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Full Length Research Paper

Extractable micronutrients status in relation to other soil properties in Billiri Local Government Area

Ibrahim, A. K.*, Usman, A., Abubakar, B., and Aminu, U. H

Federal College of Horticulture, Dadin Kowa, P. M. B 108 Gombe, Gombe State, Nigeria.

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A study of the micronutrient status of soils of Billiri was carried out at 55 different locations. The objective of the study was to evaluate the status of micronutrients and their relationship with soil properties. Soil sample were collected at 0 to 30 cm depth and analyzed for Diethylenetriamine penta acetic acid DPTA extractable micronutrients (iron, Fe, manganese, Mn, zinc, Zn, and copper, Cu). The DPTA extractable Fe, Cu, Zn ranged from 10.31 to 20.17, 4.04 to 8.43, 2.63 to 7.02 and 10.8 to 26.74 mgkg^{-1} soil respectively. All soil samples had adequate amount of micronutrients. DPTA extractable Fe gave negative non significant correlation with soil properties; Mn gave negative significant correlation with pH, clay, CEC and organic carbon while Cu and Zn were positively significantly correlated with pH, clay, cation exchange capacity (CEC) and organic carbon. Since all values were above the critical limits, there is no threat of Fe, Cu, Zn and Mn deficiency in the soils. Deficiency is however likely to develop with continuous cropping and poor fertilizer management.

Key words: Micronutrients, soil properties, pedogenic, geologic.

INTRODUCTION

Micronutrients are chemical elements required in very small amounts for growth and development of plants, this include iron, zinc, copper, boron, manganese and chlorine. Through their involvement in various plant enzymic systems and other physiologically active molecules, these micronutrients play a vital role in gene expression, biosynthesis of protein, nucleic acids, growth substances, metabolism of carbohydrates and lipids (Rangel, 2003). Goa et al. (2008) and Jiang et al. (2009) opined that original geologic substrate; subsequent geochemical and pedogenic processes determine the total levels of micronutrients in soils. Several authors have indicated that the availability of micronutrients in soils depends on soil pH, organic matter content, adsorptive surfaces and other physical, chemical and biological conditions in the rhizosphere (Kabata-Pendias, 2001; Jiang et al., 2009). Large hectares of arable land in Nigeria have been reported to be deficient in micronutrients and many of these deficiencies were brought about by the continuous use of inorganic fertilizers particularly nitrogen, phosphorus, and potassium by farmers, limited use of organic manures as well as non recycling of crop residues are some of the other factors contributing towards rapids exhaustion of micronutrients in soils.

Realizing the seriousness of the problems and considering the decreasing productivity, the present investigation was undertaken to evaluate the status and distribution of micronutrients and their relationship with soil properties.

MATERIALS AND METHODS

The study was conducted in Billiri Local Government Area, Gombe State, located in the northern guinea savanna of Nigeria and lies in latitude 09° 52"N and longitude 11°31" E. The soils parent materials were derived from the older cretaceous sand stones (Bima sandstones and Yolde formation) and the crystalline basement complex rocks (Kaltungo formation, BSADP (1981). The study area has an average rainfall about 897 mm, while the main daily temperatures range from 28 to 32°C (GSADP, 1999).

Soil sampling

Fifty five (55) composites samples were randomly collected at 0 to 30 cm depth using soil auger to avoid any contamination of the soils. The samples were air dried, ground, and passed through

*Corresponding author. E-mail: ibrahima764@gmail.com.

Table 1. Range and average values of physico-chemical properties of soils of Billiri.

Parameter	Range	Mean
Sand (%)	19 - 33	24.5
Silt (%)	26 - 36	31.3
Clay (%)	38 - 48	44.1
pH	6.2 - 7.6	6.90
OC (gkg^{-1})	10.7 - 13.9	12.39
CEC [cmol(+)kg^{-1}]	15.4 - 27.1	22.4

Cation Exchange Capacity (CEC) is expressed as centimoles of positive charge per kilogram (cmol kg-1)

Table 2. Range and average values of micronutrient of soils of Billiri L.G.A.

Parameter ($mgkg^{-1}$)	Range	Mean
Fe	10.31 - 20.17	14.48
Cu	4.04 - 8.43	6.19
Zn	2.62 - 7.02	4.65
Mn	10.88 - 26.74	17.59

2 mm sieve before analysis.

Analytical methods

Particle size analysis, soil pH, organic carbon and cation exchange capacity were determined following the methods described by Baruah and Barthaker (1997). The available fractions of iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) were extracted by DPTA according to Lindsay and Norvell (1978) and the metals in the extract were determined using an atomic absorption spectrophotometer.

The relationship between various soil properties and micronutrient content was established using simple correlation (Harry and Steven, 1995).

RESULTS AND DISCUSSION

Physico-chemical properties

The range and average values of the physico-chemical properties of the soil samples are shown in Table 1. The results showed that majority of the soil were slightly acidic to neutral reaction with medium amount of organic matter content while most of the soils were clay in texture. The soil pH ranged from 6.2 to 7.6 (mean 6.9); organic carbon contents ranged from 10.7 to 13.9 (mean 12.39 gkg). The soil pH influences the oxidation reaction and the solubility of several constituents and the ionic form of several elements. The cation exchange capacity ranged from 15.4 to 27.1 (mean 22.4). The relatively higher values of CEC indicate that some 2:1 clay mineral, probably mortmorillonite and/or illite, were present in the clay fractions.

The range and average values of micronutrients are presented in Table 2. By comparing the extractable micronutrients (Fe, Cu, Zn and Mn) contents with the established criteria set by Lindsay and Norvell (1978) and Esu (1991), in Table 3, all the soils were found to be high in iron, copper, zinc and manganese contents.

The highest mean values of micronutrient obtained from the site as supported by significant correlation value (Table 4) might be attributed to higher organic carbon content which might have likely increased the content of micronutrient. This corroborates similar observations made by Sangwan and Singh (1993), Samndi et al. (2007) and Sharma et al. (2000). Similarly, Muneshwar and Sekhon (1993) also stated that organic matter accounted between 40% DPTA extractable Cu and about 60% DPTA extractable Zn in some alfisols and inceptisols of India.

Correlation studies

Simple correlation studies between extractable micronutrients such as iron, copper, zinc and manganese were made with some physico-chemical properties as shown in Table 4.

Relationship between iron and some soil properties

The r-value between extractable Fe and soil pH was - 0.298. It showed that there was negative non significant correlation between Fe and soil pH; silt, clay, CEC and organic carbon contents r-value were - 0.077, - 0.279, - 0.235 and - 0.285 respectively, their availability in the

Table 3. Critical limits for Interpreting levels of soil nutrients.

Parameter	Rating		
	Low	Medium	High
OC (gkg^{-1})	<10	10 - 15	>15
CEC [cmol(+)kg^{-1}]	<6	6 - 12	>12
Fe ($mgkg^{-1}$)	<4.5	4.5 - 10.0	>10.0
Cu ($mgkg^{-1}$)	<0.2	0.2 - 1.0	>1.0
Zn ($mgkg^{-1}$)	<0.8	0.8 - 2.0	>2.0
Mn ($mgkg^{-1}$)	<5	5 - 10	>10

Adapted from Lindsay and Norvell (1978) and Esu (1991).

Table 4. Correlation matrix between micronutrients and some soil properties.

Parameter	Soil properties				
	pH	Silt	Clay	CEC	OC
Fe	- 0.298	- 0.077	- 0.279	- 0.235	- 0.285
Cu	0.464*	0.409	0.791**	0.756**	0.808**
Zn	0.699**	0.299	0.539*	0.843**	0.847**
Mn	0.740**	- 0.065	- 0.505*	- 0.630*	- 0.636*

**1% significant * 5% significant.

area is not dependent on any significant extent on any of these soil properties. These results are in agreement with findings of Kparmwang and Malgwi (1997) while analyzing available micronutrient in profiles of ultisols and entisols developed from sandstone in north western Nigeria.

Relationship between copper and some soil properties

The r-value between Cu and soil pH was 0.464. It showed that there was positive significant correlation between Cu and soil pH. These results were supported by Saddiq et al. (2008) and Samndi et al. (2007) who reported that Cu was positively correlated with soil pH. The correlation value (r) between Cu and Silt was 0.409. It showed that silt was positive non significantly correlated with Cu. Similar results were obtained by Sharma et al. (1996), and Nazif et al. (2006) who obtained positive correlation between Cu and silt contents. The data given in Table 4 shows that Cu was positively correlated with clay, CEC and organic carbon with (r) value 0.791, 0.756 and 0.808 respectively. Similar results were reported by Verma et al. (2005), Samndi et al. (2007), and Elbordiny et al. (2008) who also reported positive significant correlation between Cu and clay and organic carbon and CEC

Relationship between Zinc and some soil properties

The r-value obtained between zinc and soil pH was 0.699. It showed that there was positive significant correlation between zinc and soil pH. Similar results were obtained by Saddiq et al. (2008). A significant positive correlation between zinc and organic carbon (r = 0.854) indicate that complexing agents generated by organic matter promote zinc availability in soils. These results were similar to the findings of Chinchmalatpure et al. (2000), Verma et al. (2005) and Elbordiny et al. (2008). The r-value obtained between Zn and CEC was 0.843. It showed positive significant correlation between zinc and CEC contents. Similar results were obtained by Elbordiny et al. (2008). The r-value obtained between Zn and clay was 0.539. The results showed that there was positive significant correlation between Zn and clay. Similar results were derived by Mustafa and Fagam (2007). The correlation r-value between Zn and Silt was 0.299. It shows that Zn had positive non significant correlated with silt. Similar results were obtained by Nazif et al. (2006) who reported positive correlation between Zn and Silt content.

Relationship between manganese and some soil properties

The correlation value (r) between Mn and soil pH was -0.740. It shows that Mn had negative significant correlation with soil pH. This indicates that as pH increases, availability of Mn decreases. This result corroborates the reports of Patiram et al. (2000). The correlation value (r) between Mn and Clay, CEC and organic carbon was

- 0.505, - 0.630 and - 0.636 respectively; it means that Mn was negatively and significantly correlated with clay, CEC and organic carbon. This result was dissimilar to the findings of Elbordiny et al. (2008) who reported positive correlation between Mn and Clay, CEC and organic carbon content. The correlation value (r) between Mn and silt was - 0.065. The results indicates negative non significant. This result was dissimilar to the findings of Nasiz et al. (2006) and Verma et al. (2005) who reported positive correlation between Mn and silt content.

Conclusion

The study has shown that micronutrients were well supplied in the soils of the area and therefore deficiencies of the elements are unlikely. However, there is strong influence of organic carbon content on the micronutrient distribution and availability.

RECOMMENDATION

To maximize micronutrients solubility and hence availability to plants, it is best to maintain soil pH at favourable range.

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