Plant Archives Vol. 20 Supplement 1, 2020 pp. 2345-2348 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

ASSOCIATION ANALYSIS IN RICE (*ORYZA SATIVA* L.) FOR HEAT TOLERANCE

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Abstract

The present investigation is carried out at experimental farm of Genetics and Plant Breeding of faculty of Agriculture, Annamalai University, Annamai Nagar, Tamilnadu, to study the character association and path analysis in fifty genotypes of rice (*Oryza sativa* L.) under heat stress condition. Association studies revealed the importance of days to first flowering, total number of tillers per plant and grain yield per plant. Path analysis revealed that the traits panicle length, plant height at maturity, grain yield per plant, pollen fertility, days to first flowering, total number of filled spikelets per panicle as an important traits for improvement of spikelet fertility in rice under heat stress.

Key words: Rice, Association analysis, Direct and Indirect effect and Heat stress

Introduction

Global mean temperature increased by 0.5°C in the 20th century and is further increasing by 1.5 to 5.8°C in the 21st century (IPCC, 2007). Increasing in high temperature acts as an abiotic stress factor that shows strong impact on the survival growth and reproduction of all crops resulting in yield loss (Mittler *et al.*, 2012**)**. The effect of heat stress starts from the seed germination to flowering (Grass and Burris, 1995). The optimum temperature required for the growth of rice crop is 27° C to 32°C (Xin *et al*., 1996). High temperature of more than 35°C during the reproductive stage reduces yield. In general, the reproductive stage more sensitive than the all other stages in the crop species. The developmental stage at which the plant is exposed to heat stress determines the severity of the possible damage to the crop. (Wahid *et al*., 2007). However, flowering (anthesis and fertilization) and to a lesser extent the booting stage (microsporogenesis) are considered to be most susceptible to heat stress in rice (Satake and Yoshida, 1978). This higher temperature higher than the optimum (greater than 35°C) level induced floret sterility and thus decreased the yield (Jagadish *et al*., 2007).

Rice (*Oryza sativa* L.) is the world's leading cereal crop as more than half of the world's population is dependent on rice as their staple food. It is one of the major food crops of the most Asian countries like China, India, Pakistan, Bangladesh Vietnam and Korea .The world population is expected to reach 8 billion by 2030 and rice production must be increased by 50% in order to meet the growing demand (Khush and Brar, 2002). In order to meet the fastest growing demand for rice grain, development of high yielding genotypes with desirable agronomic traits for diverse ecosystem is therefore a necessity. For selection in rice, information on correlation coefficient always has been helpful as a basis for selection in a breeding programme. Path coefficient analysis partitions into direct and indirect matrix presenting correlation in a more meaningful way (Mohsin et al., 2009). The present research study was conducted to find out the direct and indirect contribution of parameters towards spikelet fertility and to identify better combinations as selection criteria for developing heat tolerant rice genotypes.

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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: 11º24 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 (1978), Burton and De Vane (1953) and Johnson et al.,(1955).

Results and Discussion

Studies on association of characters gain importance in plant breeding, because they gelp the plant breeders to know the inter-character influence and help to strike economic and reliable balance between various characters. Moreover, genotypic correlations have their own importance because of their stability and reliability as these relationships arise through genetic reasons namely, linkage or pleiotropy (Vanaja *et al.*, 1998). Therefore, the knowledge of inter relationships of characters, play a vital role in developing appropriate selection criteria for the improvement of complex characters. The results and discussion of correlation and path analysis studies between spikelet fertility and different growth parameters are presented below (Table 1 and Table 2).

In the present investigation, spikelet fertility showed positive and significant correlation with three traits *viz.,* days to first flowering, total number of tillers per plant and grain yield per plant. The findings suggests that spikelet fertility can be increased by using these traits as selection criteria in succeeding generations. Negative and significant correlation was observed with panicle length, pollen fertility, total number of spikelets per panicle and total number of filled spikelets per panicle for spikelet fertility, indicating that these traits are severely affected by temperature. Days to first flowering was showed positive and highly significant correlation with total number of productive tillers per plant and grain yield per plant, while it expressed negative and significant with pollen fertility, total number of spikelets per panicle, total number of filled spikelets per panicle and plant height at maturity. Total number of tillers per plant exhibited positive and significant association with panicle length, while negative and highly significant with total number of spikelets per panicle, total number of filled spikelets per panicle, plant height at maturity and 100 grain weight. Total number of productive tillers per plant recorded positive and highly significant correlation with

Table 1: Genotypic correlation co-efficient for heat tolerance in rice.

Characters	Days to first flowering	Total no. of tillers per plant	Total no. of productive ti-llers per plant	Panicle length	Pollen fertility	Total no. of spikelets per panicle	Total no. of filled spikelets per panicle	Plant height at maturity	Hundred grain weight	Grain yield per plant	Spikelet fertility
Days to first flowering	1.0000	0.2668	0.3902**	-0.1657	-0.3052*	-0.4939**	-0.5482**	-0.3871**	-0.2572	0.3050*	0.3074*
Total number of tillers per plant		1.0000	0.2250	0.2868*	-0.2378	-0.4621**	-0.4832**	-0.3929**	-0.3584*	-0.0358	0.3184*
Total number of productive tillers per plant			1.0000	0.2369	0.4366**	-0.2507	-0.3413*	-0.4192**	-0.4134**	-0.3678**	-0.1936
Panicle length				1.0000	0.2979*	0.3361*	-0.2326	-0.3311*	-0.2454	-0.5119**	-0.4037*
Pollen fertility					1.0000	0.2495	0.3755**	-0.2715	-0.2343	-0.5757**	-0.6040*
Total number of spikelets per panicle						1.0000	0.2990*	0.4164**	-0.1027	-0.4226**	-0.4773**
Total number of filled spikelets per panicle							1.0000	0.1926	0.3615**	-0.3027*	-0.4041**
Plant height at maturity								1.0000	0.0563	0.2972*	-0.2084
Hundred grain weight									1.0000	0.1501	0.1098
Grain yield per plant										1.0000	0.3663*
Spikelet fertility											1.0000

** Significant at 1% level *Significant at 5% level

pollen fertility and significant negative correlation with total number of filled spikelets per panicle, plant height at maturity, 100 grain weight and grain yield per plant. Panicle length exhibited positive and significant correlation with pollen fertility and total number of spikelets per panicle; while highly significant but negative correlation with plant height at maturity and grain yield per plant. Pollen fertility showed positive and significant association with total number of filled spikelets per panicle while it had highly significant and negative correlation with grain yield per plant. Total number of spikelets per panicle showed significant and positive correlation with total number of filled spikelets per panicle , plant height at maturity, while highly significant and negative correlation with grain yield per plant. Total number of filled spikelets per panicle has positive and significant correlation with 100 grain weight, while it had significant and negative correlation with grain yield per plant. Plant height at maturity showed positive and significantly correlated with grain yield per plant.

The direct and indirect effect of different characters on spikelet fertility were computed by using genotypic correlations. The study reveals that all the traits exhibited negative direct effect towards spikelet fertility and this may be due influence of heat stress on rice genotypes. Days to first flowering, total number of tillers per plant, total number of productive tillers per plant and panicle length exhibited positive indirect effects through total number of filled spikelets per panicle. Similarly, pollen fertility exhibited positive indirect effect through plant height at maturity, total number of spikelets per panicle and total number of filled spikelets per panicle with days to first flowering and panicle length. Plant height exhibited positive indirect effect through days to first flowering and 100 grain weight with panicle length. Grain yield per plant exhibited positive indirect effect through panicle length, pollen fertility and total number of filled spikelets per panicle.

In general correlation studies revealed the importance of days to first flowering, total number of tillers per plant and grain yield per plant. It could be inferred that intentional selection of these traits may results in improvement of spikelet fertility, since these traits have high magnitude of positively significant association under heat stress. Path analysis revealed that the traits panicle length, plant height at maturity, grain yield per plant, pollen fertility, days to first flowering, total number of filled spikelets per panicle as an important traits for improvement of spikelet fertility in rice under heat stress. Residual effect from path analysis indicated that variability for spikelet fertility was very well explained by all the eleven traits taken for investigation.

Table 2: Direct and indirect effect of spikelet fertility and its component character under heat stress.

Characters	**Days to first flowering**	**Total no. of tillers per plant**	**Total no. of productive ti- llers per plant**	**Panicle length**	**Pollen fertility**	**Total no. of spikelets per panicle**	**Total no. of filled spikelets per panicle**	**Plant height at maturity**	**Hundred grain weight**	**Grain yield per plant**	**Genotypic Correl- ation**
Days to first flowering	-0.474	-0.036	-0.117	0.125	0.174	0.070	0.361	0.261	0.049	-0.107	0.307*
Total number of tillers per plant	-0.126	-0.137	-0.067	-0.217	0.136	0.065	0.318	0.265	0.068	0.012	0.318*
Total number of productive tillers per plant	-0.185	-0.030	-0.301	-0.179	-0.249	0.035	0.224	0.283	0.079	0.129	-0.193
Panicle length	0.078	-0.039	-0.071	-0.757	-0.170	-0.048	0.153	0.224	0.047	0.180	-0.403**
Pollen fertility	0.144	0.032	0.131	0.225	-0.572	-0.035	-0.247	0.183	0.044	0.202	-0.604**
Total number of spikelets per panicle	0.234	0.063	0.075	0.254	-0.142	-0.142	-0.197	-0.281	0.019	0.148	-0.477**
Total number of filled spikelets per panicle	0.259	0.066	0.102	0.176	-0.214	-0.042	-0.658	-0.130	-0.069	0.106	-0.404**
Plant height at maturity	0.183	0.054	0.126	0.250	0.155	-0.059	-0.126	-0.676	-0.010	-0.104	-0.208
Hundred grain weight	0.121	0.049	0.124	0.185	0.134	0.014	-0.238	-0.038	-0.191	-0.052	0.109
Grain yield per plant	-0.144	0.004	0.110	0.387	0.329	0.060	0.199	-0.201	-0.028	-0.351	0.366*

Residual effect = 0.2503, Bold figure denotes the direct effect

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