Research Article

Response of sugarcane to different doses of Zn at various growth stages

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Abstract

Sugarcane crop has become a more important crop of Pakistan with the emerged crises of sugar in the past few years. The potential crop yield is restricted because of many factors e.g. imbalanced use of macro fertilizers, less application of micronutrients, diseases, insects and pest attacks etc. Micronutrients are usually ignored by most of our farming community. A field trial was performed at Sugar Crops Research Institute Mardan in order to assess the effect of different times of application of Zinc Sulfate (ZnSO_4) as zinc (Zn) on the sugarcane crop. Four treatments (T1: control with no application of Zinc Sulfate, T2: Soil application of ZnSO_4 , T3: Foliar application at tillering stage 1.5 kg ha^{-1} and T4: Foliar application with the 2nd dose of Nitrogenous Fertilizer) were replicated thrice at SCRI in the year 2010-12. Results showed highly significant yields and millable cane for the foliar applications at the later stages of growth. The millable cane significantly increased with foliar application at time of 2nd dose of nitrogenous fertilizer i.e. 8.71 numbers of millable canes m^{-2} . Similarly, highest yield was recorded by foliar application with the 2nd dose of N fertilizer with a value of 69.50 t ha^{-1} . It is therefore concluded that the micronutrient Zn must be applied at later stages of sugarcane growth in order to get more yield and also help getting good ratoon crop.

Key words: Sugarcane ratoon crop; Zn sulphate; Micronutrient effect on growth

Introduction

Plant nutrition is the most important factor for getting better yields. The growth and yield of a plant is determined by the availability of some specific mineral nutrients that are absolutely essential for the completion of their life cycle [1]. All the crops require macro nutrients (large quantity) and micro nutrients (small amount) in order to complete their life cycle and also

for their metabolic and physiological activities. It is the soil nutrient that most commonly limits plant growth [2]. Mostly the growers apply macro nutrients like N, P, and K fertilizers but the micronutrients are usually ignored. The deficiency of these macro and micro nutrients are specific and cannot be fixed by any alternate source. Micronutrients are of immense significance, though the plants require them in small

quantities. They have a significant role in the growth, development and yield of the crops. Moreover their role in crop production is so specific that plants are unable to complete several metabolic activities in absence of these micronutrients. Therefore the deficiency of any particular micronutrient may result in retarded growth and decrease in yield. The micronutrients also maximize the benefits of the macronutrients e.g. NPK fertilizers. For instance Zn is known for its role in the synthesis of “Indole acetic acid” (IAA) and Auxins that are most important growth regulating hormones in plants. The function of Zn as metal activator of several enzymes in plants has been reported [3]. Moreover several important compounds contain Zn as essential and tightly bound components such as dehydrogenases and other protein components etc. These dehydrogenases show sensitivity to Zn deficiency. Yaduvashi *et al.* [4] found the importance of Zn in plant metabolic activities because of its effect on several enzyme systems. Cambria *et al.* [5] reported that cane yield significantly increased with the soil application of zinc sulfate at 10 kg ha⁻¹ with normal and recommended NPK dose. However, unwise application (hyper dose) may result in yield decrease due to the fact that the micronutrients are required in small amounts only. Hence, Cambria *et al.* [5] reported that if the application rate of Zn is raised from 20 to 25 kg zinc sulfate ha⁻¹ it decreased the yield of cane. Nayer *et al.* [6] also reported from his experiments that different parameters like tillers, plant height, and others were significantly affected by the application of Zn and beyond specific levels of application a decline was observed. Pannu *et al.* [7] stated that Zn in combination with normal dose of N and P increased cane and sugar yield. Similarly Patel *et al.* [8] stated that Zn applied to foliage or soil also increased cane yield and

sugar recovery. Zn deficiency is very common in many regions of the country. Factors contributing to Zn deficiency in our soils include cultivation of high yielding varieties, calcareousness and high pH of our soils, no fallow land practice, extensive use of phosphoric fertilizers and low organic matter in our soil coupled with minimal addition of organic amendments to the soil. In order to assess the effect of Zn fertilization of soils and estimate the ultimate output on sugarcane yield and other parameters an experiment was designed and carried out at Sugar Crops Research Institute Mardan during the year 2010-12.

Materials and methods

This experiment was designed to assess the effect of Zn application on yield and quality of sugarcane at Sugar Crops Research Institute, Mardan in the year 2010-12. The dose was applied at different growth stages and various application methods. Sugarcane variety CP-77/400 was sown under the following treatments:

T-1= N-P-K 150-100-100 + No Zn application (control)

T-2= N-P-K 150-100-100 (Kg ha⁻¹) + ZnSO₄ 7H₂O @ 20 kg ha⁻¹ (as soil application)

T-3= N-P-K 150-100-100(Kg ha⁻¹) + Zn (chelated) at tillering stage @ 1.5 kg ha⁻¹ (as foliar application)

T-4= N-P-K 150-100-100 (Kg ha⁻¹) + Zn (chelated) with the second dose of nitrogenous fertilizer at the earthing up stage @ 1.5 kg ha⁻¹ (as foliar application)

The experiment was conducted under the randomized complete block design with each treatment replicated three times. Standard SCRI's plot size of 67 m² was maintained with seven furrows of sugarcane crop in each plot. The crop was given normal agronomic and plant protection practices. The sugarcane variety CP-77/400 was sown in this experiment. Recommended NPK doses i.e. 150-100-100 kg ha⁻¹ were

applied to each plot. Zinc sulfate powder with 33% of Zn was used in treatment 2 (sowing time application). Soil application of zinc sulfate was applied at sowing time in September 2010. The other treatments were applied at tillering stage with the 2nd dose of N fertilizer respectively. For the foliar application Zn was used in chelated form. The composite sample of soil was collected before the experiment for determination of nutrients and other soil properties like soil texture (Bouyoucos Hydrometer method as proposed by Kanwar & Chopra [9], soil pH (using 1:5 soil water suspension), and organic matter using standard method of Jackson [10]. AB-DTPA method by

Soltanpour & Schwab [11] was used for Zn determination. Data of various parameters like germination percentage, number of tillers, plant growth, yield t ha¹, recovery percentage, purity percentage, millable cane were recorded. Dry lead method was used for sugar analysis of the samples. The data were statistically analyzed using the MSTATC Statistical Program [12].

Results and discussion

The soil analysis was presented (Table 1) which showed that soil in the trial plots was silty clay loam in texture, non-saline and alkaline in reaction with a pH 7.5. It was low in organic matter, total nitrogen and Zn content.

Table 1. Physio-chemical properties of soil samples taken from experimental plots

Parameters	Results	Remarks
Soil reaction (pH)	7.5	Alkaline in nature
Textural class	Silty clay loam	Well drained and porous
ECe (meqL ⁻¹)	0.25	Non-saline
AB-DTPA Extractable Zn (mg kg ⁻¹)	0.42	Deficient
Lime %	11.5	Calcareous
Organic matter %	0.46	Low organic matter

Statistical analysis showed the effect of time of application of zinc sulfate and foliar application at different stages. It was interesting to note that the yield of sugarcane crop significantly increased with the application of micronutrient fertilizer in both forms.

The millable cane significantly increased with foliar application at time of 2nd doze of nitrogenous fertilizer giving 83.3 number of millable canes per 9 m² (Table 2). This was followed by the foliar application of Zn at the tillering stage which showed 73.7 number of millable canes per 9 m². Soil application of Zn sulfate as powder at sowing time gave 65 number of millable canes per 9 m². Control plot with no application of Zn showed the lowest no of

50.7 millable canes per 9 m². Results were in line with the findings of Khan [13] who reported increase in number of millable canes at foliar application of Zn @ 1.5 Kg Ha⁻¹. Jamro *et al.* [14] also had similar findings with respect to increase in number of millable canes at the same rate of application of Zn.

Data of sugarcane germination in the same experiment (Table 3) showed no significant effect of the applied micronutrient fertilizer. However lowest 19% was observed in treatment 4, where Zn used as foliar application with the 2nd doze of N fertilizer. While the treatment three showed highest germination rate of 29%.

Table 2. Effect of various methods of applications and timing of micronutrient (Zn) on the yield and quality of sugarcane

Time and methods of Zn (kg ha ⁻¹)	Millable cane per 9 m ² (No)	Recovery (%)	Purity (%)
No Zn (control)	50.7d	11.9	88.2
Soil application	65.0c	11.6	86.5
Foliar application at tillering stage	73.7b	11.4	86.1
Foliar application at the earthing up stage	83.3a	11.6	86.2
LSD_{0.05}	2.8	NS	NS

Table 3. Effect of various methods of applications and timing of micronutrient (Zn) on the yield and quality of sugarcane

Time and methods of Zn (kg ha ⁻¹)	Germination (%)	Number of Tillers per 9 m ²	Plant height (cm)	Yield (t ha ⁻¹)
No Zn (control)	27.90	58.33	193.43	62.18 d
Soil application	28.10	52.50	197.90	65.16 c
Foliar application at tillering stage	29.00	56.33	197.07	66.85 b
Foliar application at the earthing up stage	19.76	41.00	201.53	69.50 a
LSD_{0.05}	NS	NS	NS	6.23

The statistical analysis of recorded observations in terms of plant height also showed non-significant results. However the highest data of 201.53 cm was recorded for treatment 4 while lowest was observed in the control plot i.e. 193.43 cm. The increase in length of sugarcane plants also shows the effect of Zn application which in turn enabled the same for more uptake of N fertilizers as compared to the control plot (Table 3).

Yield data (Table 3) showed highly significant results for the applied treatments. Highest yield data was recorded in treatment 4 with a value of 69.50 t ha⁻¹ followed by treatment 3 and 2 with total yield 66.85 t ha⁻¹ and 65.16 t ha⁻¹ respectively. Lowest data was recorded for the control plot with no

application of micronutrient fertilizer with the yield 62.18 t ha⁻¹. Khan [13] reported increased cane yield at Zn application rate of 1.5 kg ha⁻¹. It can thus be concluded that the Zn application at the later stage has significantly increased the yield of sugarcane crop. Yaduvashi *et al.* [15] concluded his findings with the words that it was not possible to get maximum benefit from NPK fertilizers, without the application of Zn and other micronutrients.

Data regarding sugarcane tillers (Table 3) showed no significant difference in treated plots with Zn application. However lowest number of tillers 41% were observed in experimental plot 4, where Zn applied as foliar application with the 2nd doze of N

fertilizer. While the control plot (1) showed highest number of tillers percentage 58.33%. As far as the data of recovery (Table 2) is concerned, there was no significant effect of applied treatments. The highest value of 11.9 % (percent) was observed in control plot and the lowest observation was recorded in treatment 3 with a value of 11.4 % (percent).

Statistical analysis of the data for the purity percentage also revealed non-significant results. The control plot showed highest value of 88.2% and trial plot three showed the lowest purity 86.1% (Table 2).

It is concluded after the analysis with clear recommendations about the positive use of micronutrients along with macro nutrients. This helps in better absorption of the applied macro fertilizers and also the foliar application facilitated rapid absorption of Zn through leaves and finally effect on the photosynthesis process. However the results also showed that the time of application of the fertilizer also plays an important role in the efficacy of micronutrient. This experiment clearly showed that the best application time of Zn is with the second dose of N fertilizer in foliar form. This significantly increased the yield and mill able cane of sugarcane crop.

Authors' contributions

Conceived and designed the experiments: M Ismail, Performed the experiments: M Ismail & A Ali, Analyzed the data: F Munsif & G Nabi, Contributed reagents/ materials/ analysis tools: T Ahmad & N Haq, Wrote the paper: M Ismail & F Munsif.

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