Determination of Micronutrients Concentration of Some Selected Farmlands in Mubi Area, North-Eastern Nigeria

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Abstract

The present study determined the micronutrients concentration of some selected farmlands in Mubi area, North-eastern Nigeria. The results revealed that the micronutrients were moderate to high with Fe had the highest content while the Cu had the lowest. The trend of the concentrations in the studied soils were in order of Fe > Pb > Mn > Zn > Cu at surface layer (0-20 cm) while at sub-surface layer (20-30 cm) Fe > Mn > Pb > Zn > Cu with the corresponding values ranged from Fe (17.80-17.84 mg /kg), Mn (3.87-5.22 mg/kg), Pb (3.82-5.37 mg/kg), Zn (1.42-2.18 mg /kg) Cu (0.63-0.93 mg /kg) respectively. It is therefore recommended that regular monitoring and evaluation of micronutrients concentrations of soils need to be adopted planting operations in order to ensure safety of agricultural products for consumption. Also government needs to enforce regulations on indiscriminate dumping of industrial, domestic and agricultural waste for sustainable environmental management and agricultural production.

Key words: *Concentration, Farmlands, Micronutrients, Mubi, Soil*

INTRODUCTION

Fertility or what is also called fruitfulness is not attributable to living beings alone. It is also attributable to such things as the soil or earth. With regard to plant or anything that grows in the soil, the fertility of the soil on which it grows determines to fertility of the plant itself. Hence, soil fertility is an important factor which determines the growth and productivity of plants. It is determined by the presence or absence of macro or micronutrients. Iron (Fe), Manganese (Mn), Copper (Cu) and Zinc (Zn) are essential micronutrients for plant growth (Gao, *et al.*, 2008). Although required in minute quantities, however, micronutrients have the same agronomic importance as macronutrients and play vital roles in the growth of plants (Mortvedt, *et al.*, 1991), Nazif, *et al.*, 2006). Most micronutrients are associated with the enzymatic systems of plants. For instance, Zinc (Zn) is known to promote the formation of growth hormones, starch and seed development, Fe is important in chlorophyll formation, Copper (Cu) in photosynthesis and Manganese (Mn) activates a number of important enzymes. Mubi area is an agrarian community which engages in farming diverse crops, cereals; Maize, Millet, Sorghum, and Rice, roots and tubers; Yam and Sweet potatoes, Legumes; Sesame, Groundnut, Soybean and cowpea, Vegetables; Tomatoes, Pepper, etc at both subsistence and commercial scale. Importantly also is the fact that despite diversity of crops cultivated in the area, only primary nutrients fertilizers have been in use in the area with high possibility of creating nutrient imbalances. However, local farmer do not carry out soil analysis to determine the fertility status and nutrients requirement but they just apply the chemical fertilizer haphazardly and this does not give the expected yields. Due to the intense and continued cultivation with eminent consequences of declined soil productivity has led to the decline in soil nutrients. Information on soil micronutrient status of northern Nigeria savanna soils is scanty. Thus, several researches advocate the need for assessing the micronutrients status of soils (Ibrahim, *et al.*, 2011; Mustapha, *et al.*, 2011).However, quite studies in Mubi area aimed to analyze fertility status of the area such as the work of Jones and Wild (1975), Tekwa *et al.*, (2011) Sadiq and Tekwa, (2022). But there is no research conducted in the area determines the micronutrients of the soil. Thus, this research aimed to determine the micronutrients concentrations of some selected farmlands in Mubi area, North-eastern Nigeria.

MATERIALS AND METHOD

The Study Area

Mubi North and Mubi South are Local Government Areas of Adamawa State in Nigeria. Its coordinates are 10°16'N 13°16'E / 10.267°N 13.267°E (Fig. 1) with a total land mass of 506.4Km^2 and a population size of 759,045 people.

The area is home to River Yadzaram which is one of the major rivers that drain into the Lake Chad. The river has a total length of about 330 kilometers takes it source from the Hudu hills south-east of Mubi town and flows northward into the Chad (Adebayo and Dayya 2004).

The soil of Mubi regions, therefore, fall under the category of ferruginous tropical soils of Nigeria based on the genetic classification made by the Food and Agricultural Organization of the United Nations. Mubi region falls within the Sudan Savanna belt of Nigeria's vegetation zones. The region's vegetation type is best referred to as Combretaceous woodland Savanna. It is made up of grasses, aquatic weeds in river valleys and dry land weeds interspaced by shrubs and woody plants (Adebayo, 2004).The Yedzeram valley soil are mostly hydromophic in nature and fall within the 213 mapping unit made up of Entisol and Inseptisols, based on USDA soil order.

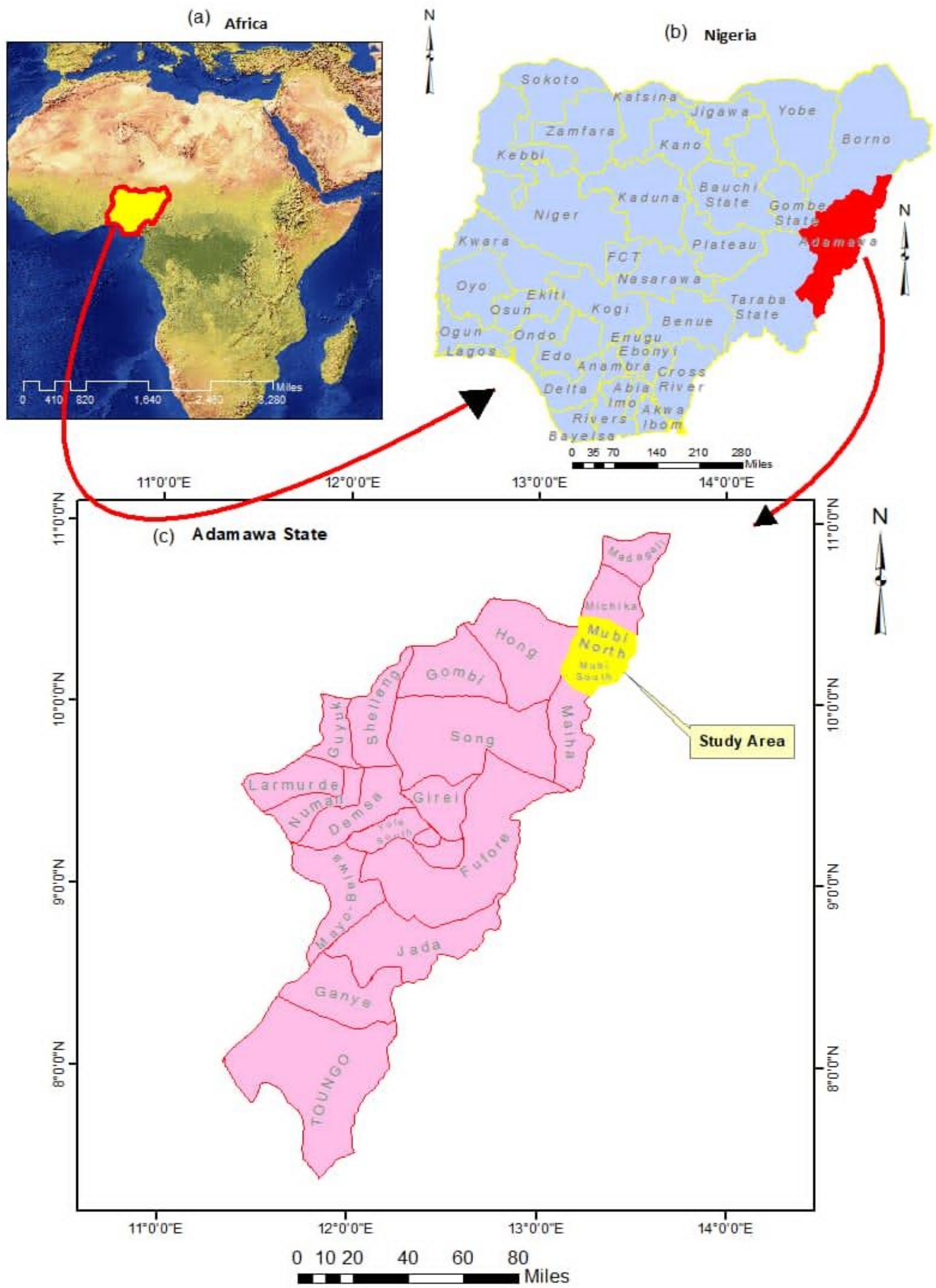

Figure 1: Map of the Study Area

Field Study and sampling

Pre-field survey was carried out in the surveyed area involving gathering information from soil and topographic maps and also to getting general idea of the soils and their variation.

Samples was purposively sampled within the grid cells, the exact field location was determined and properly marked with global positioning system (GPS) using Are GIS. The whole study area was divided into 5, 000 by 5,000 m as geo-referenced on the grid maps as shown in figure 2. Auger samples were collected at the depth of 0-20 cm and 20-50 cm for surface and sub-surface respectively, where the cells are not square, the number of the core samples was reduced equivalent to the size of the portion within the grid cell that is affected and a composite sample was made. A total of 112 samples of both surface and sub-surface were collected.

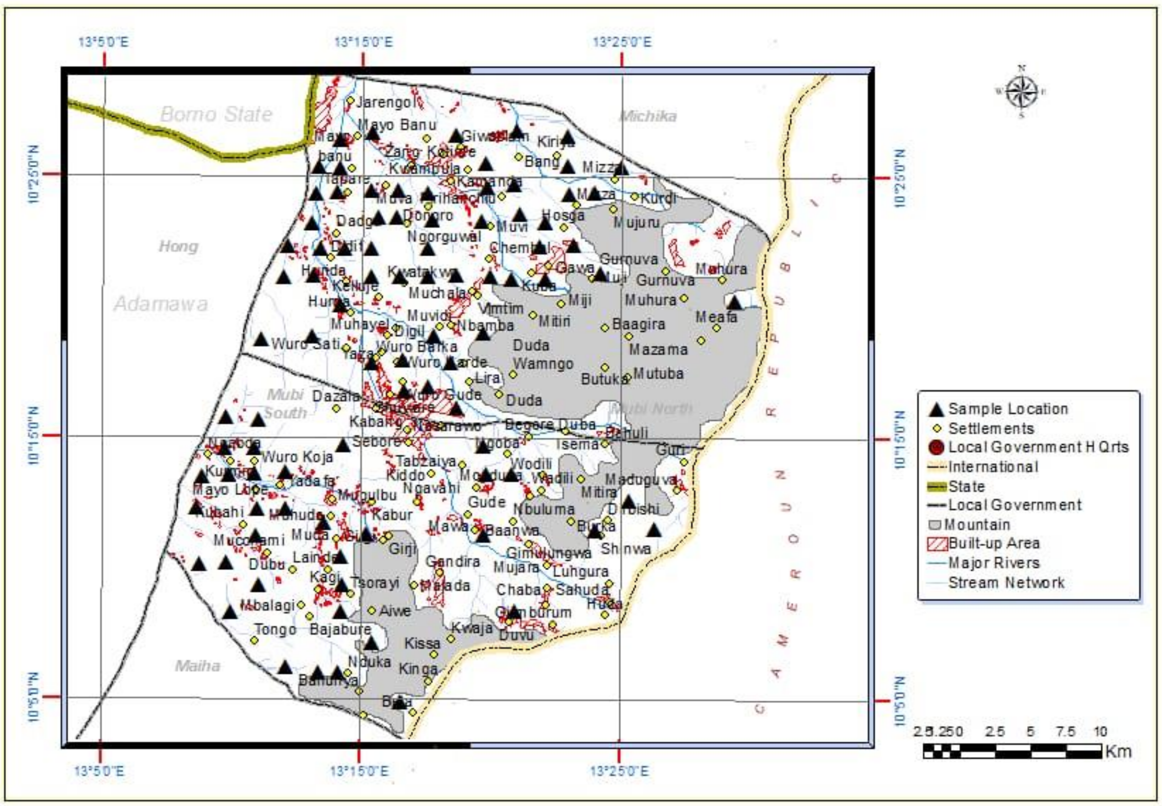

Figure 2: Map showing the sampling points of the study area

Laboratory Analyses

The soil samples collected were air-dried, and crushed using pestle and mortar to pass through a 2mm sieve, some of the samples were further passed through 0.5mm for chemical analysis. The soil samples collected were analyzed for their physical and chemical using standard laboratory procedures at the Department of Soil Science Laboratory, Modibbo Adama University Yola. Some micronutrients determined include Cu, Fe, Mn and Zn – Fe was extracted with 1N acetic acid (pH 4.8), while Mn was extracted with 1N acetic acid (pH 7.0) as described by Jaiswal, 2003. Zn and Cu were extracted by diphenylthiocarbazone complexing agent.

Data Analysis

Explanatory data analysis was performed using SAS (version 9.4) statistical software. The data distribution was analyzed by classical descriptive statistics where mean, maximum, minimum, standard deviation was determined.

RESULTS AND DISCUSSIONS

Determination of Micronutrients of Mubi North, LGA

Iron (Fe)

The soil micronutrients of Mubi North LGA are presented on Table 1. The results shows that iron content (Fe) of the soil at surface horizon (0-20 cm) ranges from 17.34-18.34 mg/kg with mean value of 17.84 mg/kg while slight decrease was observed at the sub-surface layer (20-50 cm) with a recorded values ranging from 15.87-18.03 mg/kg with averaged of 16.95 mg/kg respectively. Generally, the Fe content was characterized as high as the mean values were greater than 5 .00 mg/kg as reported by Esu, (1991) and in conformity with reported values by Mustapha and Singh (2003), Mustapha *et. al.*, (2010: Mustapha *et. al.*, (2010) and Mulima *et al.*, (2015) in some areas of Gombe State in Nigeria with mean values of 19.96 mg/kg and 10.80 mg/kg. It is, therefore, unlikely that Fe deficiency is experienced in these soils. This is true especially when viewed against the report (Chen and Barak, 1982; Sakal *et al.*, 1984; Mengel and Geurtzen, 1986) that Fe deficiency is unlikely in relatively acid soils (slightly acidic condition soil) as Fe is known to be soluble under relatively acidic and reducing conditions (Chesworth, 1991). The presence of high concentrations of Fe in soils could lead to its precipitation and accumulations and upon complex chemical reactions, lead to the formation of soft unindurated plinthite (Mustapha *et al.*, 2010). It was also observed that the values of Fe in the study area showed higher content of Fe at the topsoil and decreased at the subsoil as was also reported by Abigail and Ysuf, (2021). This could be clearly been the reason of low Avp due to fixation effects of high Fe content of the soil. Thus, Iron at the topsoil is paramount, as it is the Fe at the topsoil that is required for crop growth and development.

Manganese (Mn)

The manganese (Mn) content of the soil varied from 3.60-5.46 mg/kg at surface layer (mean =4.53 mg/kg) and 3.31-5.29 mg/kg (mean= 4.30 mg/kg). These values show that the Mn ranges between moderate to high within the soil layers (Table 1). The high Mn content observed across the different soil orders was expected with soil acidity due probably to increased solubilization of manganese oxides and release of Mn^{2+} at pH > 5 (Mulima *et al.*, 2015). This also suggests that Mn cannot be a limiting factor to sustainable cop production (Hassan and Ogbonaya, 2016). A similar report on the high content of Mn was made by Kingsley *et al.*, (2019) at Akamkpa local government area of Nigeria who posited that Mn toxicity could be a common problem. However, Mn toxicity might not be a problem on soils with a high fraction of sand; the high sand content improves aeration and drainage, thus preventing manganese reduction (Mustapha *et al.*, (2010). Thus, the results of Mn in the area could be attributed to this fact that it is unlikely for Mn to be deficient in acidic soils (Abigail and Ysuf, 2021).

Lead (Pb)

The lead (Pb) soil content observed at the surface layer (0-20 cm) varied from 3.65-5.52 mg/kg while at sub-surface (20-50 cm) ranged between 0.76-1.40 mg/kg as preseten on Table 1 respectively. It was revealed that Pb content of soil decreases apparently with an increasing depth which might be linked to the leaching effect of the soil. Thus, soils of Mubi are predominantly sandy loam with high porosity as was reported by Tekwa *et al.,* (2011).

Zinc (Zn)

The zinc content of the soil at the upper layer (0-20 cm) ranges from 0.78-2.78 mg/kg with mean value of 1.78 which is considered as high based on the rating of Esu, (1999) while at the sub-surface layer (20-50 cm) it reduced to moderate having a values varied between 1.09-1.50 mg/kg with average of 1.30 mg/kg as shown on Table 1 respectively. Declining Zn content was found down the layers of the soil justifying the leaching effect of the soil characterized with moderate to high presence of pore spaces which easily permits transmission of ions down the profile. Critical range of 1.0 to 5.0 mg/kg (Sims and Johnson, 1991, Deb and Sakal, 2002) had been reported elsewhere. However, the values obtained from this study are within the range obtained from the report of Lombin (1983), who worked on the Zn content of Nigeria savanna soils. Zinc had been reported to be generally of low mobility in soils (Chesworth, 1991) and has a tendency of being adsorbed on clay size particles (Sims and Johnson, 1991, Alloway, 2008). From the result obtained in this study, it could be inferred that some Northern Nigerian savanna soils are deficient in Zn (Oyinlola and Chude, 2010). Based on the critical limits of Esu (1991), all the soils fell in the category of ‟low” Zn status and would require Zn fertilization for a better crop production. However, as Zn decreases with depths, its implication here is that plants may not have a Zn ‟store “in the lower surface. Similar decrease with depth was also observed by Singh and Shukla, (1985) and Bassirani *et al.,* (2011). This is also in line with the findings of Mustapha *et. al.,* (2011) in soils of Gombe, Nigeria (Mulima *et al.,*2015). It is suggested that supplementary application of Zn will be required for sustainable arable crop production in the soils studied and application of organic matter to improve the overall fertility of the soil.

Copper

The results on the copper content of the soil was generally medium at both the surface (0-20 cm) and sub-surface (20-50 cm) layers with a considerable ranged values of 0.22- 2.45 mg/kg and 0.11- 2.5 mg/kg having an equal mean value of 0.93 mg/kg at both the soil surfaces as presented on Table 1 respectively. However, it could be noted that Cu content decrease with depth which might be linked to the increase of the amount of OM with depth. This is because organic matter has the affinity to hold on Cu in the soil therefore decreasing it availability.

Table 1. Soil Micronutrients Properties of Mubi North

Micronutrients	Range	Mean	SD	CV
Soil Micronutrients Properties of Mubi North At Surface(0-20 cm)				
Micronutrients	Range	Mean	SD	CV
Fe (mg/kg)	17.34-18.34	17.84	1.40	7.88
Mn (mg/kg)	3.60-5.46	4.53	2.62	57.78
Pb (mg/kg)	3.65-5.52	4.59	2.64	57.54
Zn (mg/kg)	0.78-2.78	1.78	7.98	158.30
Cu (mg/kg)	0.22-2.45	0.93	0.61	38.15
Soil Micronutrients Properties of Mubi North At Subsurface(20-50 cm)				
Micronutrients	Range	Mean	SD	CV
Fe (mg/kg)	15.87-18.03	16.95	3.04	17.95
Mn (mg/kg)	3.31-5.29	4.30	2.80	65.10
Pb (mg/kg)	0.76-1.40	1.08	0.90	83.16
Zn (mg/kg)	1.09-1.50	1.30	0.57	43.85
Cu (mg/kg)	0.11-2.5	0.93	1.75	30.64

Key: Fe=Iron, Mn=Manganese, Pd= Lead, Zn= Zinc.

Determination of soil micronutreints of Mubi South LGA.
Iron (Fe)

Results on the soil micronutrients are presented on Table 2. The results revealed that the iron (Fe) content of the soil varied from 16.99-18.69 mg/kg with mean value of 17.84 mg/kg at the surface layer (0-20cm) and at the subsurface layer (20-50 cm) varied between 17.11-18.49 mg/kg having mean value of 17.80 mg/kg respectively. The Fe content was characterized as high (5 > mg/kg) as described by Esu, (1991). These values are within the reported values by Kparmwang *et al*. (2000) and below the values reported by Kparmwang *et al*. (1995). Although available Fe is generally high in the tropical soils, localized deficiencies of Fe are known to occur (Enwezor *et al*., 1990). About 16 soils have available Fe value above the critical range of 3.0– 4.5 mg/kg Fe (Sillanpää, 1982). Deb and Sakal (2002) had reported critical range Fe as 2.5 – 5.8mg/kg

Fe. High levels of available Fe in these soils could be due to the acid conditions of the soils. Available Fe poses no fertility problem in the soils studied (Oyinlolaa and Chude, 2010). The contents of available Fe in the soils are sufficient and well above the critical range of 3.0-4.5mg/kg (Sillanpää, 1982) and 2.5-5.8mg/kg (Deb and Sakal, 2002) extractable Fe. This observation is similar to that of Mustapha *et. al.*, (2010); Biwe, (2012) and Mulima *et al.*, 2015).

Manganese (Mn)

The manganese content of the soil was moderate to high at the upper layer (0-20 cm) with mean value of 5.22 mg/kg as presented on Table 2. Conversely, at the subsurface (20-50 cm) the Mn content decreases to a mean value of 3.87 mg/kg. Esu, (1991) explained that Mn content of the soil ranged from 1.1-5.0 mg/kg is rated moderate. The high Mn content observed across the different soil orders may be due to soil acidity, probably due to increased solublization of manganese oxides and release of Mn^{2+} at pH > 5 (Mulima *et al.*, 2015). This also suggests that Mn cannot be a limiting factor to sustainable crop production (Hassan and Ogbonaya, 2016). A similar high Mn content of Mn was reported by Kingsley *et al.*, (2019). However, Rengel (2015) opined that Mn toxicity might not be a problem on soils with a high fraction of sand; the high sand content improves aeration and drainage, thus preventing manganese reduction (Mustapha *et al.*, 2010). This implies that the soils contain Mn above the critical available range of 3 to 5 mg/kg reported by Lindsay and Norvell (1978) and 1 – 5 mg/kg reported by Esu (1991). Studies carried out within Nigeria from north to the south shows that Mn deficiency was not prevalent (Abigail and Yusufu, 2021). By implication, these values suggest that Mn content of the soils is high and cannot be a limiting factor to successful crop production in the area. Although, the high contents of Mn in the soils studied could lead to the formation of complexes, which could lead to serious drainage and infiltration problems as reported by Mustapha *et. al.*, (2011) and Mulima *et al.*,2015).

Lead (Pb)

The lead content (Pb) of the soil varied from 3.84-6.90 mg/kg with mean value of 5.37 mg/kg characterized as high at the surface layer (0-20 cm) meanwhile, at the subsurface layer (20-50 cm) the Pb content varied from 2.59-5.06 mg/kg with mean value of 3.87 mg /kg as presented on Table 2 respectively. The high content of Pb at surface might be linked to activities anthropogenic sources which are associated mainly with industrial activities such as metal finishing, paint pigment, traffic emission and other human activities such as industrial production, leather tanning, battery manufacturing, mining, agriculture and transportation. Use of pesticides and phosphate fertilizers all release a high amount of heavy metals to the biosphere. (Omar, 2004).Heavy or toxic metals are common environmental. Olowookere, *et al.*, (2018) also affirmed that pollutant and are released into the soils from natural or anthropogenic sources. It could also be linked to paraent material as was ascertain by Olowookere, *et al.*, (2018) that the main natural sources of metals in soil are weathering of parent material and soil erosion)

Zinc (Zn)

The Zinc content (Zn) of the soil at the surface layer (0-20 cm) ranged from 1.14-1.70 mg/kg with mean value of 1.42 mg/kg described as moderate meanwhile, at the subsurface horizon (20-50 cm) the Zn content have increased to high level with mean value of 2.18 mg/kg (Table 2). The Increase of Zn content with depth might be attributed to leaching effects. Kparmwang and Malgwi (1997) reported for the soils in the Northern guinea Savanna of Nigeria, 0.81 to 1.34 (mean = 1.13) mg/kg for Ustults in Galambi District in Bauchi State, Nigeria (Mustapha and Singh, 2003;

Mustapha, *et al.*, 2010. It is pertinent to note that the Zn values obtained in this study fall below the critical 0.90 mg/kg given by Lombin (1983). It is therefore, follows that for successful and sustainable crop production in all the areas studied, Zn application will prove beneficial. From the result obtained in this study, it could be inferred that some Northern Nigerian savanna soils are deficient in Zn (Oyinlolaa and Chude, 2010).

Copper

The amount of copper concentration in the studied soils presented in Table 2 revealed that at surface layer of 0-20 cm depth the Cu content was found to be 0.63 mg/kg and increases slightly to 0.65 mg/kg at the sub-surface layer which are considered moderate based on the limit given by Esu, 1991. This result is in conformity with the findings of who Olowookere, *et al*, (2018) who also reported slight decrease in the amount of Cu content with increasing depth from 22.60 mg/kg to 21.00 mg/kg at Gwagwalada area of Abuja. However, it is imperative to state that the mean value reported for Gwagwalada (Kuje) area is higher than amount recorded in this study which could clearly due to disposal of waste lubricants and automobile wastes since it is very close to mechanic workshops of the area as was ascribed by Olowooker *et al.*, (2018). Thus, no such disposal observed on the farmlands of Mubi area that may leads to high content of Cu in the soil, as biodegradable waste can introduce metallic copper into the soil (Dara, 1993).

Table 2. Descriptive Statistics of Soil Micronutrients Properties of Mubi South LGA.

Soil Micronutrients Properties Of Mubi South At Surface (0-20 cm)

Micronutrients	Range	Mean	SD	CV
Fe (mg/kg)	16.99-18.69	17.84	1.59	8.90
Mn (mg/kg)	3.66-6.77	5.22	2.91	55.78
Pb (mg/kg)	3.84-6.90	5.37	2.87	53.46
Zn (mg/kg)	1.14-1.70	1.42	0.52	36.89
Cu (mg/kg)	0.11-1.91	0.63	0.39	15.83

Soil Micronutrients Properties of Mubi South At Sub-Surface (20-50 cm)

Micronutrients	Range	Mean	SD	CV
Fe (mg/kg)	17.11-18.49	17.80	1.29	7.25
Mn (mg/kg)	2.65-5.09	3.87	2.28	58.97
Pb (mg/kg)	2.59-5.06	3.82	2.31	60.37
Zn (mg/kg)	0.02-4.34	2.18	4.05	85.53
Cu (mg/kg)	0.11-1.99	0.65	0.47	22.33

Key: Fe= Iron, Mn=Manganese, Pd=Lead, Zn=Zinc

CONCLUSIONS

Micronutrients concentrations in the soil are also considered as the important soil mineral constituents which supply nutrients that support plant growth and development. Soils of Mubi area have been assessed to have varied from moderate to high level with in all the farm locations. The micronutrients was found to have increased in order of Fe > Pb > Mn > Zn > Cu at surface layer (0-20 cm) while at sub-surface layer (20-30 cm) Fe > Mn > Pb > Zn > Cu respectively. Therefore, micronutrients concentrations of soils need to be monitored before any cropping system with the aim of ensuring safety of agricultural products for consumption, and also prevent heavy metals poisoning due to soil ingestion. Government needs to enforce regulations on indiscriminate dumping of industrial, domestic and agricultural waste for sustainable environmental management and agricultural production.

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