Some Nutrient Elements in Agricultural Soils from Selected Farms in Federal Capital Territory (FCT) Nigeria

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ABSTRACT: The total levels of the nutrient metal elements: magnesium (Mg), calcium (Ca), manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn) in agricultural soils from selected farms in Kwali, Gwagwalada and Kuje area councils of the Federal Capital Territory (FCT) were determined by energy dispersive x-ray fluorescence (EDXRF) spectroscopy. The levels of Mg, Ca, Mn, Fe, Cu and Zn were 119.23 $\pm$ 0.45, 119.93 $\pm$ 0.44, 27.67 $\pm$ 0.27, 168.28 $\pm$ 0.17, 9.93 $\pm$ 0.10 and 11.83 $\pm$ 0.11 µg/g respectively and were within the normal range for optimal plant growth.
Key words: Nutrient elements, energy dispersive x-ray fluorescence.

INTRODUCTION

The composition of metal elements in the soils shows wide variations all over the world. That is, the natural distribution of metal elements in soils varies widely and the amount and distribution of these metal elements in soils largely depend on the biogeochemical cycle of the ecosystem (Bear, 1976; Biswas and Mukherjee, 1995; Wild, 1996). The soils vary in composition not only from one location to another but also with depth of the soil at the same location. The total concentrations of these metal elements in uncontaminated soils are mainly related to the soil parent material, organic matter content, soil texture and the depth of the soil (Lena *et al*., 1997).

Some elements are present in trace amounts yet, they influence crop growth either as nutrient elements or toxic elements. Nutrient elements are elements that are required by plants for growth. Magnesium and calcium are nutrient metal elements that are required in relatively large quantities (macronutrients) while, iron, manganese, copper and zinc are required in relatively small quantities (micronutrients) (Tan, 1982; Brady and Weil, 1999). Oxides, sulphides and silicates are the major sources of iron (Fe), while carbonates, silicates and oxides are the sources of manganese (Mn). Copper (Cu) is found in sulphides, hydroxycarbonates and oxides. Zinc (Zn) has been found in sulphides, carbonates and silicates. Also copper and zinc have been found to be much higher in the topsoils cultivated over twenty years than in those cultivated for less than ten years. It has also been reported that copper, manganese and zinc were higher in fine soil with high organic matter content than in coarse soils (Tan, 1982).

The amount of nutrient metal elements in soil solution at any given time is always far less than is needed to produce a mature crop. Though, most soils contain large amounts of these metal elements relative to the annual needs of the growing vegetation, the bulk of the elements are held in the structural frame work of the primary and secondary minerals as well as the organic matter. Only a small fraction of the elements is present in forms which are available to crops. One of the factors which determine good agricultural soil is the availability of the nutrient metal elements (Bear, 1976; Ishola *et al*., 1998).

Flame atomic emission, absorption and fluorescence spectrophotometry have high specificity, excellent sensitivity and selectivity. These techniques have been used widely for the determination of traces of metals in soils. X-ray fluorescence (XRF) methods have been shown to be reliable by comparison with other techniques and by inter laboratory study. XRF technique has been effectively used to detect metal pollution of soil and to determine trace levels of some metal elements (Funtua 1999; Andrew *et al*., 1997).

Energy dispersive x-ray fluorescence (EDXRF) spectroscopy which is inherently sensitive with good selectivity has been used in this study to estimate the levels of Mg, Ca, Mn, Fe, Cu and Zn in soils from selected farms in FCT.

MATERIALS AND METHOD

Soil samples were collected from selected farms in Kwali, Gwagwalada and Kuje area council of the Federal Capital Territory (FCT), Abuja. Each of the three area council was divided into two major sampling sites: site A and site B. Samples from site A comprised of soils from farms located in the Northern part of each study area while, samples from site B comprised soils located in the Southern part of each study area (Dawam, 2000). Seven composites samples were collected from each site at 15cm depth. A V-shaped hole was dug (using hand trowel) to 15cm depth and then a slice of 2cm thick sub-samples was taken from each side of the V-shaped hole. Six to ten such sub-samples each as uniform as possible in dimensions were collected from points evenly distributed over the hole to form a grab sample at that particular point (Smith and James, 1981). A composite sample was made up of five such grab samples collected from within 100 x 100 square metres of the sampling area pooled and homogenized for true representation.

Each sample was prepared by grinding manually to powder with mortar and pestle to grain size less than 125 µm.

0.5g of each prepared sample was mixed with three drops of 5% disodium tetraborate decahydrate. The mixture was pressed at a pressure of 10 tons with a hydraulic press to produce pellets (19mm in diameter) of the sample. Each pellet of sample was placed in an aluminium sample holder of an x-ray fluorescence spectrometer and irradiated using x-ray from an x-ray tube to produce secondary x-rays in the sample. These secondary x-rays were collimated by the entrance slit of the goniometer of the spectrometer and directed onto the plain surface of the analyzing crystal of the spectrometer. The radiations reflected were passed through an exit slit of the goniometer and onto the detector where the x-ray energy was converted into electrical impulses and then measured (Andrew *et al.*, 1997; Willard *et al.*, 1986).

The organic carbon was determined by Walkley-Black method and the percent organic matter obtained by multiplying with 1.729 (Black, 1965).

The hydrometer method of soil mechanical analysis was used to determine the percentage of different sizes as they existed in the soil samples. These were used to find the textural classes of the soil samples (Bouyoucos, 1951; Welcher, 1963).

RESULTS AND DISCUSSION

The results of the analysis of soils from selected farms in FCT are presented in Tables 1 and 2. The optimal and deficient levels of these nutrient metal elements are given in Table 3.

From Table 1, the levels of magnesium and calcium ranged between 114.00 and 124.00 µg/g and 109.80 and 130.30 µg/g respectively. The highest value of magnesium was obtained in site A of Kuje area council while the highest value of calcium was recorded in site A of Gwagwalada area council.

Manganese and iron ranged between 24.20 and 31.10 µg/g and 166.20 and 170.40 µg/g respectively (table 1). Copper ranged between 8.85 and 10.70 µg/g with mean value of 9.93 $\pm$ 0.10 µg/g, zinc ranged between 9.90 and 13.90 µg/g with mean value of 11.83 $\pm$ 0.11 µg/g.

The percentage organic matter of the soil samples analyzed ranged between 2.40 and 2.48 with average value of 2.45 $\pm$ 0.07. The organic matter is an important secondary source of some of these metal elements. The soil organic matter serves as a source of cation exchange capacity (CEC) for metal ions and helps in metal chelate formation. These chelated metal compounds are more soluble than the inorganic compounds. These metal ions under certain environmental conditions can react with some organic compounds to form water insoluble complexes (Chopra and Kanwar, 1991). The organic matter content can therefore increase or decrease the toxicity of these metal elements in soils.

The dominant size fraction of the soil samples analyzed is the same for the study area. The dominant textural class is the sandy clay loam (SCL). Texture is an important soil property because it is closely related to the rate of water in-take, water supplying power, the fertility, erosion, aeration as well as the energy required to till the soil (Chopra and Kanwar, 1991). High levels of the metal elements can lead to toxic effects thereby rendering the soil useless. The results showed that the levels of the metal elements determined were within the limits for optimum growth (Biswas and Mukherjee, 1995). Therefore, pollution of the soils by metals might be very negligible.

The results also showed no significant difference in the metal elements status of the areas studied. This might not be unconnected with the fact that the soils were formed from the same parent materials and same physiography region. The very slight variation in the distribution of the metal elements might be attributed to the type of agricultural activities and/or practices being carried out in the areas (Ogunkunle and Erinle, 1994). The results obtained would be useful in monitoring the levels of these nutrient metal elements in FCT.

Table 1: Levels of some nutrient elements in soils from selected farms in FCT expressed in µg/g.

Area Site	Ca	Mg	Mn	Fe	Cu	Zn
Kwali A	116.90±0.26	127.30±0.52	27.70±0.11	167.30±0.11	10.20±0.06	13.90±0.11
B	114.00±0.53	109.70±0.027	27.40±0.17	168.40±0.	9.90±0.09	9.90±0.07
G/lada A	121.00±0.71	127.50±0.66	24.20±0.90	167.10±0.12	10.70±0.08	12.30±0.12
B	123.80±0.30	114.00±0.30	31.10±0.14	166.20±0.09	8.85±0.08	11.35±0.12
Kuje A	124.00±0.28	130.30±0.57	26.60±0.14	170.30±0.34	10.30±0.17	12.80.0.11
B	115.70±0.64	110.80±0.32	29.00±0.14	170.40±0.30	9.60±0.13	10.70±0.13
Mean	119.23±0.45	119.93±0.44	27.67±0.27	168.28±0.17	9.93±0.10	11.83±0.11
Range	114.00-124.00	109.80-130.30	24.20-31.10	166.20-170.40	8.85-10.70	9.90-13.90

Table 2: The organic matter, particles and textural classes of the soil samples analysed

Area Site	Organic matter (%)	Sand (%)	Silt (%)	Clay (%)	Textural
Kwali A	2.47±0.8	52.85 ±1.04	13.20+1.24	33.95±0.80	SCL
B	2.47±0.09	52.12±1.05	14.87±1.02	33.01±0.60	SCL
G/lada A	2.43±0.09	52.99±0.90	12.89±1.28	33.55±0.84	SCL
B	2.45±0.09	53.92±0.43	12.27±0.95	33.68±0.78	SCL
Kuje A	2.48±0.05	53.12±0.59	14.00±0.76	32.88±0.59	SCL
B	2.40±0.03	52.39±1.06	13.80±1.29	33.81±0.80	SCL
Mean	2.45±0.07	52.90±0.85	13.51±1.09	33.48±0.74	SCL
Range	2.40-2.48	52.12-53.92	12.27-14.87	32.88-33.95	SCL

Where SCL = Sandy clay loam

Table 3: Normal and deficient levels of essential metal elements

Element	Threshold of Deficiency (µgg^{-1})	Optimal growth (µgg^{-1})
Ca	2.00-20.00	100-200
Mg	0.50.51.00	255-510
Fe	0.05-25.00	30
Mn	0.005-0.02	0.55-5.50
Cu	0.0001-0.005	0.05-1.00
Zn	0.0001-0.005	0.05-1.00

Source: Biswas and Mukherjee (1995)

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