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Micronutrient Concentrations of Cassava Continuously Cultivated Soils in Ezinihitte Mbaise LGA Imo State, Nigeria

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Abstract— *The study was conducted to determine the concentrations of micronutrients (Copper (Cu), Zinc (Zn), Iron (Fe), Molybdenum (Mo) and Manganese (Mn)) in soils of Ezinihitte Mbaise LGA Imo State. The research was conducted in cassava continuously cultivated areas Obizi, Eziudo, Onisha and Udo in Ezinihitte to trace the role of micronutrient in the decline of Cassava yield in the area. Samples were collected randomly using soil auger from each locations at a depth of 0-30 centimeter (cm). Control (reference) soils were collected the same way but from fallow land of 5years old. Samples were treated and analyzed routinely and micronutrients (Cu, Zn, Fe, Mo and Mn) determined using Atomic Adsorption Spectrophotometer (AAS). The result (table 1) revealed that Samples have same soil texture -Loamy Sand (LS) but differ in pH significantly ($p<0.05$). The samples are acid soils of moderately acidity, and levels ranges from 5.00 to 5.44 (lowest to highest) with mean value of 5.21. For % Nitrogen N, % Organic Matter (OM), % Base Saturation (BS), Available Phosphorus (Av. P), Potassium (K), Magnesium (Mg), Calcium (Ca), Sodium (Na), EA (Ea) and Effective Cation Exchange capacity (ECEC). They were significantly affected by cultivation and have mean values (P -1.57, N -1.33, K-1.60, OM 2.79, BS-74.3, Mg-2.46, Ca-1.47, K-0.15, Na-0.13, Ea-1.48 and ECEC-5.47) (table 1). This is a common characteristics of moderate to low fertility soils. The micronutrient levels were also significantly different. Cassava cultivation affected micronutrients levels significantly at $p<0.05$ (table2). The decrease were observed in all samples, and were significantly lower when compared with control. For Zn, Cu, Mo, Fe and Mn, the mean values are 6.05 Zn, 1.60 Cu, 1.09 Mo. 4.61 Fe and 4.90 Mn respectively. Micronutrients though significantly different between samples, and lower when compared with control, all (including control) were at low levels at which deficiency can occur when compared with critical nutrient levels (table 3).*

***Keywords*— *Cassava, Imo State, Mbaise, Micronutrient*.**

I. INTRODUCTION

Decreasing soil fertility with declining yield growth for major food crops have raised concerns about the sustainability of agricultural production at current level (Mortvedt, 1995). . The work of Grundon (1997) added important reason for us to investigate nutrient management and elements levels in the soil. He posited that, we not only need food, but quality food too.This was supported by Paterson (2002) who posited that the deficiency of zinc for instance, to tuber crops, reduces the quality of carbohydrate in the tubers likewise nitrogen deficiency, which reduces protein content in grains (Havlin *et al*., 2006}. Many declines in crop yield have be associated with micronutrients levels (Enwezor *et al.*, 1990).

Micronutrients are elements or plant nutrients which are essential for plant growth, but are required in relatively small amounts than those of the primary nutrients (N,P,K,S, Mg etc).

These micronutrients include Iron (Fe), Copper (Cu), Manganese (Mn), zinc (Zn), Boron(B), Molybdenum(Mo) and Chloride(Cl) etc. Soil vary widely in their micronutrient content and in their ability to supply micronutrients in quantities sufficient for optimal crop growth (Solberg *et al.*, 1999). Micronutrients though required by plants in small quantity but their action in plant are not small (Wiese, 2010). And what quantity is sufficient to support plant for normal growth and development (Enwezor *et al.*, 1990).

Many studies (Jacobsen and Jasper, 1991; Akinrinde and Obigbesan, 2000) have revealed micronutrient deficiency in crops, and (Boardman and McGure, 1990) stressed that, micronutrients are important for plant growth as plants requires a proper balance of all the nutrients for normal growth and optimum yield. Excessive use and or, availability of these macronutrients over nonsufficient levels of micronutrients affects the soil pH, and this in turn, tend to decrease Manganese (Mn), Iron(Fe), Copper(Cu), and Boron(B) as pH increases (Alam and Raza, 2001).

Most farmers in this part of the country apply NPK fertilizer regularly with little or no attention to micronutrients, forgetting the danger of imbalances with micronutrient s(Jones, 2007). Findings from some researches in Nigeria have found micronutrient deficiencies in Nigerian soils (Mckenzie, 2003). Each deficiency symptom is related to some function of the nutrient in the plant Also, a considerable proportion of agricultural soils in Nigeria can be classified as low fertile soils (Bennett, 2003). To this end, there is need to investigate the levels of some micronutrients (Zn, Cu, Fe, Mo, Mn) on selected soils in the study area and also determine the physico-chemical properties (soil pH, organic matter content, cation exchange capacity, exchangeable acidity etc) of arable soils in the study area.

II. MATERIALS AND METHOD

2.1. Study Area

This study was carried out in four communities in Ezinihitte Mbaise LGA, Imo state. Ezinihitte Mbaise is strategically located in Imo State of Nigeria. Ezinihitte Mbaise has the following coordinate Latitude:5.50511, Longitude:7.36771 5° 30′ 18″ N, 7° 22′ 4″ E. The temperatures ranged from 32.1-29.1^{0c} (maximum) and 24.1-22.2^{0c} (minimum), while relative humidity in these areas ranged from 77-86%, while rainy season is from April- October with a short break in August Called “August Break”.

2.2 Site Selection, Description And Soil Sampling

Reconnaissance survey visits were made to locate and select sites for the study. The experiment was conducted in Ezinihitte Mbaise LGA. The experiment was carried out in four communities namely –Udo, Eziudo, Obizi and Onicha both in Ezinihitte Mbaise LGA in Imo state. The farmlands comprises of cassava continuous cropping. The control was uncultivated lands of about 5 years. The dominant trees present are oil palm tree, oil bean and the topography is undulating.

Representative soil sample were collected randomly. Sampling was done with the aid of soil auger at a depth of 30 cm since previous work by Nyanagababo and Hamya (1986) showed that surface soils are better indicator of trace elements concentrations. Samples were randomly collected (Brown, 1987) from the sites.

These 4 villages in Ezinihitte were sampled. 20 samples were collected from Udo, and 4 samples each were bucked for 4 composite replicates. The procedure was the same for all the other villages. The samples were emptied into a paper envelop respectively.

The control was sampled from 20 fallow lands, from each of these villages. Procedures previously discussed were adopted in replication.

2.3 SAMPLE PREPARATION AND LABORATORY ANALYSIS

2.3. 1 Soil Sample Analysis

Soil samples were spread on clean and dry paper sheet for air drying. After air drying, the samples were crushed in clean ceramic mortar using a small ceramic piston. These samples were passed through 2-mm sieve to get a fine soil fraction (Nelson and Sommers, 1982). The analyses was carried out at Federal College of land Resources and Technology (FECOLART) Oforola, Imo State.

The fine soil fraction was used to extract micronutrient using the DTPA method (Lindsay and Norvell, 1978). A 10 g of soil sample was mixed with 20 ml DTPA (0.05 M – adjusted to pH 7.3 with TEA), then shaken on a reciprocation shaker or (mechanical shaker) for 30 – 45 minutes before filtering through whatman No 1 filter.

The filtrate was analysed for micronutrients (Cu, Zn, Fe, Mo, Mn) on Atomic Absorption Spectrophotometer (AAS), Perkin Elmer model 306

Soil pH was determined in distilled (deionised) water (1:2.5 Soil-Water ratio) using glass electrode pH meter (Dewer model) as described by Smith and Doran(1996). **Organic carbon** was determined by the Walkley-Black wet oxidation method (Heanes, 1984).

Organic Matter was determined by multiplying organic carbon by 1.724(Bemmelen’s Factor). **Exchangeable**

acidity was determined by the titration method (McGrath and Cunliffe, 1985).

Cation Exchange Capacity was determined using summation method (McGrath and Cunliffe, 1985). **Particle Size Distribution** was determined using hydrometer method of mechanical Analysis. **Base Saturation** was calculated by dividing total exchangeable bases by effective cation exchange capacity value and multiplied by 100.**Total Nitrogen** was determined using Kjeldahl method (Brown, 1987). **Available Phosphorus** was determined using Bray-2 method (Olson and sommer, 1982). **Effective Cation Exchange Capacity** was determined using summation method, that is, exchangeable base plus exchangeable acidic expressed in (molkg^{-1}).

Table 1. Physicochemical property of the soil

Samples	**Texture**	**pH H_2O**	**Av. P Mg/kg**	**N**	**OC**	**OM**	**BS**	**Ca**	**Mg**	**K**	**Na**	**Ea**	**ECEC**
				……………	**%**	**…..................**		**………………..**	**Cmol.Kg^{-1}**	**……..……..……...**			
Obizi (A)	LS	5.09^{b}	0.89^{c}	1.14^{b}	1.65^{b}	2.85^{b}	71.9^{b}	2.27^{c}	1.47b	0.17^{a}	0.11^{a}	1.60^{b}	5.61^{b}
Eziudo (B)	LS	5.44^{a}	2.52^{a}	1.11^{b}	1.29^{c}	2.23^{c}	78.7^{a}	2.53^{b}	1.53a	0.18^{a}	0.16^{a}	1.10^{d}	5.48^{c}
Onicha ©	LS	5.38^{a}	2.53^{a}	1.11^{b}	1.27^{c}	2.19^{c}	73.1^{b}	2.27^{c}	1.33c	0.18^{a}	0.16^{a}	1.43^{c}	5.39^{c}
Udo (D)	LS	5.15^{b}	1.61^{b}	1.10^{b}	1.21^{c}	2.09^{d}	70.4^{b}	2.40^{b}	1.60^{a}	0.11^{a}	0.08^{b}	1.47^{c}	4.95^{d}
Control €	LS	5.00^{bc}	0.32^{d}	2.20^{a}	2.61^{a}	4.59^{a}	77.6^{a}	2.86^{a}	1.46^{b}	0.13^{a}	0.16^{a}	1.80^{a}	5.96^{a}
Mean	**LS**	**5.21**	**1.57**	**1.33**	**1.60**	**2.79**	**74.3**	**2.46**	**1.47**	**0.15**	**0.13**	**1.48**	**5.47**

Within each column, means with different letters are significantly different at ($P < 0.05$).

Key: P phosphorus, N Nitrogen, OC organic carbon, Om Organic matter, BS Base Saturation, Ca calcium, Mg magnesium, k potassium, Na sodium, Ea Exchangeable acidity, ECEC Effective cation Exchange Acidity.

2.4 Data Analysis

Simple descriptive technique was used and data were summed and divided to produce means respectively. Means were separated using the Least Significant Difference (LSD) according to Snedecor and Cochran (1980), correlation with physicochemical properties were made, and comparism were made with results from the control and already established levels.

III. RESULTS AND DISCUSSON

3.1.Some Mineral Nutrient Elements

The details of physical and chemical properties of the samples are shown in table 1.

3.1.1 Nitrogen, Phosphorus and Potassium –NPK

The total nitrogen level decreased significantly between treatments with the lowest occurring at Udo. Nitrogen levels were all lower when compared with control.

Phosphorus levels were also significant different when compared between samples and control. The samples were higher in available Phosphorus than control and the highest occurred in Onicha.

Potassium levels differ in all the samples and were significantly different between the samples, and when compared with control. With addiction of NPK fertilizers, levels of macronutrient increase tremendously and can decrease through plant uptake in actively growing fields occupied by crops and weeds (Marschner, 1995). For phosphorus, the levels were in accordance with Rengel (2001), who indicated that most Ultisols are sandy and possesses P fixing ability. P becomes available if moisture content is sufficient. The fertility levels of southeastern soils are moderate to low and soil amendments including fertilizer application is crucial especially under continues cultivation (MCkenzie, 2003).

3.1.2 Magnesium (Mg) and Calcium (Ca)

There were significant difference between the samples, and the lowest occurred in Onisha but were significantly different when compared with control.

Cultivation affected the calcium levels and there were significant different between some samples and these were significantly reduced when compared with control.

3.1.3 Sodium

Cultivation affected the sodium content of the sites slightly but significantly, and these were significant different between some samples Table 1. Moderately acid soils have Mg and Ca at moderate to high levels (Enwezor *et al.*, 1990).

3.2 Chemical Properties Of The Soil

The values of chemical properties were summarized in table 1.

3.2.1 Soil texture.

The soil texture is loamy sand. FMANR (1990) revealed that sandy soils are predominant in Imo State. This soil is always low is fertility indices and has higher leaching capacity as well as high drainage potential and low water and nutrient holding capacity.

3.2.2 pH

The soil pH were significantly different between samples and the lowest occurred in control sites. The soil is moderately acidic and this justifies the many findings that reported tropical soils as acidic (Akinrinde, *et al*., 2005). Cultivation increases soil acidity through applications of chemical fertilizers which further increase soil acidity (Akamigbo and Asadu, 2001).

3.2.3 Organic Matter Content (OM)

There were significant difference between samples and control when compared, and the highest occurred in Control.

The percentage organic carbon were also affected from one sample to another and were not significantly different between samples C and D except when compared with control. There is rapid decomposition of organic matter in tropical soils, and the levels are even lower in sandy soils (Brown, 1987). Soil organic matter help in nutrient retention and slow release. It increases soil water holding capacity and as source of energy for soil biota,

3.2.4 Percentage Base Saturation (% BS)

Percentage base saturation of the samples decreased slightly and significantly, and all except Eziudo (B) were lower than control.

3.2.5 Effective Cation Exchange Capacity (ECEC) and Exchangeable Acidity (EA)

Samples exchangeable acidity were all lower and significantly different from control. The ECEC of the sites were also affected. All the sites except control were lower significantly when compared. This levels were supported by Akamigbo and Asadu (2001) who posited that Imo State Soils are generally acidic and have moderate ECEC.

3.3 Micronutrient Levels

3.3 .1 Zinc

There were significant difference in zinc content of the sample, with highest concentration occurring at Onicha when compared with control. Numerous findings especially Enwezor *et al*. (1990) revealed that eastern soils are low in micronutrient except at municipal dump sites. **Zinc** is an essential component or various enzyme systems for energy production, protein synthesis as evidenced by accumulation of soluble nitrogen compounds such as amino acids and amides, and growth regulation. It has been conducted that zinc reduces auxin content through its involvement in the synthesis of tryptophan, a precursor of the auxin.

Deficiency of **zinc** results in light green, yellow or white areas between leaf veins, particularly in older leaves, premature foliage loss, malformation of fruits, often little or no yield, may occur. Zn in soil solution ranges from 2- 70 Mg/Kg with more than half complexed with organic matter. Deficiency of Zinc are usually associated with concentrations of less than 10- 20 Mg/Kg (Paterson, 2002). Depending on the crop, toxicity will occur when the leaf concentration of Zn exceeds 400 Mg/Kg.

3.3.2 Copper

Copper levels were lower in all sample when compared with control and were significantly different between samples. **Copper** is necessary for carbohydrate and nitrogen metabolism, legume synthesis which is needed for cell wall strength. It is also known to function in photosynthesis and respiration. Copper deficiency includes, die – back of stems, chlorosis, stunted growth, pale green leaves that wither easily. **Copper** deficiency and toxicity are not as common as other micronutrients deficiency. Copper deficiency include chlorosis in young leaves, and stunted. In advance stage, necrosis along leaf tips and edges appears. Stem melanosis, root rot and ergot infection can occur in small grains (Solberg *et al*., 1999). Cu toxicity include reduced shoot vigor, poorly developed and discolored root systems. Toxicity is uncommon, occurring where there are high deposits of waste such as municipal, sewage sludge etc. Concentration of Cu in soil ranges from 1- 40 Mg/Kg and averages about 9 Mg/Kg.

3.3.3 Molybdenum

The concentrations of molybdenum was lowest at eziudo, and highest in Udo. It was significantly different when compared with control which was almost at the same level with Onisha and Obizi. **Molybdenum** sufficient levels in the soil ranges from0-02-5mg/kg and is involved in enzyme systems relating to nitrogen fixation and metabolism, protein synthesis and sulphur metabolism, pollen fruit formation. Deficiency is not common but is similar to interveinal chlorosis in Iron deficiency. Excessive amount of Molybdenum are toxic, especially to grazing cattle or sheep. Mo toxicity cause stunted growth and bone deformation in animal and can be corrected by oral feeding of Copper (Paterson, 2002). The soil concentration of Mo ranges from 0.2 to 5 Mg/Kg (Benett, 2003).

3.3.4 Iron

There was a similar trend of concentrations in iron levels. There were significant differences in iron content and the highest occurring in control. Iron content of tropical soils are different from location to location due to parent materials (Osiname, 2005). **Iron** is involved in the production of chlorophyll, component of many enzymes for energy transfer, nitrogen reduction and fixation, lignin formation. It provides the electrochemical potentials for many enzymatic transformations in plants (Jones, 2007). **Iron** deficiency symptoms include interveinal chlorosis, which progresses rapidly over the entire leaf. In severe cases, leaves turn entirely white and necrotic (Van Dijk *et al*., 1993). Iron toxicity can occur under certain condition, for example in rice grown or poorly drained or submerged soils, leaf bronzing symptoms occur with 300 mg/kg of Fe in rice leaves. Fe concentration is usually very low, 0.1-0.50 Mg/Kg and only the chelate dynamics make Fe more available (Van Dijk *et al*., 1993). **Iron** is involved in the production of chlorophyll, component of many enzymes for energy transfer, nitrogen reduction and fixation, lignin formation. It provides the electrochemical potentials for many enzymatic transformations in plants (Jones, 2007).

Table 2:

Micronutrient levels of the samples

Source	Zn	Cu	Mo	Fe	Mn
	………………...…Mg/Kg		……………..…………		
Obizi (A)	3.12^d	2.19^b	0.07^b	2.75^d	1.34^e
Eziudo (B)	5.28^c	0.10^{cd}	0.03^{bc}	3.35^e	2.59^d
Onicha ©	6.59^b	2.18^b	0.07^b	5.80^b	7.33^b
Udo (D)	6.50^b	0.13^c	0.13^a	4.34^c	4.81^c
Control €	8.76^a	3.36^a	1.16^a	6.90^a	8.47^a
Mean	**6.05**	**1.60**	**1.09**	**4.61**	**4.90**

Within each column, means with different letters are significantly different at (P < 0.05)
Key: (Zn) Zinc, (Cu) Copper, (Mo), Molybdenum, (Fe) Iron, (Mn) Manganese.

3.3.5 Manganese Mn

Mn levels were significantly different and the highest occurring in Onicha. These levels were in accordance with Adepetu (1990), who described Nigerian soils as lacking in Mn and other micronutrients. **Manganese** is necessary for photosynthesis, nitrogen metabolism and to form either compounds required for plant metabolism or enzyme activator. Manganese functions in nitrate reduction where it acts as an indicator for enzymes nitrate reductase and hydroxylamine reductase. **Its deficiency** results in interveinal chlorosis, brown necrotic spots appear on leaves, premature leaf drop, delayed maturity, whitish grey spots in leaves of cereals and shortened internodes in cotton. Manganese deficiency occur mainly in high pH soils, sandy soils low in organic matter and over limed soils (Gerendas, *et al*., 2009). Mn has a sufficient range of 15-100mg/kg.

Table 3. Critical levels of some nutrient Elements

Nutrient		Low	Marginal	Sufficient	High	Excess
	Spring	1.5	1.5 - 2.0	2.0 - 3.0	3.0 - 4.0	4.0
Nitrogen (N) %	Winter	1.25	1.25 - 1.75	1.75 - 3.0	3.0 - 4.0	4.0
Phosphorous (P) %		0.15	0.15 - 0.25	0.26 - 0.5	0.5 - 0.8	0.8
Potassium (K) %		1.0	1.0 - 1.5	1.5 - 3.0	3.0 - 5.0	5.0
Sulphur (S) %		0.1	0.1 - 0.15	0.15 - 0.40	0.40 - 0.8	0.8
Calcium (Ca) %	Other	0.10	0.10 - 0.2	0.2 - 1.0	1.0 - 1.5	1.5
Magnesium (Mg) %		0.1	0.1 - 0.15	0.15 - 0.50	0.5 - 1.0	1.0
Zinc (Zn) mg/kg		10	10 - 15	15 - 70	70 - 150	150
Copper (Cu) mg/kg	Barley	2.3	2.3 - 3.7	3.7 - 25	25 - 50	50
Iron (Fe) mg/kg		15	15 - 20	20 - 250	250 - 500	500
Manganese (Mn) mg/kg		10	10 - 15	15 - 100	100 - 250	250
Boron (B) mg/kg		3	3 - 5	5 - 25	25 - 75	75
Molybdenum (Mo) mg/kg		0.01	.01 - .02	.03 - 5	5 - 10	10

Sources: Westerman (1990).

IV. CONCLUSION

The result of the study showed that micronutrient contents are generally low when compared with control. Some are at deficiency zone at which deficiency can occur. And for normal plant growth and development, and also for optimum yield, these levels can totally affect yield critically. There were more positive correlations between the micronutrients and some selected samples and parameters. These also indicated that micronutrient was affected directly by cultivation. This reminds us that, in as much as these nutrient elements are needed in small quantity (ies); what quantity is good enough for optimum crop yield should be taken into consideration. Also, what quantity (ies) guarantees quality yield should not be ignored because quality of produce is better than quantity in nutritional terms? In targeting to get quality produce, quantity is guaranteed. It should be wrong if we measure out produce with quantity alone. In a scientific word, both quantity and quality should be a policy statement to guide the farmers. Most importantly, some micronutrients are directly involved in plant growth and developments, thus, it will amount to waste of human resources if we allow nutrient deficiency to result to low yield or in serious cases, crop failure. Deficiency of zinc for instance, to tuber crops, reduces the quality of carbohydrate in the tubers likewise nitrogen deficiency, which reduces protein content in grains. The results suggests addition of micronutrients to soils during cultivation because the micronutrient levels were below critical(sufficient) (table 3) levels and this cannot guarantee optimum yield taken cognizance of functions of micronutrients in cassava and crop production.

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