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Effect of Varying Phosphorus and Potash Levels on Agronomic Traits and Productivity of Sugarcane (*Saccharum officinarum* L.)

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Abstract: An experiment was conducted to study the effect of varying P and K levels on agronomic traits and productivity of sugarcane at the National Agricultural Research Centre Islamabad during 1996-97. Application of either phosphorus or phosphorus and potash, along with nitrogen, significantly improved the filtering of sugarcane at early stages of growth. Millable canes per hectare were the maximum (130.7 thousands) with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_20 ha^{-1} and were similar to those treatments where lower doses of P_2O_5 and K_2O ha^{-1} were applied. Stalk height (290 cm) and girth (31.2 mm) were observed the maximum with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1} but statistically similar to those produced with lower levels of P_2O_5 and/or K_20. Total soluble solids were similar at early stages of cane maturity at various levels of P_2O_5 and K_2O and were maximum (20.8%) at harvest with 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1}. Sugar recovery was also improved with the application of P and K. Maximum cane yield (138 t ha^{-1}) and sugar yield (16 t ha^{-1}) was produced with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1}.

Key words: Sugarcane (*Saccharum officinarum* L.) phosphorus, potash, cane yield, agronomic traits, tillering, sugar yield

Introduction

Highest productivity of cane and sugar depends on the selection of high yielding cultivars and proper management of the crop including application of balanced fertilizers at appropriate time. In Punjab, Pakistan, only 4% of the sugarcane growers use NPK combinations, whereas, 73% of the cane growers use only N and P (Akhtar, 1998, 1999). It is well known fact that proper supply of N to crop plants is associated with the enhancement of photosynthetic activity, vigorous vegetative growth and a dark green colour of plant leaves (Black, 1993). Clements (1980) has regarded nitrogen as the most influential plant element in the regulation of sugarcane growth and production. Nitrogen is important and essential to every enzymatic process that occurs in plants (Anderson and Bowen, 1990). Phosphorus is an important component of nucleic acid and phospholipids in plant cell. It plays important role in energy conversion process in crop plants. Sugarcane has very high demands of K. Potassium acts as an activator in protein metabolism and carbohydrate metabolism. Being major cation in cytoplasm, K balances the anionic charges in the cytoplasm (Anderson and Bowen, 1990). Past research has indicated the importance and role of balanced use of N, P and K in crop production and its economic benefits. The present study was designed to determine the effect of balanced fertilizers i.e. N, P and K on agronomic traits and productivity of sugarcane.

Materials and Methods

The experiment was conducted at the research area of National Agricultural Research Centre, (NARC), Islamabad during 1996-97. A promising sugarcane cultivar R872-454 was planted at a row spacing of 1 m during September. Two budded double setts were planted end to end. The experiment was laid out in a randomized complete block design with three replicates. The study comprised the following treatments:

No NPK (control)	NPK 200-0-0 kg ha^{-1}
NPK 200-50-0 kg ha^{-1}	NPK 200-100-100 kg ha^{-1}
NPK 200-150-150 kg ha^{-1}	

All P and K was applied at the time of planting. Nitrogen was applied in four splits. First dose of N was applied at the time of planting, Rest of the three doses of N were applied during April, May and June. Gesapax Combi 80 WP was applied as pre-emergence herbicide to control the weeds. Further weeding was done by cultural operations and earthing up during April and May. Data on tillering was recorded at early growth stages during June and July from an area of 10 m^2. Brix percentage (total soluble solids) was also recorded during October and November. The crop was harvested during December and data on stalk height, stalk girth, Brix%, sugar recovery and cane yield were recorded. The data on cane yield was recorded from an area of 15 m^2. Ten stalks were used to record the stalk height. Stalk girth was measured from 20 cm above ground, from the middle and 20 cm below the topmost node and then averaged. The data collected were analysed with PC SAS for analysis of variance using LSD to compare the treatment means at a probability level of 5%.

Results and Discussion

Stalk population: The data presented in Table 1 indicated that early stalk population was significantly higher in plots where NP or NPK was applied than those without N P and K. Number of tillers and millable canes at harvest (130.7 thousands ha^{-1}) was maximum with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1} and it was similar to those produced with other levels of applied NP or NP and K. Stalk population (68.7 thousands ha^{-1}) in the control plots or plots applied with N only (95.7 thousands ha^{-1}) was significantly lower than other treatments. Increased stalk population in various sugarcane varieties has been reported by Buraciohain (1996) with the application various NP and K fertilizaers.

Stalk height and girth: Stalks height at harvest was significantly affected with the application of N or N, P and K. Stalks in the control plots were the shortest (220 cml while the tallest stalks (290 cm) were produced with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1}. However, stalks produced with the application of 200 kg N, along with 50 kg P_2O_5 or 100 kg P_2O_5 and 100 kg K_2O ha^{-1} or 150 kg P_2O_6 and 150 kg K_2O ha^{-1} were statistically similar in height (Table 1). Stalk girth followed the similar pattern as that of stalk height (Table 1). As nitrogen plays an important role in plant growth and development, it improves

Table 1: Mean tillers during crop growth period, stalk height, stalk girth and cane yield at harvest affected by various N, P and K levels

Treatments NPK kg ha^{-1}	Tillers '000' per hectare				Stalk height (cm)	Stalk girth (mm)	Cane yield (t ha^{-1})
	June 15	July 04	July 25	At harvest			
0	125.3 b	119.0 b	107.0 b	68.7 c	220.0 c	26.4 c	46.2 a
200-0-0	131.7 b	120.6 b	108.0 b	95.7 b	269.0 b	29.2 b	71.2 d
200-50-0	194.3 a	175.7 a	168.3 a	114.0 ab	288.0 a	29.2 b	96.8 a
200-100-100	187.0 a	187.4 a	167.7 a	117.0 ab	287.0 a	31.7 a	123.5 b
200-150-150	215.3 a	208.4 a	194.3 a	130.7 a	290.0 a	31.2 a	138.0 a
LSD (<0.5)	47.5	42.7	31.8	23.2	11.5	1.1	12.5

Table 2: Mean Brix% (Total Soluble Solids) at various maturity stages, sugar recovery and sugar yield affected by various NP and K levels

Treatments NPK kg ha^{-1}	Total Soluble Solids (%)				Sugar recovery (%)	Sugar yield (t ha^{-1})
	Oct. 20	Nov. 02	Nov. 24	At harvest		
0	17.9	18.6	19.2	19.6 b	9.0 c	4.2 e
200-0-0	17.3	18.7	19.4	19.2 b	9.6 b	6.8 d
200-50-0	17.2	18.3	18.8	19.4 b	10.4 b	10.00 c
200-100-100	17.3	18.4	19.4	20.2 a	11.4 a	14.00 b
200-150-160	17.3	18.2	19.0	20.8 a	11.6a	16.00 a
LSD (<0.5)	N.S	N.S	N.S	0.7	0.9	2.0

photosynthetic activity of the plant helping in an increase in plant height. Role of P and K is very much obvious in regulating various plant systems and improving the efficiency of fertilizer use with their balanced application. Akhtar and Silva (1998) have reported improved stalk height and girth with the application of nitrogen. Buragohain (1996) has also reported improved stalk height and girth with the application of NP and K.

Cane yield: Cane yield was the minimum in the control plots (46.2 t ha^{-1}) and the maximum (138 t ha^{-1}) with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1}. Application of only 200 kg N ha^{-1} produced 71.2 tonnes of cane per hectare, while addition of 50 kg P_2O_5 ha^{-1} along with 200 kg N ha^{-1} produced 96.8 t ha^{-1} of cane. Cane yield of 123.5 t ha^{-1} was produced with the application of 200 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1} (Table 1). Application of either alone N or in combination with P or PK significantly increased cane yield over control. Cane yield increased with increasing levels of P or P and K along with 200 kg N ha^{-1} Increased cane yield with the application of NPK fertilizers has been reported by Buragohain (1996), Matin *et al.* (1997) and Akhtar and Silva (1998). Matin *et al*. (1997a) have reported that by increasing soil P, sugarcane yield was also increased.

Total soluble solids (Brix percentage): Various levels of Phosphorus and Potash did not affect the average Brix percent at early stages of crop maturity (Table 2). However, at the time of harvest, there was an increasing trend in Brix percentage with respect to the fertilizer levels. The maximum total soluble solids were recorded in the treatments where NPK levels were 200:100:100 (20.2% Brix) and 200:150:150 (20.8% Brix) and they significantly differed from the other treatments (Table 2).

Sugar recovery and sugar yield: The results of the study showed that the sugar recovery was affected with the application of various levels of P or P and K. There was a significant increase in sugar recovery with the application of various levels of P and K over the control or only nitrogen. Sugar recovery was maximum (11.6%) with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1}, however, it was statistically similar with the sugar recovery (11.4%) obtained with the application of 200 kg N, 100 kg P_2O_5 and 100 kg K_2O ha^{-1} (Table 2).

Sugar yield was significantly affected by the application of various levels of fertilizer. Sugar yield followed the similar trend as that of the cane yield. Increasing levels of fertilizer increased the sugar yield significantly. Maximum sugar yield of 16.0 t ha^{-1} was produced with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1} while the minimum sugar (4.2 t ha^{-1}) was produced in the control plots (Table 2). Matin *et al.* (1997a) have reported that by increasing soil P, sugar yield was also increased. Increased sugar recovery and sugar yield with the application of NP and P has been reported by Shand, (1997), Matin *et al.* (1997) and Andreis and McCray (1998).

The present study indicates that application of balanced dose of NP and K significantly increased crop stand, sugar recovery, cane yield and sugar yield. Maximum cane yield and sugar yield could be obtained with the application of 200 kg N, 150 kg P_2O_5 and 150 kg K_2O ha^{-1} to the September planted cane crop in Pakistan. These fertilizer levels may vary in various soils according to their nutrient status.

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