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Assessing Zinc Status of Sugarcane in Taluka Nawabshah Through Soil and Plant Analysis

Ali Hassan Mari, Riaz Noor Panhwar, Ghulam Moheyuddin Kaloi, Muhammad Chohan,
Ashfaqe Ahmed Yousuf Zai, [1]Muhammad Aslam Brohi and [2]Muhammad Abbas Bhutto
National Sugar Crops Research Institute, PARC, Thatta, Pakistan
[1]Soil and Water Testing Laboratory, Agricultural Research Sindh, Thatta, Pakistan
[2]Grain Quality Testing Laboratory, SARC, PARC Karachi, Pakistan

Abstract: Zinc status was assessed in soil and plants under sugarcane cultivation in taluka Nawabshah during 1997-98. For this purpose fifty sites were sampled at depths of 0 to 15 and 15 to 30 cm, while plant samples recent mature leaves from the third top in sugarcane were collected from the same sites. Soil was analyzed for different physico-chemical properties and available zinc. However, plant samples were tested for zinc content only. The data revealed that most of the soil samples were heavy in texture; only few were light to medium in texture. It was further observed that the soils of the area were calcareous ($CaCO_3$ = 15.43 to 15.40%), non-saline (EC = 0.82 to 0.91 dS m^{-1}), alkaline (pH = 7.80 to 7.78) in reaction and low in organic matter (1.02 to 0.76%). The availability of zinc in soils was low and 98% soils were deficient in this element. The plant analysis, however, showed entire different results. Most of the plant samples (84%) were sufficient and only 16% were deficient in zinc content. The present study thus indicated that sugarcane plant has ability to absorb the required quantity of zinc from the soil within its growing season.

Key words: Sugarcane, zinc, soil, plant, Nawabshah

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the major cash crop of Pakistan. It exerts a great impact on the economic uplift of the growers and provides raw material to the sugar industry for the manufacture of sugar and other by-products. Area under sugarcane cultivation in Pakistan has increased manifolds and now it is being grown on an area of 1.009 million ha with total annual production of 52.049 million tones[1], there is no corresponding improvement in sugarcane yields. It is an annual and exhaustive crop and requires a large amount of nutrients during its different stages of growth. Therefore an adequate supply of plant nutrients is a prerequisite to maximum sugarcane production in addition to several other factors affecting the plant growth.

Plant nutrition comprising of about sixteen elements, which are called essential elements. Like other crops, sugarcane can not make its normal growth in the absence of their ample supply[2]. Plant nutrients are classified as macro and micronutrients. This designation is based on the relative amounts that are found normally in plants. Like macronutrients, the micronutrients are of immense significance, though the plants require them in a smaller quantity and play a vital role in the growth, development and yield of the plants. The deficiency of any nutrient may result in retarded growth and decrease the yield and thus minimizes the other agricultural inputs including NPK fertilizers[3]. Zinc is an important plant nutrient element; the deficiency of this element can impede the plant growth to a great extent[4]. The zinc deficiency is distinguished by conspicuous shortening of internodes and small narrow leaves in sugarcane[5]. Trace elements are important for sugarcane crop. The deficiency or non-availability some essential elements particularly zinc in sugarcane areas has resulted in considerable yield reduction. Nayer *et al.*[6] reported that yield contributing traits like tillers, plant height and others were significantly affected by the application of zinc and beyond certain levels of the application of this element adversely affected the several traits of the sugarcane plant. The continuous use of phosphoric fertilizers and intensive cultivation of high yield crop varieties have resulted in wide spread deficiency of zinc and decrease in the growth of many field crops on almost all soil types, which are generally calcareous in nature[7].

The conclusions are generally based on soil analytical data only. There is a need to include plant tissue samples also in order to give better meaning to such analytical data, this approach was used by Iqbal *et al.*[8] who reported that the content of zinc was highest in the 0 to 15 cm layer and decreased with the

Corresponding Author: Ali Hassan Mari, Scientific Officer, National Sugar Crops Research Institute, PARC, Thatta, Pakistan

increase in depth. The zinc content of different layers ranged between 0.22 to 0.66 mg kg^{-1} of soil. The zinc in leaves varied between 4.59 to 9.4 mg kg^{-1} of dry weight.

Therefore, it may mean that soil test generally over estimates the nutrient content concentration. However, the analysis of associated plant tissue can be considered as quick and reliable technique for assessing the available status of nutrients.

In view of the above consideration an attempt have been made to assess zinc availability status of sugarcane growing area of taluka Nawabshah through soil and associated plant tissue analysis.

MATERIALS AND METHODS

In order to assess zinc status of sugarcane in taluka Nawabshah through soil and plant analysis, one hundred soil samples were collected from fifty different locations of taluka Nawabshah during 1997-98. At each location samples were taken from three places and at two depths i.e. 0 to 15 and 15 to 30 cm at the distance of one meter apart from each other. Soil samples were dried, crushed and passed through 2.00 mm sieve and analyzed for different physico-chemical properties and zinc content. Soil texture was determined by using Bouyoucos Hyderometer method[9], soil pH by digital pH meter and electrical conductivity by electrical conductivity meter (Using 1:2 soil water extract), Lime % by acid neutralization method[10], organic matter by standardized method of Jackson[11], while analysis of zinc in soil was made by AB-DTPA method as proposed by Soltanpour[12]. Plant samples were analyzed for zinc content by wet oxidation with nitric acid and perchloric acid mixture 5:1 ratio as proposed by Isaac and Johnson[13].

RESULTS AND DISCUSSION

The study of the area revealed that most of the soil samples were heavy in texture; only few were light to medium in texture (Table 1). Majority of the soils of area were non-saline in nature. The average electrical conductivity values of the soils ranged between 0.40 to 1.7 dS m^{-1} at 0 to 15 cm. In the lower horizons (15 to 30 cm) it varied from 0.51 to 1.71 dS m^{-1}. On total average basis the electrical conductivity was 0.82 and 0.91 dS m^{-1} at 0 to 15 and 15 to 30 cm, respectively and 0.86 dS m^{-1} on total mean basis for both depths (Table 2). The soils of the area were alkaline in reaction with pH values ranged from 7.39 to 8.05 at surface (0 to 15 cm) and from 7.65 to 7.95 at sub-surface (15 to 30 cm) layers. On total average basis the pH was 7.80 and 7.78 at 0 to 15 and 15 to 30 cm respectively and total mean value for pH was 7.79 (Table 2). The results are in concordant with findings of Siddiqui and Raja[14] who reported that the pH values of Sindh soils mostly varied from 7.2 to 8.2 and rarely goes up to 8.4. It was further observed that the soils of the area were highly calcareous in nature and generally contained lime from 13.25 to 17.00% at upper (0 to 15 cm) and from 13.16 to 17.80% at lower soil depth (15 to 30 cm). On an over all average basis it was 15.43 and 15.40% at 0 to 15 and 15 to 30 cm depths, respectively. The total mean value of lime was 15.41% for both depths (Table 2). The soils of the area were poor in organic matter. The organic matter percent ranged between 0.79 to 1.34% at 0 to 15 cm depth and 0.41 to 0.95 at 15 to 30 cm depth. On total average basis it was 1.02 and 0.76% at 0 to 15 and 15 to 30 cm, respectively. The total mean value of organic matter for both depths was 0.89% (Table 2). The results of the present study was in conformity with those obtained by Siddiqui and Raja[14] who reported that soils of Sindh were poor in organic matte, which varied from 0.3 to 1.39%.

AB-DTPA extractable Zn in soils: Zinc concentration of the soil varied from place to place and it ranged from 0.06 to 1.08 mg kg^{-1} at surface soil (0 to 15 cm) and from 0.04 to 0.14 mg kg^{-1} at sub- surface soil (15 to 30 cm). On total average basis the values were 0.19 mg kg^{-1} and 0.07 mg kg^{-1} at surface soil (0 to 15 cm) and sub surface soil (15 to 30 cm), respectively. The total mean value based on total samples for both depths (0 to 15 and 15 to

Table 1: Categorization of soil samples on the basis of textural class in taluka Nawabshah

	Number of soil samples			Total % of soil samples		
Textural class	0 to 15 cm	15 to 30 cm	Total	0 to 15 cm	15 to 30 cm	Total
Clayey	22	13	35	44	26	35
Clay Loam	15	13	28	30	26	28
Silty Clay	2	4	6	4	8	6
Silty Clay Loam		1	1	-	2	1
Sandy Clay Loam	7	15	22	14	30	22
Sandy Loam	4	3	7	8	6	7
Loam	-	-	-	-	-	-
Silty Loam	-	-	-	-	-	-
Loamy Sand	-	1	1	1	2	1

Table 2: Average values of some physico-chemical properties of the soil sampled from taluka Nawabshah

Name of location	Depth (cm)	EC dS m^{-1} (1:2)	Mean±SD	pH (1:2)	Mean±SD	Lime (%)	Mean±SD	OM (%)	Mean±SD
Deh-15 Nusrat	0-15	0.66	1.12±0.53	7.68	7.69±0.04	13.25	14.07±1.39	0.81	0.61±0.24
	15-30	1.59		7.71		14.90		0.41	
Deh-19 Nusrat	0-15	0.86	0.84±0.38	7.83	7.86±0.11	16.54	15.30±2.030	1.10	0.98±0.22
	15-30	0.83		7.89		14.06		0.86	
Deh-20 Nusrat	0-15	0.64	0.88±0.36	7.84	7.81±0.14	16.20	17.00±1.63	1.23	1.03±0.26
	5-30	1.12		7.79		17.80		0.84	
Deh-22 Nusrat	0-15	0.40	0.45±0.16	7.39	7.54±0.21	15.20	14.18±1.54	1.10	0.98±0.13
	15-30	0.51		7.69		13.16		0.86	
Deh-45 Nusrat	0-15	0.86	1.03±0.71	7.70	7.71±0.24	13.96	14.90±1.87	0.88	0.75±0.20
	15-30	1.20		7.73		15.85		0.63	
Deh-46 Nusrat	0-15	0.75	0.67±0.41	7.81	7.73±0.22	15.72	15.41±2.47	1.08	0.96±0.27
	15-30	0.59		7.65		15.10		0.84	
Deh-47 Nusrat	0-15	1.71	1.71±0.82	7.93	7.84±0.28	17.0	16.45±2.16	1.34	1.14±0.27
	15-30	1.71		7.76		15.9		0.95	
Deh-48 Nusrat	0-15	1.39	1.04±0.65	7.84	7.75±0.13	16.45	15.15±2.63	1.03	0.85±0.26
	15-30	0.69		7.67		13.85		0.67	
Deh-49 Nusrat	0-15	0.54	0.54±0.09	7.92	7.91±0.19	15.53	15.68±0.45	0.79	0.73±0.13
	15-30	0.55		7.91		15.83		0.67	
Deh-88 Nusrat	0-15	0.86	0.97±0.33	7.91	7.93±0.21	16.50	16.85±0.81	0.96	0.87±0.17
	15-30	1.09		7.95		17.20		0.79	
Deh-101 Nusrat	0-15	1.07	0.83±0.75	7.98	7.91±0.20	15.92	15.56±1.62	0.87	0.77±0.22
	15-30	0.60		7.84		15.20		0.67	
Chack- 2/3	0-15	0.56	0.61±0.13	8.05	7.91±0.16	16.50	16.50±0.52	0.80	0.73±0.12
	15-30	0.67		7.77		16.50		0.66	
Chack-5	0-15	0.86	0.81±0.38	7.75	7.74±0.12	14.71	14.31±0.93	1.04	0.92±0.45
	15-30	0.76		7.74		15.53		0.80	
Buchari Circle	0-15	0.72	0.80±0.38	7.83	7.76±0.14	15.60	15.93±0.81	1.11	0.98±0.20
	15-30	0.88		7.70		16.26		0.85	
Dour Circle	0-15	0.72	0.91±0.59	7.49	7.64±0.18	15.10	15.50±0.52	1.14	1.00±0.17
	15-30	1.11		7.80		15.90		0.86	
Jam Sahib Circle	0-15	0.42	0.64±0.39	7.89	7.87±0.13	13.55	13.82±2.47	1.10	0.96±0.22
	15-30	0.86		7.85		14.10		0.83	
Total Average	0.15	0.82	0.86±0.29	7.80	7.79±0.11	15.43	15.41±0.98	1.02	0.89±0.19
	15.30	0.91		7.78		15.40		0.76	
Minimum	0.15	0.40	-	7.39	-	13.25	-	0.79	-
Maximum	0.15	1.71	-	8.05	-	17.00	-	1.34	-
Minimum	15.30	0.51	-	7.65	-	13.16	-	0.41	-
Maximum	15.30	1.71	-	7.95	-	17.80	-	0.95	-

Table 3: Average data of AB-DTPA extractable zinc content in soil and plant of sugarcane at different locations of taluka Nawabshah

	AB-DTPA extractable zinc mg kg^{-1} in soil			Zinc content in plant mg kg^{-1}
	Depth in cm			
Name of locations	0 to 15	15 to 30	Mean±SD	Mean±SD
Deh-15 Nusrat	1.08	0.14	0.61±0.09	35.80±3.67
Deh-19 Nusrat	0.10	0.05	0.07±0.03	32.80±7.27
Deh-20 Nusrat	0.17	0.11	0.14±0.05	34.60±10.13
Deh-22 Nusrat	0.16	0.10	0.13±0.06	38.13±18.10
Deh-45 Nusrat	0.10	0.06	0.08±0.04	45.33±15.27
Deh-46 Nusrat	0.19	0.08	0.13±0.07	37.45±10.28
Deh-47 Nusrat	0.13	0.05	0.09±0.06	24.66±8.20
Deh-48 Nusrat	0.10	0.04	0.07±0.03	27.80±0.56
Deh-49 Nusrat	0.11	0.09	0.10±0.05	19.00±9.16
Deh-88 Nusrat	0.15	0.10	0.12±0.06	24.40±10.91
Deh-101 Nusrat	0.11	0.09	0.10±0.04	37.90±26.34
Chack- 2/3	0.06	0.04	0.05±0.01	27.90±0.40
Chack-5	0.11	0.05	0.08±0.03	31.40±11.70
Buchari Circle	0.09	0.06	0.07±0.03	31.93±11.56
Dour Circle	0.17	0.10	0.13±0.06	49.20±8.46
Jam Sahib Circle	0.20	0.05	0.12±0.09	32.80±0.14
Total average	0.19	0.07	0.14±0.19	33.13±7.60
Minimum	0.06	0.04	-	19.00
Maximum	1.08	0.14	-	49.20

Table 4: Categorization of soils on the basis of AB-DTPA extractable zinc

Category	Range (mg kg^{-1})	No. of samples		% of samples	
		0 to 15 cm	15 to 30 cm	0 to 15 cm	15to30cm
Low	< 0.9	49	50	98	100
Medium	0.9-1.5	0	0	0	0
High	> 1.5	1	0	2	0
Total		50	50	100	100

Source: Soltanpoure[12]

Table 5: Categorization of sugarcane plant samples on the basis of Zn content

Category	Range (mg kg^{-1})	No. of plant samples	% of plant samples
Low	15-19	8.0	16
Sufficient	20-100	42.0	84
High	> 100	0.0	0

Source: Jones *et al.*[17]

30 cm) was 0.14-mg kg^{-1} (Table 3). In order to understand the data better, it is classified into three groups and the data are compared with the critical limits established by Sultanpoure[11]. The categorization of soils in Table 4 further revealed that 98 and 100% soil samples at 0 to 15 and 15 to 30 cm depths, respectively were low in zinc content (<0.9 mg kg^{-1}). However, only 2% soil samples were high (> 1.5 mg kg^{-1}) in zinc content at upper surface. The results of the study were comparable to those of Sillanappa[15], who reported 100% zinc deficiencies in soil of Sindh. Similarly, Memon *et al.*[16] reported that wide spread deficiencies of zinc in Sindh soils but that deficiencies varied from place to place.

However, soils cannot be said deficient only on the basis of soil analysis and it may not be the actual one. Hence plant response should be added for diagnosing the actual deficiency. Therefore, an attempt was made to diagnose zinc deficiency on the basis of soil and plant analysis. Hence, the samples from the same location were also collected.

Plant zinc content: The plant analysis results depicted in Table 3 showed that the zinc content of sugarcane plant ranged from 19.00 to 49.20 mg kg^{-1}. The average values for different Dehs indicated that the values were minimum (19.0 mg kg^{-1}) for deh 49 Nusrat and maximum (49.20 mg kg^{-1}) for Dour circle. However, the overall average was 33.13 mg kg^{-1} in plant. The results were compared with the critical limits reported by Jones *et al.*[16]. Which revealed that only 16% samples of sugarcane were deficient and 84% of sugarcane plant samples were sufficient in Zn (Table 5).

The composition of soil and plant data showed that on soil analysis basis 98% collected samples were deficient in zinc content. Whereas, plant analysis showed that only 16% samples were deficient in zinc content. This indicated that though the soils were deficient in zinc content but sugarcane crop was able to utilize the zinc in combination to other elements. Hence, soil analysis may be supported with plant analysis.

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