Bangladesh J. Sugarcane, 22 : 59-64 *July, 2000*

Effects of Micro-nutrients on Nitrogen and Phosphorus concentration in Sugarcane Leaf

G.H. Jamro[1], L.A. Jamali[1], G.S. Khan, S.A. Sheikh[1] and A.G. Soomro[1]
Sugar Crops Rsearch Institute,
Mardan, NWFP, Pakistan.

Received on 14.7.98

ABSTRACT

Experiments were conducted on silt loam soil at Sugar Crops Research Institute (SCRI), Mardan, during 1989-1991, to assess effects of foliar application of micro-nutrients (Zn, Cu, B, and Mn) on macro-nutrients (N and P) of leaf concentration of sugarcane variety CP-65/357. Data revealed that lower levels of micro-nutrients had significant effects in N and P content of sugarcane leaves, whereas interaction of year and micro-nutrients were insignificant to both macro-nurtrient content of leaves. Similarly foliar application of micro-nutrients indicated insignificant effects for N-concentration during 1989-90 and for P-concentration during 1990-91 in sugarcane leaves. However, micro-nutrients increased N and P content of leaves over control. Further data demonstrated that N and P content in leaves of sugarcane crop were increased by minimum application of Zn and Cu. Similarly B found effective in both macro-nutrient content, while higher rates of Mn resulted into greater N and P content in leaves.

Key words: Foliar application, micro-nutrient, macro-nutrients, nitrogen, phosphorus, sugarcane leaf.

INTRODUCTION

Sugarcane is one of the most important cash crop. It provides income to growers and employment for numerous farm workers through out the year. Micro-nutrients play a vital role in the growth and development of sugarcane plant. Cu, Zn, B and Mn though required in lesser amounts for plant growth but are as essential as nitrogen, phosphorus and potassium because micro-nutrients play an important role in absorption and translocation of macro-nutrients like N, P and K whereas deficiency of micro-nutrients in soil as well as in plants develop symptoms of crop melagnency (Bowen, 1981; Jones, 1972). Increased Mn application can affect concentration of N, P and K in roots, stem tissues and leaf blades as well as chlorophyll content. Gupta and Rao (1980) reported that concentration of N, P and K were affected by increasing Mn application. Micro-nutrients like Fe, Cu, Zn and Mn are essential for production and growth regulating hormones (Kanwar and Randhawa, 1967). Chiu and Chen (1986) reported decrease of P concentration in leaf with increasing rates of B while Gupta (1976) reported that concentration of N, P and K in the above ground parts of sugarcane to be affected by application of Mn.

Keeping these views, present research was undertaken to find out effects of foliar application of micro-nutrients on macro-nutrients concentration in sugarcane leaves.

[1] Sindh Agriculture University, Tando Jam, 70060, Pakistan

MATERIALS AND METHODS

Experiments were carried out on silt loam soils at Sugar Crops Research Institute (SCRI), Mardan, NWFP during 1989-91 cropping seasons to find out effects of foliar application of micro-nutrients on macro-nutrients concentration in leaves of sugarcane variety CP-65/357. The site lies at 340N latitude, 71.50E, longitude and 354 metres above sea level. The layout of the experiment was randomized complete block design with three replications. The treatments were control, 1.5, 3.0 and 4.5 kg Zn ha^{-1}; 0.5, 1.0 and 1.5 kg Cu ha^{-1}, 0.25, 0.50 and 0.75 kg B ha^{-1} and 1.0, 2.0 and 3.0 kg Mn ha^{-1}.

The soil physical and chemical characteristics were determined. Soil texture by using hydrometer method (Kanwar and Chopra, 1950), lime by acid neutralization method, (Kanwar and Chopra, 1959), organic matter by using standard method (Jackson, 1958). Electrical conductivity and pH by US Salinity Laboratory Staffs (1954), while analytical production, soil micro and macro-nutrients by DTPA (Lindsay and Norvell, 1978) B was determined by the method as described by Jackson (1958). The physical and chemical properties of soil have been presented in the table 1.

Table 1. Physical and chemical properties of experimental soil.

Analysis	1989-90	1990-91
Texture	Silt loam	Silt loam
pH	8.20	8.30
OM (%)	0.83	1.00
ECe (ds/)	0.23	0.25
TSS (MEQ/l)	117.00	120.00
Nitrogen (ppm)	.09	0.11
Phosphorus (ppm)	21.00	23.00
Zinc (ppm)	0.40	0.60
Copper (ppm)	0.70	1.00
Boron (ppm)	0.11	0.16
Manganese (ppm)	0.60	0.90

Each treatment consisted of seven sugarcane rows of 10 m long with a row spacing of 90 cm. Plantation was done in autumn with overlapping method using three budded setts. Similar cultural practices were carried out in all treatments, as per recommendation. Micro-nutrients were applied in two splits, first at 50 cm plant height (last of April), second at the height of 75 cm (last week of May).

Twenty fully matured and fresh leaves were collected at random from each treatment separately after foliar application of various micro-nutrients each year. The leaves were washed and cleaned with tap water and then rinsed with distilled water. The leaves were oven dried and grounded for analysis.

A sample of 0.5 gm grounded leaf dust was digested. For digestion, 10 ml of HNO3 was added to each sample and then kept for over night. Next day, 4 ml of HClO4 (70%) was added to these samples and heated on hot plate at low to medium temperature till a clear digest was obtained. The digest was filtered through Whatman-42 filter paper. The final volume of filtrate was made 50 ml with distilled water. The Zn, Cu and Mn were determined by atomic absorption spectrophotometry using Double Beam Perkin

Elmer Model-2380 AAS. Phosphorus was determined by spectrometer. For the determination of Total nitrogen in sugarcane leaves was determined following procedure as outlined in the FAB Bulletin (1980). The statistical anaylsis was done according to the method described by Fisher (1958).

RESULTS AND DISCUSSION

The data shown in table 2, revealed that foliar application of micro-nutrients did not significantly increased nitrogen concentration in the leaves during 1989-90 except application of 0.5 kg, to1.0 kg cu ha^{-1} as well as 1.5 kg Zn ha^{-1}. It was observed that application of 0.50 kg to 1.0 Cu ha^{-1} and 1.5 kg Zn increased nitrogen concentration in the leaves than rests of treatments. An antagonistic interaction was observed between different rates of Zn and Cu with nitrogen. Nitrogen concentration gradually decreased as the rate of Zn and Cu was increased. Nitrogen content in leaves was maximum at the lowest level of copper and then decreased as rate of application of Cu was increased. In case of Mn application, a synergistic interaction was observed. The lowest rate of manganese resulted in the lowest nitrogen concentration of 1.03 per cent and then gradually increased with increase of manganese level. No influence of boron application was recorded on nitrogen concentration in leaves.

Table 2. Effects of foliar application of micro-nutrients on leaf nitrogen concentration of sugarcane variety CP-65/357.

Treatments	Nitrogen concentration in sugarcane leaf (%)		
	1989-90	1990-91	Mean
Control	1.08	0.93	1.01
1.50 kg Zn ha^{-1}	1.23	1.34	1.28
3.00 kg Zn ha^{-1}	1.10	1.22	1.16
4.50 kg Zn ha^{-1}	1.12	1.18	1.15
0.50 kg Cu ha^{-1}	1.30	1.40	1.35
1.00 kg Cu ha^{-1}	1.23	1.30	1.27
1.50 kg Cu ha^{-1}	1.20	1.16	1.18
0.25 kg B ha^{-1}	1.14	1.34	1.24
0.50 kg B ha^{-1}	1.10	1.36	1.23
0.75 kg B ha^{-1}	1.12	1.36	1.24
1.00 kg Mn ha^{-1}	1.03	1.13	1.08
2.00 kg Mn ha^{-1}	1.08	1.16	1.12
3.75 kg Mn ha^{-1}	1.12	1.28	1.20

(1989-90)	S.E. for micro-nutrients (%)	= 0.089 nitrogen
(1990-91)	S.E. for micro-nutrients (%)	= 0.048 nitrogen
	LSD (5%)	= 0.140 nitrogen
	LSD (1%)	= 0.190 nitrogen
Mean	S.E. for year (%)	= 0.025 nitrogen
	S.E. for micro-nutrients (%)	= 0.050 nitrogen
	LSD (5%)	= 0.143 nitrogen
	LSD (1%)	= 0.190 nitrogen
	S.E. for year x micro-nutrient	= 0.071 nitrogen

In 1990-91, foliar application of micro-nutrients significantly increased nitrogen concentration in leaves than control (Table 2). Among micro-nutrients, the highest nitrogen concentration (1.40 %) was found with application of 0.50 kg Cu ha^{-1}. The second highest nitrogen concentration (1.36 %) was recorded when 0.50 kg B ha^{-1} was applied. Zn and Cu showed an antagonistic interaction with nitrogen and nitrogen concentration gradually as level of Zn and Cu was increased in leaves. However, like 1989-90 crop season, a synergistic interaction was observed between Maganese and nitrogn. Nitrogen concentration of leaves gradually increased with increasing rate of manganese. No impact of boron application was observed on nitrogen concentration in sugarcane leaves.

The average of two years data indicated that micro-nutrients had significant effects on nitrogen content of sugarcane leaves (Table 2). The interaction effects of year and micro-nutrients on per cent nitrogen concentration in leaves was not significant indicating that both the years, the response of sugarcane to micro-nutrients for nitrogen concentration in leaves was similar. The maximum average nitrogen concentration of 1.35 per cent was recorded in the treatments receiving the lowest level of 0.50 kg ha^{-1}. This was closely followed by application of 1.50 kg Zn ha^{-1} giving 1.28 per cent nitrogen concentration.

The data also manifested that increase of nitrogen in leaves was inversely proportional to increasing rates of copper and zinc and directly proportional to that of manganese doses. Gupta and Rao (1980) have also reported that concentration of P and K were affected by increased Mn application. Bowen (1975) and Jones (1972) reported that increased Mn application can affect concentration of N, P and K in root, stem tissues and leaf blades as well as chlorophyll content.

Table 3 revealed that phosphorus concentration in sugarcane leaves was significantly increased by foliar application of micro-nutrients at the 5 per cent level of significance except application of 3-4.5 kg Zn and 2 kg Mn ha^{-1} (1989-90). Among micro-nutrients, application of 1.50 kg Zn and 0.5 kg cu ha^{-1} gave the highest phosophorus concentration in leaves. Phosphorus concentration was observed inversely related to increasing rates of Zn. The data also indicated that the lowest levels of Zn and Cu were more effective in increasing level of phosphorus in leaves than higher rates of these elements. Application of different rates of manganese resulted in variable P concentrations in leaves.

During 1990-91, phosphorus concentration in leaves was not significantly affected by foliar application of micro-nutrients (Table 3). The lowest levels of all applied micronutrients increased phosphorus concentration in leaves. An antagonistic interaction was observed between zinc and phosphorus while no consistant effect was observed due to application of copper and manganese in respect to leaf phosophorus concentration.

The combined analysis of two years data (Table 3) showed that foliar application of micro-nutrients significantly increased phosphorus concentration at the 5 per cent probability level over control. Interactions between years and micro-nutrients were insignificant. Phosphorus concentration was positively related to the lowest levels of all applied micro-nutrients as compared with higher rates of same elements. The highest phosphorus concentration of 0.14 per cent in leaves was recorded for the treatment receiving 1.50 kg Zn ha^{-1}. However, leaf phosophorus concentration was inversely proportional to higher rates of Zn and thus exhibited an antagonistic interaction. Chiu and Chen (1986) reported a decrease in leaf P concentration with the increasing rates of B, while Gupta (1976) reported the concentration of N, P and K in the above ground parts of sugarcane to be affected by application of Mn. Jones (1972) also reported that increased Mn application can affect N, P and K concentration of leaf.

Table 3. Effects of foliar application of micro-nutrients on leaf phosphorus concentration of sugarcane variety CP-65/357.

Treatments	Phosphorus concentration in Sugarcane Leaf (%)		
	1989-90	1990-91	Mean
Control	0.08	0.11	0.09
1.50 kg Zn ha^{-1}	0.13	0.14	0.14
3.00 kg Zn ha^{-1}	0.09	0.13	0.11
4.50 kg Zn ha^{-1}	0.08	0.10	0.09
0.50 kg Cu ha^{-1}	0.13	0.14	0.13
1.00 kg Cu ha^{-1}	0.10	0.12	0.11
1.50 kg Cu ha^{-1}	0.11	0.13	0.12
0.25 kg B ha^{-1}	0.11	0.12	0.12
0.50 kg B ha^{-1}	0.11	0.12	0.11
0.75 kg B ha^{-1}	0.11	0.11	0.11
1.00 kg Mn ha^{-1}	0.11	0.13	0.12
2.00 kg Mn ha^{-1}	0.09	0.11	0.10
3.75 kg Mn ha^{-1}	0.12	0.12	0.12

(1989-90) S.E. for micro-nutrients % = 0.012 phosphorus
LSD (5 %) = 0.035 phosphorus
(1990-91) S.E. for micro-nutrients = 0.012 phosphorus
Mean S.E. for year (%) = 0.053 phosphorus
S.E. for micro-nutrients = 0.091 phosphorus
LSD (5%) = 0.032 phosphorus
S.E. for year x micro-nutrients = 0.127 phosphorus

REFERENCES

Anonymous, 1980. Total nitrogen: Soil and plant testing as a basis of fertilizer recommendation. FAO. Bulletin. 100 pp.

Bowen, J.E. 1975. Recognizing and satisfying the micro-nutrient requirement of sugarcane. *Sugar-Y-Azucar-*70, **12**: 15-18.

Bowen, J.E. 1981. Micro element nutrition of suagrcane: effect of micro element on growth and yield. *Trop. Agri.* **58**: 13-21.

Chiu, T.F. and Chen, S.S. 1986. Diagnosis and correlation of boron deficiency in the citrus orchard. *Taiwan Soil and Fert. Abst.,* 49-72.

Fisher, R.A. 1958. Statistical methods for research workers. 13th Ed. Oliver and Boyed, London.

Gupta, A.P. 1976. Critical level assessment and physiological role of trace elements in sugarcane. A Review Part-II. *Indian Sugar,* **28** (9): 615-662.

Gupta, A.P. and Rao, G.S.C. 1980. A study on the effect of Mn on growth, total protein and nucleic acid in sugarcane plant. *Proc. ISSCT.* **17**: 213-216

Jackson, M.L. 1958. Soil chemical analysis. Prentice Hall. Inc. Engle-Wood, Cliff, N.3. pp. 372-374.

Jones B, Jr. 1972. Plant tissue analysis for micro-nutrients. Micro-nutrients in agirculture (Zn, Fe, B, Cu, Mn and Mo). Soil Sci. Soc. Ame. Inc. Madison, Wisconsin , US-336.

Kanwar J.S. and Chopra, 1950. Byouyoncos hydrometer method. Practical Agri. Chem. Method No. 2, **12**: 48.

Kanwar, J.S. and Chopra, 1959. By acid neutralization method Puries method. 2, **13**: 52.

Kanwar, J.S. and Randhawa, N.S. 1967. Micro-nutrients research in soil and plants in India. A review. Indian Council of Agric. Res. New Delhi.

Lindsay, W.L. and Norvell, W.A. 1978. Development of a DTPA soil test for zinc, iron, manganese and copper. *Soil Sci. Soc. Amer. J.*, **42** (3): 421-428.

US. Salinity Lab. Staff. 1954. Diagnosis and improvement of saline and alkaline soil. USDA Hand Book No. 60, Washington, DC.