Sugarcane Response to Soil Phosphorus

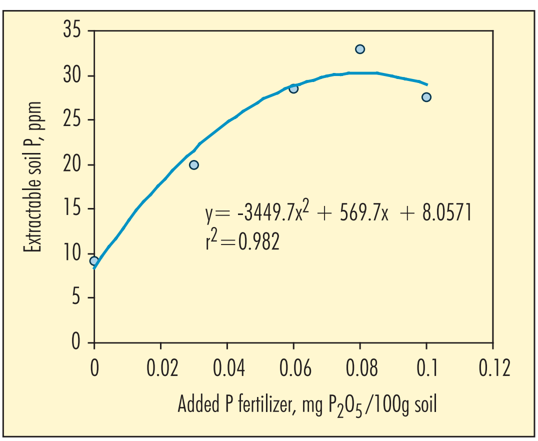
By S.M. Bokhtiar and K. Sakurai

The Bangladesh Sugarcane Research Institute (BSRI) examined the potential for improving cane yield through increased phosphorus (P) fertilizer use accompanied with adequate nitrogen (N), potassium (K), sulfur (S), and zinc (Zn). Results revealed that higher P application rate in a balanced fertilization strategy significantly increased cane and sugar yield. Improved soil P status alone, increased cane yield by 31% over yields obtained under present soil P fertility. A more balanced approach to P nutrition is needed to achieve improved cane and sugar yields.

In Bangladesh, sugarcane is mainly cultivated in the northwestern part of the country and is typically cultivated on an area about 164,000 hectares (ha) annually. Average cane yields for the region are about 41 t/ha. Soils of the region are commonly P deficient with levels far below critical values. Application of P fertilizer promotes root growth, stimulates tillering, influences millable cane growth, and thereby sugarcane yield per ha (Pannu et al., 1985). Besides yield, adequate P nutrition is conducive for higher sugar accumulation in cane tissues. Kumar and Verma (1999) observed that application of 50 kg P_2O_5/ha and above increased cane yield significantly over the control (37.2 to 56.4 t/ha). About 10 to 20% of applied P is utilized, much less than that of other nutrients like N and K (Oseni, 1978).

The objective of the study was to determine the optimum level or range of soil P for sustainable sugarcane production for the High Ganges River Floodplain soils in Bangladesh, represented by the BSRI experimental farm. It is in the Ishurdi series, Typic-Eutrocrept, agro-ecological zone (AEZ) 11; sandy loam; pH 7.5 to 8.0; low in total N, 0.06%, available P 8.0 parts per million (ppm), K 0.19 $cmol_+$/kg, and S 6.0 ppm. The climate of the region is tropical and sub-tropical.

Figure1. Relationship between added P and extractable sodium bicarbonate P in soil after 20 days of incubation.



The six treatments: [T_1, 8 ppm P (control); T_2, 14 ppm P; T_3, 20 ppm P; T_4, 26 ppm P; T_5, 32 ppm P; and T_6, 38 ppm P] were created by adding P fertilizer based on a regression curve (**Figure 1**). Each treatment was replicated three times in a randomized complete block design. One-eyed

Soil P levels, ppm	Millable cane stalks, '000/ha	Yield, t/ha	Yield increase, t/ha	Gross income	Variable cost (P fertilizer)	Net benefit
				- - - - - - -	US$/ha - - - - - - -	
T_1- 8	77.5	73.1	—	—	—	—
T_2-14	100.3	84.1	10.7	208	32	175
T_3-20	110.9	91.9	18.5	357	46	312
T_4-26	113.5	94.7	21.3	412	60	352
T_5-32	115.8	97.6	24.2	470	74	396
T_6-38	121.3	115.7	42.3	820	88	733
$LSD_{(0.05)}$	11.3	15.9	—	—	—	—
SE (±)	3.6	5.1	—	—	—	—

Table 1. Sugarcane yield responses and net profit to soil P levels, BSRI farm, Ishurdi, Bangladesh.

N = 198; K = 81; S = 20; Zn = 3 kg/ha, respectively.

nursery seedlings (variety Isd 29) grown in polyethylene bags for 40 days were planted in a 8 x 6 m plot with a 1.0 m interrow and 0.45 m interplant spacing. Fertilizer sources for N, P, K, S, and Zn were urea, triple superphosphate (TSP), potassium chloride (KCl), gypsum, and zinc sulfate ($ZnSO_4$). One third of the KCl and the full amount of TSP, gypsum, and $ZnSO_4$ were applied basally and one-third of the N was applied 30 days after seedling transplantation (DAT). The remaining N and KCl were top-dressed at two equal installments at tiller completion (120 DAT) and grand growth stage (180 DAT).

Yield and Foliar Nutrient Content as Affected by Varying Soil P Levels

The range of soil P levels significantly increased growth of millable cane stalks and cane yield (**Table 1**). The highest soil P level of 38 ppm produced the highest number of millable cane stalks (121,300/ha) and yield (115.7 t/ha), while control plots which received no P fertilizer produced the lowest number of millable cane stalks (77,500/ha) and yield (73.1 t/ha). The second highest yield of 97.6 t/ha was produced with T_5, which was similar to T_4, T_3, and T_2. Compared to T_1, cane yield increased by 7.9, 13.6, 15.6, 17.8, and 31% using T_2, T_3, T_4, T_5, and T_6, respectively.

S.M. Bokhtiar at sugarcane field, Ishurdi, BSRI farm.

A simple economical analysis for the different soil P treatments was calculated (**Table 1**). There was an excellent response to P application and steadily improved profits with increased P application rate. **Figure 2** shows the significant sugar yield response to increasing levels of soil P and a highest sugar yield of 12.4 t/ha with the 38 ppm soil P level. Because a yield threshold was not reached, further investigation is needed to determine the P and other nutrient requirements to achieve maximum economic yield.

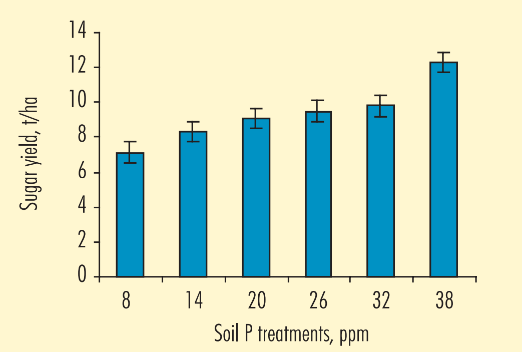


Figure 2. Response of sugar yield to soil P levels. Vertical bars and lines on the vertical bars indicate the mean and standard error of three replicates, respectively.

The range of soil P treatments only improved the concentrations of P, K, and S in leaves, although the response was minimal

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able soil P status in a variety of soils. The various cropping systems of Guangxi Province currently are based on soils with low available P contents. Application of P fertilizer to these systems and soils resulted in very significant and profitable yield increases. If P is omitted from common farmer practice, crop yield and profits suffer. These trials point to the continuing need to test higher P application rates as in most cases the response curve for P was linear. Hence, a maximum yield and profitability could not be defined. In such studies it will also be necessary to test the P response curves using higher rates of N, K, and other deficient plant nutrients based on soil test information. While some scientists in China have suggested P application rates could be reduced in certain areas, this does not apply to the vast majority of cropping systems in Guangxi. **BCI**

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Sugarcane...*continued from page 21)*

(**Table 2**). After harvest, the minor differences in available soil P among treatments indicates the P uptake and use-efficiency is substantially improved when adequate and balanced fertilizers are applied to sugarcane. **BCI**

Table 2. Effect of soil P levels on the nutrient content of sugarcane leaf at mature stage and post harvest soil P level, BSRI farm, Ishurdi, Bangladesh.

Soil P levels, ppm	Leaf, % P	Leaf, % K	Leaf, % S	Soil P[1], ppm
T_1- 8	0.09	1.88	0.09	9
T_2-14	0.09	1.95	0.11	12
T_3-20	0.09	1.95	0.11	13
T_4-26	0.10	1.98	0.11	11
T_5-32	0.11	2.00	0.12	13
T_6-38	0.10	1.88	0.10	11

[1]After harvest

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