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Effect of Zinc, Boron and Molybdenum Application on the Yield and Nutrient Uptake by BRRI Dhan 30

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Abstract: A field experiment was conducted to observe the effect of micronutrients (Zn, B and Mo) fertilization on the growth, yield, and nutrient uptake by Transplanted aman rice (CV. BRRI Dhan-30). The experiment was laid-out with eight fertilizer treatments control, Zn, B, Mo, Zn+B, Zn+Mo, B+Mo and Zn+B+Mo. Rate of Zn was 5 kg ha^{-1}, B; 3 kg ha^{-1} and Mo; 2 kg ha^{-1} from zinc sulphate, boric acid and ammonium molybdate, respectively. There was a significant positive effect of micronutrients on the yield of T.aman rice. The highest grain yield (4.8 t ha^{-1}) was obtained in the treatment where all the 3 micronutrients were applied. The individual effect of B and Zn was quite pronounced with respect to grain yield of the crop.

Key words : Zinc, boron, molybdenum, yield, BRRI Dhan 30

Introduction

Fertilizers are indispensable for the crop production system of modern agriculture. Today inorganic fertilizers, hold the key to success for increased crop productivity under Bangladesh agriculture, being responsible for about 50 % of the total production (FRG, 1997). In past, only three primary nutrients viz. N, P and K along with one secondary nutrient S are commonly used in Bangladesh. The importance of micronutrient nutrition of crops was almost overlooked. However, some micronutrients are essential plant nutrients and play a significant role in crop nutrition which finally leads to healthy growth and increased yield. Need for micronutrient fertilization in soil is increasing, yet the proportion of different fertilizer used in the country is not quite balanced. Nitrogen alone constitutes about 80 % of the total nutrients used in country (FRG, 1997) which only can not help to improve crop productivity unless other limiting nutrients are supplemented along with nitrogen.

In Bangladesh, nutrient stress on soils are progressively increasing due to high cropping intensity with high yielding crop varieties. Besides, there are many soil reactions that immobilize the plant nutrients in soil and thus restricts their availability to plant. Zinc deficiencies are widely spread throughout the world, especially in the rice lands of Asia and deficiencies occur in neutral and calcareous soils (Tisdale *et al.*, 1997). Deficiency of micronutrients with an emphasis to zinc in particular, has been reported in wetland rice soils of Bangladesh and spectacular response by application of 5 kg Zn ha^{-1} have been recorded (Rahman *et al.*, 1978). It was reported that about 2.0 M hectare of agricultural land is zinc deficient under different agroecological zones (AEZ) of Bangladesh. Zinc is essential for numerous enzyme systems and is capable of forming many stable bonds with N and S ligands.

Boron deficiency is reported on some soils and crops (Jahiruddin *et al.*, 1993, 1995; Mondal *et al.*, 1992 and Islam *et al.*, 1997). Boron deficiency may induce grain sterility in rice (Ambak and Tandano, 1991). Approximately 1 M ha of cultivable land in Bangladesh is suspected to have B deficiency problem (Ahmed and Hossain, 1997).

It was reported that molybdenum deficiency is usually common in acid sandy soils having pH <5.5 where leaching losses, strong molybdate adsorption and few molybdenum minerals occur (Mengel and Kirkby, 1987). Soils high in metal oxides (Sesquioxides) have low Mo availabilities (Miller and Donahue, 1997). Response of rice and mungbean to Mo application have been reported in the Brahmaputra floodplain soils of Bangladesh (Ahmed, 1982). Higher crop yields naturally have higher requirement of nutrients due to more pressure on the land for available forms of nutrients.

Thus, the investigation was undertaken with a view to assess the effect of zinc, boron and molybdenum application on the yield and their uptake by BRRI Dhan 30 (*Oryza sativa*) for increased sustainable yield.

Materials and Methods

The experiment was conducted on Non-calcareous Dark Grey Floodplain soil of Brahmaputra alluvium (Haplaquept) at Bangladesh Agricultural University (BAU) Farm, Mymensingh during July to December, 1999. The important physico-chemical characteristics of the experimental soils are presented in Table 1. The experiment was laid out in a Randomized Complete Block Design having eight treatments. The treatment were as (1) control, (2) Zn, (3) B, (4) Mo, (5) Zn+B, (6) Zn+Mo, (7) B+Mo and (8) Zn+B+Mo. The rate of Zn was 5 kg ha^{-1}; B, 3 kg ha^{-1} and Mo, 2 kg ha^{-1} from zinc sulphate, boric acid and ammonium molybdate, respectively. A blanket doses of 75 kg N ha^{-1}, 15 kg P ha^{-1}, 25 kg K ha^{-1} and 30 kg S ha^{-1} from urea, triple super phosphate, muriate of potash and gypsum, respectively, were applied in every plots. The full doses of triple super phosphate, muriate of potash, gypsum, zinc sulphate, boric acid and ammonium molybdate were applied at the time of final land preparation. Urea was applied in three equal splits. The first split was added during final land preparation, the second split after 4 weeks of transplanting at tillering stage and the final split before panicle initiation stage of crop growth. 30 days old seedlings of BRRI Dhan-30 were transplanted in the experimental plots and were harvested at maturity. 10 plants were randomly collected from each plot before harvesting to record the data on yield contributing parameters. Grain and straw yields were recorded plot wise. The plant samples were oven dried at 65° C for 48 h and ground. Plant samples were chemically analyzed to determine N, P, K, S, Ca, Mg, Zn and B contents following standard analytical methods (Page, *et al.*, 1989; Hunter, 1984).

Results and Discussion

Grain yield responded significantly to the application of micronutrients treatments (Table 2). The treatment containing Zn, B and Mo together produced the highest grain yield (4.79

t ha^{-1}) which was statistically identical with that recorded in (4.74 t ha^{-1}) T_5 treatment. On the other hand, the lowest grain

Table 1: Important physico-chemical characteristics of the experimental soil

Properties	value
Sand (%)	25.0
Silt (%)	65.0
Clay (%)	10.0
pH (Soil: Water = 1:25)	7.20
Organic Matter (%)	1.37
Total N (%)	0.09
Available P (mg kg^{-1})	12.8
Exchangeable K (meq.100g^{-1} soil)	0.08
Exchangeable Ca (meq.100g^{-1} soil)	6.30
Exchangeable Mg (meq.100g^{-1} soil)	2.32
Available S (mg kg^{-1})	17.5
Available Zn (mg kg^{-1})	1.01
Available B (mg kg^{-1})	0.16

Table 2: Effect of micronutrients on yield and yield components of BRRI DHAN-30 as influenced by different treatments

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Plant height (cm)	Panicle length (cm)	1000 grain wt (g)	Filled grain (%)/ panicle
T_1 (Control)	3.80f	5.16d	104d	20.47c	21.76c	76.63b
T_2 (Zn)	4.49cd	6.65abc	121ab	23.60ab	22.91ab	87.37a
T_3 (B)	4.43de	6.27bc	115c	23.33ab	23.44a	89.33a
T_4 (Mo)	4.34e	6.44bc	118bc	23.83ab	23.43a	88.43a
T_5 (Zn+Mo)	4.74a	6.69ab	120ab	24.36ab	23.67a	88.03a
T_6 (Zn+Mo)	4.60b	6.25c	119ab	21.87bc	22.09c	86.09a
T_7 (B+Mo)	4.56abc	6.39bc	117bc	22.80ab	23.09ab	89.37a
T_8 (Zn+B+Mo)	4.79a	7.07a	122a	24.40a	23.54a	90.37a

The figures having common letter in a column are not significantly different by DMRT at 5% level.

Table 3: Nutrient uptake (kg ha^{-1}) by BRRI Dhan 30 (grain+straw) rice as affected by different treatments

Treatment	N	P	S	Ca	Mg	Zn	B
T_1	64.40c	7.98d	8.04c	8.13	15.33d	0.223d	0.089e
T_2	86.24b	10.01bc	8.81bc	10.73	19.88ab	0.401ab	0.122d
T_3	83.48b	9.65c	9.89ab	9.74	19.04b	0.355b	0.154ab
T_4	85.87b	10.15bc	9.94ab	0.54	16.56d	0.291c	0.132cd
T_5	87.44ab	10.74ab	10.92a	11.54	19.63ab	0.391ab	0.157a
T_6	87.20b	10.67ab	10.21ab	9.33	18.65bc	0.359b	0.128cd
T_7	86.43b	10.32abc	10.51a	6.59	18.33bc	0.29c	0.14bc
T_8	94.89a	11.07a	11.00a	11.84	21.79a	0.420a	0.158a

The figures having common letter in a column are not significantly different by DMRT at 5% level.

Table 4: Correlation matrix (n=6)

Characters	Grain yield	Straw yield	Plant height	Panicle length	Tiller/ hill	1000 grain wt.	Grains panicle
Grain yield	1						
Straw yield	0.921**	1.000					
Plant height	0.933**	0.959**	1.000				
Panicle length	0.770*	0.918**	0.819*	1.000			
Tillers/hill	0.601^{NS}	0.658^{NS}	0.569^{NS}	0.566^{NS}	1.000		
1000 grain wt.	0.653^{NS}	0.786*	0.640	0.943**	0.614^{NS}	1.000	
Grain/panicle	0.872**	0.899**	0.873**	0.832*	0.833*	0.800*	1

*, $P<0.05$. **, $P<0.01$, NS= non significant

yield (3.8 t ha^{-1}) was recorded in the control treatment. The next highest yield of 4.60 t ha^{-1} obtained with T_6 treatment recorded in T_7 (Table 2). Further more, it was observed that the yield demonstrated by Zn alone was statistically identical to that recorded in T_7 or T_3. The results recorded in the experiment indicated that amongst the three nutrients used, effect of Zn was dominant, however for obtaining maximum yield, along with NPKS and Zn, application of B and Mo is also essential. The combined treatment of Zn, B and Mo (T_8) resulted in a 26% yield increase over control as against 25% yield increase due to T_5, 21% due to T_6 and 20% increase for T_7. Such positiveresponse of rice to B and Zn is also reported in other countries such as India (Dixit and Patro, 1994; Ramadas *et al.*, 1995 ; Agarwal *et al.*, 1997); China (Zou, 1992); Russia (Sheudzhen *et al.*, 1991) and Egypt (Mostafa, 1990). Although low grain yield in rice was recorded from individual application of Mo, but it was reported that foliar application of Mo at tillering stage produced increased grain yield of rice as compared to soil application (Ahmed, 1982). The available Zn and B content of the soils under study were 1.01 and 0.16 mg kg^{-1}, respectively, which indicates a low status of Zn and B in that soil (FRG, 1997). Thus the crop response to added Zn and B in the soil is expected. The pronounced effect of Zn and B on grain yield of rice agrees well with the findings of Islam *et al.* (1997), Jahiruddin *et al.* (1992) and Abedin *et al.* (1994).

Like grain yield, straw yield was also significantly affected by fertilizer treatments (Table 2). The yield of straw varied from 5.16 t ha^{-1} to 7.07 t ha^{-1} depending on the treatments used. The highest yield in T_8 treatment was statistically identical with T_5 or T_2. Next to those three treatments T_4, T_7 and T_3 produced higher yield. Similar to grain yield, the lowest straw yield (5.16 t ha^{-1}) was recorded in control which received no micronutrients (Table 2).

Plant height responded significantly to the fertilizer treatments (Table 2). The height of the plant depending on the treatment varied from 104 cm to 123 cm. The highest plant height (123 cm) was observed in T_8 treatment and the lowest (104 cm) in control which received none of the three elements.

Panicle length also responded significantly to the fertilizer treatments (Table 2). The panicle length ranged from 20.5 cm to 24.4 cm depending on different treatments. The longest panicle length was observed in T_8 treatment and the lowest value was observed in control treatment which receive none of the micronutrients. The highest panicle length was recorded in T_8 treatment which was statistically identical with that recorded in T_5, T_2, T_3, T_4 and T_7 treatments.

There was a significant effect of the applied nutrients on the per cent of filled grains/panicle, showing a variation from 76.6 to 90.4 (Table 2). Every micronutrient treatment like Zn, B, Mo and their combinations gave significantly higher per cent of filled grain as compared to control but they were statistically identical with each other. So it is clear that the effect of B was more pronounced (Table 2) than any other micronutrients. This result otherwise indicated that the addition of B had a vital role on the grain set in rice.

Like other yield components, 1000 grains weight also showed significant influence of different treatments (Table 2). The 1000-grain weight varied from 21.76 g to 23.67 g. The highest 1000-grain weight was recorded in T_5 treatment which was statistically not different with that recorded with T_8, T_3, T_4, T_7 and T_2 treatment. The lowest 1000-grain weight (21.76 g) was obtained in control treatment.

The uptake of N, P, S, Mg, Zn and B by crop (grain + straw) were markedly influenced by different treatments. The lowest uptake of N, P, S, Ca, Mg, Zn and B were noted in control treatment and the highest uptake in combined micronutrient treatments i.e T_8. The total uptake of N, P, S, Ca, Mg, Zn and B ranged from 64.4-94.9 kg ha^{-1}, 7.98-11.07 kg ha^{-1}, 8.04-11.00 kg ha^{-1}, 8.13-11.84 kg ha^{-1}, 15.33-21.79 kg ha^{-1}, 0.223-0.420 kg ha^{-1} and 0.089-0.158 kg ha^{-1}, respectively. To examine the interrelationship among the yield and yield components, correlation statistics was done (Table 4). The values of correlation coefficient indicated that grain yield was dependent on grains/panicle (r = 0.872**; P ≤ 0.01), plant height (r = 0.933**; P ≤ 0.01) and panicle length (r = 0.770; P ≤ 0.05). Grain yield was also significantly correlated with straw yield (r = 0.921**; P ≤ 0.01).

The foregoing results thus, suggested that application of micronutrients Zn, B and Mo along with NPKS is necessary for obtaining satisfactory yield of rice.

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