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EFFECT OF BORON FERTILIZATION ON THE GROWTH AND YIELD OF RICE

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A net house experiment was carried out to find out the effect of boron on growth and yield performances of rice (IRRI-11) grown on a loamy soil. Boron was applied at the rate of 0, 1, 2, 4 and 8 kg B ha^{-1}. Soil treated with boron showed a significant effect on the growth and yield of the crop. 2 kg B ha^{-1} produced the highest straw (10.01 g pot^{-1}) and grain (9.69 g pot^{-1}) yields and maximum uptake of N, P and K nutrients (193, 29 and 208 mg pot^{-1}) by the rice plants. The treatment (2 kg B ha^{-1}) increased about 139 and 149% more straw and grain, respectively over the control. The further increment in the dose of boron (i.e. 4 and 8 kg B ha^{-1}), however, reduced the growth and yield components of rice plant.

Keywords: Boron; Growth; Nutrient uptake; Yield.

Introduction

Crop production is greatly influenced by the micronutrients availability in soil. Boron is one of the important one, whose deficiency and toxicity would cause great reduction in the output of the agricultural crops. However, the margin between these two levels is very narrow. In Bangladesh, the unwise application of chemical fertilizers without testing create the critical problem for soils. Due to sedimentation materials of the river water of the southern and southeastern side of the country are becoming alkaline, which resulted the land of the surrounding areas with high pH. This prevailing condition made boron unavailable due to their adsorption or fixation tendency in the soil of high pH (> 7.0). Studies by Peterson and Newman[1] showed that a negative relationship between soil pH and plant boron occurs when soil pH levels are higher than 6.5. Goldberg *et al.*[2] observed that adsorption of boron increased with increasing solution pH to an adsorption peak near pH 9 and then decreased as the pH continues to increase. Kabir and Mandal[3] reported through their investigation that due to having higher pH value in the soil of the Charland of the river Meghna, boron deficiency has occurred and their subsequent replacement caused the higher production of Jumboo grass (sweat clover x sorghum).

Literature review reveals that information on effect of boron in young Brahmaputra flood plain soils is scantly. Thus, the present study was carried out to find out the role of boron on the growth and yield of rice (IRRI-11).

Materials and Methods

The experimental soil (0-15 cm) was taken from Sonatola series under the upazila of Ghatail, district of Tangail. According to USDA Taxonomic classification, the soil belongs to inceptisols order and aquept suborder. The pH value[4] and organic matter[5] status of the soil were found to be 6.9 and 1.13%, respectively. The available N[6] and P[7] were 17 and 20.5 mg kg^{-1} respectively. Exchangeable K, Ca and Mg[6] were 0.04, 0.35 and 0.30 c mol kg^{-1} respectively. The available B[8] (hot water extract), exchangeable Mn[6] and available S[6] were recorded to be 0.2, 4.1 and 24 mg kg^{-1} respectively.

Two kg of surface soil was taken in each of the bottom sealed plastic pot. Soil in each pot was treated with a basal dose of N (100 kg N ha^{-1}) as urea, P (90 kg P ha^{-1}) as TSP and K (80 kg K ha^{-1}) as MP fertilizers. N was given in each potted soil in three equal splits.

Five doses of boron (0, 1, 2, 4 & 8 kg B ha^{-1}) as Borax ($Na_2B_4O_7.5H_2O$) were selected. The amounts of boron were uniformly mixed with the soil in the form of aqueous solution. All the treated pots were kept in the net house following a randomized block design with three replications. Necessary cultural practices were done as and when required. Two hills consisted of three uniform healthy seedlings were allowed to grow in each pot.

Plant height was recorded after 15 days of interval from the date of transplantation of rice seedlings up to 90 days. Tillers were recorded at the maturity of the plant. Grains and shoots were harvested carefully and weights were recorded.

Plant samples were digested with H_2SO_4[9], and N, P and K contents were determined by Kjeldahl distillation, calorimetrically and flame photometrically. Least significant difference (LSD) of the treatments and correlation co-efficient between uptake of nutrients and yield of grain were calculated by standard methods.

Table 1. Influence of boron on the height and tiller number of rice plants.

Treatments kg B ha^{-1}	Plant height (cm) Days						Tiller plant^{-1}
	15	30	45	60	75	90	
0	14	22	31	40	46	47	1.83
1	16	23	30	49	51	51	2.17
2	15	20	30	43	53	56	2.17
4	16	21	30	41	44	46	1.70
8	14	21	30	45	50	53	1.83
LSD at 5% level	NS	NS	NS	3.5	4.0	4.0	0.24

Table 2. Influence of boron on the yield and yield components of rice.

Treatments kg B ha^{-1}		Panicle pot^{-1}	Wt. of straw g pot^{-1}	Wt. of grain g pot^{-1}	Filled grain %
0	9	7.20	6.56	64	
1	9	8.57	6.07	59	
2	13	10.01	9.69	72	
4	7	7.10	7.32	63	
8	9	6.99	8.64	75	
LSD at 5% level		1.2	1.65	1.06	8

Table 3. Influence of boron on the nutrient (NPK) uptake by rice plant.

Treatments kg B ha^{-1}	Nutrient uptake (mg pot^{-1}) N	P	K
0	110	7	43
1	146	21	154
2	193	29	208
4	177	16	112
8	158	13	90
LSD at 5% level	18.5	3.3	23.5
r value	0.72	0.51	0.49

Results and Discussion

Height and tiller production: Application of boron fertilizer influenced the height and production of tillers of the rice plant (Table 1). The results revealed that addition of boron did not show any significant difference up to 45 days after transplantation in all the treatments. However, after this growth period, a significant (p=0.05) increase in the height of rice plants was observed in boron treated pots over the control. The highest height of the plant was recorded in the treatment receiving 2 kg B ha^{-1} (56 cm) followed by 1 kg B ha^{-1} (51 cm) at 90 days of transplantation. Almost similar trends in height of the rice plant were recorded both at 60 and 75 days of growth. It has been marked that the impact of added boron became positively effective after 45 days of growth. A further increase in the dose of boron (i.e. 4 and 8 kg B ha^{-1}) failed to increase the height of the plant significantly. Moreover, the rate of increase of height of rice plants at higher doses of boron was found to be less than that of 2 kg B ha^{-1} treated pots.

In case of tiller number, a similar significant (p = 0.05) effect of boron was observed (Table 1). The highest number of tillers $plant^{-1}$ was recorded in the pot provided with 2 kg B ha^{-1} (2.17 $plant^{-1}$) which followed by the same trend as in the case of height of the rice plant.

Production of panicles and percent filled grains: The production of panicles and the percentage of filled grain were found to be noticeably modified by the added fertilizer. The highest number of panicles (13 plants pot^{-1}) and percentage of filled grain (72%) were recorded in the treatment where 2 kg B ha^{-1} was applied. The production of panicles and the percentage of filled grain were found to be appreciably modified by the supplied fertilizer.

Yields of straw and grain: The results presented in Table 2 showed that the yields of straw and grain of rice increased significantly (p=0.05) with the supply of boron. The highest increments in straw and grain production were recorded to be 10.01 and 9.69 g pot^{-1}, respectively, where 2 kg B ha^{-1} was added. The results also revealed that the percent increment over the control by 2 kg B ha^{-1}, yields of straw and grain were recorded to be 139 and 149% more, respectively. Habib[10] reported similar results that the lack of boron in the complete fertilizers caused a significant decrease in the growth and yield of rice in soils of Kalma, Silmondi and Gopalpur series. This result is also in good agreement with the findings of Sinha *et al.*[11] who reported that added boron increased markedly the yield of both the kharif and robi crops. A relatively lower yields were found due to further increase in boron from 2 to 4 kg ha^{-1} resulting 7.10 and 7.32 g pot^{-1} of straw and grain respectively. However, the yields were found to significantly lower. The highest dose of boron (8 kg B ha^{-1}) reduced the yields to a limited extent (6.99 and 8.64 g pot^{-1}) and was not found to be statistically significant. This decrease might be due to toxic effect of this fertilizer. It was noticeable that the necessity of boron was proven but only in small amount in this soil. The reason might be due to the continuous application of unsystematic and higher amount of chemical fertilizers. Kabir and Mandal[3] showed that addition of boron in the sandy soil of Meghna river bank area increased the dry matter and protein content of Jumboo grass appreciably. It could be seem that the yields of straw and grain of rice is a reflection of total number of panicles pot^{-1} and percent filled grains.

Nutrient uptake (NPK) by rice plant: The accumulations of N, P and K in the rice plant have been estimated and the results thus obtained are presented in Table 3. Accumulation of these nutrients followed the similar trends as in the case of growth components and yields of straw and grain of rice. The highest increase in nutrients uptake (NPK) were recorded in the plants supplemented with 2 kg B ha^{-1} yielding 193, 29 and 208 mg pot^{-1}, respectively. The accumulation of nutrients was also found to be significantly higher than the control. Positive correlation was obtained between N uptake (r = 0.79) and yield of grain of rice. The uptake of P and K by the rice plants also bears a positive correlation with grain yield but their level of significance was lower (r = 0.47 and r = 0.43) than that of N. Uptake of nutrients at higher doses of boron through increased over the control but not significantly.

References

1. Paterson LA and Newman RC 1975, Influence of soil pH on availability of added boron. *Soil Sci. Soc. Am. J.* **40** 280.
2. Goldberg SH, Forster S and Heick EL 1993, Temperature effects on boron adsorption by reference minerals and soils. *Soil Science* **156** 316-317.
3. Kabir SM and Mandal R 2003, Response of Jumboo grass (sweet clover x sorghum) to boron and molybdenum application in sandy soil. *J. Phytol. Res.* **16(1)** 9-14.
4. Jackson ML 1973, Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi, pp. 215-224. Jackson ML 1973, Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi, pp. 215-224.
5. American Society of Agronomy 1965, Methods of a Soil Chemical Analysis. Part 2. Madison, USA. Chapter 83.
6. Jackson KL 1985, Soil Chemical Analysis. Prentice-Hall, Englewood Cliffs, NJ. pp 498.
7. Murphy J and Riley JP 1962, A modified single solution method for the determination of phosphate in natural water. *Anal. Chim. Acta* **27** 31-36.

8. Berger KC and Troug E 1939, Boron determination of soils and plant using the quinalizarin reaction. *Ind. Engl. Chem.* **11** 540-545.
9. Cresser MS and Parsons JW 1979, Sulphuric-perchloric acid digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. *Anal. Chim. Acta* **109** 489-500.
10. Habib MA 1995, Iron, manganese, copper, zinc and boron dynamics in submerged soils and growth and yield of rice M. Sc. These, Department of Soil, Water and Environment, D.U. pp. 84-85.
11. Sinha RB, Sakal R, Singh SP and Bhogal NS 1991, Response of some field crops to boron application in calcarious soils *J. Indian Soc. Soil Sci.* **39** 118.