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A CASE STUDY

Secondary genetic productivity factors (SGPFs) in expression of grain yield in rainfed upland rice of Bastar Plateau

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In present investigation, 18 new genotypes were tested for upland rainfed ecology during *Kharif* 2013 and 2014, to identify promising genotypes and formulate phenological relationships at phenotypic and genotypic levels with uncertain weather parameters. The test populations exhibited enough variation to carry on crop breeding research however, genotypes responded differentially to water stress and late season drought with respect to morphological and yield traits. Considering genetic secondary productivity factors (SGPF), days to flowering, plant height, panicles per unit area, spikelet fertility and harvest index was observed to be major contributors for water scarce survivals. Days to flowering was found to be negatively associated with grain yield (-0.1941, -0.2986*, -0.2586 for *Kharif* 2013, 2014 and pooled over environment, respectively). Grain yield was positively and significantly associated with total crop biomass (0.6669**, 0.6122**, 0.6185**), plant height (0.5059**, 0.4145**, 0.4541**) and crop duration. Biased selection for earliness cause reduction in grain yield due to shortened vegetative phase hence, research is to be focused to minimize the yield penalty associated with earliness.

Key words : Upland rice, Rainfed ecosystem, Stress physiology, Genetic productivity factors

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INTRODUCTION

Rice is the cereal food stuff which forms an important part of more than three billion people's diet around the world (Srivastava *et al*., 2014). The potentially yielding ability of currently available rice varieties has to be increased twice by 2020 to meet the existing demand through utilizing valuable yield genes and genes containing resistance to biotic and abiotic stress (Kanbar *et al*., 2010; Fischer *et al*., 2012). Upland rice ecology is much harsh environment for rice production where intermittent moisture deficit is the major constraint (Hanamaratti *et al*., 2005) and cause a yield penalty from 12 to 46 per cent (Oak *et al*., 2006). It is grown with little or no fertilizer input with direct seeded methodology in moisture deficit unsaturated soils (Aditya and Bhartiya, 2013). Further, poor ability of varieties to produce economic quantity of grain, due to the concomitant poor panicle yield, caused by varying degrees of water stress, makes rice production risky and unattractive due to low yield of 1 to 2 tones/hectare (Atlin *et al*., 2006; Adewusi and Nassir, 2011).Therefore, genetic management strategies should be undertaken for cultivating rice with less water and maximizing extraction of soil moisture and its efficient use in crop establishment and growth to enhance biomass and yield.

RESEARCH METHODOLOGY

The experiment was undertaken with 18 genotypes under rainfed conditions during *Kharif* 2013 and 2014 at Upland Rice Breeding Block of S.G. College of

Agriculture and Research Station, Jagdalpur, IGKV, Raipur, Chhattisgarh. An upland ecology simulation model was created by choosing experimental plot where no water accumulates and cent per cent rainfed treatment was given during entire life cycle of crop. Sowing was completed by just onset of monsoon by direct seeding in agronomically standardized geometry in 10 sqm plot with two replications. Trench was made in periphery of experimental plot to avoid no water accumulation. The data were recorded for 10 quantitative characters namely days to flowering, crop duration, plant height, and panicles per sqm, panicle length, spikelets per panicle, spikelet fertility, grain yield, biological yield and harvest index.

The mean over replication of each character were subjected to statistical analysis. Pearson's correlation coefficients were calculated and data were analyzed using unweighted paired group method using cetroids. For statistical analysis software Window State Version 9.1 was used.

RESEARCH FINDINGS AND ANALYSIS

Grain yield is the end expression of genotypes with respect to economic dry matter. Amount and extent of dry matter production is a unique feature genotype and to produce higher unit yield it has to produce some secondary genetic productivity factors (SGPFs) like higher numbers of panicles, lengthy panicles, higher spikelets etc. Moreover, genotype can have optimum SPFs but may not yield higher because of micro and macro environmental contributions. Therefore, it's necessary to indentify SPFs accurately and validate role of genetics and environment in determination of yield pathway. Further, upland rice accentuated by the unpredictable genotypic performance in many rice growing regions (Samonte *et al*., 2005; Atlin *et al*., 2006; Nassir and Ariyo, 2011). Direct selection for yield has been the most commonly used selection strategy by cereal breeders to improve yield in water limiting environment (Araus *et al*., 2002 and Banziger *et al*., 2006). Nonetheless, several secondary traits associated with the understanding of stress tolerance and the effects crop yields have also been identified and studied to some extent (Price, 2002 and Kumar *et al*., 2008). Therefore, genotypic, phenotypic and environmental correlations were worked out to ascertain these factors and external contribution.

In the biannual experiment, days to flowering was found to be negatively associated with grain yield (Fig. 1, 2, 3) (-0.1941, -0.2986*, -0.2586 for 2013, 2014 and pooled over environment, respectively) and is quite interesting in upland rice research. In irrigated rice it has positive association with grain yield due to availability of lengthy preflowering span, however, in rainfed ecology biased selection for earliness makes the association negative (Lanceras *et al*., 2004). Spikelet fertility was found to be positively linked with prolonged vegetative growth (0.0255, 0.5682**, 0.2685*) because of ample supply of food material. Plant height was observed to be very important in operating grain yield via panicle length (0.2518, 0.3233*, 0.2841*), spikelet per panicle (0.2821*, 0.5840**, 0.4737**), spikelet fertility (0.5058**, 0.4560**, 0.4756**) and biological yield (0.3972**, 0.2383,

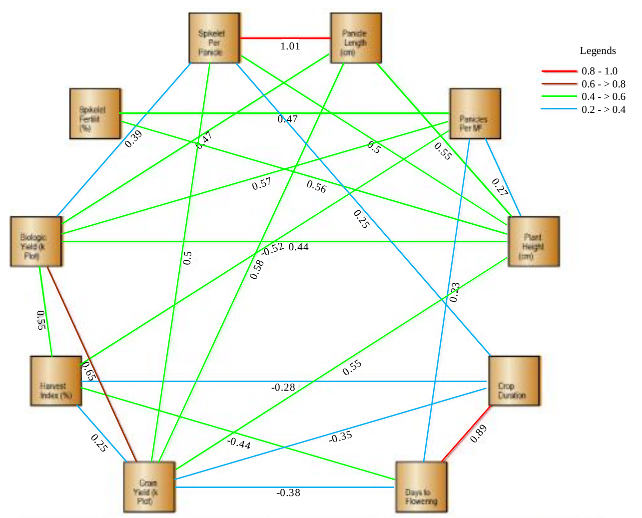

Fig. 1 : **Secondary genetic productivity factors in *Kharif* 2013**

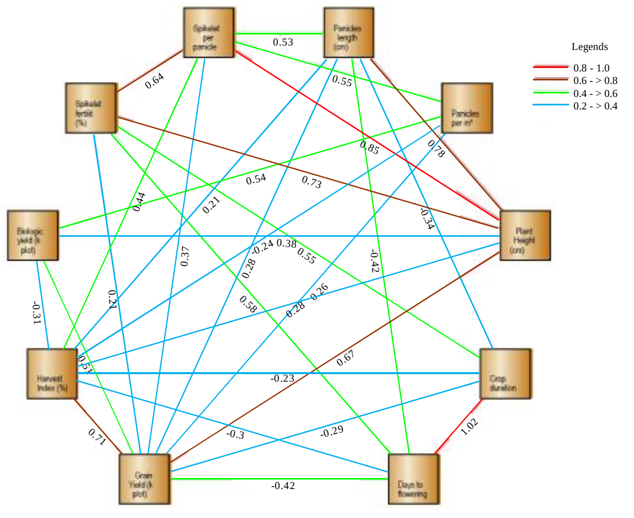

Fig. 2 : **Secondary genetic productivity factors in *Kharif*, 2014**

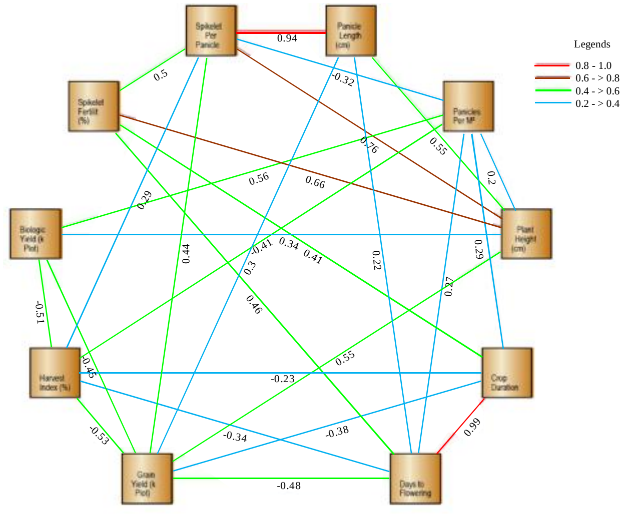

Fig. 3 : **Secondary genetic productivity factors – pooled over environments**

0.3181**) (Agbo and Obi, 2005). Greater plant height improves panicle productivity and produce deep root system which aids in moisture interrupt survival. However, negative association of plant height with grain yield has also been reported earlier (Lafitte *et al*., 2006) because, usually, rice genotypes with greater plant height often produce large plant size, intercept more light and use water faster by transpiration, leading to rapid depletion in plant water status (Kamoshita *et al*., 2004), higher dead leaf scores, and more spikelet sterility (Kato *et al*., 2007). Spikelet fertility recorded positive association with days to flowering (0.1242, 0.4490**, 0.2896*), crop duration (-0.0255, 0.5682**, 0.2685*), plant height (0.5058**, 0.4560**, 0.4756**) and spikelets per panicle (0.1644, 0.4779**, 0.3259**).

Grain yield was positively and significantly associated with total crop biomass (0.6669**, 0.6122**, 0.6185**), plant height (0.5059**, 0.4145**, 0.4541**) (Fig. 1, 2, 3) and crop duration (Manna *et al*., 2006; Eradasappa *et al*., 2007 and Khan *et al*., 2009). Information on inter association of yield components showed nature and extent of their relationship with each other. This will help in simultaneous improvement of different characters along with yield in breeding programmes. Harvest index (HI), measurement of photosynthetic efficiency of genotypes, is among the critical parameters for upland rice breeding. Higher HI estimates assures the linear partition of carbon assimilates to panicles (Chakraborty and Chakraborty, 2010). As per theoretical background, HI was found to have negative relationship with days to flowering and crop biomass since prolonged vegetative phase cause the crop suffers from monsoon switch drought. In rainfed scenario it's mandatory to opt for genotypes which have discriminate formation and translocation of carbohydrate.

Conclusion :

Based on results of *Khraif* 2013 and 2014, it can be concluded that, shortage of water instigated a reduction in assimilate availability between panicle initiation and anthesis and between anthesis and maturity, culminating into negative effects on grain yield. Over the years, research reports have shown that rice reacts to drought stress with reductions in height, leaf area and biomass production, tiller abortion, changes in root dry matter and rooting depth, particularly deep rooting and a delay in reproductive development, especially flowering. Direct selection for yield under drought conditions may not be particularly rewarding and preferred laying emphasis on traits related to drought tolerance. Traits including continued early flowering, early maturation, and increase in harvest index and reduction in plant height have been associated with moisture stress tolerance in upland rice.

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