ELEMENTAL STATUS ON DIFFERENT SUGARCANE FIELD SOILS WITH AND WITHOUT RED ROT DISEASE INCIDENCE BY ICP-AES STUDY

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Abstract. In this study all the samples like soils, sugarcanes and red rot causing fungi (*C. falcatum* Went) collected from red rot prone and resistant areas sugarcane fields are analyzed in order to estimate the presence of some important macro and micro elements. This analysis reveals the presence of trace elements like Ca, Na, K, Fe, Mg, Zn, Cu, Mn, Cr, B and Co, in varying quantities. A correlation study has been attempted between the elemental status and the disease prone and resistant samples.

Key words: Red rot, sugarcane soil, inductively coupled plasma-atomic emission spectrometry (ICP-AES).

INTRODUCTION

Trace elements play an important vital role in the metabolism of the healthy and diseased plants. The presence of trace elements in sugarcane plants gives a clear picture of the distribution of these elements in the soil where plants absorb essential and necessary trace elements from the soil. It gives an idea about the structure and composition of the soil, sugarcane plant and sugar products [10]. The cane plant takes up its need of trace elements from the surrounding soil. The presence of large concentrations of these elements before planting and subsequent lowering of the concentrations after planting in soil samples at 30 cm depth indicate that the plant at this depth absorbs the trace elements. This may be ascribed to the release of the exchangeable cations and anions from the soil solution at this depth and their adsorption by the plant [3]. It only signifies that plants interact with their local environment, namely air, water, and soil [4]. Several workers studied the soil due to disease incidence in plants but very limited information is available on the role of infected soil initiating red rot infection [2, 6, 9]. Some micronutrients deficiency in soil is one of yield limiting factors [12].

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Hence the present study has been taken up to determine and to study the variation trace elements with respect to the sugarcane growing soils in the redroot disease prone and disease resistant sugarcane fields.

MATERIALS AND METHODS

The soil Samples are collected from red rot disease prone and resistant sugarcane growing areas. The sample areas are Bannari Amman Sugars (P) Ltd., Sathiyamangalam, Erode District, Tamil Nadu, India (red rot disease resistant area) and EID parry (I) Ltd., (red rot disease prone area) Nellikuppam, Cuddalore district, Tamil Nadu, India. Representative composite soil samples are taken from the study areas up to 30 cm depth as per standard procedure of IARI (Indian Agricultural Researcher Institute) New Delhi [20]. The locations of sampling sites are randomized to avoid biasing in results. The collected samples after coning, quartering and sieving are used for analysis. Trace elements like Ca, Na, K, are determined by flame photometer and also Fe, Mn, Cu, Zn, B, Co, Cr are analyzed by using ICP-AES.

SAMPLE PREPARATION FOR ICP-AES

One gram of oven dried powdered soil sample is transferred to a Teflon beaker and 10 mL concentrated nitric acid and 2.5 mL concentrated perchloric acid are added. The sample is then brought very slowly to boiling on a hot plate and heated to dryness. If sample blackening occurred during the fuming stage, nitric acid is added dropwise. The sample is then cooled and redissolved in 10 mL distilled water and 1 mL concentrated hydrochloric acid and brought to volume in a 25 mL volumetric flask. The solution is then analyzed against calibration curves established.

RESULTS

Tables 1.1 and 1.2 show the concentration of calcium, sodium, potassium, magnesium, iron, zinc, copper, manganese, chromium, boron and cobalt present in various soils in two different sugarcane growing areas like red rot prone and red rot resistant areas.

CALCIUM

Calcium deficiency or excess may completely stop the growth and plants may die. The roots are severely affected and discoloration of roots follows the attack by microorganisms [18]. Calcium is found to be varying from 180.0 to 283.0 ppm and

120.0 to 158.0 ppm at red rot disease prone and red rot resistant soils respectively. The concentration of Ca from red rot disease prone areas is greater than that in red rot resistant area soil samples. Similar results have been reported by Kumar *et al*., 1999; Rajakumar and Narayanaswamy, 2004 [7, 11].

SODIUM

Sodium along with calcium that can accumulate under acid condition is very harmful to plant growth. Low quantity of Na is necessary for good quality juice to get higher production. When juice sodium is low, K, Ca, Mg, sulphate, chloride, N, ash, electrical conductivity, colloids and reducing sugars are also low, which is a favorable situation for better sugar production [19]. The amount of sodium (Na) in sugarcane growing soil varies from 26.1 to 48.9 ppm and 10.7 to 16.2 ppm respectively for red rot prone and red rot resistant areas. The concentrations of sodium obtained from red rot prone areas are higher when compared to red rot resistant areas.

POTASSIUM

It is the major inorganic constituent of sugarcane juice amounting to 34.5 per cent and the beneficial effects of K on juice quality have been reported by Singh *et al*. [17]. The potassium (K) content in the sugarcane growing soil shows a variation of 26.2 to 62.7 ppm and 61.2 to 98.2 ppm with respect to red rot prone and red rot resistant areas. The concentration of K in soils in red rot resistant areas is found to be greater than in prone areas.

MAGNESIUM

It acts as cofactor in sugar synthesis when it is available in greater amount in the metabolic environment [11]. It has been observed that the concentration of magnesium (Mg) in soils shows a variation in the red rot prone and red rot resistant areas as 102.0 to 172.8 ppm and 191.0 to 340.7 ppm respectively. The concentration of magnesium in the red rot prone is higher than that in red rot resistant areas.

IRON

Iron is essential for chlorophyll and protein formation, photosynthesis, electron transfer, oxidation and reduction of nitrates and sulphates and other enzyme activities [10]. Iron deficiency causes interveinal Chlorosis in newly emerging young leaves due to reduced chlorophyll synthesis resulting in poor growth as well as loss in yield and sucrose content up to 74% and 42% respectively [16]. The iron (Fe) content of the sugarcane growing soil shows a variation from 530.3 to 1112.0 ppm in red rot prone area and red rot resistant, 439.4 to 684.08 ppm. The concentration of iron is present in higher values in red rot prone area soils whereas it is lower in red rot resistant area soils, a similar trend being found by [5, 7, 11].

ZINC

The present study shows the variation of the concentration of Zinc from 1.359 to 1.753 ppm and from 1.909 to 2.207 ppm for soils in red rot prone and red rot resistant sugarcane planting areas. The content of Zn in red rot prone area soils is in a lower amount compared with red rot resistant areas. Similar results have been reported by many workers [8, 11, 19].

COPPER

Copper is one of essential micronutrients for normal plant growth but it is required in very small amounts [1]. The copper (Cu) observed in the sugarcane growing soils samples of prone areas is lower compared to the red rot resistant areas. In all the sampling points, it ranges from 0.706 to 0.991 ppm and 1.060 to 1.220 ppm for the red rot prone and red rot resistant areas.

MANGANESE

Manganese gets fixed only when Mn ion undergoes high oxidation. High Manganese status for availability combined with high organic matter is observed to improve both field and quality. The taste, color, and smell of juice and molasses may be attributed to the presence of Manganese [7, 13]. The present study indicates the high amount of Mn concentration in soil when compared to red rot prone areas, which is in close agreement with the results obtained by Singh and Singh [18].

CHROMIUM

Chromium is an essential element for increasing glucose tolerance. It also serves as a cofactor and activator for several enzymes involving the synthesis of fatty acids, DNA and RNA, and cholesterol from acetate. In the sugarcane growing soils, the concentration of chromium varies from 2.033 to 2.945 ppm (red rot prone) and 1.223 to 1.950 ppm (red rot resistant). Red rot disease prone soils have more Cr compared with red rot from resistant areas.

BORON

Chromium and Boron are necessary micronutrients for the sugarcane plants as the farmer regulates the metabolic enzymes, takes part in oxidation reduction processes and later participates in sucrose translocation and accumulation [15]. The content of Boron in sugarcane growing soils varies from 1.423 to 2.038 ppm (red rot prone) and 1.126 to 1.557 ppm (red rot resistant).

It is observed from the analyzed data that the concentration of the elements Ca, Na, Fe, and B is increasing while the concentration of Mg, Zn, Mn and Cu decreasing in red rot disease resistant sugarcane planting soils. Similar results are observed in soils by Connolly and Jellison [4].

Table 1.1

Macro elements of different sugarcane growing soils

Macro elements (ppm)										
Variety	Ca		Na		K		Mg		Fe	
	P	R	P	R	P	R	P	R	P	R
Coc671	242.0	158.0	38.0	11.4	62.7	98.2	172.8	340.7	712.0	684.08
Co88025	202.0	120.0	46.8	15.4	45.9	61.2	137.0	264.2	530.30	469.60
C07805	283.0	153.0	48.9	16.2	38.3	72.9	119.0	227.6	700.15	505.55
Mc707	180.0	136.0	26.10	12.70	26.20	75.30	102.0	191.0	600.70	480.80
Cov94101	222.0	144.0	26.7	10.7	35.5	66.3	121.0	211.2	736.68	439.40

Each value is the mean of four individual observations.

Table 1.2

Micro elements of different sugarcane growing soils

Micro elements (ppm)												
Variety	Zn		Cu		Mn		Cr		B		Co	
	P	R	P	R	P	P	R	R	P	R	P	R
Coc671	1.75	2.20	0.99	1.07	9.14	2.03	1.55	1.22	2.03	1.55	0.64	0.24
Co88025	1.62	2.05	0.95	1.19	7.76	1.54	1.23	1.22	1.54	1.23	0.36	0.22
C07805	1.49	1.96	0.98	1.72	7.21	1.48	1.18	1.34	1.48	1.18	0.41	0.23
Mc707	1.35	1.90	0.70	1.06	6.66	1.42	1.26	1.46	1.42	1.26	0.46	0.27
Cov94101	1.70	2.14	0.81	1.22	8.10	1.62	1.39	1.95	1.62	1.39	0.38	0.21

Each value is the mean of four individual observations.

CONCLUSION

The quantitative analysis shows the presence of Ca, Na, K, Mg, Fe, Zn, Mn, Cu, Cr, Co and B in varying amounts in sugarcane growing soils. Quantitative estimation of the above elements has been carried out by flame photometer and inductively coupled plasma atomic emission spectrometric techniques, respectively. In the quantitative estimation, it is found that the concentrations of Ca, Na, Fe and B are low while the concentrations of Mg, Zn, Mn and Cu are high in red rot disease resistant sugarcane growing soils. Sugar synthesis needs a low concentration of Ca and a high concentration of Mg. But red rot prone soils contain increased concentrations of Ca, Na, Fe and B and lower concentrations of Mg, Zn, Mn and Cu. This type of variation favors rapid reduction in sucrose content and increase in amino acid. Hence, by lowering the concentration of Ca, Na, Fe and B and increasing the concentration of Mg, Zn, Mn and Cu in soils, we may try to decrease the disease incidence in sugarcane as evidenced by this elemental analysis.

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