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Original Research Article

Effect of Cold Stress on Primary Nutrient Level during Seedling Growth of Boro Rice

Seema[1*], N. Y. Azm[2], P. K. Singh[3] and Manish Kumar[4]

[1]Department of Botany & Plant Physiology, NCOH, Noorsarai, Nalanda, Bihar-803113, India
[2]Department of Soil Science, NCOH, Noorsarai, Nalanda, Bihar-803113, India
[3]NCOH, Noorsarai, Nalanda, Bihar-803113, India
[4]Department of Agril. Engineering, NCOH, Noorsarai, Nalanda, Bihar-803113, India
**Corresponding author*

Keywords

Boro rice, cold stress, primary nutrients

A B S T R A C T

Boro rice crop sown in November and December is exposed to adverse effect of low temperature during seed germination and seedling growth stage. Temperature is one of the vital factors in nutrient absorption. Beyond a certain limit of temperature, nutrient absorption gets inhibited and stops because of denaturation of enzymes involved directly or indirectly in the process. The present experiment was conducted with six rice genotypes to study the primary nutrient concentration in the rice seedling grown under low temperature stress. Result showed that with the increase in duration of chilling and seedling age, nitrogen decrease by 12.50-70.75 percent, phosphorus by 6.89-80.64 percent and potassium by 11.76-66.50 percent in shoot at 70DAS(days after sowing) stage of various rice genotypes in respect of 40DAS seedling. A similar trend of decrease in mineral levels was observed in roots. The root nitrogen level decreased by 12.87- 64.15percent, phosphorus by 12.25-78.57percent and potassium by 16.06-62.19percent. Cold tolerant genotypes (Gautam, Richharia & Dhanlaxmi) had significantly higher values than those of susceptible genotypes (Turanta, Heera & Jaya) both in root and shoot. Phosphorus level in plants has been correlated with tolerance as it facilitates the energy transfer reaction, besides being a structural element. Similarly, the maintenance of chlorophyll content in leaves requires adequate levels of nitrogen under cold stress for tolerant rice cultivars. From the above studies it may be inferred that nutrient content under low temperature declined both in shoot and root of rice seedlings reflecting that chilling reduced absorption and translocation of primary nutrient.

Introduction

Low temperature tolerant plant ideotype in rice is required to exploit the optimum yield potential of boro, when the rice ecosystems are nutrient and moisture subsidized naturally and the return from the previous kharif season are low. The success of boro rice in low land areas taking advantages of the residual water in the field after harvest of kharif paddy, longer moisture retentivity of the soil and surface water stored in the nearby ditches have encouraged the farmers in eastern states to increase the boro rice area to supplement poor kharif harvest. As a result boro season rice produces more yields (2.5-4.5t/ha) than the Kharif rice (1.5-2.7t/ha)in the same ecology. In Bihar average productivity is about 4t/ha and the yield of 8-10t/ha from high yielding varieties on farmers' field have been reported. Temperature is one of the vital factors in nutrient absorption. Beyond a certain limit of temperature, nutrient absorption gets inhibited and stops because of denaturation of enzymes involved directly or indirectly in the process

Materials and Methods

Twenty six genotypes of rice (Table1) were subjected to preliminary screening under Boro season. Genotypes were selected on the basis of their differential ability to tolerate cold condition at seedling stage. Cold tolerance was determined on the basis of yellow, chlorosis of seedlings survival on 1-9 scale by simple eye observation (IRRI, 1996). For further study six genotypes viz V1- Gautam, V2-Richharia, V3-Dhanlaxmi, from cold tolerant group and V4 -Turanta, V5 -Jaya and V6 –Heera from cold susceptible group. The experiment was conducted in rabi season and was repeated two years at Rajendra Agril. University, Pusa campus. The maximum and minimum temperature during the experiment period ranged between 27.74-11.60 in 1st year and 23.53 to 11.88 in 2nd year. Sowing is done on 8th Nov. and the data was recorded at three period of fifteen days intervali.e.T1-40days after sowing(DAS), T2-(DAS), T3-(DAS).Analysis of the dried plant sample was done for the estimation of nitrogen, phosphorus and potassium. The plant samples of root and shoot were finely ground using an electric grinder fitted with stainless steel blade. The nitrogen content was determined by automatic N analyser, phosphorus by vanadomolybdate yellow colour method and potassium by flame photometer.

Results and Discussion

Result showed that the average value of nitrogen content of T1 and T3 seedling, depicted a consistent decrease from 25.40-14.80mg/g dry weight and periodic decrease of nitrogen content of shoot of various rice genotypes during T1-T2 showed a decrease of 28.42 percent while the decrease during T2-T3 period was 18.59%(Fig.1a). The variation in nitrogen content among various rice genotypes was statistically significant. Nitrogen content of roots at three-time interval, on an average depicted a consistent decrease from 26.90 mg/g dry weight to 16.82 mg/g dry weight. However, decrease during T1-T2 periodwas25.31 percent while that during T2-T3 was 16.28 percent (Fig. 1b). Phosphorus content in shoot depicted a consistent decrease from 3.02mg/g dry weight to 1.78 mg/g dry weight. The rate of decrease during T1-T2 period was 33.77 percent while during T2-T3 period of seedling growth the decrease was relatively less being 11.00 percent (Fig.2a). Phosphorus content in seedling roots during T2-T3 stage depicted a consistent decrease from 4.32 mg/g to 2.50 mg/g dry weight. The phosphorus content in root during T1-T2 period showed a decrease of 34.95 percent while during T2-T3 the value decline by 11.03 percent (Fig.2b). Potassium content in shoots decreased by20.64 mg/g to 15.0 mg/g dry weight during T1-T2 stages whereas during T2-T3 the potassium content was 15.70 mg/g to 13.52 mg/g dry weight The rate of decrease during T1-T2 was 23.93 percent while that during T1-T3 was 34.50 percent(Fig.3a) The potassium content of T1-T2 and T3 seedling in roots of various rice genotypes depicted a consistent decrease in value from 27.62 mg/g to 17.05 mg/g dry weight. The potassium content in root during T1-T2 period decreased by 22.30 percent while during T2-T3 period decrease was 22.55 percent (Fig.3b).

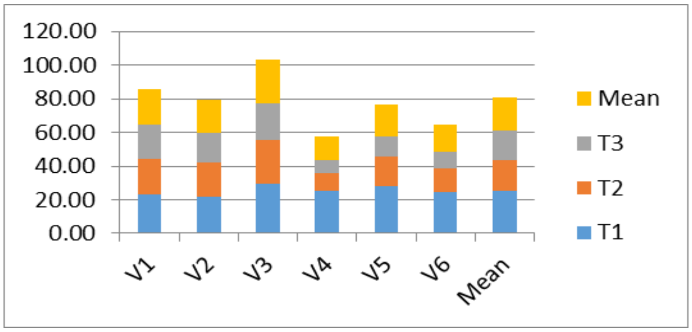
The result of the present study however indicated that the growth under low temperature stress leads to a general decline in the contents of primary nutrient both in roots and shoots. The nutrient content declined with increase in duration of cold stress. The findings of primary nutrient deficiency in rice when its growth was limited by chilling stress is in consonance with wide spread poor nutrient status observed in thermophilic plants under cold stress (Baruah and Medhi, 1993). Cold stress induced tissue dehydration reduced growth development of plants in cereals which was due to the accumulation of MDA content as a result of lipid peroxidation in membranes (Yadav, 2010). The various causes attributed to low nutrient status of plants under low temperature appear to be related with absorption of nutrients, nutrient concentration in the surrounding medium, leakage of electrolytes transport from roots to shoot and genotypic sensitivity to cold (Salvakumar *et al.,* 1987).

Table.1 Planting material of rice used and their cold tolerance (CT) score

Name of Genotypes	Cold tolerance score
RAU441-65-88-1	5.00
RAU448-46-47-1	4.33
RAU520-34-8	5.00
RAU1344-4-1	6.67
RAU494-624	6.67
RAU1346-4-1	5.00
RAU1344-3-2(Dhanlaxmi)	4.00
PSBR-150	7.00
IR59471-213-20-2-1	7.67
IR55275-8-8-1-1-1-3	4.67
IR56383-77-1-1-1	5.33
IR53970-100-3-3-2	7.00
RAU8772	7.33
PUSA835-203-2-13-102	6.67
CN925-KGR-88-2-52	4.33
RAU1345-2(Richharia)	4.67
RAU461-55-1	4.00
RAU1345-12-1	5.33
PSRM1-15-3b-13	7.67
CN881-5-1-2	8.00
PSRM16-4B-11(Gautam)	3.00
Heera	8.67
IR25374-3-7-3-3-3	7.67
Turanta	8.00
Pusa2-21	7.00
Jaya	7.67
S.Em± C.D.(P=0.05)	0.585 1.662

Fig.1 Effect of low temperature on nitrogen content (mg/g dry weight) of different genotypes of rice with age of seedling

1a. Shoot



1b. Root

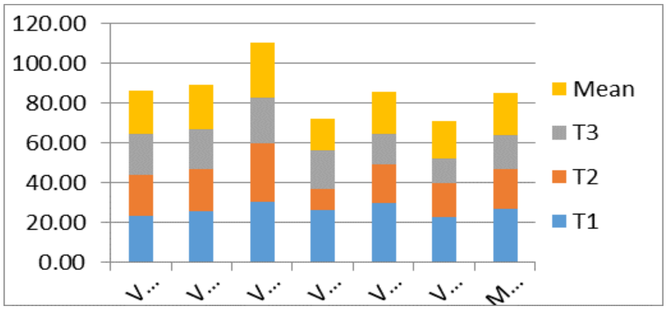
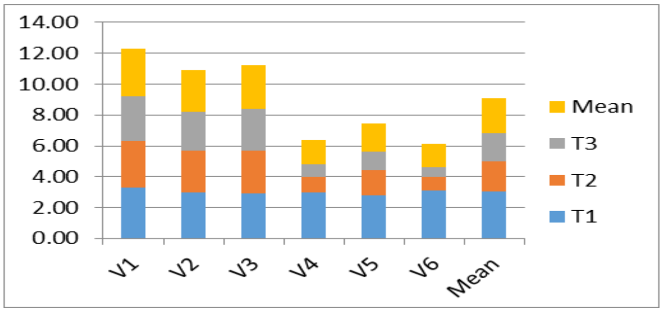


Fig.2 Effect of low temperature on Phosphorus content (mg/g dry weight) of different genotypes of rice with age of seedling

2a. Shoot



2b. Root

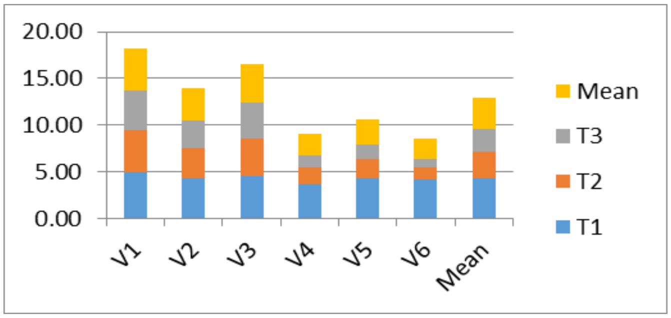
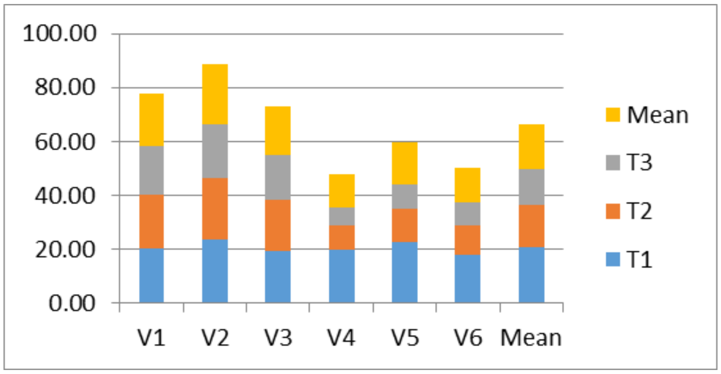
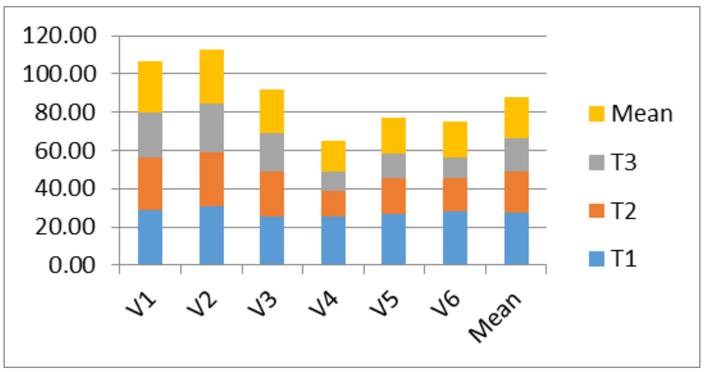


Fig.3 Effect of low temperature on potassium content (mg/g dry weight) of different genotypes of rice with age of seedling

3a. Shoot



3b. Root



The nutrient content of roots remained higher than that in the shoots during the seedling growth under cold, indicated that the seedling response to chilling induces decrease in there translocation. In view of the wilting of leaves reported in several cold sensitive plants have resulted from reduced absorption and translocation of minerals.

Distribution of mobile nutrient within the plant organ which are transported with the transpiration stress during the mass flow of water may have especially been affected. It is of significant to note that the major function of elements especially is to maintain osmotic potential of cells and turgor mediated responses like elongation, stomatal and leaf movement. The present investigation is in consonance with the observation in as far as the decline in element content was accompanied with stunted shoot growth under low temperature condition of rice genotypes. During stress condition, the leakage of electrons from the electron transport activities of chloroplasts, mitochondria and plasma membranes or also as a byproduct of various metabolic pathways localized in different cellular compartments (Sharma *et al.*, 2012). These stress alter the normal homeostasis of plant cells by disrupting photosynthesis and increasing photorespiration (Noctor *et al.*, 2012) Low temperature induced nutrient deficiency at root level is reported to affected the level of growth regulator with the consequence of affected the shoot phenology(Setter and Greenway, 1988).

The nutrient content in plant tissues has been related with their cold tolerance.

However plants have evolved variety of responses to extreme temperatures that help in minimizing damages and provide cellular homeostasis (Kotak *et al.,* 2007). Direct link exists between ROS scavenging and plant stress tolerance under temperature stress conditions which is often related to enhance activities of antioxidative defence enzymes that confers stress tolerance to low temperature stress (Almeselmani *et al.*, 2009). Genotypic sensitivity of rice in the present study is in consonance with these study. Tolerance rice varity viz., Gautam, Richharia and Dhanlaxmi could retain higher nutrient content in comparison to the susceptible varieties i.e. Jaya, Turanta and Heera. The maintenance of relatively higher content of K^+ in the tolerant genotypes puts them at an advantageous position, under low temperature, on account of maintenance of osmotic potential for cell elongation. Similarly the role of potassium as enzyme activator and for efficient function of photosystem II enables the genotypes with relatively higher content of nutrient to perform physiological functions with reduced damage to subsist under the low temperature stress. Phosphorus level in plants has been correlated with tolerance as it facilitates the energy transfer reactions, basides being a structural element. Similarly, the maintenance of chlorophyll content in leaves requires adequate levels nitrogen under cold stress for tolerant rice cultivars. From the above studies it may be inferred that mineral content under low temperature decline both in shoot and root of rice seedlings reflecting that chilling reduced absorption and translocation of minerals. The content of minerals in root and tolerant genotypes, however remained higher than that in the shoot and susceptible genotypes respectively.

References

Almeselmani, M., Deshmukh, P.S. and R.K. Sairam 2009. High temperature stress tolerance in wheat genotypes: Role of antioxidant defence enzymes. *Agron. Hungar,* 57:1-14.

Barua, K.K. and A. Medhi 1993. Growth and metabolic response of rice (*Oryza sativa* L.) to low temperature stress. *Indian. J. Plant Physiol.*, 36(1) 53-55.

IRRI 1996. Standard evaluation system for rice, IRRI, Los Banos, Philippines, pp1-49.

Koskull, P.V., K.D. Scharf and L. Nover 2007. The diversity of plant heat stress transcription factors. *Trends in plant Science*, Science Direct, 12(10):452-457.

Noctor, G., A. Maamdi, S. Chaouch, Y. Hans, J. Neukermans, B.M. Garcia, G. Queval and C.H. Foyer 2012. Glutathione in plants: an integrated overview. *Plant cell and Environment*, 35:454-484.

Selvakumar, K.S., G. Soundarapandian and R. Vaithialingam 1987. Physiological indices for cold tolerance in rice. *Madras Agric. J*., 74(1):34-41.

Setter, T.L. and H. Greenway 1988. Growth reduction of rice of low root temperature, decrease nutrient uptake and development of chlorosis. *J. Expt. Bot*., 39:811-829.

Sharma, P., A. Bhushan Jha, R.S. Dubey and M. Pessarakli 2012. Reactive oxygen species, oxidative damage and Antioxidative Defence Mechanisum in plants under stressfull condition. *J. of Botany*, 2012:26.

Yadav, S.K., 2010. Cold Stress Mechanism in Plants. A Review-Hal. *Spinger*, 30(3): 515-527.