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ORIGINAL ARTICLE **OPEN ACCESS**

Effect of drought stress at reproductive stage of rice (*Oryza sativa* L.) genotypes.

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ABSTRACT
A pot experiment was conducted with five rice genotypes to evaluate rice genotype at reproductive stage drought stress. Rice genotypes were exposed to 15 days drought at reproductive stage by receding the water. The leaf rolling, relative water content (RWC) leaf, total chlorophyll content (SPAD) and leaf proline content were recorded at the end of drought. Less leaf rolling and less reduction in RWC and SPAD value and high proline content were recorded in Nagina 22 over other genotypes. Swarna sub1 was the most susceptible rice genotype as it showed high leaf rolling and more reduction in RWC and SPAD value and less accumulation in proline content.
Key word: *Drought, Genotypes, Stress and Yield*

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INTRODUCTION

Drought is one of the important abiotic stresses that severely effects on growth, development, and metabolism renfed areas [7]. Drought is an abiotic stress which affects plants at various levels and stages of their life period. But drought stress at reproductive stage is more serious than any other stage. The drought 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 and ultimately yield of the plant [17]. A low water potential effect of on mineral nutrition and plant metabolism which decrease the leaf area and alter assimilates partitioning among the plant organs [15, 19].

Rice varieties have differential responses to abiotic stresses because of the complexity of interactions between stress factors and various molecular, biochemical, and physiological processes that affect plant growth and development [20, 21]. Drought stress affects the growth behavior and yield and yield components irrespective rice genotypes [20]. Drought stress due to water deficit is a common constraint in upland cultivation systems of plants [9, 10]. Drought stress reduces the rice growth and severely affects different traits, such as seedling biomass, stomatal conductance, photosynthesis, starch metabolism, and plant–water relations [12, 14, 16, 18]. Rice genotypes have differential response to water deficit 6]. Grain yield of some rice varieties was reduced by up to 81 % under drought condition and this reduction depended on timing, duration, and severity of the plant water stress [14, 18]. When rice genotyped exposed to water deficit; panicle length and fertile grains in two tolerant varieties were not significantly decreased, leading to greater productivity than in two sensitive cultivars.

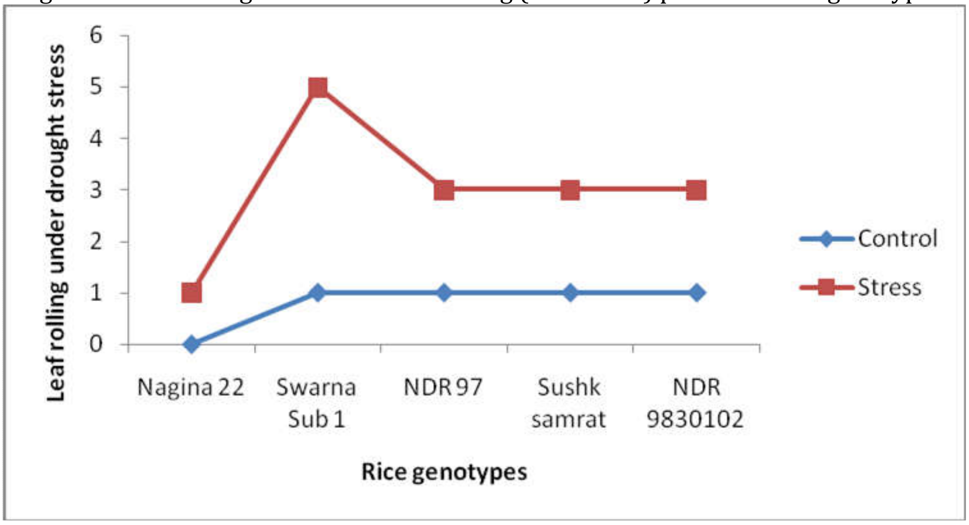
MATERIALS AND METHODS

Five rice genotypes Nagina 22, Swarna sub1, NDR 97, Sushk Samrat and NDR 9830102 were selected to give heat treatment at reproductive stage. Rice genotypes were sown in pot condition two sets with five replication as per CRD design. All the standard cultural practices were followed as per norms during the crop growth. Drought treatment was given for 15 days at reproductive stage by receding the water. Leaf rolling (IIRI Scale), RWC (Slatyer, 1967), total chlorophyll content (chlorophyll meter) and proline content (Bate et al., 1973) were recorded at the end drought treatment against the control. Grain yield per plant was recorded at physiological maturity at 12 to 14 % moisture of replicated plant and average out to one as grain yield per plant.

RESULTS AND DISCUSSION

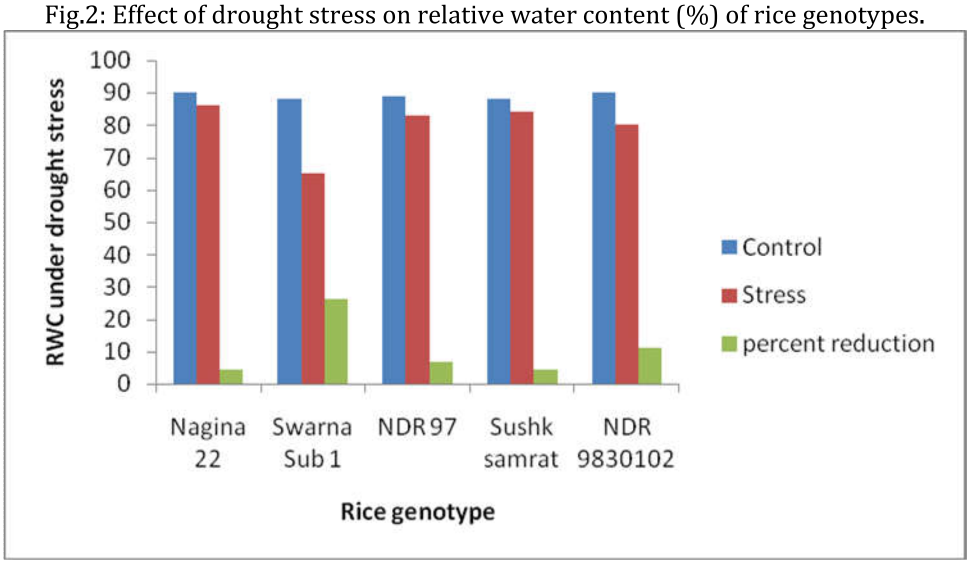
Leaf rolling varied among rice genotypes at the end of drought treatment (fig.1). Highest leaf rolling was recorded in Swarna sub1 (5) while lowest in Nagina 22(1) under drought stress condition. In control condition, all rice genotypes showed more or less same type of appearance. Leaf is an indicator water deficit in plants. High leaf rolling showed more water deficit and low leaf rolling less water deficit. Low or temporary leaf rolling actually a adaptive feature of tolerant plant to reduced water loss from its body [4, 5].

Fig.1: Effect of drought stress on leaf rolling (IRRI Scale) pattern of rice genotypes.



Relative water content among rice genotypes varied under drought stress condition (fig.2). High RWC was recorded in angina 22, NDR 97 and Susk Samrat while low in Swarna Sub1 under drought stress condition. Relative water content is comparative water status in same plant tissue with turgid condition. The rice plant that maintain high RWC under drought stress appers with low leaf rolling and tolerant behavior. Tolerant rice genotypes show less water deficit by adapting osmotic adjustment or deep root system to overcome the affect drought stress [6].

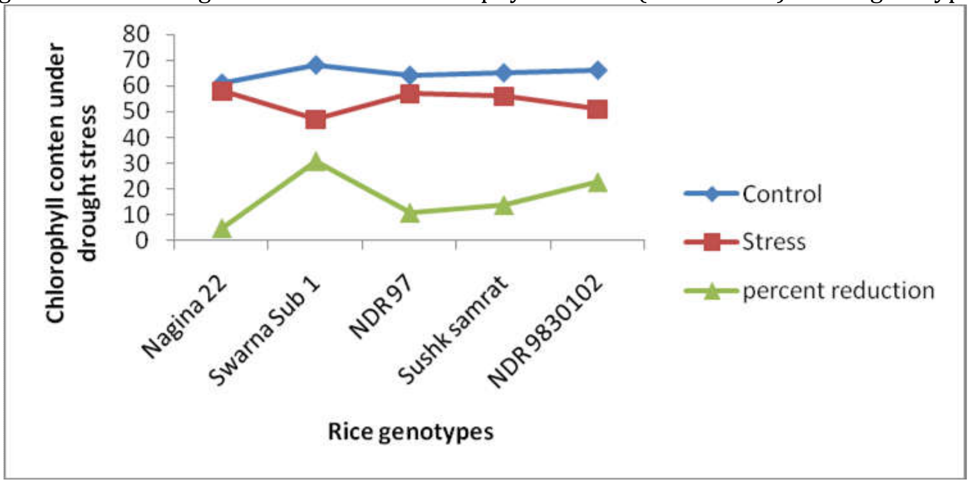
Fig.2: Effect of drought stress on relative water content (%) of rice genotypes.



Rice genotypes showed genetic variability in total chlorophyll content (fig.3). High chlorophyll was recorded in Swarna sub1 and NDR 9830102 under control condition. But the genotypes also showed high percent reduction under drought stress condition. Less percent reduction chlorophyll was noted in

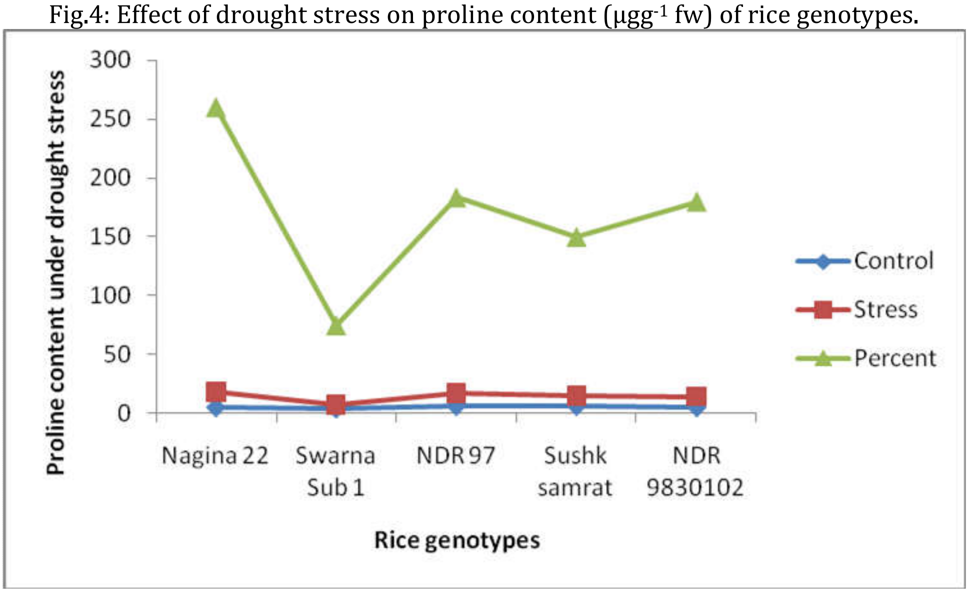
Nagina 22, NDR 97 and Susk Samrat under drought stress condition. Drought stress reduced chlorophyll content due to reduced water content in plant. Chlorophyll synthetic process highly reduced due to reduce activity chlorophyllase, proteinase activity and disturb metabolism under water deficit condition in plants [7, 12, 13, 8].

Fig.3: Effect of drought stress on total chlorophyll content (SPAD value) of rice genotypes.



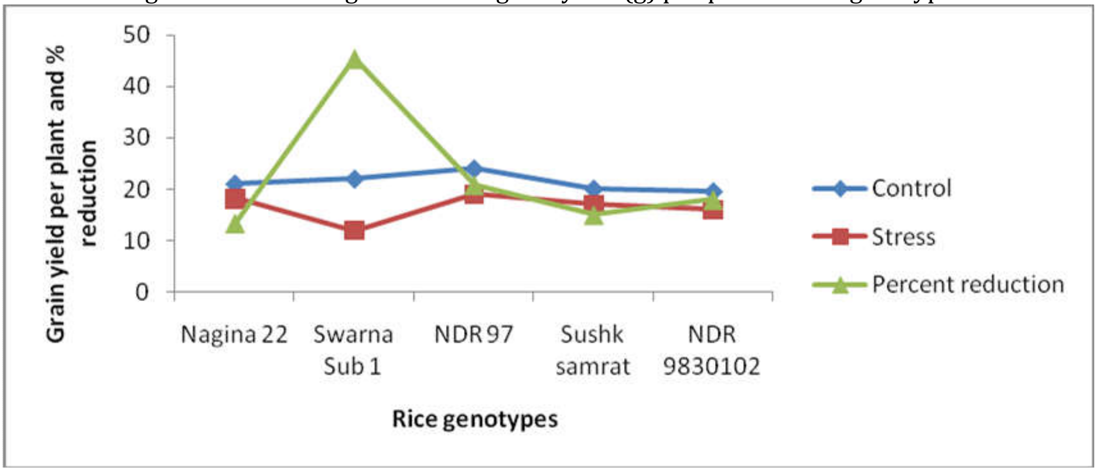
Total proline content significantly varied among rice genotypes under drought stress (fig.4). High proline content was recorded in Nagina 22, NDR 97 and Susk Samrat while less in Swarna sub 1 and NDR 9830102. Drought tolerant rice genotypes accumulated high proline content as osmolyte and create more negative water potential in plant tissue and plant absorb water from low soil water potential. Accumulation high proline is a osmotic adjustment traits of tolerant plant under water deficit condition [1, 11].

Fig.4: Effect of drought stress on proline content ($\mu g g^{-1}$ fw) of rice genotypes.



Drought stress reduced the grain yield irrespective of rice genotypes (fig.5). High reduction in grain yield was recorded in Swarna sub1 and NDR 9830102 under drought stress condition. Nagina 22, NDR 97 and Susk Samrat showed less percent reduction under drought stress over control. Grain yield is control by multigenic factors. Drought stress disturb the normal plant metabolism due to imbalance water status in plant. In water deficit condition, the photosynthetic activity of plant reduced and ultimately affect the grain yield. Tolerant rice genotypes maintains its water balance either by osmotic adjustment or any other changes in its morphology or physiology during water deficit condition and comparatively show less reduction in grain yield [3, 4, 5, 16, 9, 10].

Fig.5: Effect of drought stress on grain yield (g) per plant of rice genotypes.



CONCLUSION

Drought stress affects the yield component irrespective of rice genotype. The extent of reduction in growth and yield components depends on stage of plant, intensity and duration of stress. The rice genotypes Nagina 22, NDR 97 and Susk Samrat less affected while Swarna Sub1 highly affected in physiological traits for drought stress.

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REFERENCES

1. Ashraf M, Foolad M R. (2007). Role of glycine betaine and proline in improving plant abiotic stress resistance. *Environ Exp Bot*, **59**(2): 206–216.
2. Bates L S, Waldren R P, Teare I D. (1973). Rapid determination of free proline for water stress studies. *Plant Soil*, **39**(1): 205–207.
3. Cabuslay G S, Ito O, Alejar A A. (1999). Genotypic differences in physiological responses to water deficit in rice. *In*: Genetic Improvement of Rice for Water-Limited Environments. Los Banos, the Phillipine: International Rice Research Institute: 99–116.
4. Cabuslay G S, Ito O, Alejar A A. (2002). Physiological evaluation of responses of rice (*Oryza sativa* L.) to water deficit. *Plant Sci*, **163**(4): 815–827.
5. Chaturvedi G S, Singh A, Bahadur R. (2012). Screening techniques for evaluating crop germplasm for drought tolerance. *Plant Arch*, **12**(1): 11–18.
6. Cha-um S, Yooyongwech S, Supaibulwatana K (2010) Water deficit stress in the reproductive stage of four indica rice (Oryza sativa L.) genotypes. Pak J Bot 42(5):3387–3398
7. Chutia J, Borah SP (2012) Water stress effects on leaf growth and chlorophyll content but not the grain yield in traditional rice (Oryza sativa Linn.) genotypes of Assam, India II. Protein and proline status in seedlings under PEG induced water stress. Am J Plant Sci 3: 971–980.
8. Dalal VK, Tripathy BC (2012) Modulation of chlorophyll biosynthesis by water stress in rice seedlings during chloroplast biogenesis. Plant Cell Environ 35:1685–1703
9. Fang Y J, Xiong L Z. (2015). General mechanisms of drought response and their application in drought resistance improvement in plants. *Cell Mol Life Sci*, **72**(4): 673–689.
10. Fen L L, Ismail M R, Zulkarami B, Rahman M S A, Robiul Ismail M. (2015). Physiological and molecular characterization of improvement in plants. *Cell Mol Life Sci*, **72**(4): 673–689.
11. Lum, M.S., M.M. Hanafi, Y.M. Rafii and A.S.N. Akmar, (2014). Effect of drought on growth, proline and antioxidant enzyme activities of upland rice. The Journal of Animal & Plant Sciences, 24: 1487-1493.
12. Mohan MM, Laxmi NS, Ibrahim SM (2000). Chlorophyll stability index (CSI): its impact on salt tolerance in rice. International Rice Research notes**,** 25: 38-39.
13. O'Neill P M, Shanahan J F, Schepers J S. 2006. Use of chlorophyll fluorescence assessments to differentiate corn hybrid response to variable water conditions. *Crop Sci*, **46**(2): 681–687.
14. Ouk M, Basnayake J, Tsubo M, Fukai S, Fischer KS, Cooper M, Nesbitt H (2006). Use of drought response index for identification of drought tolerant genotypes in rain-fed lowland rice. *Field Crop Research*, 99: 48-58.
15. Pandey V, Shukla A. (2015). Acclimation and tolerance strategies of rice under drought stress. *Rice Sci*, **22**(4): 147–161.

16. Pantuwan G, Fukai S, Cooper M, Rajatasereekul S, O'Toole JC (2002) Yield response of rice (Oryza sativa L.) genotypes to drought under rainfed lowlands. 2. Selection of drought resistant genotypes. Field Crops Res 73:169–180.
17. Passioura, J. (2007). The drought environment: physical, biological and agricultural perspectives. *J.Exp. Bot.*, 58: 113-117.
18. Raman A, Verulkar S, Mandal NP, Varrier M, Shukla VD, Dwivedi JL, Singh BN, Singh ON, Swain P, Mall AK, Robin S, Chandrababu R, Jain A, Ram TR, Hittalmani S, Haefele S, Piepho HS, Kumar A (2012). Drought yield index to select high yielding rice lines under different drought stress severities. *Rice*: 5(31): 1-12.
19. Sikuku P A, Onyango J C, Netondo G W. (2012). Physiological and biochemical responses of five nerica rice varieties (*Oryza sativa* L.) to water deficit at vegetative and reproductive stage. *Agric Biol J N Am*, **3**(3): 93–104.
20. Singh S, Singh TN (2000). Morphological, chemical and environmental factor affecting leaf rolling in rice during water stress. *Indian J Plant Physiol*., 5: 136-141.
21. Vikram P, Swamy B P M, Dixit S, Ahmed H U, Cruz M T S, Singh A K, Kumar A. 2011. *qDTY1.1*, a major QTL for rice grain yield under reproductive-stage drought stress with a consistent effect in multiple elite genetic backgrounds. *BMC Genet*, **12**: 89.

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