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Genetic variability and component parameters of water stress tolerant upland rice (*Oryza sativa* L.) germplasms of Kerala based on phenotypic markers

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Abstract
An experiment was conducted to detect the genetic parameters such as variability, heritability and genetic advance for morpho-physiological and yield related traits in rice under drought stress. For this study, 30 genotypes were screened initially using PEG 6000 in laboratory and 21 genotypes were phenotyped for drought tolerance under field conditions using CRD at FSRS, Sadanandapuram during 2019-21. The result obtained from the study showed that adequate variability was present among the genotypes for morpho-physiological and yield related parameters. And for all the traits tested, phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV). Similarly, high GCV and PCV were observed for grain yield under drought.

Keywords: Variability, GCV, PCV, Heritability, GAM, QTL

1. Introduction

Rice is the most important staple crop in the world. It is phylogenetically considered as a semi-aquatic crop and therefore, it has fewer adaptations to water-scarcity conditions and is tremendously sensitive to drought stress [1]. The major limitation that affects yield in rice production is water deficiency at various critical growth stages and irrigated agriculture is considered as a distinctive feature of rice production. Because of this, the increasing worldwide water shortage and irregular rainfall desperately affects the production of rice.

In order to cope up with the increasing irrigation costs, there is a need to develop novel rice varieties which are more effective in the utilization of minimum available water.

Mainly, the duration of drought, stages of growth in which stress is experienced, and the extent of its severity determines the impact of drought on rice yields [11]. Though, the effect of moisture stress on specific morpho-physiological characters changes significantly in different rice cultivars [12].

The breeding strategies implemented for drought stress rely on the moisture stress conditions. Direct selection for yield may not be sufficient as it would be affected by water holding capacity of the soil, root characteristics etc. A more reasonable strategy is to select for yield under various drought prone environments. Moreover, a number of morphological, physiological and biochemical traits could be utilised for the selection process [18]. The present investigation deals with the evaluation of genetic variability and component parameters of upland rice genotypes of Kerala for water stress tolerance.

2. Materials and Methods

The study was conducted in two experiments viz. laboratory and field experiments using thirty rice genotypes collected from Regional Agricultural Research Station (RARS), Pattambi, Department of Seed Science and Technology, COA, Vellanikkara, KAU, Thrissur and ICAR-NBPGR, New Delhi.

In the first experiment, thirty genotypes were screened for moisture stress tolerance at seedling stage in laboratory using PEG 6000 (Polyethylene Glycol- 6000) at five different concentrations of 0, 5, 10, 15, 20 percentage (%) in FCRD with three replications. In Experiment-II, twenty-one best performing genotypes including the high performing standard check variety Apo in randomized block design were selected and evaluated in the field where irrigation was withheld for 10 days at critical growth stages.

The seeds were sown on raised beds of 4 m^2 size at a spacing of 20 cm x 20 cm and cultural operations were adopted as per the "Package of Practices" of Kerala Agricultural University. Statistical analysis was carried out and the phenotypic and genotypic coefficient of variability was computed as per the formula by Jain [5]. Heritability was calculated using the formula suggested by Burton and Jhonson [3]. Genetic advance was worked out as per the formula given by Jhonson [6].

3. Results and Discussion

Genetic variability parameters offer information about the extent of variation in a population. The co-efficient of variation which is expressed at phenotypic and genotypic levels were used to compare the variability among different characters. In the present study, PCV was higher than GCV for all the selected characters.

Table 1: Values of Genetic parameters

Character	PCV (%)	GCV (%)	H^2 (%)	GAM (5%)
Days to 50% flowering	10.264	10.074	96.30	20.365
Number of productive tillers per plant	28.109	27.005	92.30	53.445
Plant height at maturity (cm)	13.311	12.702	91.10	24.968
Panicle length (cm)	24.474	24.112	97.10	48.936
No. of spikelets per panicle	21.614	21.318	97.30	43.311
No. of filled grains per panicle	30.594	29.830	95.10	59.915
Spikelet sterility (%)	29.976	29.153	94.60	58.405
Grain weight per panicle (g)	45.756	44.867	96.20	90.632
1000 grain weight (g)	12.837	12.353	92.60	24.490
Grain yield per plant (g)	38.061	37.352	96.30	75.510
Straw yield per plant (g)	22.035	20.813	89.10	40.497
Harvest index (%)	14.629	12.880	77.50	23.359
Leaf rolling score (0-9 scale)	48.816	35.161	51.90	52.171
Root length (cm)	24.675	24.029	94.80	48.206
Root dry weight (g)	32.385	31.892	97.00	64.697
Proline content (μ mol g^{-1})	22.110	21.726	96.60	43.977
Chlorophyll content (mg g^{-1})	42.505	41.776	96.60	84.584
Relative Leaf water content	11.684	11.322	93.90	22.602
Leaf soluble protein content (mg g^{-1})	42.775	41.718	95.10	83.817
Leaf area index	25.786	25.092	94.70	50.298
Recovery after stress release (%)	50.097	46.093	84.30	87.362

Similar results were obtained by [7, 22, 13, 16]. A slight difference between the GCV and PCV value indicate their minimum environmental influence and the consequent role of genetic factors on the expression of traits. The phenotypic and genotypic coefficient of variation, heritability and genetic advance (5%) were computed for twenty-four characters and are shown in the table (1). The PCV, GCV, heritability and GAM ranged from 10.264 to 50.097, 10.074 to 46.093, 0.519 to 0.973, 20.365 to 90.632 respectively. High PCV and GCV were observed in the characters, *viz.* number of productive tillers per plant, panicle length, number of spikelets per panicle, number of filled grains per panicle, spikelets sterility, grain weight per panicle, grain yield per plant, straw yield per plant, leaf rolling score, root length, root dry weight, proline content, chlorophyll content, leaf soluble protein content, leaf area index and recovery after stress release. Similar findings were elucidated by [16] for grain yield per plant and straw yield per plant; [17] for straw yield per plant; [13] for panicle length and number of grains per panicle; [10, 20] for number of productive tillers per plant, number of spikelets per panicle and filled grains per panicle indicating that these characters could be used as an important selection criterion for crop improvement.

Moderate PCV and GCV were observed in days to 50% flowering, plant height at maturity, thousand grain weight, harvest index and relative water content. These findings were supported by [21] for plant height, thousand grain weight and plant height at maturity; [16] for plant height, days to 50% flowering and relative water content.

The estimation of heritability provides information about the transmission of traits over various generations. While genetic advancement reveals the superiority of the chosen individuals over the parental population. Selecting traits with high heritability coupled with genetic advance can result in effective selection. High heritability was recorded for the characters *viz.* days to 50% flowering, number of productive tillers per plant, plant height at maturity, panicle length, number of spikelets per panicle, number of filled grains per panicle, spikelet sterility, grain weight per panicle, thousand grain weight, grain yield per plant, straw yield per plant, harvest index, root length, root dry weight, proline content, chlorophyll content, relative water content, leaf soluble protein content, leaf area index and recovery after stress release. This was in consonance with the findings of [8, 21] for days to fifty per cent flowering; [9] for number of grains per panicle, grain yield per plant, straw yield per plant, harvest index and 1000-grain weight. Leaf rolling score exhibited low heritability and this was in conformity with [14]. High GAM was observed for number of productive tillers per plant, plant height at maturity, days to 50% flowering, panicle length, number of spikelets per panicle, number of filled grains per panicle, spikelet sterility, grain weight per panicle, thousand grain weight, grain yield per plant, straw yield per plant, harvest index, root length, root dry weight, proline content, chlorophyll content, relative water content, leaf soluble protein content, leaf area index and recovery after stress release.

This was in corroboration with the findings of [9] for number of spikelets per panicle; [16] for straw yield per plant; [14] for plant height, number of productive tillers per plant, panicle length, harvest index, number of grains per panicle and grain yield per plant [19].

High heritability coupled with high GAM was observed in grain weight per panicle, number of productive tillers per plant,

plant height at maturity, panicle length, number of spikelets per panicle, number of filled grains per panicle, spikelets sterility, thousand grain weight, grain yield per plant, straw yield per plant, harvest index, root length, root dry weight, proline content, chlorophyll content, relative water content, leaf soluble protein content, leaf area index and recovery after stress release. The result was in agreement with the findings of [14] for plant height, panicle length, harvest index, number of grains per panicle and grain yield per plant, [2] for plant height and spikelets per panicle; [15] for plant height, number of productive tillers per plant, panicle length, harvest index, straw yield per plant and grain yield per plant, [10, 20] for thousand grain weight, plant height and grain yield, [4] for relative water content (%) and proline content.

PCV v/s GCV of selected characters and Heritability v/s GAM of selected characters were expressed in the graphs depicted below.

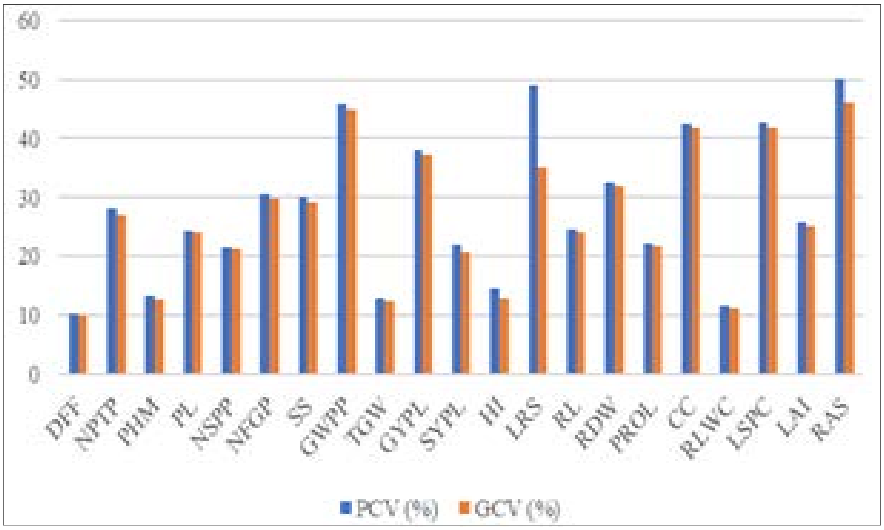

Fig 1: PCV and GCV of selected characters

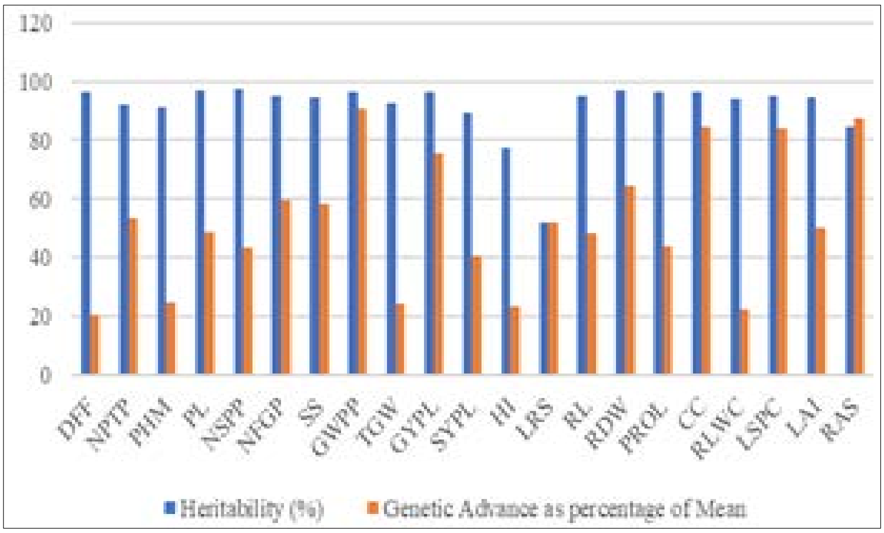

Fig 2: Heritability and GAM of selected characters

4. Conclusions

The characters which were studied in this experiment like plant height, days to 50% flowering, relative water content and final grain yield exhibited relatively high GCV, PCV, heritability and genetic advance. Such characters could be transmitted through hybridization to the progeny and phenotypic selection would be effective in such cases. These high estimates point out that diverse rice cultivars have an inherent potential in drought tolerance which could be a useful tool to isolate novel genes and drought QTL from such diverse germplasms to crop breeding programmes in the future through molecular studies.

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