Bangladesh J. Sugarcane, 18-20 : 30-36

July, 1998

Effects of Magnesium, Zinc and Organic Manures on Sugarcane

S.C.Saha, M.M.Uddin and S.R. Ghosh
Bangladesh Sugarcane Research Institute,
Ishurdi, Pabna, Bangladesh.

Received on 10.10.96

ABSTRACT

The experiment was conducted in Old Himalayan Piedmont Plain region of non-calcareous brown flood plain soils (Typic Haplaquept) at the North Regional Station farm, Thakurgaon in the field as well as in pot during 1989-90 crop season to assess the effect of Mg, Zn, cowdung (CD), mustard oil cake (MOC) in combination with NPKS fertilizers on the yield of cane and sugar. Application of different plant nutrients significantly influenced number of tillers, millable canes, yield of cane and percent recoverable sucrose. Zinc along with NPKS produced the highest tiller (273.33 x 10^3 ha^{-1}) and recoverable sucrose (8.94%). But MOC along with NPKS produced highest millable cane (138.43 x 10^3 ha^{-1}) and yield (85.9 ton ha^{-1}). In the field as well as in pot experiment, the highest cane yield and millable cane were obtained from MOC along with NPKS followed by Zn, Mg, CD and only NPKS. There was no significant yield difference among these treatments but they differed significantly from the rests. The yield increase in these treatments was due to production of higher number of tillers and millable canes. Results indicate ample scope for increasing higher yield of sugarcane by applying Mg, Zn, CD and MOC in addition to NPKS fertilizers in the experimental sites under the Old Himalayan Piedmont Plain soils.

INTRODUCTION

Magnesium plays vital roles in chlorophyll synthesis, cellular pH control, protein synthesis and transfer of phosphate (Phosphatase and ATPases) in energy metabolism of plants (Marschner, 1986; Dev and Kumar, 1982). Therefore, the role of magnesium in sugarcane production is manyfold. Magnesium has considerable significance in acid soils and the loss of magnesium through leaching is very high. Furthermore, higher the soil acidity, the greater is the Mg loss. Again in light textured soils, the Mg loss is greater than that in the heavy soils. Response of sugarcane to root growth and transport of photosynthates from leaves to stems are impaired when the plant suffers from Mg deficiency. Sugarcane response to applied magnesium has been reported by Rahman *et al.* (1986) in acid soils of Bangladesh with low exchangeable magnesium (Anon., 1989). In Bangladesh zinc deficiencies in different crops are becoming more frequent and an addition of zinc resulted in significant increase in the yield of crops (Anon., 1982). Bedsol and Bregger (1953) also reported that application of 33 kg $ZnSO_4$ ha^{-1} increased cane yield in Florida.

Continuous use of commercial fertilizers alone deteriorates the physico-chemical soil properties, and reduces sugarcane yield. Results of 258 experiments conducted over eight states and 19 experimental stations of India showed the average response of eight tons of sugarcane to the application of 25 tons of farmyard manure or compost (Gaur, 1982). Supply of fertilizer N along with organic manure is known to stimulate mineralization and immobilization of organic N (Prasad and Rokima, 1991). Application of organic and inorganic fertilizer source of N and their management for efficient and economic use and maintenance of soil fertility and productivity are very important for tropical countries. Combined use of fertilizers and manures can influence the forms and availability of P and K in soils in many ways. Organic acids and other microbial product of decomposition may solubilize the insoluble P by interacting with P-binding cations and clay minerals (Stevenson, 1967). Information regarding the effects of Mg, Zn, and organic manures in combination with NPKS on sugarcane yield in acid sandy soils of northern part of Bangladesh is very scanty. Considering the above situation this investigation was undertaken to study the response of sugarcane to Mg, Zn, and organic manures in combination with NPKS in Old Himalayan Piedmont Plain soils.

MATERIALS AND METHODS

Field experiment

The experiment was conducted in the Old Himalayan Piedmont Plain region of non-calcareous brown flood plain soils (Typic Haplaquept) at the North Regional Station farm, Thakurgaon in the field as well as in pot during the 1989-90 crop season. Soil samples from the depth of 0-25 cm were collected before planting to determine the physico-chemical properties of soil. Results on physico-chemical properties of soil samples are presented in the Table 1.

Table 1. Physico-chemical characteristics of experimental soil.

pH	5.20
Sand (%)	65.00
Silt (%)	22.00
Clay(%)	13.00
Texture	Sandy loam
Organic C(%)	1.27
Total N (%)	0.07
Available P (ppm)	14.00
Exchangeable K (me%)	0.06
Exchangeable Mg (me%)	0.12
Available S (ppm)	12.00
Available Zn (ppm)	1.80

Chemicals fertilizers like urea, TSP, MP, gypsum, MgO, ZnO for nitrogen, phosphorus, potassium, sulphur, magnesium and zinc were applied @ 160, 58, 183, 40, 20 and 8 kg ha^{-1}, respectively. Cowdung and mustard oil cake were also applied @ 18 and 0.5 tons ha^{-1}, respectively. No fertilizers were applied in control plots. The variety L. Jaba C was used as test crop. There were seven treatment combination in the experiment as fertilizers were applied as per treatment combination noted below :

T_0 : Control
T_1 : N P K
T_2 : N P K S
T_3 : NPKS + Mg
T_4 : NPKS + Zn
T_5 : NPKS +CD
T_6 : NPKS + MOC

The experiment was laid down in randomized complete block design with four replications. Forty five days old polybag settlings of sugarcane variety L Jaba C were transplanted in the field in November, 1989. After final land preparation full P, S, Mg, Zn, cowdung and mustard oil cake were applied in the trench at planting. Nitrogen and K were added in three splits viz., one third at planting, one third at tiller initiation and the final split after completion of tiller stage. All intercultural operations and plant protection measures were adopted for necessary growth and development of crops as per recommendation. The field experiment was harvested in January, 1991 and data on number of tiller production, millable cane, yield of cane, recoverable sucrose percent and sugar yield (t ha^{-1}) were collected.

Pot culture experiment

Bulk soil samples (0-25cm) were collected from the field, properly processed and filled in bitumen coated earthen pots of 10 kg capacity. The seven treatments as mentioned in case of field trial were applied in the pots and fitted in a completely randomized design with three replications. In total there were 21 (7 x 3) pots. One polybag settling of 45 days old was transplanted in each pot, and was grown up to maturity. Necessary intercultural operations, watering, application of fertilizers were made and protection measures were adopted as per recommendations.

The crop of the pot experiment was harvested in January, 1991. Dat on millable cane and yield of cane were recorded at harvest. The recoverable sucrose percentage was determined at harvest according to Horn's Dry Lead Method (Meade and Chen, 1977). The collected data were statistically analyzed and the significance of mean difference were adjusted as per LSD (Steel and Torrie, 1960).

Soil pH was determined in 1 : 2.5 (soil : water) suspension by pH meter and organic carbon by chromic acid wet oxidation method as described by Walkley and Black. Soil

texture was determined by hydrometer method and total nitrogen by modified Kjeldahl method. Available phosphorus was determined after extraction with 0.5M $NaHCO_3$ at pH 8.5 following chlorostannous reduced molybdophosphoric blue colour method, exchangeable potassium with flame photometer in NH_4OAc extract and exchangeable Mg in NaOAc extract by titrating with EDTA solution (Jackson, 1967). Available soil sulphur was determined after extraction with NaOAc by developing turbidity using $BaCl_2$ and gum acacia (Chesnin and Yien, 1950). Available soil zinc was extracted by 0.1N HCl (Lantin *et al.* 1979) and determined by atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Field experiment

The soils of the experimental field had pH 5.20, soil texture sandy loam, organic carbon 1.27%, total N 0.07%, available phosphorus 14.00 ppm, exchangeable potassium 0.06 me%, exchangeable magnesium 0.12 me%, available sulphur 12.00 ppm and available zinc 1.80 ppm (Table 1). The salient results of the field experiment are presented in the Table 2. The fertilizers NPK, NPKS, NPKSMg, NPKSZn, and NPKS with organic manures significantly increased different yield contributing parameters of sugarcane. Application of NPK alone produced 45% higher cane yield over absolute control (Table 2). Addition of S in combination with NPK produced 13.8% higher cane yield over NPK. Similar results were also obtained earlier (Rahman *et al.* 1988; Saha *et al.* 1984).

Table 2. Yield and yield parameters of sugarcane as influenced by the application of different plant nutrients in the field.

Treatments	Tillers in May ($x10^3 ha^{-1}$)	Millable cane ($x10^3 ha^{-1}$)	Yield of cane (tons ha^{-1})	Recoverable sucrose(%)	Sugar yield (tons ha^{-1})
T_0 :Control	122.08	82.45	48.70	8.16	3.97
T_1 :NPK	255.49	123.26	70.60	8.34	5.88
	(109.2)*	(49.5)	(44.9)		
T_2 :NPKS	260.43	136.74	80.40	8.47	6.81
	(113.3)	(65.8)	(65.0)		
T_3 :NPKSMg	266.81	136.97	83.70	8.91	7.46
	(118.5)	(66.1)	(71.8)		
T_4 :NPKSZn	273.33	137.94	85.40	8.94	7.63
	(123.8)	(67.3)	(75.4)		
T_5 :NPKS+CD	268.06	136.75	83.10	8.35	6.93
	(119.6)	(65.9)	(70.6)		
T_6 :NPKS+ MOC	270.38	138.43	85.90	8.68	7.46
LSD(P=0.01)	6.62	3.85	4.03	0.29	

* Figures in parentheses indicates % increase over control.

Addition of Mg, Zn, cowdung, and mustard oil cake in combination with NPKS produced further 4.1, 6.2, 3.5, and 6.9% higher cane yield over NPKS, respectively (Table 2).Rahman *et al.* (1986) obtained higher sugarcane yield by applying Mg on acid soils of Bangladesh. In an experiment with Zn on Gangetic flood plain soils of Ishurdi showed that application up to 15 kg ha^{-1} had a positive effect on cane yield (Chowdhury and Rahman, 1987). Khondakar *et al.* (1987) recorded increased cane yield with the application of cowdung and mustard oil cake along with NPK fertilizer over NPK alone in Ganges River Flood Plain soils of Carew & Co. Sugar mills farm.

Highest cane yield of 85.9 t ha^{-1} was obtained from the application of NPKS with mustard oil cake (T_6) followed by Zn, Mg cowdung and only NPKS (T_4, T_3, T_5 and T_2, respectively) (Table 2). Howerver, there was no significant yield difference among these treatments but they significantly differed from the rests. The yield increase in these treatments were due to higher number of tiller, and millable cane. The yield increase due to the application of organic manures might be contributed by improvement of soil texture, higher water holding capacity and enhanced availability of plant nutrients.

Table 3. Yield and yield parameters of sugarcane as influenced by different plant nutrients applied in pot.

Treatments	Tillers in May per pot (No.)	Millable cane per pot (No.)	Cane yield (kg/pot)
T_0 :Control	12.67	4.67	2.62
T_1 :NPK	20.33	9.00	4.05
	(60.5)*	(92.7)	(54.6)
T_2 :NPKS	27.33	10.33	4.50
	(115.7)	(121.2)	(71.8)
T_3 :NPKSMg	27.33	10.33	4.85
	(115.7)	(121.2)	(85.1)
T_4 :NPKSZn	27.67	10.00	5.82
	(118.4)	(114.1)	(122.1)
T_5 :NPKS+CD	26.67	9.33	4.79
	(110.5)	(99.8)	(82.8)
T_6 :NPKS+MOC	28.33	11.33	5.88
	(123.6)	(142.6)	(124.4)
LSD (P=0.01)	2.66	2.23	1.09

* Figures in parentheses indicates % increase over control.

Pot culture experiment

In the pot culture experiment, fertilizers like NPK, NPKS, NPKSMg, NPKSZn, and NPKS organic manures significantly increased different productivity components of sugarcane like tiller population and millable canes (Table 3). Application of NPK alone produced 54.6% higher cane yield over control. Addition of sulphur in combination with

NPK produced 11.1% higher cane yield over NPK. Addition of Mg, Zn, cowdung and mustard oil cake in combination with NPKS produced further 7.8, 29.3, 6.4, and 30.6% higher cane yield over NPKS, respectively (Table 3). Highest cane yield per pot was obtained from the application of NPKS with mustard oil cake (T_6) followed by Zn, Mg, Cowdung, and only NPKS (T_4, T_3, and T_2, respectively). In pot culture, like field experiment no significant yield difference was found among these treatments but they significantly differed from the rests. The yield increase in these treatments were due to production of higher number of tillers, and millable canes.

Results of this experiment indicate ample scope for obtaining higher yield of sugarcane by applying Mg, Zn, cowdung and mustard oil cake in addition to NPKS fertilizers in the experimental sites under the Old Himalayan Piedmont Plain soils.

REFERENCES

Anonymous, 1982. Second Annual Report of Coordinated Soil Test Crop Response Correlation Studies. Soils & Irrigation Division, Bangladesh Agricultural Research Council, Dhaka, 146p.

Anonymous, 1989. Potassium studies in soils and crops of Bangladesh. Annual Report 1988-89. Bangladesh Agricultural Research Institute, Joydebpur. 496 p.

Bedsole, M.R. and Bregger, T. 1953. Some relations of chemical analysis of soil and fresh sugarcane tissue to growth yield. *Proc. ISSCT*, **8** : 24-39.

Chesnin, L. and Yien, C.H. 1950. Turbidimetric determination of available sulphates. *Soil Sci. Soc. Am. Proc.*, **15** : 149-151.

Chowdhury, M.K.A. and Rahman, M.H. 1987. Effect of zinc on sugarcane - A Preliminary study. *Bangladesh J. Sugarcane*, **9** : 112-113.

Dev, G. and Kumar, V. 1982. Secondary Nutrients. ***In*** Review of Soil Research in India Part 1, 12th International Congress of Soil Science, Indian Society of Soil Science, New Delhi, India. pp. 342-360.

Gaur, A.C. 1982. Organic Manures and Biofertilizers. ***In*** Review of Soil Research in India Part 1, 12th International Congress of Soil Science, Indian Society of Soil Science, New Delhi, India. pp. 278-305.

Jackson, M.L. 1967. Soil Chemical Analysis (3rd ed.). Prentice Hall of India Pvt. Ltd., New Delhi, India. 498 p.

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.

Lantin, R.S.; Cayton, M.T.C. and Ponnamperuma, F.N. 1979. A simple test for available zinc and copper in soils used for wetland rice. *IRRI Newsletter*, **4** : 21-22.

Marschner, H. 1986. Mineral nutrition of higher plants. Academic Press Inc., London. pp. 235-242.

Meade, G.P. and Chen, J.C.P. 1977. Cane Sugar Handbook (10 ed.). Wiley - Interscience Publications. John Wiley and Sons, New York. 947 p.

Piper, C.S. 1966. Soil and Plant Analysis. Hans Publishers, Bombay. 367 p.

Prasad, B. and Rokima, J. 1991. Integrated Nutrient Management 1. Nitrogen fractionation and their availability in calcareous soils. *J. Indian Soc. Soil Sci.,* **39** : 693-698.

Rahman, M.H.; Khondaker, M.; Pal, S.K.; Alam, F.; Hossain, A.H.M.D. and Ali, M.Y. 1988. Effect of sulphur on growth, yield, and sucrose content of sugarcane in Ganges river flood plain soils of Bangladesh. *Bangladesh J. Sugarcane,* **10** : 23-28.

Rahman, S.B.M.F.; Rahman, A.B.M.M.; Sarkar, M.A.A. and Saha, S.C. 1986. Calcium and magnesium fertilization of sugarcane. *Bangladesh J. Sugarcane,* **8** : 64-66.

Saha, S.C.; Rahman, S.B.M.F. and Sarkar, M.A.A. 1984. Effect of elemental sulphur on the yield and sugar content of sugarcane. *Bangladesh J. Sugarcane,* **6** : 24-26.

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

Stevenson, F.J. 1967. Phosphorus fixation. ***In*** Soil Biochemistry (A.D. Mac Laren and G.H. Peterson ed.). Marcel Dekkar Inc., New York. 119 p.