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Effects of Potassium on Sugarcane Production in Piedmont Plain Soils of Bangladesh

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ABSTRACT

Field experiments were conducted in the piedmont plain soils of Thakurgaon, Bangladesh during the 1989-90 and 1991-92 crop seasons to investigate the influences of potassium on growth responses by sugarcane. Potassium was applied @ 0, 75, 150, 225, 300 and 375 kg K_2O/ha. The N,S, Mg, and Ca status of initial soils of the experimental sites were below critical level, whereas K and P status were slightly higher than critical level. Sorption study indicated that release of P,K,S and Zn was very low on addition of respective elements to the soil. Sorghum [*Sorghum biclor* (L) Moench] as a indicator plant showed a good response to N, P, K, S, Zn and Mg in green house study. Progressive increase in cane yield compared to control was observed due to successive higher dose of K upto 150 Kg K_2O/ha in both the years. The yield increase was statistically significant in second crop season only. Further increase in the levels of K did not show any positive effects on the yield and yield contributing parameters of sugarcane. The highest net benefit was also obtained with the same treatment (150 kg K_2O/ha) in both the years.

INTRODUCTION

Potassium is an essential element for sugarcane. It is required by the crop in a large quantity and its function for sugarcane plant are many (Humbert, 1968). A crop producing 100 tons of cane per hectare might remove 370 kg potassium per hectre (Morachan, 1989). Potassium is known for maintaining in plant tissues by regulating stomatal opening and turgidity of cell, besides playing an important role in the synthesis and translocation of sugars, activation of plant enzymes and many other processes (Anon, 1989). The requirement of potassium by sugarcane is twice that of nitrogen (Patashkar, 1972). Dagade (1976) indicated that cane and sugar yield increased with K application and optimum dose was 100 kg K_2O/ha. Kadian *et al.* (1981) found no significant effects of potash on yield and quality of sugarcane. Locsin *et al.* (1955) obtained significantly increased yield after potash fertilization when soil available potash was below 95 ppm, but no response was obtained when soil available potash was above 120 ppm. Considering importance of potassium fertilizer as a major yield contributing factor, the present study was conducted with different levels of potassium to find out optimum dose of potassium for sugarcane production in piedmont plain soils of Bangladesh.

MATERIALS AND METHODS

Sixty composite soil samples were collected from Baliadangi soil series of Thakurgaron. The soil was noncalcareous dark Piedmont plain, sandy loam, having pH 5.0 and organic matter content 1.5%. The pH was determined by taking soil and distilled water in 1:2.5 ratio with glass electrode pH meter (Hunter, 1980), and organic matter was determined by wet oxidation method (Jackson, 1973). The extractant of KCl was used

for determination of exchangeable Ca and Mg, NH_4-N was measured by atomic absorption spectroplotometer (Hunter, 1984). For determination of P, K, Cu, Fe, Mn, & Zn, the mixture of 0.25N sodium bicarbonate, 0.01 M ethylene diamine tetraacetic acid and 0.01 N ammonium flouride with 0.5g polyacrylamide 127 (Superfloc) per 10 litres was used. Calcium hydrophosphate was used for S and B determination. All these elements were measured by atomic absorption spectrophotometer.

The sorption study was carried out to know the adsorption and releasing behaviour of nutrients to the soil, by adding different rate of sorption solution (Hunter, 1980), drying them for 48 hr. The samples were extracted and analyzed for potassium, phosphorus, sulphur, boron, copper, manganese and zinc. Releasing behaviour of major nutrients have been shown in Figures 1a-1b.

Greenhouse study was carried out on the basis of results obtained from initial soil analysis and sorption study. The effect of potassium and likely other nutrients was observed in a short period for field study. P,K,S,Cu, Zn, B and Mn were added to the optimum treatment (3 times the deficiency critical level as given by Hunter 1984). There were 14 treatments for pot experiment in greenhouse study, viz.

T_1 - optimum treatment
T_2 - addition of K
T_3 - omission of N
T_4 - addition of P
T_5 - omission of S
T_6 - omission of Zn
T_7 - addition of Ca
T_8 - addition of Mg
T_9 - addition of Fe
T_{10} - addition of Mo
T_{11} - addition of Cu
T_{12} - addition of Mn
T_{13} - omission of B
T_{14} - the control

Randomized complete block design was followed with 4 replications. In a green plastic pot 500g soil was taken and placed on a black plastic reservoir containing deionized water. Irrigation was provided through an uncut cigarette filter, serving as a capillary tube. Sorghum (*Sorghum bicolor* (L) Moench), which is sensitive to most of the elements was used as indicator plant. Eight plants were allowed to grow per pot upto six weeks and then harvested, dried and weight. Relative dry metter yield (%) was calculated (Table 1).

The field experiment was conducted during 1989-90 and 1990-91 crop season in farmers field condition of Thakurgaon, Bangladesh (Agro Ecological Zone 1). Six weeks old settlings of variety Isd 16 were transplanted in mid Octover. Five levels of potassium 75, 150, 225, 300 and 375 kg K_2O/ha and one control (no application of K), were arranged in randomized complete block design with four replications. Potassium source was muriate of potash. Recommended doses of nitrogen (200 kg/ha), phosphorus (150 kg P_2O_5/ha), sulphur (40 kg/ha), and magnesium (20 kg/ha) fertilizer were applied in all treatments as urea, triple supper phosphate (TSP), gypsum, and magnesium oxide respectively. Entire quantity of TSP, gypsum, and magnesium oxide and one third urea and muriate of potash (MP) were applied at the time of transplanting. The remaining two thirds urea and MP was top dressed at 90 and 150d of transplanting. Number of tillers were recorded at 120 d of transplanting, number of millable cane, yield of cane were recorded and socrose content was determined at harvest.

RESULTS AND DISCUSSION

The soil of experimental site before setting up experiment was found deficient in available N, S and Mg but K and Zn were near critical level and P content was higher than critical level. The critical levels of N, P and Zn were 75, 17, 14ppm, K and Mg were 0.20 and 0.12 meq/100g soil respectively for sugarcane. The sorption study indicated that the release of P, K, S and Zn were very low on addition of respective elements, Hence, fixation capacity of experimental soil to these elements were very high, i.e. P, K, S, and Zn were not released very quickly from soil (Fig.1a-1b). In greenhouse study dry matter yield of sorghum increased when P, K, and Mg were added to treatments (T_4, T_2 and T_8) and yield of sorghum decreased greatly on omission of N,S, and Zn from treatments (T_3, T_5 and T_6) compared to optimum treatment T_1 (Table 1). Addition of these elements would be highly beneficial for such soils.

Table 1. Dry matter (g) of sorghum as affected by different nutrients in green house.

Treatments*	Nutrient	Dry matter Yield(g)	Relative Yield (%)
T_1	Optimum	8.01	100
T_2	+ K	8.55	107
T_3	- N	3.54	44
T_4	+ P	9.93	124
T_5	- S	5.61	70
T_6	- Zn	5.54	69
T_7	+ Ca	8.01	100
T_8	+ Mg	8.87	111
T_9	+ Fe	8.11	101
T_{10}	+ Mo	6.5	82
T_{11}	+ Cu	7.32	91
T_{12}	+ Mn	7.86	98
T_{13}	- B	6.32	79
T_{14}	Control	5.45	68

* Details of treatments are given under Materials and Method.
+ Addition of particular nutrients to the treatments in pot.
- Omission of particular nutrient from the treatments in pot.

Application of K fertilizer produced the highest tillers over control with treatment 150 and 225 kg K_2O/ha in the first and second year respectively, further increase in K application did not show any effects on tiller numbers (Table 2). There was no significant difference in tiller production among the treatments in first year, but in second year at 150, 225 & 300kg K_2O/ha tiller production was significantly higher over control. On an average 15-34% tiller failed to produce any millable cane.

Data on number of millable cane depict that an increase in amount of K fertilizer had a marked effect on number of millable cane (Table 2). Millable cane production increased upto 150kg K_2O/ha application in both the years, further increase in levels did

not increase number of millable cane. There was no significant difference among treatments in first year but second year data on millable cane showed a significant increase over control. Similar results was obtained by Chowdhury *et al.* (1991). Gill and Singh (1976) also reported an increase in number of millable cane with 150kg K_2O/ha.

Table 2. Effects of potassium on yield parameters of sugarcane.

Crop year	Treatment (K_2O kg/ha)	Tiller no./ha x 000	Millable Cane/ha x 000	Cane yield (tons/ha)	Recovery (%)	Sugar yield (tons/ha)
1989-90	0	105.3a*	89.9 a	55.1 a	8.52 a	4.7
	75	107.3 a	94.2 a	57.3 a	9.13 a	5.2
	150	114.9 a	100.8 a	69.4 a	8.90 a	6.2
	225	115.1 a	94.1 a	64.3 a	8.98 a	5.8
	300	109.7 a	95.4 a	65.4 a	8.70 a	5.7
	375	105.8 a	88.2 a	60.7 a	8.68 a	5.3
1990-91	0	108.2 c	98.6 b	43.9 c	8.26 ab	3.6
	75	111.4 bc	101.8 b	54.9 ab	7.94 b	4.4
	150	122.9 b	115.5 a	60.6 a	8.15 ab	4.9
	225	162.6 a	106.0 b	55.6 ab	8.54 a	4.8
	300	151.8 a	104.6 b	53.7 b	8.13 ab	4.4
	375	115.1 bc	104.7 b	54.7 ab	8.12 ab	4.5

* Figures accompanied by the same letter are not significantly different as per DNMR test.

Field experiment data show that the highest yield of cane was obtained at 150 K_2O/ha in both the years. This increase was not significant among treatments in first year study, but significantly higher cane yield was obtained at 150 kg K_2O/ha over control in second year study. Khondaker *et al.*(1988) reported that potash application upto 240kg K_2O/ha had no significant effects on yield of cane. The increase in cane yield at 150kg K_2O/ha application was 14.3 and 16.7 ton/ha over control in first and second year respectively. Jahagirdar (1964) showed that potash application gave an average increased yield of 7.6 ton/ha. Chowdhury *et al.* (1991) also found 9.5 ton/ha yield increase over control. The higher rate of K (225,300 & 375 kg K_2O/ha) declined cane yield compared to lower rate of K (150kg K_2O/ha) in both the years. Etwali and Gascho (1983) reported that higher rate of K (560kg/ha) reduced sugarcane yield, but application of 280kg K/ha yielded significantly more cane but no sugar than control.

The chemical analysis shows that soils of the experimental site contain replaceable potash 0.21 meq/100g soil and sorption study also indicates that release of potassium is negligible. It is assumed that a soil containing below 0.21 meq/100gm soil has no effects on high dose of K application beyond 150kg K_2O/ha without increasing dose of other essential fertilizers. Moreover, most of nutrients status initially present in soil were below critical level for growth and production of sugarcane and as such a disproportionate increase of K without increasing other nutrients has a failure for crop to

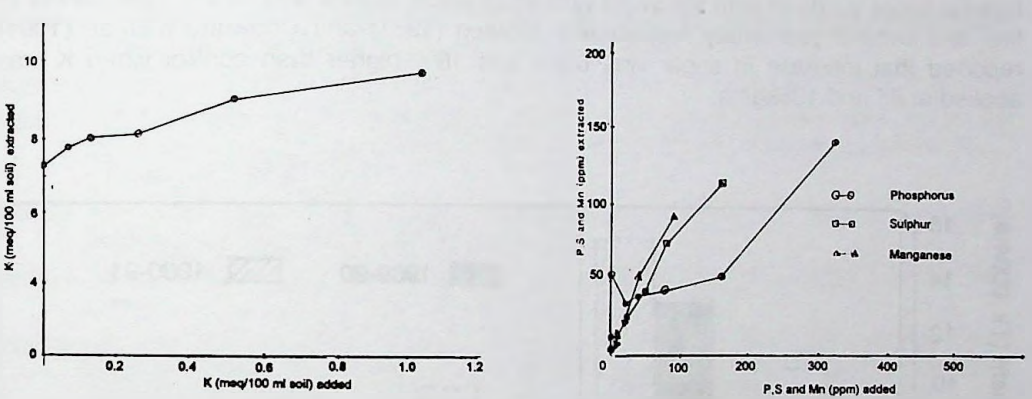

Figure 1a. Releasing behavious of Potassium and Phophorous Sulphur and Manganease.

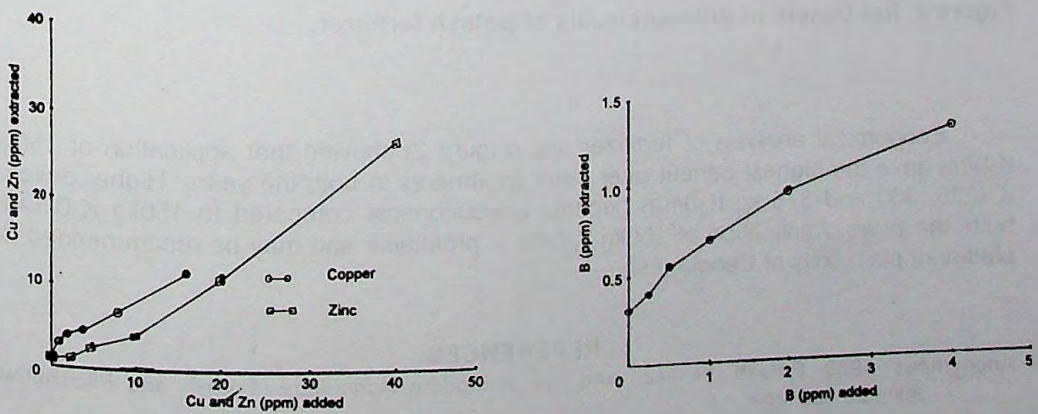

Figure 1b. Releasing behavious of Copper, Zinc and Boron.

respond favorably in increased K after a certain level. Leverington *et al.* (1962) reported that when replaceable K_2O was 0.12 to 0.20meq/100g soil, the maximum yield were not obtained if less than 120kg K_2O/ha was applied. Potash fertilizer had no significant effects on recoverable sucrose content in first year experimentation. But in second year K application significantly increased recoverable sucrose content with a maximum of 8.5% with application of 225 kg K_2O/ha. Application of K (150 kg K_2O/ha) gave the highest sugar yields in both the years with an increase of 31.6 and 36.2% over control in first and second year study respectively. Golden (1981) and Chowdhury *et al.* (1991) reported that increase in sugar was 6.3% and 18% higher than control when K was applied at 85 and 108kg/ha.

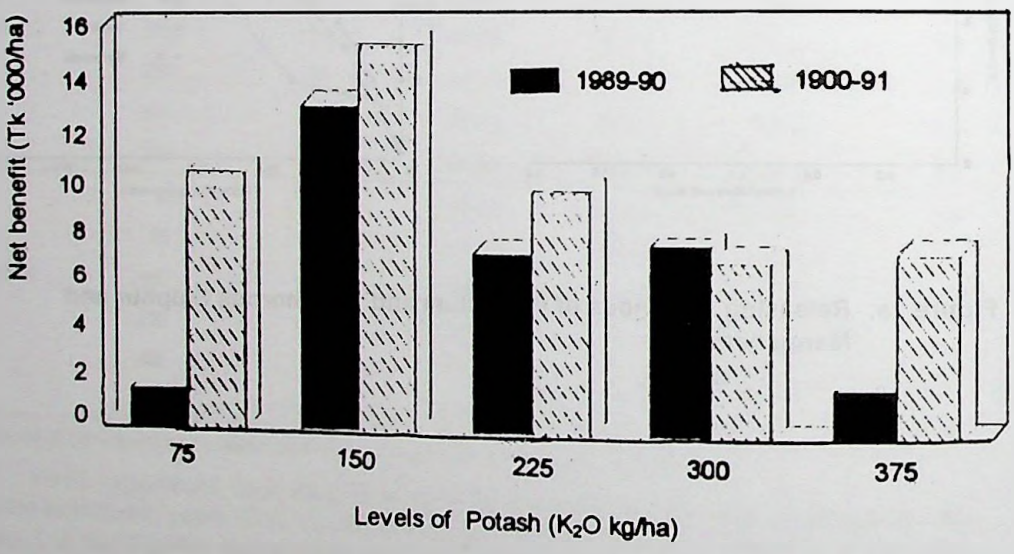

Figure 2. Net benefit of different levels of potash fertilizer.

Economical analysis of fertilizer use (Figure 2) showed that application of 150kg K_2O/ha gave the highest benefit over other treatments in both the years. Higher dose of K (225, 300 and 375 kg K_2O/ha) become uneconomical compared to 150kg K_2O/ha in both the years. Application of 150kg K_2O/ha is profitiable and may be recommended for piedmont plain soils of Bangladesh.

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