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Potassium : Its Influence on Sugarcane Production in Ganges River Floodplain Soils of Bangladesh

F.Alam, M.A.Majid and M.H.Rahman
Sugarcane Research & Training Institute,
Ishurdi, Pabna, Bangaldesh.

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ABSTRACT

An investigation was conducted in the Ganges River Floodplain Soils of Ishurdi, Bangladesh during 1988-89 and 1989-90 crop seasons with five levels of potassium (50,100, 150, 200, and 250kg K_2O/ha) and one control to determine the effect of potassium on growth response by sugarcane. Adsorption and releasing behavior of nutrients in the soil were studied through sorption study. Release of K was very negligible on addition of the element to sorgham the soil. In greenhouse study sorghum [*Sorghum bicolor* (L) Moench] as an indicator plant responded in respect of dry matter yield to N, P, K, Zn and B. In the field experiments, 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 and the yield increase was statistically significant. Further increase in the levels of K failed to show any positive effect on yield and yield contributing parameters of sugarcane. Potassium did not show any positive effect on percentage recoverable sucrose content of sugarcane. The highest net profit was found with the treatment 150kg K_2O/ha in both the years.

INTRODUCTION

Being a heavy consumer of potassium, sugarcane is known as a potash loving crop. The requirement of potassium by sugarcane is twice than of nitrogen (Pataskar, 1972). A crop producing 100 tons of cane per hectare might remove 370 Kg potassium per hectare (Morachan, 1984). Nutrient requirement of sugarcane varies from place to place according to the soils and climatic conditions (Davidson,1962). Potassium plays an important role in sugarcane nutrition and its function for sugarcane nutrition are many (Humbert, 1968). It is essential for normal growth process of sugarcane, photosynthesis for carbohydrates formation and translocation of sugar. Potassium also helps drought tolerance, maturity and sugar content. Response of sugarcane studied by many investigators, was found to be variable due to several factors (Golden, 1983; Tabayoyong and Robeniol, 1962). Potassium requirement of sugarcane varies depending upon the replaceable potash content in soil (Chowdhury *et al.* 1991). However, Etwali and Gasho (1983) reported that the highest rate of K reduced both sugarcane and sugar yield. Considering the importance of potassium fertilizer as a major yield contributing factor, the present study was undertaken to evaluate the optimum requirement as well as the growth response of sugarcane to K fertilizer in Ganges River Floodplain soils of Bangladesh.

MATERIALS AND METHODS

Sixty composite soil sample were collected from Sara soil series at Ishurdi. The soil was calcareous brown flood plain, clay loam, with pH 7.5 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 the determination of exchangeable Ca and Mg and NH_4-N was measured by atomic absorption spectrophotometer (Hunter, 1980). For determination of P,K, Cu, Fe, Mn & Zn, the mixture of 0.25 N sodium bicarbonate, 0.01M methylene diamine tetraacetic acid and 0.01 N ammonium flouride with 0.5g polyacrylamide 127 (Superfloc) per 10 liters was used. Calcium hydrophosphate was used for S & B determination. All these elements were measured by atomic absorption spectrophotometer.

The sorption study was carried out to know the adsorption and releasing behavior of nutrients to the soil, by adding different rate of sorption solution (Hunter, 1980), drying them for 48 h. The samples were extracted and analyzed for potassium, phosphorus, sulfur, boron, copper, manganese and zinc.

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 were observed in a short period for field study. P,K,S.Cu,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 potash; T_3-omission of N; T_4- omission 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}- addition 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 a indictor plant. Eight plants were allowed to grow per pot upto six weeks and then harvested, dried and weighed. Relative dry matter yield (%) was calculated (Table 1). On the basis of sorption and greenhouse studies field experiment was conducted during two crop seasons 1988-89 and 1989-90 in farmers field condition of clay loam soils of Sara series. Six weeks old settlings of variety Isd 16 were transplanted in mid October of each year. Five levels of potassium 50, 100, 150, 200 and 250 kg K_20 /ha and one control (no application of K) were arranged in a randomized complete block design with four replications. Potassium was applied as Muriate of potash (MP). Scheduled dose of nitrogen (200kg N/ha), phosphorus (150 kg P_2O_5/ha), sulphur (40 kg /ha) and boron (2 kg/

ha) fertilizers were applied in all the treatments as urea, Triple super phosphate (TSP), gypsum and boric acid respectively. Full quantity of TSP, gypsum and boric acid and one third urea and MP were applied at the time of transplanting. The remaining two thirds urea and MP were top dressed at 90 and 150 days of transplanting. Number of tillers were recorded at 180 days of transplanting, number of millable canes, sucrose content and yield of cane were recorded at harvest.

RESULTS AND DISCUSSION

The initial soils of the experimental site showed deficiencies in available N, P, K and S (below critical level, but Ca, Mg and Mn content was higher than critical level and zine content was almost near to critical level. The critical level of N, P, S, Zn and Mn were 75, 17, 14, 2, and 5 ppm, and that of Ca, Mg, and K were 2, 0.8, and 0.2 meq% respectively for sugarcane. Sorption study indicated that the release of K was very negligible and the release of P, S, and Zn were also low on addition of the respective element. Similar results were obtained by Rahman *et al.* (1992). Hence, the fixation capacity of the experimental soil was very high i.e. the nutrients were not released very quickly from the soil (Figures 1a, 1b, 1c and 1d). In greenhouse the test crop sorghum responded well in terms of dry matter yield on addition of K and B to the treatment T_2 and T_{13} (Table 1). The dry matter yield of sorghum affected adversely on omission of N, P, S, and Zn from the treatments (T_3, T_4, T_5, and T_6) compared with the optimum treatment T_1 (Table 1). The results indicate that addition of these elements would be highly beneficial for such soils.

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

Treatments	Nutrient	Dry matter yield (g)	Relative yield (%)
T_1	Optimum	6.66	100
T_2	+ K	6.85	103
T_3	- N	5.32	80
T_4	- P	1.92	29
T_5	- S	2.68	40
T_6	- Zn	4.82	72
T_7	+ Ca	6.60	99
T_8	+ Mg	6.42	96
T_9	+ Fe	6.50	97
T_{10}	+ Mo	6.56	98
T_{11}	+ Cu	6.13	92
T_{12}	+ Mn	6.24	94
T_{13}	+ B	8.04	121
T_{14}	Control	1.64	24

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

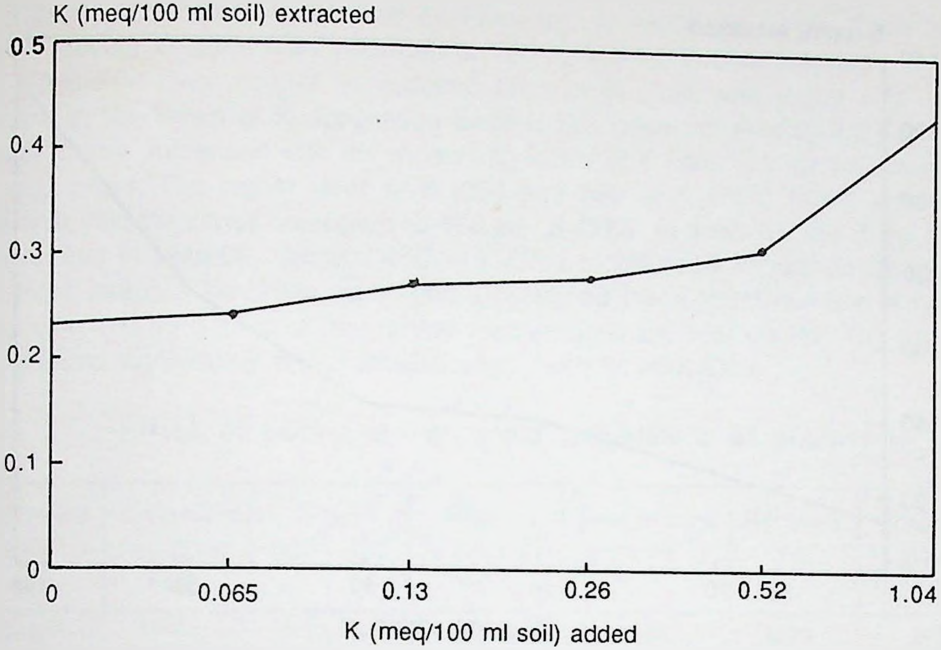

Figure 1a. Releasing behaviour of K.

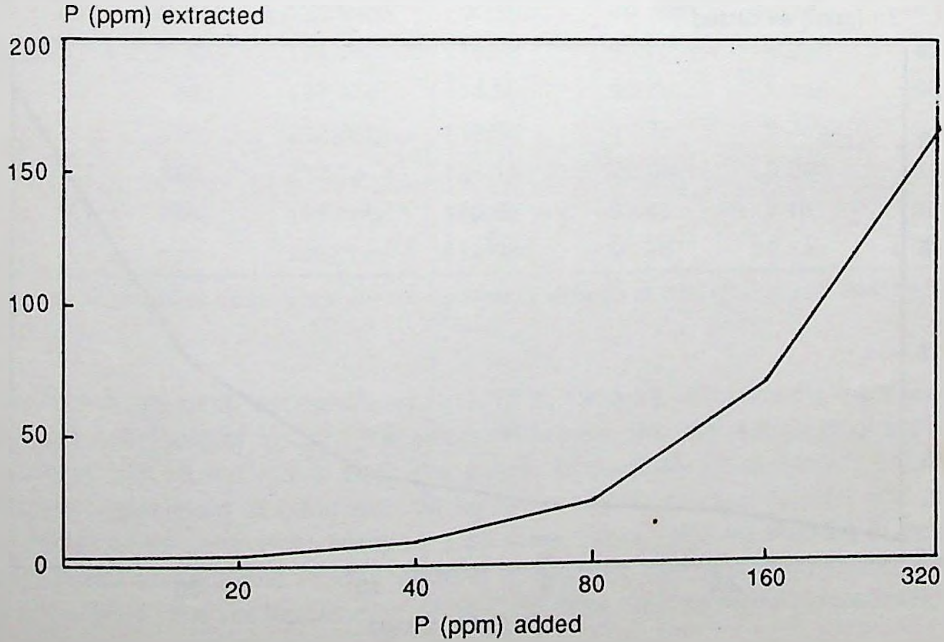

Figure 1b. Releasing behaviour of P.

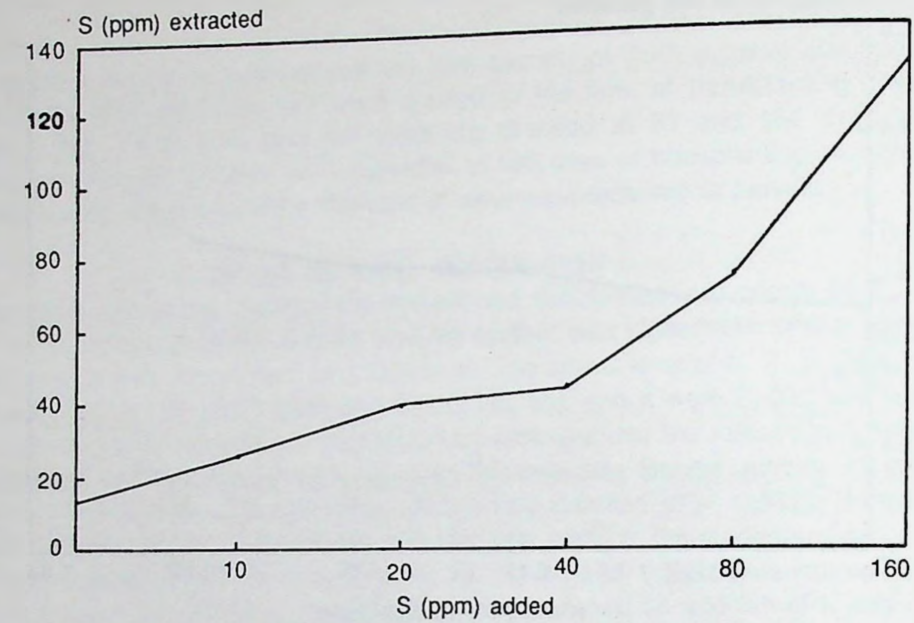

Figure 1c. Releasing behaviour of S.

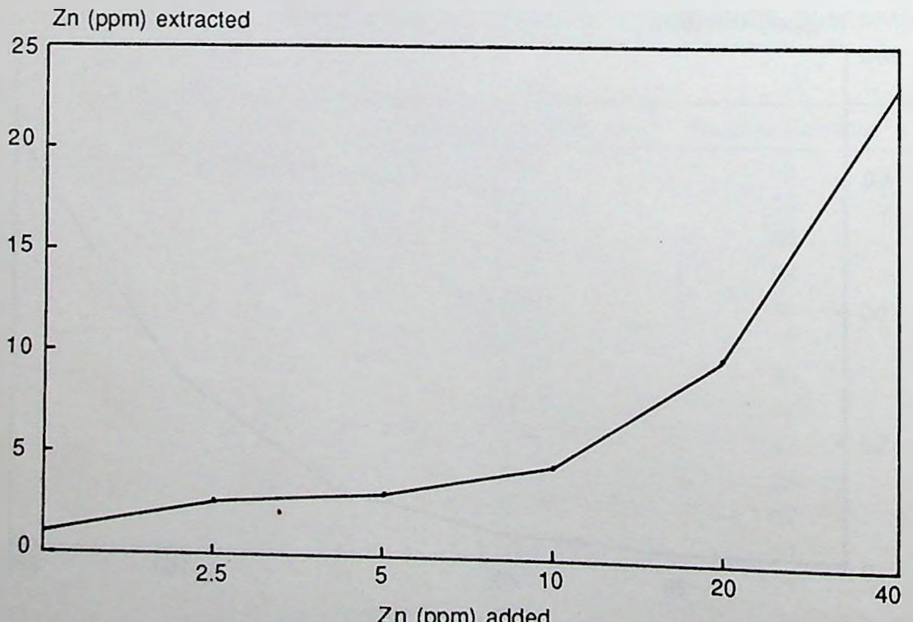

Figure 1d. Releasing behaviour of Zn.

Results obtained from the field experiments are presented in the Table 2. The highest number of tillers were recorded at 150 kg K_2O/ha in both the years, and that was significant over control. A reduced tiller production was found with further increase in the levels of K application beyond this dose. In general the number of millable canes increased with the increasing levels of K upto 150 kg K_2O/ha in both the crop years. The higher rates of K (200 and 250 kg K_2O/ha) failed to produce additional millable canes compared to 150 kg K_2O/ha. In 1988-89, the dose 150 kg K_2O/ ha and in 1989-90, 100 and 150 kg K_2O/ha significantly increased the number of milable canes. Khondaker *et al.* (1989) obtained the highest number of millable canes with 160 kg K_2O/ha although that was insignificant over control. Gill and Sing (1976) found significantly higher millable canes with 50 kg K_2O/ha .

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

Crop years	Treatment (K_2O kg ha^{-1})	Tillers ($x10^3 ha^{-1}$)	Millable cane ($x10^3$ ha^{-1})	Yield of cane (tons ha^{-1})	Recovery (%)	Yield of sugar (tons ha^{-1})
1988-89	0	116.1b*	87.5b	72.6c	9.2a	6.7
	50	122.1ab	91.5ab	81.1bc	9.8a	7.9
	100	114.7b	85.9b	82.0ab	9.6a	7.8
	150	131.2a	98.3a	91.2a	9.8a	8.9
	200	124.6ab	93.3ab	88.5ab	9.9a	8.7
	250	123.9ab	92.9ab	89.7ab	10.0a	8.9
1989-90	0	177.4c	110.7c	90.1c	9.2ab	8.3
	50	197.4bc	114.5bc	96.7b	9.4ab	9.1
	100	202.0ab	118.3b	95.7b	9.7ab	9.3
	150	221.1a	126.1a	102.0a	9.2ab	9.4
	200	196.6bc	110.8c	94.4b	9.1b	8.6
	250	190.2bc	114.7bc	95.8b	10.1ab	9.6

* Figures accompanied by same letters are not significantly different at 0.05 level as per Duncans Multiple Range Test.

All the doses of K, except 50 kg K_2O/ha in 1988-89, significantly increased the cane yield over control in both the years. However, the highest yield of cane was obtained at 150 kg K_2O/ha in both the years. Chowdhury *et al.* (1991) obtained a significant higher yield of cane with 90 kg K/ha. Higher rates of K (200 and 250 kg K_2O/ha) declined cane yield compared to lower rates (150 kg K_2O/ha in both the years. Etawali and Gaucho (1983) reported that higher rate of K (560 kg/ha) reduced sugarcane yield, but the application of 280 kg K/ha yielded significantly more cane than control.

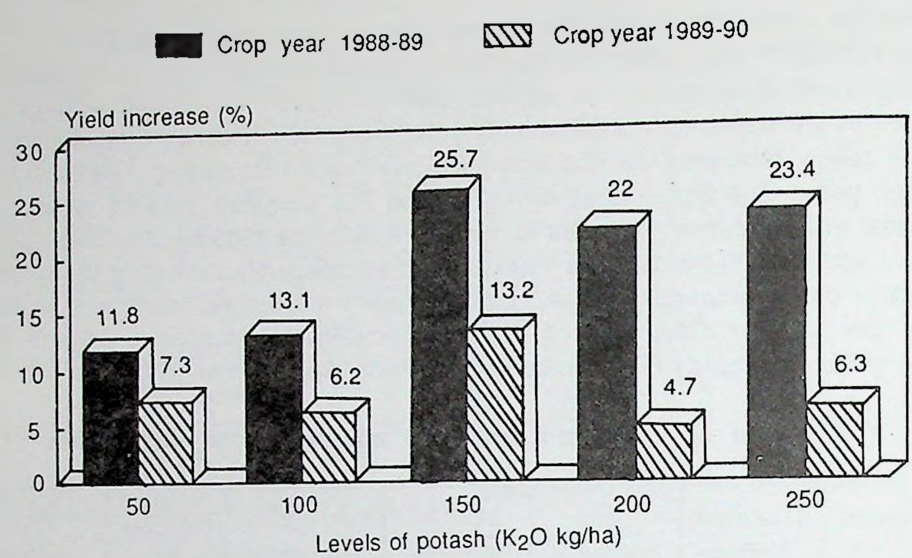

Figure 2. Yield increase (%) with different doses of potash fertilizer.

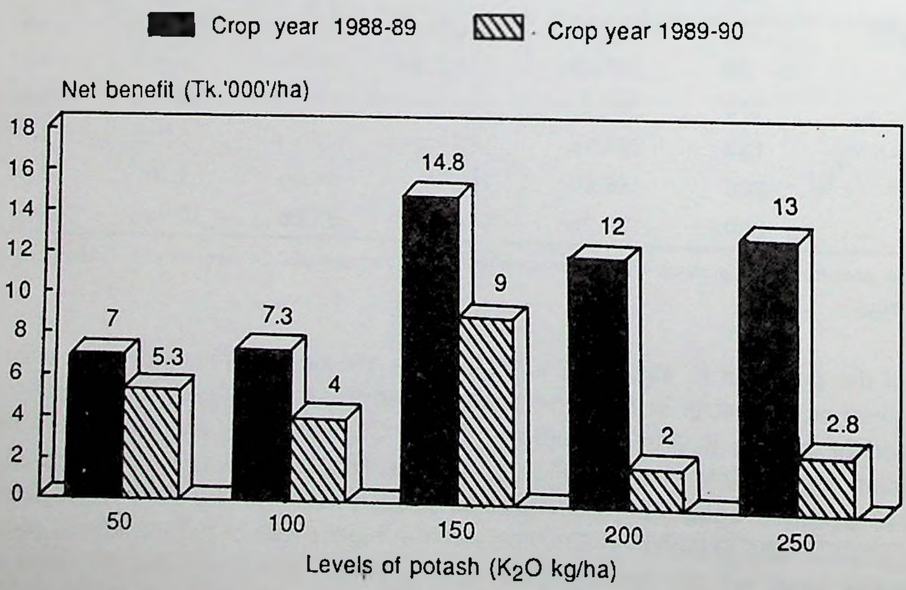

Figure 3. Monetary benefit of different levels of potash fertilizer.

The percentage increase in cane yield at 150 kg K_2O/ha application was 25.7 and 13.2 over control in first and second year respectively (Figure 2). Chowdhury *et al.* (1991) found 13.4 and 15.7% yield increased over control respectively for first and second year study with the dose of 90 kg K_2O/ha.

Sorption study indicated that release of potassium is very negligible and chemical anylases showed that the soils of the experimental site contained replaceable potash 0.15 meq/100 g soil. It is assumed that soils containing below 0.15 meq/100 g soil has no effect on higher dose of K application beyond 150 kg K_2O/ha without increasing rate of other essential fertilizers. Moreover, most of the nutrient status initially present in the soil were below critical level for growth and production of sugarcane and as such a disproportionate increase of K without increasing other nutrients had no favorable crop response in increment of K after a certain level. Chowdhury *et al.* (1991) reported that when replaceable potash was 0.21 meq/100g soil, maximum yield was reported that when 90 kg K_2O/ha. Leverington *et al.* (1962) also reported that when replaceable K_2O was 0.12 meq/100g soil, the maximum yield were not obtained if less than 120 kg K_2O/ha was applied. Potash fertilizer had no significant effect on recoverable sucrose content of sugarcane over control in both the years (Table 2). However, application of K 150 kg K_2O/ha gave the highest sugar yield in both the years. Golden (1981) and Khondaker *et al.* (1989) obtained higher sugar yield over the control when K was applied at 88 and 80 kg K_2O/ha respectively.

Results of the economic analysis of fertilizer use (Figure 3) showed that application of 150 kg K_2O ha gave the highest benefit over other treatments in both the years. Higher dose of K (200 and 250 kg K_2O/ha) became uneconomical compared to 150 kg K_2O/ha in both the years. Thus application of 150 kg K_2O/ha is profitable to growers and may be recommended for Ganges River Floodplain soils of Bangladesh.

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