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Site Specific Nutrient Requirement for Sugarcane Production at Old Himalayan Piedmont Plain

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ABSTRACT

A field study was carried out to determinate the appropriate fertilizer dose for maximizing sugarcane yield and economic return at Old Himalayan Piedmont Plain soils of Bangladesh. Results revealed that the highest sugarcane yield of 58.28 tones per hectare with marginal benefit cost ratio 1.62 was found with N_{110} P_{30} K_{120} S_{25} Mg_{20} $Zn_{2.5}$ B_2 in T_3 but treatment T_5 having soil test based fertilizers for moderate yield goal at N_{163} P_{21} K_{100} S_{10} kg ha^{-1} gave the significant sugarcane yield of 53.84 tones with gross margin of Taka 73,066 per hectare and highest marginal benefit cost ratio 3.32 under the study. The highest yield found in T_3 treatment but the marginal benefit cost ratio was lower than that under T_5 treatment due to increase of total variable cost. Thus, the fertilizer level of N_{163} P_{21} K_{100} S_{10} kg ha^{-1} appeared to be the most profitable combination in this study.

Key words: Sugarcane, yield, nutrient, cost, Old Himalayan Piedmont Plain.

INTRODUCTION

Sugarcane is a long duration exhaustive crop requiring huge amount of nutrients for its growth and development. Soil is the main source of supplying nutrients to the plants. Sugarcane soil loosing its inherent nutrient supply capacity due to intensive cultivation of high yielding varieties, little use of organic materials and improper soil management. As a result the crop supplied with inadequate amount of nutrients gives lower yield and poor quality of cane. Thus, there is a need to add nutrients to the soil through fertilizers in order to get targeted yield.

Fertilizer has a crucial role for increasing crop production all over the world and responsible for about 50 per cent of the total production (FRG, 2005). Nitrogen is essential for plant growth; phosphorus for developing roots, influencing the ripening process, and purifying the juice; and potassium for promoting cell activity and growth, increasing resistance to infection and lodging, and improving sucrose content and sulphur for healthy growth and bumper yield of sugarcane. Inorganic fertilizers are important for enhancing sugarcane production to meet the sugar needs of growing population. Due to high cost of chemical fertilizers and poor economic conditions of the farmers, apply inadequate fertilizers in the fields that produce very low yields of sugarcane. Balanced fertilization along with good management practices are needed for efficient and profitable production of crops for achieving maximum economic benefits. The chemical fertilizers have been a significant source of readily available nitrogen and other plant nutrients for maximizing yields and quality of crops (Ahmed *et al.*, 1996).

Keeping in view, the socio economic status of the farmers and high cost of inorganic fertilizers, this study was undertaken to determinate the suitable dose of inorganic fertilizers for profitable sugarcane yields at Old Himalayan Piedmont Plain Soil.

MATERIALS AND METHODS

Experimental site and soil characteristics

An experiment was carried out in 2006-07 cropping season at RSRS Thakurgaon under Old Himalayan Piedmont Plain soils of Bangladesh (AEZ 1). The climate of the location was sub-tropical. The soil (0-15 cm depth) was sandy in texture having sand, silt and clay of 54.74, 34.00 and 11.26%, respectively with pH 4.98, OC 1.09 %, total N 0.07%, available P 12.0 ppm, exchangeable K 0.12 meq% and available S 18 ppm (Table 2).

Treatment details and fertilizer application

The experiment consisted of six treatments viz., T_1: Control (No fertilizer), T_2 : N_{125} P_{35} K_{130} S_{25} Mg_{25} $Zn_{2.5}$ B_2 (Fertilizer doses as fertilizer recommendation guide 2005 as targeted high yield goal of 100.00 $\pm$ 10.0 tha^{-1}), T_3 : N_{110} P_{30} K_{120} S_{25} Mg_{20} $Zn_{2.5}$ B_2 (Fertilizer doses as fertilizer recommendation guide 2005 as targeted moderate yield goal of 80.00 $\pm$ 8.0 tha^{-1}), T_4 : N_{224} P_{31} K_{120} S_{16} ((Fertilizer recommendation as soil test value for high yield goal), T_5 : N_{163} P_{21} K_{100} S_{10} (Fertilizer recommendation as soil test value for moderate yield goal) and T_6 : N_{115} P_{34} K_{125} S_{25} (Farmers practice). The experimental design was a randomized complete block design with four replications. Full amount of TSP, gypsum, zinc sulphate, one third of urea and MOP were applied in trenches as basal and thoroughly mixed with soil by spade prior to plantation. The rest amount of urea and MOP were applied in two equal splits; at tillering stage (120 DAP) and at grand growth phase (180 DAP).

Planting technique and harvesting

Three budded sugarcane setts were planted on November 23, 2006. The dimension of each plot was 6m × 8m in which 6 rows of cane were planted at row to row spacing of 1m; and 0.45m was interplant spacing. Sugarcane variety Isd 35 was used as test crop in the experiment. The crop was harvested on January 8, 2008.

Chemical analyses and other operations

Soil textural class was determined by hydrometer method and soil pH was measured in a 1:2.5 soil water suspension by glass electrode pH meter. Total N was determined by Kjeldahl procedure and organic carbon by Walkley and Black method. Available soil P was extracted with 0.5M $NaHCO_3$ and the amount was determined by Spectrophotometry. Exchangeable K (1N NH_4OAc extractable) was determined by flame photometry and available S by turbidimetric method (Black, 1965) for soil and plant leaf. Necessary intercultural operations like weeding, mulching, earthing-up, tying and mechanical control of insect pests were done as and when required. Field crops were harvested on January, 2008. Juice quality parameters Brix per cent was estimated in randomly selected ten canes from each replication. The data were statistically analyzed by using analysis of variance and least significant difference (LSD) test.

RESULTS AND DISCUSSION

Yield, yield components and Brix per cent indices

Data on yield and its components like germination, tiller, millable cane stalk and Brix of cane are shown in Table 1. Application of inorganic fertilizer showed significantly better in respect of germination, tiller, millable cane stalk, yield, height and girth. Highest germination per cent was recorded in T_6 (34.00%) followed by T_2 (32.75%) and T_3 (32.75%). T_2 produced the highest number of tiller and millable cane (223.59×10^3 ha^{-1} and 135.31×10^3 ha^{-1}, respectively) where recommended

dose of fertilizer were applied for HYG. Likewise, the tiller in T_2 was identical with T_6 (213.08×10^3 ha^{-1}) and in respect of millable cane production for all the treatments were statistically similar. Though the cane yield was increased significantly over control but it was statistically similar for all other treatments. The highest cane yield of 58.28 tha^{-1} was recorded in T_3 where recommended dose of fertilizer were applied for MYG. The highest cane height of 2.96 m was also recorded in T_3 treatment, but it was identical to all other treatments except control. Highest girth of 1.95 cm was noted in T_4 with soil test based fertilizers applied for HYG, which was identical with T_5 (1.92 cm), T_3 (1.85 cm) and T_2 (1.85 cm). Majid and Alam (1998) reported that application of different fertilizers significantly influenced the number of millable cane, yields of cane and sugar. Saha *et al.* (1998) showed that application of different plant nutrients significantly influenced the number of tiller, millable canes, yields of cane and per cent recoverable sucrose. Bokhtiar *et al.* (1998) reported that the number of tillers, millable cane and yield of cane were increased significantly due to N, P, and K fertilizer application which is in agreement with our findings.

Soil nutrient status after sugarcane harvest

From the Table 2 it showed that the soil pH, organic C, total N, available P, K and S contents of the soil increased a little over initial value in the plots where inorganic fertilizers were used. Thus it indicated a need of balanced fertilizer application in sugarcane crop field for obtaining higher crop yield.

Economics aspect

Farmers in Bangladesh face many socio-economic problems regarding crop production, so the economic aspect of different fertilizer management packages for sugarcane production needs to be considered. Hence, a cost and return analysis was done considering all the production cost involved in sugarcane cultivation (Table 3). Fertilizers cost were calculated separately as per treatment. From the economic analysis, it was found that the treatment T_6 gave highest gross margin of Tk. 76,039 ha^{-1} with MBCR 2.90 followed by Tk. 73,066 ha^{-1} with the highest MBCR 3.32 from the T_5 treatment. Thus, the treatment T_5 at fertilizer doses as per soil test base for moderate yield goal was found to be the most profitable one in this study.

In conclusion, results of the study revealed that due to highest marginal benefit cost ratio of 3.32, treatment T_5 having soil test base inorganic fertilizer for moderate yield goal at N_{163} P_{21} K_{100} S_{10} kg ha^{-1} appeared to be the most profitable combination for economic production of sugarcane at Old Himalayan Piedmont (AEZ 1) soil of Thakurgaon.

Table 1. Effects of different fertilizer treatments on the yield, yield attributes and Brix (%) of sugarcane

Treatments	Germination (%)	Tiller ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Yield (tha^{-1})	Height (m)	Girth (cm)	Brix (%)
T_1	24.75b	130.89e	95.94b	26.51b	2.58b	1.68c	19.33
T_2	32.75a	223.59a	135.31a	52.67a	2.78ab	1.85ab	19.45
T_3	32.75a	191.20bc	132.29a	58.28a	2.96a	1.85ab	19.67
T_4	21.75b	175.10cd	128.02a	56.14a	2.90a	1.95a	19.41
T_5	22.00b	161.20d	129.58a	53.84a	2.93a	1.92ab	19.35
T_6	34.00a	213.08ab	129.79a	56.88a	2.81ab	1.80bc	19.68
LSD (0.05)	3.30	22.65	7.91	8.08	0.23	0.13	NS

In a column, the figures having same letter do not differ significantly as per DMRT at 5% level.

Table 2. Status of initial and post harvest soil of the experimental site

Treatments	Nutrient status					
	pH	OC (%)	Total N (%)	Avail. P ($\mu g g^{-1}$)	Exch. K (c mol kg^{-1})	Avail. S ($\mu g g^{-1}$)
Initial soil	4.98	1.09	0.07	14.00	0.18	24.00
Post harvest soil						
T_1	5.10	1.16	0.05	14.00	0.17	24.00
T_2	5.09	1.20	0.09	22.00	0.23	48.00
T_3	5.13	1.16	0.10	20.00	0.22	46.00
T_4	5.24	1.09	0.10	20.00	0.18	36.00
T_5	5.12	1.16	0.11	14.00	0.23	46.00
T_6	5.12	1.20	0.05	17.00	0.26	46.00

Table 3. Cost and return analysis of different fertilizer management treatments for sugarcane production

Treatments	Gross Return (Tk. ha^{-1})	Fertilizer cost (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	Marginal Benefit Cost Ratio (MBCR)
T_1	39765	0	60286	39765	-
T_2	79005	14080	74366	64925	0.786
T_3	87420	12795	73081	73340	1.62
T_4	84210	10167	70453	74043	2.32
T_5	80760	7694	67980	73066	3.32
T_6	85320	9281	69567	76039	2.90

Price of fertilizer (Tk. per kg) : Urea-6.95 ; TSP-16.0; MP-16.25 ; Zypsum-5.5 ; Zinc sulphate-55; Magnesium oxide-40; Boric acid-200 Price of cane (Tk. per ton): 1,500.00; Total production cost for growing sugarcane was Tk. 60,286.00 excluding only fertilizer cost.

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