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Association Study in Selected Genotypes of Rice (*Oryza sativa* L.) under Irrigated Rainfed and Terminal Stage Drought conditions

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Abstract

The growth and productivity of rice is adversely affected by water scarcity. Water stress is a limiting factor in agriculture production by preventing a crop from reaching the genetically determined theoretical maximum yield. Association studies among thirteen traits for grain yield were studied in sixty lines of rice during *kharif* (June-December), 2017 and 2018 at IGKVV, Raipur Chhattisgarh. The materials were selected among from the 400 rice core group which represents the entire diversity. In plants, a better understanding of the morphological and physiological basis of changes in water stress resistance could be used to select or create new varieties of crops to obtain a better performance under water stress conditions. So, the result of correlation coefficient depicts that biological yield and harvest index showed positive association with grain yield under all the condition on the basis of pooled data of two years. On the contrary, days to 50% flowering showed negative but significant correlation with grain yield under stress condition only this suggests that due to differences in rainfall pattern and water scarcity the flowering get delayed hence, the yield is reduced. Considering the result of path analysis based on the pooled data of *Kharif,* 2017 and 2018 number of filled grains and total number of grains were found to have positive and high direct effect on grain yield under all the conditions, it signifies true relationship with grain yield and selection for above mentioned trait could be good for yield improvement under stress as well as non-stress environment.

Keywords:Rice, Correlation, path, rainfed, terminal stage drought

1. Introduction

Rice is the World's most important food and second most widely cultivated cereal in the world and is a staple food for more than half of the world's population. Rice grain yield being a complex trait, depends upon the various yield contributing traits like test weight, number of grains per panicle, panicle length, effective bearing tiller number etc. The developing countries account for about 95% of the total rice production where China and India alone produced nearly half of the world output (Dhakal et al., 2020).

Drought is one of major constrains for rice production globally. Drought stress mostly happen in unbunded upland, bunded upland, shalow rainfed, mid-lowland rainfed areas. Drought affects around 23 mha of rainfed rice across the World (Serraj et al., 2011). Developing drought tolerance rice cultivars is the direct and effective way to reduce crop

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loss. Rice encounters many obstacles in the form of stresses both biotic and abiotic (Sabouri et al., 2011) that restricts its ability to reach its complete yield potential. Abiotic stresses especially drought can affect the physiological status of an organism and have adverse effects on growth, development, and metabolism (Chutia and Borah, 2012). Drought is an abiotic stress which affects plants at various levels and stages of their life period. This abiotic stress not only affects plant water relations through the reduction of water content, turgor and total water, but it also affects stomatal closure, limits gas exchange, reduces transpiration, and disturbs photosynthesis (Razak et al., 2013). Rice is highly prone to water stress during the reproductive stage, leading to signifcant decrease in grain yield (Palanog et al., 2014). Developing drought tolerance rice varieties is often challenging because of the complexity of drought. In nature, drought stress may occur at any stage of rice growth and the effects of drought stress on rice are various at different growth stage (Cui et al., 2018).

The existing relationships between traits are, generally determined by the genotypic, phenotypic and environmental correlations. The phenotypic correlation measures the degree of association of two variables and is determined by genetic and environmental factors. The environmental correlation is mainly responsible for the association of traits of low heritability, such as grain yield. The genotypic correlation on the other hand, which represents the genetic portion of the phenotypic correlation, is the only one of inheritable nature and therefore, used to orient breeding programs (Falconer, 1989).Character association derived by correlation coefficient which is one of the important biometrical tools for formulating a selection index as it reveals the strength of relationship among the group of traits.

Association between traits is so important because it helps the breeder to select important characters from the studied traits. Most of the traits such as yield and yield component traits are influenced by interaction of genotype and environment, and, therefore, selection based on correlation coefficient makes it easy for plant breeders (Ahmadikhah et al., 2008). Path coefficient analysis provides an exact picture of the relative importance of direct and indirect effects of each of the component character towards yield. With a view to having effective improvement of rice, its character associations as well as the nature and the extent of direct and indirect effects on yield were investigated (Ratna et al., 2015).

The proper and appropriate phenotype plays an increasingly important role in the selection of drought resistant genotype (Dhakal et al., 2020). Recent studies showed that direct selection for grain yield in artificial or natural drought stress conditions is the most effective way for developing drought tolerance rice with high yield potential under non-tress conditions (Vnuprasad et al., 2007; Guan et al., 2010).Correlation and path analysis establish the extent of association between yield and its components and also bring out relative importance of their direct and indirect effects, thus giving an obvious understanding of their association with grain yield. Ultimately, this kind of analysis could help the breeder to design his selection strategies to improve grain yield (Tejaswini et al., 2018). Keeping above points in mind the experiment was conducted among sixty germplasm of rice under three different conditions with the objective of studying the character associations in rice for yield improvement.

2. Materials and Methods

The current research study was conducted at Research cum Instructional farm, College of Agriculture, Indira Gandhi Agricultural University, Raipur, Chhattisgarh during June to December, 2017 and 2018. Sixty rice accessions were planted with a row length of one meter and row-row distance of 25 cm using randomized block design (RBD) with two replications in irrigated and terminal stage drought condition by transplanting the rice seedlings, whereas under rainfed condition the seeds were broadcasted. Measurements of different yield traits of these collected landraces at different stages of growth were recorded. The data were collected on five randomly selected plants from each accession. Observations were recorded for thirteen yield traits such as Days to flowering, Plant height (cm), Flag leaf Length (cm), Flag leaf width (cm), Number of tillers, Panicle Length (cm), Thousand grain weight (g), Number of filled grains, Number of unfilled grains, Total Number of grains, Biological yield per plot(g), Harvest index (%), Grain yield per plot (g). The data on the thirteen traits were subjected to correlation and path coefficient analysis suggested by Miller et al. (1958) and Dewey and Lu (1959), respectively to study direct contribution of different traits and nature of their relation to grain yield.

3. Results and Discussion

Days to flowering is positively and significantly correlated with grain yield under irrigated condition on the contrary it is negatively but significantly correlated with grain yield in TSD and rainfed conditions. This association indicates that early flowering will increase the grain yield whereas under water stress condition due to water sacristy at reproductive stage there is delay in flowering and due to delay in flowering the grain yield is automatically reduces. This clearly shows that the crop under stress condition received severe stress for about 2 weeks during panicle development to pre-flowering stage. The negative association of days to flowering with grain yield was previously reported by Vikram et al. (2011) and Zhao et al. (2010) (Table 1).

Plant height showed significant and positive association with grain yield under rainfed condition whereas it was found non-significantly associated under irrigated as well as under TSD conditions. Panicle length showed significant and positive correlation with grain yield under irrigated as well as under rainfed condition. Biological yield and harvest index showed positive and significant correlation with grain yield under all the three conditions based on pooled data of two

Table 1: Correlation between grain yield and yield attributing traits under different conditions

Trait	Genotypic Correlation with grain yield		
	Irrigated	Rainfed	TSD
DTF	0.310**	-0.493**	-0.531**
PH	0.032	0.250**	0.05
FLL	0.078	-0.086	-0.079
FLW	0.073	0.085	0.372**
NT	0.215*	-0.267**	0.014
PL	0.228*	0.642**	0.062
BYP	0.714**	0.562**	1.572**
HI	0.463**	0.751**	1.046**
TGW	0.138	0.320**	0.224*
NFG	0.290**	0.409**	0.144
NUFG	-0.092	0.452**	-0.113
TNG	0.227*	0.473**	0.175

DTF: Days to flowering; PH: Plant height (cm); FLL: Leaf Length (cm); FLW: Leaf width (cm); NT: Number of tillers; PL: Panicle Length (cm); TGW: Thousand grain weight (g); NFG: Number of filled grains; NUFG: Number of unfilled grains; TNG: Total Number of grains; BYP: Biological yield per plot (g); HI: Harvest index (%); GYP: Grain yield per plot (g)

years. Aghaei et al. (2017), Kumar et al. (2018) also reported significant relation with these two traits. Thus, it could be the suitable character for selection of the rice genotypes. Number of filled grains and total number of grains showed significant and positive association with grain yield under both irrigated and rainfed condition whereas under TSD condition it shows non-significant association. Number of tillers per meter square showed positive and significant association under irrigated condition whereas under rainfed condition it was found negative significant association, this might be because, under irrigated condition transplanting is there which increase the grain yield whereas under rainfed condition the direct seeded method was the reason for yield loss. It was earlier reported by Peng et al. (1994) and Ahmad et al. (2005) that under direct seeded condition, excessive tillering leads to high tiller abortion, poor grain setting, and small size of panicle which ultimately leads to poor grain yield. Aforesaid result is similar with the findings of Badshah et al. (2014) who also reported negative significant association of tiller number on grain yield under direct seeded rice. In view of this results found, it may be resolved that traits like biological yield, days to flowering, panicle length, harvest index and thousand grain weight can used as a direct selection criteria for higher grain yield.

3.1. Direct effect of yield on its component traits (Path analysis) based on pooled data

Based on the pooled data of two years, number of filled grains and total number of grains showed high positive direct effect on grain yield under all the three conditions. Days to 50% showed negligible direct effect on grain yield under irrigated and TSD conditions whereas under rainfed direct seeded condition it shows negative very high direct effect, it also showed negative correlation with grain yield so, selecting this trait under stress condition for grain yield improvement may not be rewarding. For the trait 1000 grain weight under irrigated and rainfed condition it was found positive negligible and positive high direct effect respectively on grain yield (Table 2).

Table 2: Direct effect of traits upon grain yield under different condition

Traits	Direct effect of independent traits on grain yield		
	I	RF	TSD
DTF	0.013	-1.479	0.075
PH	0.137	0.81	0.017
FLL	0.074	0.643	0.045
FLW	0.056	0.134	0.013
NT	0.017	-0.336	-0.031
PL	-0.012	0.728	-0.034
BYP	0.962	0.788	0.248
HI	0.665	-1.011	0.651
TGW	0.022	0.192	-0.029
NFG	1.450	1.740	1.688
NUFG	-1.355	0.443	0.857
TNG	1.059	1.091	1.064
Residual effect	0.0139	0.1670	0.0140

But under TSD condition it was found negative as well as negligible direct effect and the corresponding correlation value was found positive and significant, this indicates that the effect seems to be the cause of correlation and the trait can be considered simultaneously for selection. Biological yield per plot showed high positive direct effect under irrigated and rainfed condition whereas under TSD condition it was found to have moderate direct effect on grain yield, under all the conditions it also depicts positive significant correlation so this trait can be selected for yield improvement under stress as well as under non-stress condition.

On the contrary to our findings, direct effect of constituent characters on grain yield were informed former by Ravindra et al. (2012) by effective tillers, plant height and grains panicle^{-1}, Wattoo et al. (2010) with 100 seed weight and Kumar et al. (2018) and Bhujel et al. (2018) by way of plant height. As a result, direct selection on the basis of above mentioned characters will be worthwhile for yield enhancement in rice. Sreedhar and Reddy (2019) informed positive direct effect on grain yield by DTF, harvest index, leaf length, and effective

tillers. Although negative but direct effect on grain yield was also reported by Bhujel et al. (2018) for plant height, Kumar et al. (2018) for tillers number. Negative but direct effect specifies that the direct selection from this attribute may not prove to be beneficial for the enhancement of grain yield. The research study of Kharel et al. (2018) was consistent with the result of above study. The residual effect of each condition determines how best the causal factors accounts for the variability of the grain yield. The values of residual effects was found 0.0139, 0.1670 and 0.0140 for irrigated, rainfed and TSD condition respectively suggests that the characters taken for the study are sufficient.

4. Conclusion

Sixty rice genotypes were evaluated under irrigated, rainfed and terminal stage drought condition. Result showed that the trait biological yield and harvest index showed positive association as well as high direct effect with grain yield under all three aforesaid conditions during both the years, hence, selection for these traits could bring improvement in yield and yield components to develop drought tolerant lines.

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