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Correlation of Growth Traits and Yield of Sugarcane with Micronutrients

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Abstract: Experiments on the correlation coefficient of growth and cane yield traits of sugarcane with micro nutrients like: Zn (1.50, 3.00 and 4.50 kg ha^{-1}), Cu (0.5, 1.0 and 1.5 kg ha^{-1}), B (0.25, 0.50 and 0.75 kg ha^{-1}) and Mn (1.0, 2.0 and 3.0 kg ha^{-1}) and control were conducted. The results revealed that all micro nutrients showed positive correlation with tillers, top weight, cane length, internode number and length, stem diameter, height, millable cane and cane yield, except copper for tillers, zinc for top weight, boron for top weight and manganese responded significant response for stem diameter and millable canes, respectively. It is suggested that micro nutrients are essential elements for obtaining satisfactory yields of sugarcane. Application of excess amount of these elements reduces the yield by reducing the crop parameter values, but, adequate quantities produced boosted yield. Thus, it is recommended that micro nutrients may be applied after various soil tests and proper levels should be chalked-out.

Key Words: Sugarcane, Micro Nutrients, Correlation

Introduction

Sugarcane is one of the most important cash and industrial crop of Pakistan. It contributes about 55% white sugar for world consumption and our country ranks fifth in respect of cane acreage and stands in 15th position in cane yield. Our low yields may be attributed to low input resources, consistency in traditional farming systems, natural climatic hazards and irrigation constraints. Beside all these factors, unawareness of our farming community in respect of sugarcane requirements for various macro and micro nutrients is also a major cause for low yield in Pakistan. Micro nutrients play a vital role in the growth and development of sugarcane plant. Though these elements are required in lesser amounts for plant growth but, are as essential as N, P and K. Furthermore, deficiency of micro nutrients in soil as well as in plants develop symptoms of crop malignancy (Bowen, 1975), and Li (1985) has reported the best response of sugarcane variety CP-65/352 to zinc in terms of growth, yield and sugar recovery but micro nutrients requirement of sugarcane crop varies with variety of soil type and agro-climatic conditions of area. Further, he reported that plant have more demand for Mn, Zn and Cu at different phases of crop growth while ratoon crop have more demand for Fe throughout the crop growth. Furthermore, Ahmed (1977), Nayyar *et al.* (1984), Sen *et al.* (1985), Shinde *et al.* (1986) and Naemat *et al.*(1992) reported that highest volume of stalk diameter was observed with the application of Zn, Cu, Fe, Mg, Mn and also they reported positive correlation. Palanival (1990) and Willcox (1981) reported a negative correlation of stem diameter with the application of Zn, Cu and Fe. Tonapy (1965) reported that some varieties of sugarcane are more responsive than others to micronutrients application in respect of growth and yield. Kumaresan *et al.* (1987) and Li (1985) have also reported negative correlation of Cu, Fe and Zn with length of internodes, but Banger *et al.* (1991) reported an increase in length of internodes with the application of Zn, Fe and B. Singh and Singh (1973) have reported the essentiality of Zn, Cu and Mn for the production of growth regulating hormones for vegetative growth of plant. Keeping in view the above findings and importance of sugarcane crop the correlation studies of growth traits and yield of cane with micro nutrients were undertaken because it gives information about correlated response to directional model for growth and yield of sugarcane.

Materials and Methods

The experiments on the effect of micro nutrients on the growth and yield of sugarcane were carried-out to study the correlation of growth and yield of sugarcane variety CP-65/1357 with the foliar feeding of micro nutrients. The experiment was set in Randomized Complete Block Design with three replications. The treatments were, 1.50, 3.00 and 4.50 kg ha^{-1} Zn, 0.50, 1.00 and 1.50 Cu kg ha^{-1}, 0.25, 0.50 and 0.75 B kg ha^{-1} and 1.00, 2.00 and 3.00 Mn kg ha^{-1}. Soil physico-chemical characteristics as soil texture was determined by using hydrometer method (Practical Agril. Chemistry, Kanwar and Chopra, 1950); neutralization method (Kanwar and Chopra, 1959); organic matter by standardized method of Jackson (1958); electrical conductivity and pH by 1:5 soil water suspension as described in hand book 60 (U.S Saline by Lab Staff 1954), while analaytical procedure for soil micro and macro nutrients by DTPA (Lindsay and Norvell, 1978) and B was determined by method as described by Jackson (1958). The pre-research soil physico-chemical properties of the soil are given in Table 1.

Each treatment consisted of seven rows 10 meters long with a row spacing of 90 cm and sowing was done in autumn with overlapping method using three budded sets. All the agronomic practices like fertilization, irrigation, hoeing, earthing-up, plant protection and other cultural practices were carried out uniformly in all the treatments. Micro nutrients were applied in two splits, first at 50 cm height, second at the height of 75 cm. For ensuring application of the requisite amount of each micro nutrient in each plot, the hand sprayer was thoroughly calibrated and operator speed adjusted in the field prior to application.

Results and Discussion

Number of Tillers: Correlation/ regression analysis revealed that the number of tillers was positively related to the foliar application of zinc, boron and manganese with an r value of 0.63, 0.75 and 0.57 respectively. Number of tillers was negatively related to the higher rates of copper (r=-0.14) which was not significant at the 5% probability level (Table 2). It showed that the number of tillers can be increased with the application of small quantity of Zn, Cu and Mn which will ultimately result in more cane yield.

Cane Top Weight: The relationship of top weight with zinc and boron was found negative with r values of -0.07 and -0.01 respectively while positive association was observed with manganese with r=0.20. None of the correlation were significant at the 5% level of significance indicating no response to foliar application of these elements on the top weight of sugarcane. No relationship of top weight with copper application was also observed (Table 2). Willcox (1981) have also reported a negative correlation of tops weight with Zn and B.

Cane Length: Cane length was directly related to the application of micronutrients. Though the association was not significant at the 5% probability level, cane length increased with the application of zinc, copper, boron and manganese with r values of 0.37, 0.56, 0.85 and 0.14, respectively (Table 2). It showed that for better growth and development of sugarcane, application of these elements at an optimum rate, is essential. Positive correlation of micro nutrients with the cane length has also been reported by Shinde *et al.* (1986) and Bowen (1984). While Willcox (1981) and Nayyar *et al.* (1984) have observed negative relationship of micro nutrients (Cu, Fe and Zn) with the growth and development of sugarcane crop. The reason might be difference in varieties, micro nutrient status of the soil and the agro-climatic conditions under which these experiments were conducted.

Number of Internodes: Correlation studies of the data revealed that the number of internodes was positively associated with the application of micro nutrients, zinc, copper, boron and manganese with r values of 0.55, 0.50, 0.47 and 0.83 respectively which were not significant at the 5% level of significance (Table 2). In general, it was concluded from the results that micro nutrients application is essential for the development of more number of inter-nodes per plant and consequently more cane yield. The work of Li (1985) and Palanival (1990) deviate from the present findings by reporting a negative correlation between internodes number and micro nutrients viz., Cu, Fe, Zn and Mn. This deviation might be due to the difference in varieties tested under different climatic and soil conditions.

Internode Ength: Regarding the relationship of internode length with the applied micro nutrients, the correlation analysis indicated a positive association with all the elements with r values of Zn 0.42, Cu 0.37, B 0.35 and Mn 0.52. All these r values were not significant at the 5% probability level (Table 2). It is suggested that internodes length can be maximized with the application of these micro nutrients. However, Willcox (1981), Li (1985) and Kumaresan *et al.* (1987), have reported negative correlation of Cu, Fe and Zn with the length of internode.

Stem Diameter: Correlation studies revealed that the stem diameter was positively associated with the application of micro nutrients. The r values obtained for Zn 0.01, Cu 0.19 and Mn 0.75, and highly significant value of B by recording r=0.97 (Table 2). These results are in agreement with the findings of Ahmad (1977), Nayyar *et al.* (1984), Sen *et al.* (1985), Shinde *et al.* (1986), Naemat *et al.* (1992) who observed the highest value of stalk diameter with the application of Zn, Cu, Fe, Mg and Mn. They also reported a positive correlation for stalk diameter with the applied micro nutrients. However, the work of Willcox (1981) and Palanival (1990) contradict with the present studies by quoting a negative correlation of stem diameter with the application of Zn, Cu and Fe. As reported by Tonapy (1965), some varieties of cane are more responsive than others to micro nutrients application in respect of yield and quality characters.

Plant Height: Correlation/ regression analysis revealed that plant height was positively associated with the application of micro nutrients. Although the correlation between plant height and applied micro nutrients was not significant ($P<0.05$), there was an increasing trend in plant height with micro nutrients application (Table 2).

Number of Millable Canes: Correlation between the number of millable canes and the application of zinc, copper and boron was positive with r values of 0.12, 0.02 and 0.45 respectively which were not significant at the 5% probability level. A negative relationship was observed between the number of millable canes and manganese application (r=-0.26) which was not significant at the 5% level of significance (Table 2). Reduction in the number of millable canes with the application of Mn has also been reported by Tanopy (1965). He suggested that the higher rates of manganese are not beneficial for obtaining maximum number of millable canes from sugarcane crop.

Cane Yield: Correlation/ regression analysis illustrated that cane yield was positively associated with the application of micro nutrients. The r values obtained were Zn 0.11, Cu 0.34, B 0.80 and Mn 0.96. All these values were not significant except manganese which was significant at the 5% probability level (Table 2). It suggests that cane yield can be increased with the application of manganese if applied in relatively adequate amounts.

Table 1: Physico-chemical Analysis of the Experimental Area

Soil characters	Value
Clay (%)	24.4
Silt (%)	66.0
Sand (%)	9.6
Textured class	Silt loam
pH	8.8
Organic matter (%)	1.1
E.C (mmhos cm-1) ECx103	0.18
TSS (mmhos cm-1)	160.0
Nitrogen (mg kg-1)	0.14
Phosphorus (mg kg-1)	20.0
Zinc (mg kg-1)	0.6
Copper (mg kg-1)	0.7
Boron (mg kg-1)	0.1
Manganese (mg kg-1)	0.5

Table 2: Correlation Coefficient (R) of Growth and Yield Traits of Sugarcane with Micro Nutrients

Micro nutrient	Intercept	Slope	r value
Number of tillers			
Zinc	231.19	14.40	0.63 ns
Copper	290.15	- 6.37	-0.14 ns
Boron	223.42	89.99	0.75 ns
Manganese	227.45	14.61	0.57 ns
Top weight			
Zinc	8.90	-0.012	-0.07 ns
Copper	-	-	-
Boron	8.75	-0.004	-0.01 ns
Manganese	8.65	0.067	0.20 ns
Cane length			
Zinc	211.20	2.92	0.37 ns
Copper	213.99	15.44	0.56 ns
Boron	206.04	32.56	0.85 ns
Manganese	211.70	1.31	0.14 ns
Number of internodes			
Zinc	17.23	0.52	0.55 ns
Copper	17.28	1.39	0.50 ns
Boron	16.97	2.14	0.47 ns
Manganese	16.53	0.89	0.83 ns
Internode length			
Zinc	8.36	0.14	0.42 ns
Copper	8.58	0.50	0.37 ns
Boron	8.40	0.72	0.35 ns
Manganese	8.17	0.17	0.52 ns
Stem diameter			
Zinc	2.28	0.001	0.01 ns
Copper	2.34	0.070	0.19 ns
Boron	2.14	0.276	0.97 **
Manganese	1.48	0.333	0.75 ns
Plant height			
Zinc	223.32	3.10	0.35 ns
Copper	227.65	14.62	0.48 ns
Boron	217.99	35.81	0.84 ns
Manganese	223.49	1.20	0.1 ns
Number of millable canes			
Zinc	117.15	0.32	0.12 ns
Copper	116.98	0.14	0.02 ns
Boron	112.68	1.74	0.45 ns
Manganese	113.37	-0.55	-0.26 ns
Cane yield			
Zinc	80.72	0.88	0.11 ns
Copper	79.56	7.90	0.34 ns
Boron	72.30	25.21	0.80 ns
Manganese	68.94	5.96	0.96 *

ns =Non significant. * and ** =Significant at 5% and 1% probability level respectively

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