Bangladesh J. Sugarcane, 30 : 21-27

Recycling of Agricultural Wastes to Sugarcane Production in Old Himalayan Piedmont Plain Soils

G. C. Paul, S. M. Bokhtiar, A. Haque, K. M. Alam and R. C. Kabiraj
Bangladesh Sugarcane Research Institute,
Ishurdi-6620, Pabna, Bangladesh

ABSTRACT

A field study was conducted to develop an economically suitable package of organic and inorganic fertilizers for sustainable sugarcane production in Old Himalayan Piedmont Plain soils of Bangladesh. There were eight treatments in the study. Results revealed that treatment T_7 that received 2/3rd of recommended inorganic fertilizer 120 kg N, 35 kg P, 100 kg K, 25 kg S and 2 kg Zn ha^{-1} along with press mud at the rate of 10 t ha^{-1} produced the highest cane yields of 54.2-100.4 t ha^{-1} followed by T_8 with 52.7-100.3 t ha^{-1} in two consecutive years. Further treatment T_7 gave the highest gross margins of BD Taka 53, 024-1, 05, 022 ha^{-1} and MBCR 2.14-5.52.

Key words: Recycling, agricultural wastes, inorganic fertilizer, sugarcane, soil

INTRODUCTION

Bangladesh agriculture is facing a challenge to prevent its soil degradation and depletion of fertility. Plant nutrients in soil, whether naturally endowed or artificially maintained, are a major determinant of the success or failure of a crop production system. Sugarcane is the only source of white sugar in Bangladesh, cultivated over an area of about 0.41 million hectares annually with an average low yield of 41.2 tonnes per hectare (BBS, 1998). Sugarcane being a long durable exhaustive crop with heavy nutritional demands its soils become less fertile and fails to produce higher cane yield. Sugarcane is grown well in the soils having sufficient level of organic matter and available nutrients (Islam *et al.*1998). But the organic matter content in Bangladesh soil is far below (~1-2%) than crop requirement and it is depleting day by day (Mia *et al.*, 1993). 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. In Nigeria, an organically made fertilizer named Agromax was found to increase the yield and quality of sugarcane (Oworu, 1987). The uses with soil conditioner (blended organic and inorganic mineral nutrients), and integrated nutrient management of organic and inorganic fertilizers demonstrated sustainable sugarcane yields in Old Himalayan Piedmont Plain soils of Bangladesh (Paul *et al.* 1999, 2004, and 2005a). Nutrient replenishment through recycling of agricultural wastes and inorganic fertilizers in sugarcane soil is indispensable for sustainable cane production. However, little information is available on this aspect. Therefore, a study was conducted to develop an economically suitable package of fertilization with recycling of some agricultural wastes and inorganic fertilizers for sustainable sugarcane production in Old Himalayan Piedmont Plain soils of Bangladesh.

MATERIALS AND METHODS

An experiment was conducted during 2004-05 and 2005-06 at Regional Sugarcane Research Station farm, Thakurgaon under Old Himalayan Piedmont Plain soils of Bangladesh to develop an economically suitable fertilizer management package with recycling of agricultural wastes and inorganic fertilizers for sustaining sugarcane yield. It was laid out in randomized complete block design (RCBD) with three replications. Eight treatments were comprised in the study, which are shown in Table 3. The size of unit plot was 48 sq. m. The test variety of sugarcane was Isd 32. The method of planting was spaced transplanting with two budded settlings in soil bed. It was harvested after full maturity of the crop. 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 two splits of N and K were applied at 120 and 160 days after transplanting as top dressing. Initial soil status is presented in Table 1. Bio-chemical composition of press mud, farmyard manure, poultry litter and wheat straw is shown in Table 2. 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. The cost and return analysis for different fertilizer management options for sugarcane production is shown in Table 5. Means of treatments were compared by LSD and DNMR test statistically using 'Analysis of Variance' technique (Steel & Torrie, 1960).

RESULTS AND DISCUSSION

In the cropping year 2004-05 treatment T_7 having 2/3rd of recommended inorganic fertilizers along with press mud @ 10 t ha^{-1} produced significantly higher number of tillers per hectare (247.22 x 10^3) over control and higher number of millable cane per hectare (124.75 x 10^3) among all, except T_8 which was identical (Table 4). In the cropping year 2005-06 all the treatments progressively increased number of tiller, millable cane, stalk height, girth of cane and brix (%) over control. The highest number of tiller was obtained from T_7 (165.1 x 10^3) having 2/3rd of recommended inorganic fertilizers along with press mud @ 10 t ha^{-1}. However, it was statistically identical with all other treatments except T_1. The highest millable cane was also found in T_7 treatment (102.8 x 10^3) followed by T_8 (97.92 x 10^3), T_3 (97.90 x 10^3) and T_4 (97.17 x 10^3 ha^{-1}). But the effect of T_7 treatment was statistically identical with T_8, T_3 and T_4 in millable cane production. Further in 2004-05, treatment T_7 produced significantly higher cane yield (100.38 t ha^{-1}) over all other treatments except T_8 and T_4, which were statistically similar. In 2005-06, treatment T_7 further showed significantly higher cane yield (54.16 t ha^{-1}) over all other treatments except T_8, T_4, T_3 and T_2 which were statistically similar. There were insignificant treatment effects on stalk height in 2004-05, whereas significant effect was obtained in 2005-06. In 2005-06, the highest cane stalk was obtained from T_2 (2.81 m) followed by T_3, T_4 and T_6. In both the years cane girth and brix in cane under study showed insignificant treatment effect. While the treatment T_1 (control) in both the crop year, produced significantly lower number

of tillers (160.00 x 10^3 and 60.62 x 10^3, respectively) and millable cane per hectare (85.56 x 10^3 and 54.18 x 10^3, respectively) among all. It also produced significantly lower cane yield (47.54 t and 25.05 t ha^{-1} respectively) among all other treatments in the study. Furthermore, treatment T_8 having 2/3rd of recommended inorganic fertilizers along with press mud @ 10 t ha^{-1} + wheat straw @ 10 t ha^{-1} produced the second highest number of tillers (245.90 x 10^3 and 162.60 x 10^3 respectively) and millable cane (124.44 x 10^3 and 97.92 x 10^3 respectively) per hectare. It also produced the second highest cane yield (100.32 and 52.65 t ha^{-1} respectively) among the rest of the treatments in 2004-05 and 2005-06. Similar results were obtained by Paul *et al.* (2004, 2005a) and Paul and Mannan (2006) in their experiments where they applied organic materials in combination with inorganic fertilizers. Many other scientists also supported our results where they found that application of integrated fertilizers with organic and inorganic sources should better cane yield and yield attributes (Hossain *et al.*, 1989; Khondakar *et al.,* 1987). It was further noted that treatment T_7 having integrated use of 2/3rd of recommended inorganic fertilizers along with press mud @ 10 t ha^{-1} gave the highest gross margin of BD Taka 1, 05, 022 and 53, 024 ha^{-1} with MBCR 5.52 and 2.14 in 2004-05 and 2005-06, respectively. Treatment T_8 having 2/3rd of recommended inorganic fertilizers along with press mud @ 10 t ha^{-1} + wheat straw @ 5 t ha^{-1} showed the second highest gross margin of BD Taka 1, 03, 704 and 50, 075 ha^{-1} with MBCR 4.49 and 1.39, respectively for the seasons (Table 5). Islam *et al.* (1998) found similar observation of higher economic return from the combined application of organic and inorganic fertilizers in sugarcane production. This result is consistent with the findings of Singh *et al.* (1995). Yadhuvanshi & Yadav (1992) and Bokhtiar *et al.* (2001) similarly found the beneficial effect of press mud application in sugarcane yield.

Finally, it can be concluded that treatment T_7 having integrated application with 2/3rd of recommended inorganic fertilizers along with press mud @ 10 t ha^{-1} would be beneficial for sustaining sugarcane yield and higher income in Old Himalayan Piedmont Plain soils of Bangladesh.

Table 1. Initial nutrient status of the experimental soil.

Physico-chemical properties of soil	Values	Method used for the analysis
pH	5.00	Glass electrode pH meter
Organic C (%)	1.05	Wet oxidation method
Total N (%)	0.07	Kjeldhal method
Available P (mg kg^{-1})	14.00	0.5 M $NaHCO_3$ extraction method
Available K (meq %)	0.17	1 M NH_4-acetate extraction method
Available S (mg kg^{-1})	12.00	Turbid metric method by spectrophotometer

Table 2. Composition of press mud, farmyard manure, poultry litter and wheat straw used in the experiment (on oven dry basis).

Characteristics	Organic manure			
	Press mud	FYM	Poultry litter	Wheat straw
Moisture (%)	55	45	23	21
N (%)	1.37	1.21	1.80	0.52
P (%)	0.13	0.08	2.91	0.31
K (%)	0.54	0.41	2.12	0.94
S (%)	0.56	0.22	1.09	-

Table 3. Treatment codes.

Code	Treatment detail
T_1	Control
T_2	Recommended Fertilizer Doses of $N_{120}P_{35}K_{100}S_{25}Zn_2$ kg ha^{-1} (RFD)
T_3	2/3rd RFD + Poultry litter @5 t ha^{-1}
T_4	2/3rd RFD + Poultry litter @5 t ha^{-1} + Wheat straw @5 t ha^{-1}
T_5	2/3rd RFD + Farm yard manure @10 t ha^{-1}
T_6	2/3rd RFD + Farm yard manure @10 t ha^{-1} + Wheat straw @5 t ha^{-1}
T_7	2/3rd RFD + Press mud @10 t ha^{-1}
T_8	2/3rd RFD + Press mud @10 t ha^{-1} + Wheat straw @5 t ha^{-1}

Table 4. Yield and yield attribute of sugarcane as affected by agricultural wastes and inorganic fertilizer.

Crop Year	Treatments	Maximum tiller (10^3 ha^{-1})	Mill able cane at	Cane yield (t ha^{-1}) harvest (10^3 ha^{-1})	Stalk height (m)	Girth (cm)	Brix (%)
2004-05	T_1	160.00 b	85.56 d	47.54 d	2.78	2.14	17.33
	T_2	233.96 a	107.08 c	86.96 c	2.90	2.22	17.18
	T_3	239.58 a	110.76 bc	89.77 c	2.96	2.26	17.55
	T_4	240.13 a	113.83 b	93.94 abc	3.00	2.28	17.46
	T_5	239.09 a	112.92 bc	90.37 bc	2.96	2.25	17.36
	T_6	239.36 a	112.31 bc	91.04 bc	2.99	2.27	17.29
	T_7	247.22 a	124.75 a	100.38 ab	2.98	2.28	17.53
	T_8	245.90 a	124.44 a	100.32 a	3.00	2.27	17.29
	LSD (0.05)	16.18	6.61	10.01	ns	ns	ns

2005-06	T_1	60.62b	54.18c	25.05d	2.00e	1.89	17.47
	T_2	158.1a	89.33b	50.34ab	2.81a	2.04	18.33
	T_3	155.7a	97.90a	50.56ab	2.74ab	1.99	18.46
	T_4	161.2a	97.17a	52.59a	2.64abc	2.05	17.71
	T_5	152.3a	89.86b	44.78b	2.38bcde	2.09	19.04
	T_6	159.8a	85.00b	43.23bc	2.49abcd	2.07	19.02
	T_7	165.1a	102.8a	54.16a	2.37cde	2.09	18.02
	T_8	162.6a	97.92a	52.65a	2.36cde	2.06	19.05
	LSD (0.05)	18.43	6.63	6.50	0.38	NS	NS

*Figures in column with same letter (s) do not differ significantly at 5% level as per LSD test

Table 5. Cost and return analysis for different fertilizer management options for sugarcane production.

Crop Year	Treatment	Gross Return (Tk ha^{-1})	Fertilizer cost (Tk ha^{-1})	Total variable cost (Tk ha^{-1})	Gross Margin (Tk ha^{-1})	MBCR
2004-05	T_1	53, 483	-	33, 898	53, 483	-
	T_2	97, 830	10, 463	44, 361	87, 367	2.24
	T_3	1, 00, 958	10, 906	44, 804	90, 052	2.35
	T_4	1, 05, 683	12, 156	46, 054	93, 527	2.29
	T_5	1, 01, 666	8, 906	42, 804	92, 760	3.41
	T_6	1, 02, 420	10, 156	44, 054	92, 264	2.82
	T_7	1, 12, 928	7, 906	41, 804	1, 05, 022	5.52
	T_8	1, 12, 860	9, 156	43, 054	1, 03, 704	4.49
2005-06	T_1	28181	-	33, 898	28181	-
	T_2	56633	10, 463	44, 361	46170	0.72
	T_3	56880	10, 906	44, 804	45974	0.63
	T_4	59164	12, 156	46, 054	47008	0.55
	T_5	50378	8, 906	42, 804	41472	0.49
	T_6	48634	10, 156	44, 054	38478	0.02
	T_7	60930	7, 906	41, 804	53024	2.14
	T_8	59231	9, 156	43, 054	50075	1.39

*Calculations made on the following price for different inputs and output of the experiment (Bangladesh Taka/kg): (Input) Urea = 6.50, TSP = 14.00, MP =11.00, Gypsum = 4.00, Zinc sulphate = 60.00, MgO = 40.00, FYM = 0.40, Poultry litter = 0.80, Press mud = 0.20, Wheat straw = 0.25, (Output) Sugarcane = 1.125

REFERENCES

BBS. 1998. Year Book of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of People's Republic of Bangladesh. 75p.

Black, C.A. 1965. Organic matter in methods of soil analysis (Part-2). American Society of Agronomy, Inc. Madison, Wisconsin, pp.1397-1408.

Bokhtiar, S.M.; Paul, G.C.; Rashid, M.A and Rahman, A.B.M.M. 2001. Effect of press mud and inorganic nitrogen on soil fertility and yield of sugarcane grown in High Ganges River Floodplain soils of Bangladesh. *Indian Sugar*, **LI** (4): 235-241.

Hossain, A.H.M.D.; Ali, M. and Shaheen, M. 1989. Effect of Vesimex on sugarcane yield. *Bangladesh J. Sugarcane*, **11**: 109-111.

Islam, M.J.; Majid, M.A.; Paul, G.C; Bokhtiar, S.M. and Hossain, A. 1998. Integrated effect of organic and inorganic fertilizers on sugarcane production. Proceedings of the National Workshop on Integrated Nutrient Management for Crop Production and Soil Fertility, pp. 159-166.

Khondaker, M.; Rahman, M.H.; Chowdhury, M.K.A. and Hossain, A.H.M.D. 1987. Influence of different organic manures on sugarcane productivity. *Bangladesh J. Sugarcane,* **9**: 48-52.

Mia, M.M.U.; Habibullah, A.K.M. and Ali, M.F. 1993. Depletion of organic matter in upland soils of Bangladesh. *AGROKEMIAESTALAJTAN Tom,* **42** (1 &2): 70-78.

Oworu, O.O. 1987. The efficacy of a liquid fertilizer (Agromax) on yield and its components in sugarcane. *Bangladesh J. Sugarcane*, **9**: 32-36.

Parthasarathy, S.V. 1972. Organic matter in Sugarcane in India. The K.C.P. Ltd. Madras, pp.332-333.

Paul, G.C.; Islam, M.J. and Bokhtiar, S.M. 1999. Efficacy of cake-o-meal-an organic manure on sugarcane yield. *Bangladesh J. Sugarcane,* **21**: 37-40.

Paul, G.C.; Rahman, M.H. and Rahman, A.B.M.M. 2004. Integrated nutrient management with organic and inorganic fertilizers on productivity of sugarcane in Bangladesh. *Indian J. Sugarcane Technol.* **19** (1 & 2): 23-26.

Paul, G.C.; Rahman, M.; Khan, N.U. and Rahman, A.B.M.M. 2005a. Contributions of Rice Mill Ash and Press mud with Inorganic Fertilizers to Sugarcane Production in Old Himalayan Piedmont Plain Soils of Bangladesh. *Korean J. Crop Sci.* **50** (2): 108-111.

Paul, G.C.; Rahman, H. and Rahman, A.B.M.M. 2005b. Integrated Nutrient Management with Organic and Inorganic Fertilizers on Productivity of Ratoon Sugarcane in Bangladesh. *Sugar Tech J.* **7** (2&3): 20-23.

Paul, G.C. and Mannan, M.A. 2006. Integrated Nutrient Management in Sugarcane to Enhance Sugar Productivity. Proc. Internl. Symp. on Technologies to Improve Sugar Productivity in Developing Countries, Guilin, P. R. China, pp. 108-121.

Singh, O.P.; Singh, G.; Singh, B.B. and Sharma, M.S. 1995. Effect of press mud and fertilizer on yield and quality of plant and ratoon sugarcane (*Saccharum officinarum*) in flood-prone areas. *Indian J. Agron.* **40** (3): 469-473.

Steel, R.G.D. and Torrie, J.H. 1960. Principles and procedures of statistics. McGraw Hill, New York. 481p.

Yadhuvanshi, N.P.S. and Yadav, D.V. 1992. Effect of direct, residual and cumulative application of press mud with nitrogen on soil properties and on yield and quality of sugarcane. *Indian J. Sugarcane Technol.* 7 (1): 33-39.