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ENUMERATION OF FOLIAR FERTILIZER EFFICIENCY IN INDIA'S TOP COMMERCIAL CROP-TEA

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ABSTRACT: The present study was carriedout to compare the foliar fertilizer efficiency in determining the micronutrients and macronutrient status of tea (*Camellia sinensis)* plantations. Leaf samples were collected from the Woodland Estate in Ooty. The results; showed that Fe, Cu, Zn and Mn contents of NO BCX sample were 44.5, 21.02, 117.8, 0 ppm respectively. Fe, Cu, Zn and Mn contents of BCX sprayed sample were determined as 52.38, 21.06, 122.3, 0 ppm respectively. Ca, Mg, Na, K, B, S contents of NO BCX sample were 2.0 ml,7.0 ml, 0, 18, 5838, 371.16 respectively. Ca, Mg, Na, K, B, S contents of BCX sample were 3.5 ml, 8.6 ml, 0, 17, 6528, 371.29 respectively. Consequently, the results indicated that tea plantations with foliar fertilizers were more efficient in absorbing the nutrients than the tea plantations wherein only normal fertilizers were used.

KEY WORDS: Dry ash, foliar fertilizer, Macronutrients, Micronutrients, *Camellia sinensis*

I.INTRODUCTION

Plant nutrition is the study of the chemical elements and compounds that are necessary for plant growth, and also of their external supply and internal metabolism. In 1972, E. Epstein defined two criteria for an element to be essential for plant growth, the plant is unable to complete a normal life cycle in its absence or that the element is part of some essential plant constituent or metabolite. This is in accordance with Liebig's law of the minimum. There are 17 essential plant nutrients. Carbon and oxygen are absorbed from the air, while other nutrients including water are obtained from the soil. Plants must obtain the following mineral nutrients from the growing media.

- The primary macronutrients: nitrogen (N), phosphorus (P), potassium (K)
- The secondary macronutrients: calcium (Ca), sulphur (S), magnesium (Mg)
- The micronutrients: boron (B), chlorine (Cl), manganese (Mn), iron (Fe), zinc (Zn), copper (Cu) and sodium (Na)

Macronutrients are consumed in larger quantities and are present in plant tissue in quantities ranging from 0.2% to 4.0% (on a dry matter weight basis). Micronutrients are present in plant tissue in quantities measured in parts per million, ranging from 5 to 200 ppm, or less than 0.02% dry weight. Sixteen chemical elements are known to be important to a plant's growth and survival. The sixteen chemical elements are divided into two main groups: non-mineral and mineral (Allen, Barker and Pilbeam, 2007).

The Non-Mineral nutrients are hydrogen (H), oxygen (O), & carbon (C). These nutrients are found in air and water. Plants use energy from the sun to change carbon dioxide and water into starches and sugars in photosynthesis. These starches and sugars are the plant's food. Photosynthesis means "making things with light". Since plants get carbon, hydrogen, and oxygen from air and water, there is little that farmers and gardeners can do to control how much of these nutrients a plant can use. The 13 mineral nutrients which come from the soil are dissolved in water and absorbed through a plant's roots. There is not always enough of these nutrients in the soil for a plant to grow healthy. This is why many farmers and gardeners use fertilizers to add these nutrients to the soil. The mineral nutrients are divided into two groups: macronutrients and micronutrients (Epstein, *et .al.*, 1972).

Macronutrients

Sulphur is a structural component of some amino acids and vitamins, and is essential in the manufacturing of chloroplasts. Sulphur is also found in the Iron Sulphur complexes of the electron transport chains in photosynthesis. Calcium regulates transport of other nutrients into the plant and is also involved in the activation of certain plant enzymes. Magnesium is an important part of chlorophyll, a critical plant pigment important in photosynthesis. It is important in the production of ATP through its role as an enzyme cofactor.

Micronutrients

Some elements are directly involved in plant metabolism. However, this principle does not account for the so-called beneficial elements, whose presence, while not required, has clear positive effects on plant growth. Mineral elements that either stimulate growth but is not essential, or that are essential only for certain plant species, or under given conditions, are usually defined as beneficial elements (Lowenfels, *et .a.l*., 2011).

Street *et .al.,* (2006) in Czech Republic studied that the total of 30 tea samples of different origins, 13 green tea samples,13 black tea samples, two semi-fermented tea samples and one white tea, imported to the Czech Republic, were collected and analysed for the total content of copper, iron, manganese, and zinc in tea leaves and tea infusions. The total contents of metals in tea leaves differ according to the type of tea (green or black) and are probably influenced by many other factors, e.g. soil properties. The total contents of Mn were much higher compared to the total contents of Cu, Fe, and Zn, and varied between 511–2220 mg/kg. To compare easily, hot water soluble concentrations of Cu, Fe, Mn and Zn, 5 min, 60 min, and 24 h infusions were prepared. The extractability of the elements was in the order Cu > Zn > Mn > Fe. The proportions of the element contents in the infusion related to the respective total contents in leaves were 30 ± 16% Cu, 26 ± 10% Zn, 18 ± 10% Mn, and 1.5 ± 0.8% Fe, respectively. The results confirmed that tea infusion can be an important dietary source of Mn.

Mehmet, *et .al*..(2011) determined micronutritients status of tea (*Camellia sinensis L.*) plantations in the Eastern Black Sea Region of Turkey. Soil and leaf samples were taken from the 220 tea gardens belonging to 36 tea processing plants during the 2nd shoot period (between July 15th and 30th July in 2003) by taking into consideration the tea planted areas and production potentials of these tea gardens. According to their results, Fe, Cu, Zn and Mn contents of soils varied within the range of 2.1 to 168.9, 0.02 to 14.69, 0.01 to 8.45 and 0.4 to 101.4 mg kg-1, respectively. Fe, Cu, Zn and Mn contents of leaf samples were determined as 86 to 959, 4.5 to 73.9, 5.6 to 46.3 and 141 to 2767 mg kg-1, respectively. Consequently, it is possible to state that the tea plantations of Rize and Artvin Regions have some places involved with insufficient microelement concentration. On the other hand, it was detected that there was no deficiency in the study area, when the mean values for both soil and leaf samples were taken into consideration.

Nath (2013) determined the concentrations of micronutrients of tea plantations in Assam. Soil and leaf samples were collected from the ten tea estates in the month of December every year during the period of 2007 to 2009. Soil samples were taken from 0 to 30 cm depth. Leaf samples (two apical leaves and the bud) were collected from the same plots as the soil samples. According to their results, Mn, Fe, Cu and Zn concentration of soil varied within the range of 118.53 to 420.57; 89.34 to 307.72; 12.73 to 26.32 and 21.43 to 45.28 mg/kg respectively. Mn, Fe,Cu and Zn concentration of leaf samples were ranged as 224.36 to 568.64; 212.85 to 546.42; 14.34 to 29.78 and 24.82 to 58.26 mg/kg respectively. From the study it was found that the micronutrients concentration of the tea leaves was higher than the concentration of the tea soil. It was also detected that there was no micronutrients deficiency in the study area, when mean values for both soil and leaves samples were taken into consideration.

II.MECHANISM FOR FOLIAR UPTAKE OF NUTRIENTS

Mechanism generating the uptake of foliar applied nutrients involves the entry of the applied nutrients into the leaf tissue & translocation to other parts of the plants. Foliar absorption, like root absorption, involves both active and passive mechanisms (Fageria, *et .al.*, 2009) entry of nutrients through aqueous pores that are found on the cuticle of the leaves, then the cell walls of the epidermal cells and finally through the plasma membrane by active transport (Cheristensen, 2005).

The leaf's ability to absorb nutrients from the surface depends upon the degree of permeability of the leaf epidermis (outer layer) and the presence and density of stomata (Newett, 2005). This is controlled by a number of factors

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including the structure of the leaf surface, number, permeability and arrangement of ectodesmata, degree of surface wetting, concentration of micronutrients in the aqueous blend and humidity.

Uses of foliar feed

Seaweed contains natural growth stimulants and research has shown that it makes plants less susceptible to pests and diseases, including the dreaded potato and tomato blight. The reasons for this aren't completely understood, but it seems likely that it, not only makes the plant stronger, but the micro-organisms in the solution compete with the spores and bacteria that cause disease (Durtsberger,T., *et .al.*,2008).

Keeping this in view, the current study aims at

- To study the chlorophyll content in the tea leaves.
- To determine the macro and micronutrient level in tea samples.
- To enumerate the efficiency of foliar fertilizer in tea leaves.
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III.MATERIALS AND METHODS

Chlorophyll test

1 g of leaves were taken and grounded with 95% of ethanol for 2-5 mins. 5 ml of 80% of acetone was added in dark conditions for 15-30 mins. Then the solution was transferred to the test tube under dark conditions and the above procedure was repeated six times. The absorbance was measured at 645nm and 663nm.

Dry ashing method

Some of the leaves (2 – 3 g) were taken and cut into pieces. The leaves were kept inside the furnace for 2-3 hrs. The furnace was left undisturbed for 30mins to 1 hr. After 1hr, the ash of the leaves was collected.

IV.RESULTS

Chlorophyll test for NO BCX

a) C_a (mg/g) $= (12.7 * A_{663} - 2.69\ A_{645})\ V/1000 * W = 0.0497$ (mg/g)

b) C_b (mg/g) $= (22.9 * A_{645} - 4.86 * A_{663})\ V/1000 * W = 0.0266$ (mg/g)

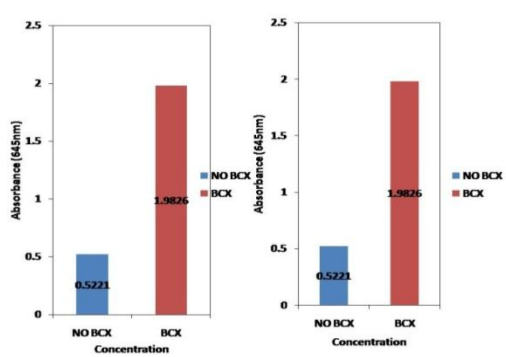
c) $C_{(a+b)}$ (mg/g) $= (8.02 * A_{663} + 20.20 * A_{645})\ V/1000 * W = 0.0771$(mg/g)

Chlorophyll test for BCX

a) C_a(mg/g) $= (12.7 * A_{663} - 2.69\ A_{645})\ V/1000 * W = 0.1375$(mg/g)

b) C_b(mg/g) $= (22.9 * A_{645} - 4.86 * A_{663})\ V/1000 * W = 0.1208$(mg/g)

c) $C_{(a+b)}$ (mg/g) $= (8.02 * A_{663} + 20.20 * A_{645})\ V/1000 * W = 0.2605$(mg/g)



NUTRIENT CONTENTS IN SAMPLES

Micro &macro nutrients	NO BCX	BCX
Nitrogen	6.650ppm	10.461ppm

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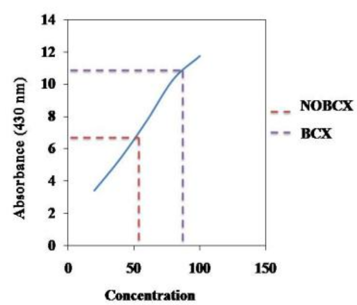
Phosphorus	2.977ppm	3.0373ppm
Potassium	17 ppm	18 ppm
Sodium	0	0
Calcium	0.8 %	2.3 %
Magnesium	0.48 %	0.54 %
Boron	5838 ppm	6528 ppm
Sulphur	371.16 ppm	371.29 ppm
Zinc	117.8ppm	122.3ppm
Manganese	0	0
Copper	21.02ppm	21.06ppm
Ferrous	44.54ppm	52.38ppm

Calculation for nitrogen

NO BCX – 6.65 ppm & BCX – 10.461ppm

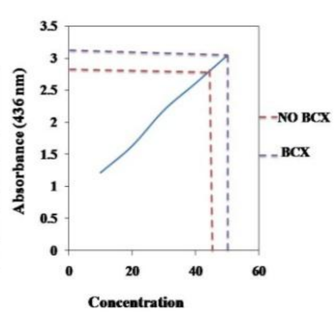
Standard (ppm)	OD (430nm)
20	3.395
40	5.412
60	7.763
80	10.317
100	11.752



Calculation for phosphorus

PHOSPHORUS

Standard (ppm)	OD (436nm)
10	1.213
20	1.632
30	2.189
40	2.612
50	3.046



NO BCX – 2.977 ppm & BCX – 3.037

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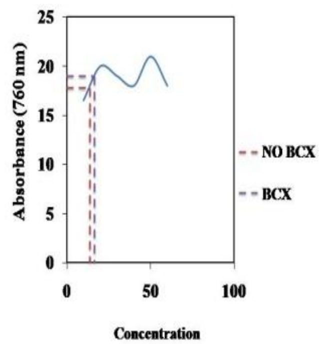
Calculation for potassium

POTASSIUM

Standard (ppm)	OD(760 nm)
10	16.5
20	20
40	19
60	18
80	21
100	18

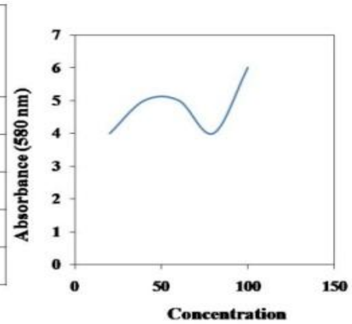


NO BCX – 17 ppm & BCX – 18 ppm

Calculation for sodium

SODIUM

Standard (ppm)	OD (580 nm)
20	04
40	05
60	05
80	04
100	06



NO BCX & BCX – 0

Calcium & magnesium for NO BCX

Calcium NO BCX

Ca(meq/l) = (V-B*N*R*1000) / Wt

= (2-1.2*0.01*0.5*1000)/1= 4 (meq /l)

Ca(mg/l) = (4*40)/2

= 80 (mg/l)= 80 ppm

Ca = 0.8%

Magnesium for NO BCX

Mg (meq/l) = (V-B*N*R*1000) / Wt

= (7-5.4*0.01*0.5*1000)/1 = 8(meq/l)

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Mg (mg/l) = ((8-4)*24.3)/2 = 48.6(mg/l) = 48.6 ppm

Mg = 0.486%

For Calcium

Ca (meq/l) =((V-B)×N×R×1000)/ Wt

Blank = 1.2 ml

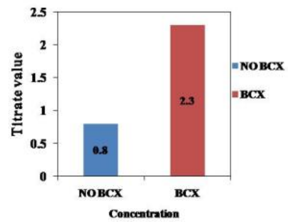
N = 0.01N

R = 0.5

Wt = 1ml

NO BCX = 2.0 ml

BCX = 3.5 ml



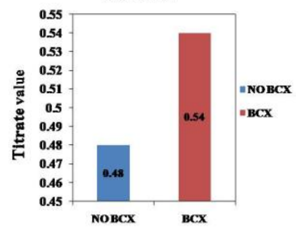
For Magnesium

Mg(meq / l)=((V-B)×N×R×1000) / Wt)

Blank = 5.4 ml

NO BCX = 7.0 ml

BCX = 8.6 ml



Calcium for BCX

Ca(meq/l) = (V-B*N*R*1000) / Wt
= (3.5-1.2*0.01*0.5*1000)/1
= 11.5 (meq/l) = (11.5*40)/2
= 230(mg/l)= 230 ppm

Ca = 2.3%

Magnesium for BCX

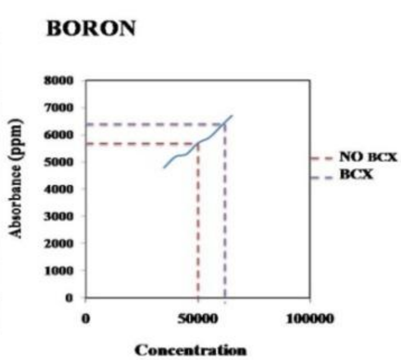
Mg(meq/l) = (V-B*N*R*1000) / Wt
=(8.6-5.4*0.01*0.5*1000)/1
= 16 (meq/l)

Mg(mg/l) = (16-11.5*24.3)/2
= 54.78(mg/l) = 54.78ppm

Mg =0.547%

Calculation for boron

Standard (ppm)	OD (420nm)
35000	4800
40000	5200
45000	5300
50000	5700
55000	5900
60000	6300
65000	6700



NO BCX – 5838 ppm & BCX – 6528 ppm

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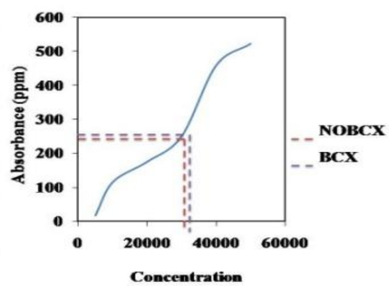
Calculation for sulphur

SULPHUR

Standard (ppm)	OD (470nm)
5000	17
10000	115
20000	175
30000	250
40000	458
50000	522

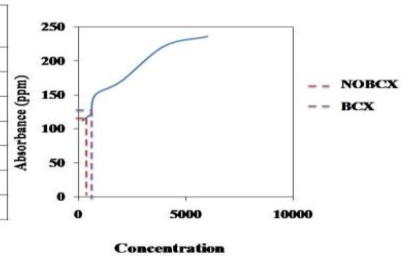


NO BCX – 371.16 ppm & BCX – 371.29 ppm

Calculation for zinc

ZINC

Standard (ppm)	OD (ppm)
200	112.2
400	117.5
600	122.6
800	150.3
2000	170.2
4000	221.7
6000	235.8

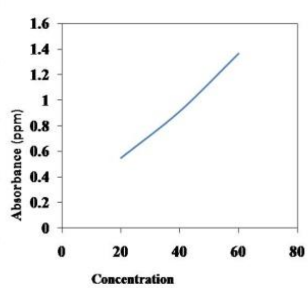


NO BCX – 117.8 ppm & BCX – 122.3 ppm

Calculation for manganese

MANGANESE

Standard (ppm)	OD (ppm)
20	0.548
40	0.913
60	1.365



NO BCX & BCX = 0

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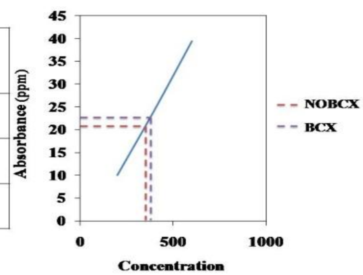
Calculation for copper

COPPER

Standard (ppm)	OD (ppm)
200	10.01
400	24.37
600	39.44

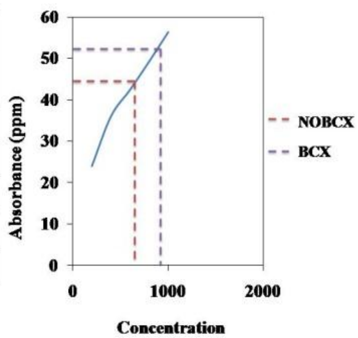


NO BCX – 21.02 ppm & BCX – 22.06 ppm

Calculation for ferrous

FERROUS

Standard (ppm)	OD (ppm)
200	24.0
400	36.0
600	42.4
800	49.2
1000	56.3



NO BCX – 44.54 ppm & BCX – 52.38 ppm

V.DISCUSSION

In the current study, the results obtained for macronutrients, Ca, Mg, Na, K, B, S contents of NO BCX sample were 2.0 ml, 7.0 ml, 0, 17, 5838, 371.16 respectively. Ca, Mg, Na, K, B, S contents of BCX sample were 3.5 ml, 8.6 ml, 0, 18, 6528, 371.29 respectively. Basically, potassium should be more than sodium and the result, in the present study are in accordance with earlier repeats. 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.

The results obtained for micronutrients, Fe, Cu, Zn and Mn contents of NO BCX sample were 44.5, 21.02, 117.8, 0 ppm respectively. Fe, Cu, Zn and Mn contents of BCX sprayed sample were determined as 52.38, 21.06, 122.3, 0 ppm respectively. Basically, manganese content should be very less in plant leaves and the result for these two was 0 ppm. The results indicate that the tea leaves have no manganese content. Street's research was conclude that the tea infusion can be an important dietary source of Mn but in our current study the tea leaves does not contain Mn. Nath's study was that the micronutrients concentration of the tea leaves was higher than the concentration of the tea soil and our current study conclude that the foliar fertilizer efficiency is higher than the normal fertilizer.

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Finally, it can be inferred that in the tea leaf samples analysis, macro and micro nutrients K, P, Na, B, S, Ca, Mg, Mn, Fe, Cu and Zn contents were sufficient and the efficiency increased with foliar fertilizer. Easy uptake of foliar fertilizer by tea leaves is an important factor for its high efficiency. In order to solve the micronutrient deficiency problem in tea leaves, awareness about the fertilizer has to be created to enhance the quality of tea and its production. Plants treated with foliar fertilizer have higher efficiency in absorbing nutrients than the normal fertilizer and the result of the present study also showed the efficiency of foliar fertilizer.

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