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Research Paper

Determination of micronutrients (Mn, Fe, Cu, Zn) in tea plantations in Sivasagar district of Assam, India.

Environment

KEYWORDS : Micronutrients, beverages, organic matter and deficiency.

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ABSTRACT

Tea is the most popular beverage in the world and contains several essential micronutrients, which are beneficial for human health.This investigation was carried out to determine the micronutrient concentration of tea plantations in Sivasagar district. A total of 60 soil samples were taken from 0 to 30 cm depth of different area and 60 leaf samples were collected from the same plots as the soil samples.The concentration of micronutrients were determined by atomic absorption spectroscopy (AAS). In this study Mn, Fe, Cu and Zn concentration of soil varied within the range of 96.25 to 380.84; 378.67 to 603.22; 10.54 to 20.78 and 24.57 to 52.94 and concentration of leaf samples were ranged as 184.32 to 498.65; 492.68 to 788.38; 11.12 to 22.68 and 29.74 to 54.40 mg/kg respectively. The micronutrients concentration in the soil and tea leaves samples can be arranged in the following order Fe> Mn> Zn> Cu. It was found that the micronutrients concentration of the tea leaves was higher than soil.There was no micronutrients deficiency in the study area.

Introduction

Tea is one of the most popular beverages after water in the world. Tea is a healthy and cheap drink. Use of tea as folk medicine for headache, digestion, immune defense, energizer and longevity of life is well known. Thus the associated chemical components in tea received a notable concern as it is related to human health. The quality of tea leaf used in the process is highly important and the contents of the nutrient in tea soil and tea plant affect the leaf quality (Kacar, 1984). The concentration of nutrients element of tea leaf are related with the soil environment (Ozyazici et al., 2011). The availability of nutrient elements in the plant at a certain level is vital for growth. The concentration of elements is closely related with growth of plant, nutrition and useful mineral matter of earth. The uptake of micronutrients by plants from soil depends on their concentration in soil, soil pH, organic matter, clay content, cation exchange capacity, and their specific geochemical properties. Therefore, the contents of nutrition element of tea plant are related with soil environments. Fresh tea leaf has a mineral content which may vary depending on the soil structure on which it is grown, maintenance and fertilizing. The objective of this study was to determine micro nutritional concentration of tea grown Sivasagar district by analyzing soil and leaf.

Material and methods

Field description: Sivasagar district is historically one of the most important districts of Assam. It is located between $25^0$45/ to $27^0$15/ N latitudes and $94^0$25/ to $95^0$25/ E longitudes. The geographical area covered by Sivasagar district is 2668 sq km.

Climate: Sivasagar district carries a pleasant weather throughout the year. The temperature ranges from 8^0C to 18^0C in winter and 15^0C to 35^0C during summer. The district is characterized by highly humid atmosphere and abundant rains. The average annual rainfall is about 230 cm.

Physico-chemical properties of soil: In the plains of Sivasagar, the soil is alluvial. The soil adjacent to the river banks is sandy and away from the bank is muddy. The main crops grown in this district are tea and rice.

Procedure used: This research was conducted in the selective ten tea estates in Sivasagar district (Figure 1) of Assam. Sixty Soil samples and sixty leaf samples were collected from the tea estates in the month of December every year during the period of 2007 to 2009, because no fertilization or compost was applied during this month in the tea estates. Leaf samples (two apical leaves and the bud) were collected from the same plots as the soil samples. Composite soil samples and control soil were taken from 0 to 30 cm depth and prepared for necessary analysis in laboratory (Jackson ,1974). Location of sampling sites was determined using Global Positioning System (GPS) shown in figure 2. Soil pH was determined by using procedure (Thomas, 1996). Organic matter was determined by the procedure (Walkley and Black ,1974). Micronutrients (Mn, Fe, Cu and Zn) were determined on each sample by using the procedure (Pinta ,1974). Leaf samples were taken in the month of December every year from the same locations brought to laboratory, washed with distilled water, dried at 65^0C temperature and ground. Micronutrients were then estimated by AAS after proper digestion and analytical procedure (Pinta ,1974).

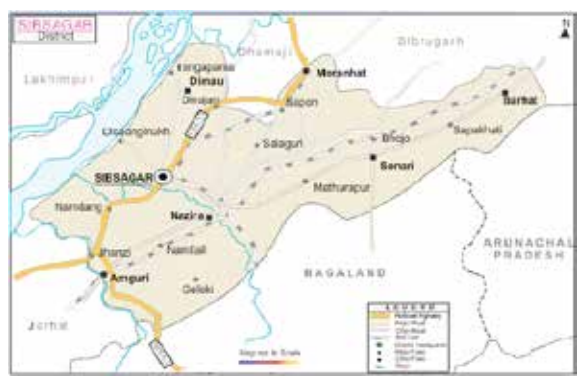

Figure1 : Map of Sivasagar district

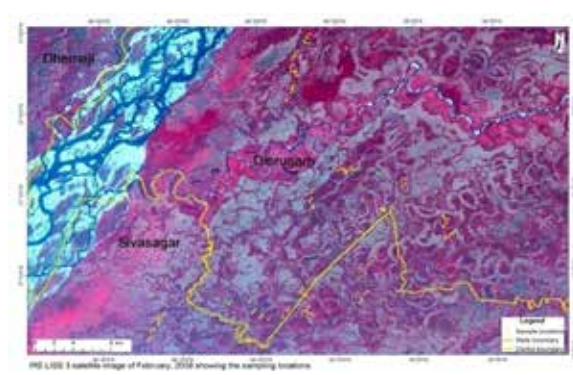

Figure 2: Satellite map of the study area showing the soil sampling sites

RESULTS AND DISCUSSION

Micronutrient content of soil samples: The values of the pH, organic matter and micronutrient concentration of soil samples were given in table 1 and 2. The pH values of soil samples ranged from 4.42 to 5.54. The soil samples were moderately acidic and adequate for tea soil. Organic matter of soil samples ranged from 1.64 to 3.08%. The organic carbon of the soil samples were higher in tea estate soil, this may be due to addition of fertilizers, animal wastes, tea leaves and branches into the soil. The concentration of Mn in soils ranged from 96.25 to 380.84

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mg/kg; Fe contents of soil samples were 378.67 to 603.22 mg/kg; Cu contents were 10.54 to 20.78 mg/kg and Zn contents were 24.57 to 52.94 mg/kg respectively.

Table 1: PH and total organic matter content (%) of the soil samples

Properties	Minimum	Maximum	Average	Standard deviation
P^H	4.42	5.54	5.26	0.28
Total organic matter (%)	1.64	3.08	2.88	0.48

Table 2: Micronutrient element contents of the soil samples (mg/kg)

Micronutrients	Minimum	Maximum	Average	Standard deviation	Control
Mn	96.25	380.64	320.28	86.54	84.25
Fe	378.67	603.22	275.86	76.98	308.32
Cu	10.54	20.78	18.62	7.46	8.36
Zn	24.57	52.94	49.34	15.76	18.72

The concentration of micronutrient metals Mn,Fe,Cu and Zn increases with increase in organic matter content in the soil. The soil samples showing high levels of micronutrient metal concentration had high organic matter content. Increase in pH in the soil results in increase micronutrient metal concentration in the soil. The micronutrient metal uptake by plants decreases as the pH value increases. The pH value of the tea estate soil was found to be acidic. This indicates that the uptake by plants was high and the biological system was contaminated by the micronutrient metals. Soil pH and high total organic matter content have a higher retention capacity of micronutrient metal in soil. The maximum permissible limits of micronutrients in soils are 2 to 250 mg/kg for copper and 10 to 300 mg/kg for zinc respectively (Kabata-Pendias ,1984; Fergusson ,1990; Alloway, 1990) .It was found that the accumulation of micronutrient metals in soil has had an adverse effect on the growth and development of wide variety of plant species. Although low quantity of some micronutrient metals such as copper and zinc are necessary for the proper functioning of most plant system, higher concentrations of copper and zinc have been found to be responsible for metabolic disturbance and growth inhibition of some plants. Trace metal play an essential biological role in plant and human metabolism. Copper and Zinc are considered as good source of protein (Nwajei et al., 2012). Micronutrient metals are naturally present in soils as natural components. The presence of micronutrient metals in the environment has accelerated due to human activities. It was found that the concentration of micronutrient metals of the tea estate soil increases during the study period but still below its maximum limits. Table 3 shows that the correlation results between pH and organic matter with micronutrient elements in tea soil found that pH of the soil correlated positively and significantly with micronutrients. Also, there was positive correlation between organic matter contents and micronutrient elements.

Table 3: Correlation between micronutrients and soil properties of the soil samples

Soil Properties	Mn correlation coefficient value(r)	Fe correlation coefficient value(r)	Cu correlation coefficient value(r)	Zn correlation coefficient value(r)
Soil pH	0.82	0.86	0.80	0.74
TOM	0.84	0.88	0.78	0.82

Micronutrient contents of tea leaf samples: Micronutrient contents of tea leaf samples are given in table 4. Total Mn contents of leaf samples were 184.32 to 498.65 mg/kg. According to these results, 100% of leaf samples were sufficient and there was not found in deficiency (Bergmann, 1992). It was reported that Mn content of more than 4000 mg/kg in a tea plant would be able to adversely affected while Mn content in the tea leaves in between 12 to 45 mg/kg were suffered in Mn deficiency (Tolhurst, 1963).

Iron contents of leaf samples ranged from 492.68 to 788.38 mg/kg. Ninety seven percent was sufficient and three percent was deficient (Jone et al., 1991). The Fe contents of tea leaves in the different tea estates in the different region in the world varied from small amount to a large amount depending on the soil structures. In this study it was found that the iron concentration of tea leaves was higher during the study period which is adequate for the tea leaves.

Copper contents of tea leaf samples were determined between 11.12 to 22.68 mg/kg. Eighty six percent was deficient and fourteen percent was excess of these values (Bergmann, 1992). It was reported that the Cu contents in tea leaves collected different offshoot periods were ranged 13 to 23.60 mg/kg (Horuz and Korkmaz, 2006). In this research the Cu contents of tea leaves have attained little higher concentration value.

Zinc contents of tea leaf samples were 29.74 to 54.40 mg/kg. 93% was sufficient, 5% was excess and 2% was deficient of these values (Jone et al., 1991 and Bergmann,1992). The Zn content in tea leaves show similarity with the findings (Arslan and Togrul, 1996; Ozdemir, 1999).

Table 4: Micronutrient element contents of the tea leaf samples (mg/kg)

Micronutrients	Minimum	Maximum	Average	Standard deviation
Mn	184.32	498.65	386.44	74.96
Fe	492.68	788.38	626.72	89.85
Cu	11.12	22.68	14.84	4.54
Zn	29.74	54.40	47.48	12.18

Table 5: Allowable limit value of Mn , Fe, Cu and Zn contents of tea leave according to Jone et al. (1991) and Bergmann (1992)

Micronutrients	Limit value(mg/kg)	Description	Ratio
Fe(Jone et al., 1991)	<500	Deficiency	03
	500-1000	Sufficient	97
	>1000	Excessive	nil
Zn(Jone et al., 1991)	<30	Deficiency	02
	30-50	Sufficient	93
	>50	Excessive	05
Cu(Bergmann, 1992)	<7	Deficiency	nil
	7--15	Sufficient	86
	>15	Excessive	14
Mn(Bergmann, 1992)	100-5000	Sufficient	100
Zn (Bergmann, 1992)	30-80	Sufficient	93

The micronutrients concentration in the tea leaves can be arranged in the following order, with regards to their total contents: Fe> Mn> Zn> Cu. The results obtained in this study agree with the finding (Adiloglu and Adiloglu , 2006 ; Kacar et al., 1979 ; Street et al., 2006) . It was found that the contents of micronutrient in tea leaves were sufficient and trends to high level. The ability of tea plants to accumulate metals, particularly Mn and Fe, and to a lesser extent of zinc and copper (Saud and Oud, 2003). The total metal components in tea plants depend on many factors, primarily the age of the tea leaves, but also the soil conditions, rainfall, altitude, genetic makeup of the plant. In

this research it was observed that the tea leaf samples result are similar with soil analysis results.The micronutrients concentration of tea leaves are higher than the soil samples. The plant is grown in acid soil, therefore, Mn, Fe, Cu and Zn deficient is not seen in tea plant.

Conclusion

There was wide variation in the micronutrient content of tea soil and leaf samples collected from different locations of the tea estates. The soil and leaf samples analysis results of the investigation, Mn, Fe, Cu and Zn contents were sufficient and increasing trends. To minimize the micronutrient deficiency in the tea plant, the fertilizer program should carefully be chosen to enhance the tea quality and production. Maintenances of proper liming to increase the pH also keep the micronutrient concentration from the tea plant uptake.

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