade moderate PCV and GCV *viz.,*100 grain weight, panicle length, plant height at maturity, total number of productive tillers per plant and for rest of the traits PCV and GCV was low. The study revealed that heritability in broad sense was high for high heritability values for plant height at maturity, pollen fertility, panicle length, total number of spikelets per panicle, total number of filled spikelets per panicle, days to first flowering, total number of tillers per plant total number of productive tillers per plant indicating that the variation observed was mainly under genetic control and less influenced by environment and hence selection will be effective for these traits. High heritability coupled with moderate genetic advance was observed for plant height at maturity, total number of spikelets per panicle and total number of filled spikelets per panicle which indicated the presence of additive gene action and thereby these traits could be considered as reliable indices for selection

Table 1: Analysis of variance for eleven characters in rice under heat stress

Sr.No	Characters	Replication mean square	Genotype mean square	Error mean square
1.	Days to first flowering	0.08	118.76**	1.12
2.	Total number of tillers per plant	1.48	32.78**	0.91
3.	Total number of productive tillers per plant	3.63	32.86**	1.06
4.	Panicle length	0.21	79.64**	0.52
5.	Pollen fertility	0.21	270.84**	0.86
6.	Total number of spikelets per panicle	3.32	986.05**	7.75
7.	Total number of filled spikelets per panicle	27.22	938.33**	8.38
8.	Spikelet fertility	33.11	13.41**	9.76
9.	Plant height at maturity	6.74	1136.74**	1.29
10.	Hundred grain weight	0.19	0.59**	0.04
11.	Grain yield per plant	7.55	16.34**	3.99

* Significant at 1 % level of significance

Table 2: Estimates of parameters of variability for different characters in 50 rice genotypes

S. no	Characters	Range of mean	PCV	GCV	h^2	GA	GA% Over mean
1.	Days to first flowering	60.42-84.95	8.67	8.54	97.20	12.71	17.36
2.	Total number of tillers per plant	16.60-28.93	15.83	15.19	92.06	6.44	30.03
3.	Total number of productive tillers per plant	12.50-24.90	19.57	18.66	90.88	6.39	36.65
4.	Panicle length	17.50-42.25	22.90	22.68	98.06	10.47	46.27
5.	Pollen fertility	61.77-95.88	11.15	11.10	99.04	19.44	22.76
6.	Total number of spikelets per panicle	71.33-132.66	16.59	16.39	97.67	36.76	33.38
7.	Total number of filled spikelets per panicle	59.62-122.62	18.16	17.92	97.36	35.78	36.43
8.	Spikelet fertility	83.58-93.06	3.72	1.24	11.10	0.75	0.82
9.	Plant height at maturity	77.26-164.25	20.61	20.58	99.65	40.00	42.32
10.	Hundred grain weight	0.95-2.64	25.80	23.07	79.90	0.78	42.48
11.	Grain yield per plant	15.26-30.66	14.08	10.03	50.71	2.97	14.72

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