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Contribution of Rice Mill Ash and Press Mud with Inorganic Fertilizers to Sugarcane Production in Old Himalayan Piedmont Plain Soils of Bangladesh

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ABSTRACT: A field study was conducted to develop an economically suitable combination of organic and inorganic fertilizers for sugarcane cultivation in sandy acidic soil of a commercial sugarcane farm under Old Himalayan Piedmont Plain of Bangladesh. Results revealed that the treatment T_4 which received 75% of Recommended fertilizers (N 120, P 35, K 100, S 25, Zn 2 kg ha^{-1}) + 10 Mg ha^{-1} Rice mill ash + Mg ha^{-1} press mud significantly produced higher sugarcane yield (72.34 Mg ha^{-1}) among all the treatments except T_5 having 100% of Recommended fertilizers + 10 Mg ha^{-1} Rice mill ash + 10 Mg ha^{-1} press mud, which was identical. T_4 also gave the highest net economic benefit at Bangladesh Taka 15, 920.47 per hectare from the added nutrient management. Thus, the integrated use with organic and inorganic fertilizer is highly essential for sustainable production of sugarcane in commercial farm of the region in Bangladesh, where it has been grown year after year.

Keywords: rice mill ash, press mud, inorganic fertilizer, sandy acid soil, sugarcane

Sugarcane (*Saccharum officinarum* L.) is one of the most important industrial crops in Bangladesh. It is being cultivated on an area about 0.17 million hectares annually with an average cane yield of only 41 tons/ha (BBS, 1998). Sugarcane is a long durable exhaustive crop and requiring a high level of nutrient input. The continuous use of inorganic fertilizers alone for a long period causes deterioration of physical and chemical conditions of soil and subsequently, reduces crop yield. Combined use of inorganic fertilizers with organic manures can improve soil fertility and crop productivity, especially in production of crop like sugarcane, which has high nutritional requirement. Many important soil properties are dependent to some degree on the quantity of organic matter (Black, 1965). Parthasarathy (1972) reported that if a field receives adequate or optimum quantities of organic matter, such fields rarely deteriorate in crop productivity. Paul *et al.* (1999) observed that the use of a soil conditioner named cake-o-meal, blended organic and inorganic mineral nutrients, produced higher yield of sugarcane in Old Himalayan Piedmont Plain soils of Bangladesh. In Nigeria, another organically made fertilizer named Agromax was found to increase the yield and quality of sugarcane (Oworu, 1987). Therefore, this investigation was undertaken to develop an economically suitable combination of organic and inorganic fertilizers for sustained sugarcane yield in the sandy acidic soil of a commercial sugarcane farm under Old Himalayan Piedmont Plain of Bangladesh.

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MATERIALS AND METHODS

The study was conducted during cropping season from 2002 to 2003 at Jamalpur farm of Thakurgaon Sugar Mills Ltd. under Old Himalayan Piedmont Plain soil of Bangladesh to find out an economically suitable fertilizer packages for obtaining high sugarcane yield. It was laid out as randomized complete block design (RCBD) with four replications. Five treatments were comprised in the study at Table 3. The size of unit plot was 80 m^2. The test variety of sugarcane was Isd 31. The method of planting was spaced transplanting with two budded settlings in soil bed. The date of transplanting and harvesting were January 2003 and January 2004, respectively. All amounts of P with triple super phosphate, S with gypsum, Mg with magnesium oxide and Zn with zinc sulphate were applied as basal. One third of K with muriate of potash and one third of N with urea were also applied as basal. The rest of two splits of N and K were applied at 90 and 150 days after transplanting as top dressing. Initial soil status was presented in Table 1. Recorded data on the number of tiller at 150 days after transplanting (DAT), millable cane at harvest, cane yield, stalk height, girth and percent brix in cane have been presented in Table 4 and the increases of yield (%) over control are shown in Figure 1. Means of treatments were compared by LSD and DNMR test statistically using 'Analysis of Variance' technique (Steel & Torrie, 1960).

RESULTS AND DISCUSSION

The soils of the experimental field were acidic (pH 4.50) and sandy loam having organic C of 1.05%, total N of 0.07%, available P of 12.00 mg kg^{-1}, exchangeable K of

Table 1. Initial nutrient status of the experimental soil.

Physico-chemical properties of soil	Values	Method used for the analysis
pH	4.50	Glass electrode pH meter
Organic C (%)	1.05	Wet oxidation method
Total N (%)	0.07	Kjeldhal method
Available P (mg kg^{-1})	12 00	0 5 M $NaHCO_3$ extraction method
Exchangeable K (meq %)	0 14	1 M NH_4-acetate extraction method
Available S (mg kg^{-1})	10 00	Turbid metric method by spectrophotometer

Table 2. Major nutritional composition of press mud and rice mill ash used in this study.

Name of organic materials	Total N (%)	Available P (%)	Exchangeable K (%)	Available S (%)
Press mud	1.37	0.13	0.54	0.56
Rice mill ash	-	0.12	1 02	0.09

Table 3. Treatment codes.

Code	Treatment detail
T_1	Usual farm practice with N 125, P 35, K 93 kg ha^{-1} (Control)
T_2	Recommended Fertilizer Doses of N 120, P 35, K 100, S 25, Zn 2 kg ha^{-1} (RFD)
T_3	50% of RFD + 10 Mg ha^{-1} Rice mill ash + 10 Mg ha^{-1} Press mud
T_4	75% of RFD + 10 Mg ha^{-1} Rice mill ash + 10 Mg ha^{-1} Press mud
T_5	100% of RFD + 10 Mg ha^{-1} Rice mill ash + 10 Mg ha^{-1} Press mud

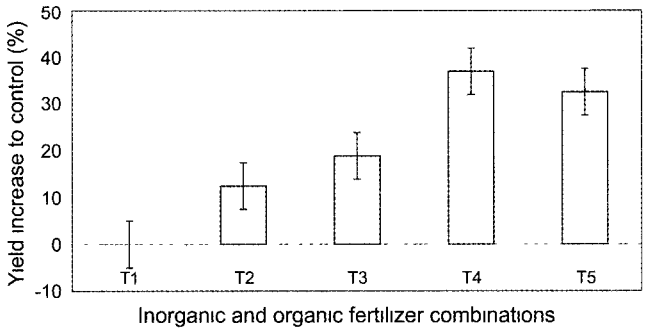

Fig. 1. Response of organic and inorganic fertilizers on cane yield. Vertical bars and lines on the bars indicate the mean and standard error, respectively; see Table 3 for treatment code.

0.14 meq%, available S of 10.00 mg kg^{-1} (Table 1). Compositions of press mud and rice mill ash for major plant nutrients are shown in Table 2. The results of the investigation on yield and yield attributes of sugarcane are presented in Table 4. The effect of different fertilizer management practices on the nutrient uptake and apparent nutrient balance in soil is shown in Table 5, and its effect on the yield and economic benefit of sugarcane production are computed in Table 6. Fig. 1 shows the percent increase in cane yield by different treatments over control.

Evaluating the results reported in Table 4, it is found that the treatment T_4 produced significantly higher percent germination (48.59), higher number of tillers (304.46×10^3) and millable cane per hectare (107.03×10^3) among all the treatments but it was statistically similar with T_3 and T_5. The treatment T_4 also produced significantly higher cane yield (72.34 Mg ha^{-1}) over all other treatments except T_5, which was statistically similar. Again, the effects of T_4 on stalk height and cane girth production were found significant over control. But, there were non-significant treatment effects on brix in cane under study. While the treatment T_1 (usual farm practice) produced significantly lower percent germination (38.18), lower number of tillers (197.85×10^3) and millable cane per hectare (79.01×10^3) among all. It also produced significantly lower cane yield (52.81 Mg ha^{-1}) and lower stalk height (2.83 m) and girth (1.86 cm) among all other treatments in the study. Furthermore, the treatment T_5 produced the second highest percent germination (44.27), number of tillers (266.45×10^3) and millable cane per hectare (101.41×10^3). It also produced the second highest cane yield (70.00 Mg ha^{-1}), stalk height (2.98 m) and girth (2.03 cm), and percent brix (18.58) in cane among the rest of the treatments. Similar result was obtained by Bokhtiar *et al* (2001) in their experiment where they applied press mud at 20 Mg ha^{-1} in combination with 200 kg N ha^{-1}. Evaluating nutrient uptake by cane and added nutrient from different fertilizer management practices, it is found higher apparent nutrient balance in soil for integrated use with organic and

Table 4. Changes of yield and yield attributes affected by fertilization packages on sugarcane production; see Table 3 for treatment code.

Treatments	Germination (%)	Maximum tiller (10^{-3} ha^{-1})	Mill able cane at harvest (10^{-3} ha^{-1})	Cane yield (Mg ha^{-1})	Stalk height (m)	Girth (cm)	Brix (%)
T_1	38.18 c	197.85 c	79.01 c	52.81 d	2.83 b	1.86 c	18.48
T_2	42.65 b	229.11 bc	95 00 b	59.43 c	2.91 ab	1.98 b	18.60
T_3	44.13 ab	264 94 ab	100.45 ab	62.78 bc	2.97 ab	2.00 a	18.63
T_4	48 59 a	304.46 a	107.03 a	72 34 a	3.01 a	2.08 a	18 75
T_5	44.27 ab	266.45 ab	101.41 ab	70.00 a	2.98 ab	2.03 ab	18.58
LSD (%)	4.67	45.89	7.04	4 81	0.17	0 09	NS
CV (%)	6.95	11.79	4.73	4.92	3.72	2.87	1.06

*Figures in column with same letter (s) do not differ significantly by LSD test at 5% level of probability.

Table 5. Changes of the nutrient uptake and apparent nutrient balance in soil affected by fertilization packages; see Table 3 for treatment code.

Treatments	Major nutrient uptake (kg ha^{-1})				Major nutrient added (kg ha^{-1})				Apparent nutrient balance (kg ha^{-1})			
	N	P	K	S	N	P	K	S	N	P	K	S
T_1	32	27	123	17	125	35	93	-	93	8	-30	-17
T_2	36	31	138	19	120	35	100	25	84	4	-38	6
T_3	38	32	146	20	197	43	206	78	159	11	60	58
T_4	44	37	168	23	227	52	231	84	183	15	63	61
T_5	43	36	162	23	257	61	256	90	214	25	94	67

*Nutrient uptake was calculated on the basis of nutrient contents in cane as: N- 0.0610%, P- 0.0516%, K- 0 2320%, S- 0.0322% (Islam, *et al* 1998) and nutrient addition was computed from both the sources of organic + inorganic fertilizers.

Table 6. Integrated effect of organic and inorganic fertilizer management packages on the yield and economic benefit of sugarcane cultivation; see Table 3 for treatment code.

Treatments	Cane yield (Mg ha^{-1})	Added benefit for added nutrient management (Taka ha^{-1})	Added cost for added nutrient management (Taka ha^{-1})	Net benefit for added nutrient management (Taka ha^{-1})	Benefit/Cost Ratio for added nutrient management
T_1	52.81	-	-	-	-
T_2	59.43	6, 620.00	812.70	5, 807.30	8.15
T_3	62.78	9, 970.00	3, 406 35	6, 563.65	2.93
T_4	72.34	19, 530.00	3, 609 53	15, 920.47	5.41
T_5	70 00	17, 190 00	3, 812.70	13, 377.30	4.51

*Calculations made on the following price for different inputs and outputs of the experiment (Bangladeshi Taka / kg): Urea-6 50, Triple super phosphate-14.00, Muriate of potash-11 00, Gypsum-4.00, Zinc sulphate-40.00, Press mud-0.10, Rice mill ash-0.20 and Sugarcane-1.00

inorganic fertilizers (Table 5). It reveals that the highest build up of available NPKS in soil was obtained due to use of 100% recommended inorganic NPKSZn fertilizers + press mud 10 Mg ha^{-1} + rice mill ash 10 Mg ha^{-1}. However, the reasonably higher proportionate of apparent nutrient balance in soil was found either from the use of 75% or 50% recommended inorganic NPKSZn fertilizers + press mud 10 Mg ha^{-1} + rice mill ash 10 Mg ha^{-1}. Many scientists demonstrated similar result of higher apparent nutrient balance in soil and improvement in soil fertility for the integrated use of organic manures and inorganic fertilizers (Mathur, 1997; Singh & Singh, 2002; Bokhtiar, 2004). It further reveals that the integrated use of 75% recommended inorganic NPKSZn fertilizers + press mud 10 Mg ha^{-1} + rice mill ash 10 Mg ha^{-1} gave the highest net benefit at Bangladesh Taka 15, 920.47 per hectare for the added nutrient, where 50% recommended inorganic NPKSZn fertilizers + press mud 10 Mg ha^{-1} + rice mill ash 10 Mg ha^{-1} showed the second highest net benefit at Bangladesh Taka 13, 377.30 per hectare for additional inputs in sugarcane production (Table 6). Islam *et al* (1998) found similar observation of higher economic return from the combined application of organic and inorganic fertilizers

in sugarcane. Fig. 1 further shows the highest percent increase in cane yield (37.0) by the T_4 treatment over control (T_1). This result is consistent with the findings of Singh *et al* (1995). Yadhuvanshi & Yadav (1992) similarly confirmed the beneficial effect of press mud application in sugarcane production.

Finally, it can be concluded that the treatment T_4 which received 75% of recommended fertilizers of N 120, P 35, K 100, S 25, Zn 2 kg ha^{-1} (RFD) + 10 Mg ha^{-1} rice mill ash + 10 Mg ha^{-1} press mud produced significantly higher sugarcane yield with reasonably increased proportionate of apparent nutrient balance in soil and higher net economic benefit among all the treatments, except T_5 that received 100% of RFD + 10 Mg ha^{-1} rice mill ash + 10 Mg ha^{-1} press mud. Thus, T_4 having 75% of RFD with 10 Mg ha^{-1} rice mill ash + 10 Mg ha^{-1} press mud was found superior over all other treatments for sustaining sugarcane yield and income at Jamalpur farm soils under Old Himalayan Piedmont Plain of Bangladesh.

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