Assessment of Zinc and Copper Status of Fadama Soils In Borgu Local Government Area, Niger State

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Abstract— *The status of Zinc (Zn) and Copper (Cu) of fadama soils under cultivation at Borgu Local Government Area, Niger State, Nigeria was studied. Soil samples were purposely collected from three extension blocks, namely; Wawa, Babana and Goffanti. Particle size distribution of the soils showed sandy loam texture. The soils pH were either slightly acidic or neutral with a range between 6.05 and 6.93. The level of Organic Carbon (OC) ranged between low and medium, total nitrogen were rated high, available phosphorus were low while exchangeable cations (Na, K, Ca, Mg) were all rated high. Though soil content of Zn and Cu were very low, values were not significantly (P<0.05) different for all locations. The mean values for Zn ranged between 0.496 and 0.592 mg/kg, while Cu ranged between 0.550 and 0.945 mg/kg. This result implies that soil amendments in the form of organic manure and/or supplement of Zn and Cu would enhance nutrient availability for optimum yields of crops for the resource-poor farmers in the study area.*

Keywords— Zinc, Copper, Fadama, soil fertility, Borgu.

I. INTRODUCTION

Micronutrients refer to a number of metals and their ions which are mostly of high density (usually < 50 mg $m^{-3)}$ and belong largely to the group of transition element of the periodic table. Micronutrients occur naturally in the soil. The origin and sources in soils varies greatly. However, the major sources include, parent material, sewage sludge, town refuse, farmyard manure and organic matter (Nazif *et al.*, 2006). They are usually of relatively low abundance in soil but play key roles in the growth and development of crop plant, hence essential for plant growth (Mustapha *et al.*, 2010). Although required in minute quantities, micronutrients have the same agronomic importance as macronutrients and play vital roles in the growth of plants (Nazif *et al.*, 2006). The availability of these elements in correct amounts and proportions play a vital role in the absorption of other nutrient elements, especially nitrogen, phosphorus and potassium.

Most micronutrients are associated with the enzymatic system of plants. For instance, Zinc is an essential component of various enzyme systems for energy production, protein synthesis, and growth regulation. Zn is known to promote the formation of growth hormones, starch and seed development (FFTC, 2001). Copper is necessary for carbohydrate and nitrogen metabolism and also is required for lignin synthesis which is needed for cell wall strength. Through their involvement in various enzymes and other physiologically active molecules these micronutrients are important for gene expression, biosynthesis of proteins, nucleic acid, growth substances, chlorophyll and secondary metabolites, metabolism of carbohydrates and lipids, stress tolerance (Rengel, 2003; Gao *et al*., 2008).

Soil fertility, generally determines the growth and productivity of plants. It is determined by the presence or absence of macronutrients and/or micronutrients. The distribution of available micronutrient is considered useful for a better understanding of soils' capacity to sustain an adequate amount or supply of nutrients to plant so as to meet the increasing demanded for food sufficiency. In view of this, several researchers have suggested the need for assessing the micronutrients state of soils (Ibrahim *et al*., 2011 and Mustapha *et al.*, 2011).

Fadama is a local (Hausa) name for irrigable lands which are flood plains and low lying plains underlined with shallow aquifer found along Nigeria's river system. *Fadama* farming has been a long time practice in Nigeria for several decades. The basic phenomenon is the ease of accessibility of shallow ground water and on surface water for agricultural production (Edo ADP, 2000). Due to its peculiar characteristic, crop cultivation is usually done almost all year round. The continuous cultivation of *Fadama* soils, owing to its better crop production potential, may lead to depletion of plant micronutrient elements. This is as a result of continuous cultivation on these soils without proper management practices. In addition, farmers usually apply macronutrients in form of fertilizers but overlook the possibility of micronutrient deficiency.

Globally, there is the quest for high food production in order to meet up with the food need of the ever increasing population. In Nigeria, this has brought about the need to harness the fertility of *fadama* soil which has the potential of all-year-round cultivation. The sustainable exploitation of the *fadama* land is, however, currently hindered by lack of site specific information on these soils (Mustapha and Loks, 2005) thereby making them prone to mismanagement. As preliminary measure to successful implementation of proper agricultural practices, the assessment of the nutrient status of the soils becomes necessary. Furthermore, most fertility researches are focused on assessment of macronutrients while neglecting micronutrients. For this reason, this study is aimed at determining the Zn and Cu content of *fadama* soils in Borgu L.G.A.in order to sustain its productivity.

II. MATERIALS AND METHOD

2.1 Study area

The study was carried out in Borgu Local Government Area located within the plains of Niger State (Ikusemoran *et al.*, 2014) at latitude 09^o and 53$'$ N and longitude 04^o and 31$'$ E. Borgu Local Government is made up of Wawa, Goffanti, and Babana extension blocks. The climate type of the study area is semi arid. The vegetation is guinea savannah and is characterized by grasses, shrubs and sparse trees. Crops grown in this area include rice, maize, guinea corn, groundnut, beans, soybeans, okra, tomato, pepper and leafy vegetables. *Fadama* here are usually utilized for rice and vegetable production.

2.2 Soil sampling

Soil samples were collected from three extension blocks (Wawa, Babana and Goffanti). There are several cells under each extension block. However, three cells were selected for each block. They include Dongon-Gari, Fakun and Bussa cells for Wawa. Konkoso, Kuble and Babana cells for Babana. Luma, Luma Ba'are and Goffanti cells for Goffanti. These cells were selected on the basis of proximity.

In each cell, three fadama farms were visited in which twenty soil samples were randomly collected at each farm. The samples were bulked for each cell making a total of nine samples.

2.3 Soil preparation

Soil samples were air-dried, ground and sieved through a 2 mm sieve. Samples were ground and sieved in order to remove the gravels and plant roots, and as well as obtain a homogenous sample for each cell. After the sieving operation, samples were packaged properly in polyethylene bags and labelled appropriately for laboratory analysis.

2.4 Laboratory analysis

Hydrometer method (Jou, 1988) was adopted for particle size determination. Soil pH was determined in water solution at a ratio of 1:2 soil-water suspension. Soil organic carbon was determined using the wet combustion method of Walkley and Black (1934). Cation exchange capacity was estimated using the NH_4O Ac saturation (pH 7) method, while the leachate was used to determine the exchangeable bases. Total nitrogen was determined by Kjeldahl method. Available phosphorus was determined by Bray II method (Bray and Kurtz, 1945). Zinc and Copper were determined by digesting samples with 0.1M HCl and the filtrate of the digested samples were analysed by UNICAM 929 London, Atomic Absorption Spectrophotometer powered by the SOLAR software.

2.5 Data analysis

The data obtained were analysed with Analysis of Variance using SPSS version 15.0. Least significant difference (LSD) was used to separate means. Simple descriptive statistics including mean and range were also used.

III. RESULTS

- As shown in Table 1, the textural class for all the soils were sandy loam with high sand portions ranging from 564.8 – 914.8 g/kg.

TABLE 1
TEXTURAL CLASSIFICATION OF THE *FADAMA SOILS*

Location		Sand	Silt	Clay	Textural class
Block	Cell	(g/kg)			
Wawa	Fakun	608.4	330	61.6	Sandy loam
	Bussa	658.4	272.8	68.8	Sandy loam
	Dogongari	654.8	266.4	78.8	Sandy loam
Goffanti	Luma	644.8	276.4	78.8	Sandy loam
	Luma Ba'are	681.2	230	88.8	Sandy loam
	Goffanti	564.8	326.4	108.8	Sandy loam
Babana	Kuble	724.8	203.6	71.6	Sandy loam
	Konkoso	914.8	16.4	68.8	Sandy loam
	Babana	738.4	188.8	78.8	Sandy loam

TABLE 2
CHEMICAL PROPERTIES OF THE *FADAMA* SOILS UNDER STUDY AND THEIR RATINGS

Location		pH		Organic carbon g/kg		Total Nitrogen g/kg		Available P g/kg		Zn mg/kg		Cu mg/kg		Na		K		Ca Cmol/kg		Mg		CEC	
Block	**Cell**																						
Wawa	Fakun	6.05	SA	10.27	M	3.1	H	8.6	L	0.511	VL	1.032	L	0.538	H	0.316	H	7.814	H	1.595	H	10.544	L
	Bussa	6.93	N	13.87	M	3.8	H	7.6	L	0.482	VL	0.918	VL	0.513	H	0.286	M	7.856	H	1.504	H	10.259	L
	Dogongari	6.73	N	13.47	M	3.2	H	4.0	L	0.494	VL	0.884	VL	0.524	H	0.291	M	7.419	H	1.746	H	10.180	L
	Mean	6.57		12.53		3.4		5.5		0.496		0.945		0.525		0.298		7.696		1.615		10.328	
Goffanti	Luma	6.33	SA	6.28	L	3.9	H	9.5	L	0.656	VL	0.867	VL	0.542	H	0.325	H	9.164	H	1.833	H	11.863	L
	Luma Ba'are	6.77	N	7.68	L	3.1	H	4.1	L	0.530	VL	0.913	VL	0.492	H	0.278	M	7.285	H	1.599	H	9.664	L
	Goffanti	6.39	SA	11.37	M	3.5	H	2.9	L	0.589	VL	0.876	VL	0.537	H	0.316	H	8.038	H	1.816	H	10.928	L
	Mean	6.50		8.44		3.5		5.5		0.592		0.885		0.524		0.306		8.162		1.749		10.818	
Babana	Kuble	6.05	SA	9.28	L	3.5	H	2.9	L	0.634	VL	0.684	VL	0.489	H	0.260	M	7.763	H	1.644	H	10.337	L
	Konkoso	6.91	N	15.46	M	3.1	H	7.9	L	0.492	VL	0.112	VL	0.518	H	0.301	M	7.537	H	1.754	H	10.420	L
	Babana	6.65	N	15.66	M	4.2	H	1.8	L	0.525	VL	0.854	VL	0.486	H	0.256	M	6.907	H	1.547	H	9.316	L
	Mean	6.54		13.46		3.6		4.2		0.550		0.550		0.498		0.272		7.402		1.648		10.024	
	Grand Mean	6.53		11.48		3.48		5.47		0.545		0.793		0.515		0.292		7.753		1.670		10.390	
	Range	0.88		9.38		1.1		7.7		0.174		0.92		0.056		0.069		2.257		0.329		2.547	
	LSD (0.05)	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

NS = Non Significant, N = Neutral, M = Medium, VL = Very Low, SA = Slightly Acidic, H = High, L = Low

- All soil chemical properties analysed were not significantly different (P>0.05) for all locations (Table 2). The pHs of soils were either slightly acidic or neutral with range between 6.05 and 6.93.

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	Range	0.88		9.38		1.1		7.7		0.174		0.92		0.056		0.069		2.257		0.329		2.547	
	LSD (0.05)	NS		NS		NS		NS		NS		NS		NS		NS		NS		NS		NS	

- Organic carbon, total nitrogen and available phosphorus ranged between 6.28-15.66, 3.1-4.2 and 1.8-9.5 g/kg respectively. Babanna had the highest mean values for organic carbon and total nitrogen while the highest mean value for available phosphorus was obtained both in Wawa and Goffanti.
- Mean values for exchangeable cations (Na, K, Ca, Mg) ranged from 0.498-0.525, 0.272-0.306, 7.402-8.162 and 1.615-1.749 cmol/kg. Sodium, calcium and magnesium were rated high (Esu, 1991). However, calcium dominated the exchange sites.
- The mean values for Zn ranged between 0.496 and 0.592 mg/kg while Cu ranged between 0.550 and 0.945 mg/kg. The highest mean value for Zn was obtained in Goffanti while Wawa had the highest mean for Cu.

IV. DISCUSSION

The sandy loam texture obtained for soils studied is in contrast to the report of Singh (1997) that *Fadama* are generally clayey and hydromorphic. The texture of these soils may be attributed to deposition of soil from upland by erosion (Yakubu *et al.*, 2008). The relative high proportion in sand and low clay fraction may lead to poor soil structure and consequently a reduction in water retention.

The pH obtained is characteristic of guinea savannah soils which may be due to high level of basic cations in the soil.

According to the ratings of Esu (1991), organic carbon ranged between low and medium, total nitrogen were rated high while available phosphorus were low. Mustapha and Nnalee (2007) also reported low values of organic carbon for soils in the guinea savanna zones of Nigeria. Low organic matter, a phenomenon associated with savanna soils are attributed to the high degradation rate due to high temperature in these areas (Agbede, 2009). Organic matter is known to supply about 85 to 90% of soil nitrogen in unfertilized soils (Amalu, 1997). The high nitrogen may be attributed to residual nitrogen-base fertilizer previously applied. Furthermore, the low content of organic carbon may have resulted to the low values of cation exchange capacity as rated by Black (1965). Incorporation of plants residues, especially legumes is recommended for such soils (Achor *et al.*, 2013).

Sodium, calcium and magnesium were rated high (Esu, 1991). Similar result was obtained by Lawal *et al.* (2014) in Minna, Niger state. Soils with high calcium, magnesium and sodium salt content are known to have low organic carbon (Otisi, 1996). The high value of sodium salt in these soils may pose a problem to the structure of the soil.

Zn and Cu content of soils were low at all locations as rated by Esu (1991). However, Lawal *et al.* (2012b) reported adequacy of Zn and Cu in hydromorphic soils around Minna. The low values of Zn and Cu obtained may be attributed to the lack of adequate organic matter in these soils. Organic matter is an important secondary source of some micronutrients (Das, 2014). Also, the continuous cultivation without appropriate management practice in form of fertilizer program can deplete the micronutrients. According to Ajiboye *et al.* (2011), a pH value above 6 may limit availability of micronutrients such as Fe, Cu, Zn, and Mn. Continuous use of farmyard manure or of other organic sources arrests the depletion of available micronutrient pools from soils (Das, 2014).

V. CONCLUSION

The levels of Zinc and Copper in the *fadama* soils investigated were low. The level of organic carbon ranged between low and medium while the total nitrogen and exchangeable cations (Na, K, Ca, Mg) were all rated high in the soils under study.

The soil amendment of Zn and Cu would enhance the availability of these micronutrients for optimum yields of crops grown in these *fadama* soils for the resource-poor farmers in the study area. It should be noted that foliar application of micronutrients may last only for one growing season while soil application can persist for more than one growing season. In addition, foliar applications usually produce fast response in plants.

Management practices that will improve soil organic carbon such as incorporation of plant residues and manures are also recommended. This will not only increase micronutrient content but also reduce the cost of using inorganic micronutrient carriers.

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