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Effects of Boron and Molybdenum on Sugarcane Grown in Old Himalayan Piedmont Plain Soils of Bangladesh

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ABSTRACT: A field study was conducted to investigate and ascertain the effects of boron and molybdenum with recommended N P K S Zn fertilizers (RFD) for sustained sugarcane yield in the sandy acidic soil in Old Himalayan Piedmont Plain of Bangladesh. Results revealed that the treatment T_7 having recommended fertilizers of N 120, P 35, K 100, S 25 and Zn 2 kg ha^{-1} + B 2 kg ha^{-1} + Mo 2 kg ha^{-1} produced significantly higher number of millable cane (126.96 × 10^3 ha^{-1}) except in T_9 with RFD + B 2 kg ha^{-1} + Mo 4 kg ha^{-1}, and higher cane yield (92.83 Mg ha^{-1}) among all except in T_3 with RFD + B 2 kg ha^{-1}, T_5 with RFD + Mo 2 kg ha^{-1} and T_9 where the effects were statistically identical. The increase in cane yield by T_7 was 164.6% over control. The treatment T_7 having RFD + B 2 kg ha^{-1} + Mo 2 kg ha^{-1} further gave the highest additional net economic benefit of Taka 16, 500.00 for added B and Mo at 2 kg ha^{-1} among all the treatments in the study.

Keywords: boron, molybdenum, Old Himalayan Piedmont Plain, sugarcane

Sugarcane is one of the most important cash crops in Bangladesh. It provides income to growers and employment for many farm workers throughout the year. In recent years, the importance of micronutrients in increasing agricultural production and correcting deficiencies in crops has been realized all over the world. Micro-nutrients play a vital role in the growth and development of sugarcane plant. Juang *et al.* (1974) found beneficial effects of a micro-nutrient like zinc application in sugarcane. Although Cu, Zn, B and Mn are required in lesser amounts for plant growth but are essential as much as N, P and K because micro-nutrients play an important role in absorption and translocation of macro-nutrients like N, P and K whereas deficiency of micro-nutrients in plants develops symptoms of crop malignancy (Bowen, 1981; Jones, 1972). Increased Mn application can affect concentration of N, P and K in roots, stem tissues and leaf blades as well as chlorophyll content. Micro-nutrients like Fe, Cu, Zn and Mn are essential for production of growth regulators (Kanwar & Randhawa, 1967). Under the coarse-textured acidic soils of Old Himalayan Piedmont Plain, for leaching of boron and unavailability of molybdenum for acidity, crop might not sustain normal growth. It is expected that proper use of B and Mo can increase sustained growth of sugarcane in this sugarcane-growing region of Bangladesh. Besides, the information on the requirement of boron and molybdenum on sugarcane production in Bangladesh is scarce. Therefore, this investigation was undertaken to ascertain and quantify the requirement of boron and molybdenum on sustainable production of sugarcane.

MATERIALS AND METHODS

The study was conducted during 2002 - 2003 crop season at Regional Sugarcane Research Station farm, Thakurgaon in Old Himalayan Piedmont Plain soil of Bangladesh to find out the effects of boron and molybdenum on sustained yield of sugarcane. It was laid out in RCBD with three replications. Treatments in this study were shown in Table 2. The unit plot size was 48 m^2. Variety of sugarcane was Isd 31. The method of planting was spaced transplanting in soil bed with 2-eyed settlings. The date of transplanting and harvesting was November 2003 and January 2004, respectively. All amounts of P, S, Mg, Zn, B and Mo were applied as triple super phosphate, gypsum, magnesium oxide, zinc sulphate, borax and ammonium molybdate at the time of transplanting. One third of K (muriate of potash) and one third of N

Table 1. Initial nutrient status of the experimental soil under Old Himalayan Piedmont Plain.

Physico-chemical properties of soil	Values
pH	5 00
Organic C (%)	1.04
Total N (%)	0 08
Available P (ppm)	11.00
Exchangeable K (meq %)	0 15
Available S (ppm)	9.00
Available B (ppm)	0.12
Available Mo (ppm)	0.05

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Table 2. Treatment codes.

Code	Treatment detail
T_1	Control (No fertilizer)
T_2	Recommended Fertilizer Doses of N 120, P 35, K 100, S 25 and Zn 2 kg ha^{-1} (RFD)
T_3	RFD + B 2 kg ha^{-1}
T_4	RFD + B 4 kg ha^{-1}
T_5	RFD + Mo 2 kg ha^{-1}
T_6	RFD + Mo 4 kg ha^{-1}
T_7	RFD + B 2 kg ha^{-1} + Mo 2 kg ha^{-1}
T_8	RFD + B 4 kg ha^{-1} + Mo 2 kg ha^{-1}
T_9	RFD + B 2 kg ha^{-1} + Mo 4 kg ha^{-1}
T_{10}	RFD + B 4 kg ha^{-1} + Mo 4 kg ha^{-1}

(urea) were also applied as basal. The rest of two splits of N and K were applied at 90 and 150 days after transplanting as top dressing. Initial soil status is presented in Table 1. The number of tiller at 150 days after transplanting (DAT), millable cane at harvest, cane yield, stalk height, girth and percent brix in cane were measured and the economic benefit of boron and molybdenum fertilization on sugarcane production was estimated. Yield improvement were analyzed and calculated as a percentage over control. All data were compared by LSD and DNMR test statistically using 'Analysis of Variance' technique (Steel & Torrie, 1960).

RESULTS AND DISCUSSION

The soil of the experimental field had pH 5.00, texture sandy

Table 3. Effects of boron and molybdenum on sugarcane production in Old Himalayan Piedmont Plain soils of Bangladesh; see Table 2 for treatment code.

Treatments	Maximum tiller (10^{-3} ha^{-1})	Mill able cane at harvest (10^{-3} ha^{-1})	Cane yield (TCH)	Stalk height (m)	Girth (cm)	Brix (%)
T_1	203 47 c	68.66 e	35.08 d	3.46 c	1.94	17.3 bc
T_2	268.01 b	105.85 d	74.00 c	3.65 b	2.01	17.7 b
T_3	285.53 ab	116 29 c	88.75 ab	3.72 ab	2.03	18.2 ab
T_4	273.76 ab	113 70 c	79 08 bc	3.70 ab	2.02	18.2 ab
T_5	284 54 ab	118 03 bc	85.58 abc	3.71 ab	2.02	18 3 a
T_6	276.09 ab	118 00 bc	76.42 c	3.66 b	2.01	18 2 ab
T_7	294.39 a	126.96 a	92.83 a	3 78 a	2 04	18.4 a
T_8	288.08 ab	118.62 bc	81 75 bc	3.73 ab	2 01	18.1 ab
T_9	284.75 ab	125.18 ab	89.00 ab	3 74 ab	2 03	18 3 a
T_{10}	283.12 ab	113.48 c	78.83 bc	3 69 ab	2 01	18.3 a
LSD (%)	22.10	7.62	9.92	0 09	NS	0.52
CV (%)	4.70	3 95	7.40	1 50	2.96	1.67

*Figures in a column with same letter (s) do not differ significantly by LSD test at 5% level of probability.

Table 4. Economic benefit of boron and molybdenum fertilization for sugarcane production in sandy acidic soils of Bangladesh, see Table 2 for treatment code.

Added boron and molybdenum with recommended NPKSZn (kg/ha)	Cost of boron and molybdenum fertilizer (Taka/ha)	Yield of sugarcane (t/ha)	Increase in cane yield by boron and molybdenum over recommended NPKSZn (t/ha)	Net benefit from added boron and molybdenum (Taka/ha)
0	-	74.00	-	-
B_2	1, 200.00	88 75	14 75	13, 550.00
B_4	2, 400.00	79.08	5 08	2, 680.00
Mo_2	1, 110.00	85.58	11 58	10, 470.00
Mo_4	2, 220 00	76.42	2.42	200.00
$B_2 + Mo_2$	2, 310.00	92 83	18.83	16, 520.00
$B_4 + Mo_2$	3, 510 00	81 75	7 75	4, 240.00
$B_2 + Mo_4$	3, 420.00	89 00	15 00	11, 580.00
$B_4 + Mo_4$	4, 620.00	78.83	4 83	210.00

*Borax (10% B) and ammonium molybdate (54% Mo) were used for boron and molybdenum fertilizer respectively. Cane price in Bangladesh was Taka 1000.00 per ton, and borax and ammonium molybdate were 60.00 and 300.00 Taka per kg, respectively.

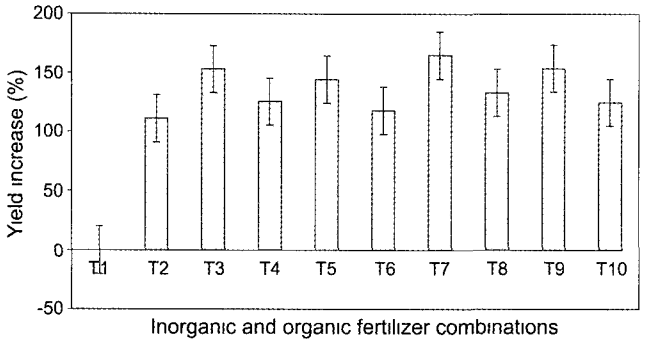

Fig. 1. Response of boron and molybdenum on cane yield. Vertical bars on the bars indicate the standard error; see Table 2 for treatment code

loam, organic C 1.04%, total N 0.08%, available P 11.00 mg kg^{-1}, exchangeable K 0.15 meq%, available S 9.00 mg kg^{-1}, available B 0.12 mg kg^{-1} and available Mo 0.05 mg kg^{-1} (Table 1). The results of the investigation on yield and yield attributes of sugarcane are presented in Table 3. The economic benefit of boron and molybdenum fertilization for sugarcane production is computed in Table 4. Fig. 1 shows the percent increase in cane yield by different treatments over control.

From the results presented in Table 3, it was found that the treatment T_7 produced significantly higher number of millable cane per hectare (126.96×10^3) among all other treatments except T_9. The treatment T_7 also produced significantly higher cane yield (92.83 t/ha) over all other treatments except, T_3, T_5 and T_9, which were found as identical. It further showed significantly better stalk height (3.78 m) over T_1, T_2, and T_6, and higher brix (%) over T_1 and T_2. But the effects on cane girth were non-significant for all the treatments. While the treatment T_1 (control) produced the lowest number of tiller (203.47×10^3) and millable cane (68.66×10^3) per hectare. It also produced the lowest cane yield (35.08 t ha^{-1}), stalk height (3.46 m), cane girth (1.94 cm) and brix (17.3 %). Similarly, Jamro *et al* (2000) reported beneficial effect of micronutrient application on sugarcane growth through increased N concentration in leaves. Kalyani *et al* (1994) also found that boron application increased crop growth and yield in pigeonpea. The positive effect of Mo application in crop was reported by Kumar *et al* (1993). They observed significantly higher dry matter yield in berseem clover grown in light textured soil deficient in Mo. Anderson & Bowen (1990) also reported the essentiality of boron nutrient in sugarcane that involved in sugar translocation, protein synthesis and cell wall formation. Similarly, Sinha & Chatterjee (1994) confirmed that application of boron enhanced sugar accumulation in pearl millet crop in India. They further confirmed the boron deficiency in well-drained sandy-textured soils like our experimental soils grown with sugarcane. Better effect from molybdenum application in sugarcane was highly supported by Anderson & Bowen (1990) where they mentioned its responsibility for reduction of NO_3^- to NO_2^-, converting inorganic to organic N in the rootlets. Furthermore, the treatment T_9 produced the second highest number of millable cane per hectare (125.18×10^3), yield of cane (89.00 t/ha), stalk height (3.74 m), cane girth (2.03 cm) and brix (18.3 %) among all the rest of the treatments. The treatment T_7 that received combined application of B and Mo at 2 kg ha^{-1} with recommended fertilizers N P K S Zn gave the highest additional net economic benefit of Taka 16, 520.00 per hectare among all the treatments in the study (Table 4). Fig.1 further showed the highest percent increase in cane yield (164.6) by T_7 over control.

Finally, it can be concluded that the treatment T_7 which received recommended fertilizers of N 120, P 35, K 100, S 25 and Zn 2 kg ha^{-1} added with B 2 + Mo 2 kg ha^{-1} produced significantly higher sugarcane yield with higher additional net economic benefit among all the treatments in the present study. Thus, the treatment T_7 is found superior over all other treatments for sustaining sugarcane yield and income at the soils in Old Himalayan Piedmont Plain of Bangladesh.

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