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Status and distribution of available micronutrient in Udic Kanhaplustults of Bauchi local government area, Bauchi state

Hassan, AM*, Ogbonnaya, C.S
Department of Crop Production, Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi. PMB 0248, Bauchi State, Nigeria.

***Corresponding Authors**
Name: Hassan, AM
Email: ahmahd@atbu.edu.ng

Abstract: A study was conducted to assess the status and distribution of available micronutrient (Zn, Mn, Cu and Fe) in Udic Kanhaplustults of Bauchi local government area, Bauchi state. A total of 12 composite soil samples were collected at 0-15 and 15-30 cm depths from six different, purposively selected representative locations (Yelwa Tudu, Yelwa Makaranta, Gwallameji, Lushi, Bayara and Mararaba Liman Kataghum). The soil samples were bulked together to form a composite sample for each site and was analyzed using standard procedure. The results showed that the soil texture ranged from sandy loam to loam and the mean values were 0.22, 0.25, 2.25 and 1.81mg/kg for Zn, Cu, Fe, and Mn respectively. The extractable micronutrient distribution was not significantly influenced by depth but varied significantly ($P<0.05$) with locations. The soils across the location were generally below the critical limiting especially Zn content and would benefit immensely from zinc application. However, the contents of Cu, Fe, and Mn were rated low to medium in all the locations considered except for Yelwa Tudu where Fe content was high. Therefore, for sustainable and efficient food production, supplementary application of these elements is suggested and application of organic matter to improve the overall fertility of the soil and to reduce the possible development of plinthic/petroplinthic layers.
Keywords: Micronutrient, double acid extractant, soil, fertility, texture

INTRODUCTION

Micronutrients are element required in small quantities for higher plant growth and production. These elements are important in enzyme metabolism of organic acids, protein synthesis, respiration, oxidation processes, and stability of cytoplasmic ribosome and activation of enzymes system. Over the years, emphasis has been on ways to ameliorate soil macronutrient deficiency with little effort made on micronutrient deficiency in Nigeria soils; especially Udic Kanhaplustust. Just like macronutrient, micronutrient deficiencies are hampering crop productivity. By and large, micronutrient deficiencies do not only reduce crop productivity but crop plant low in these nutrients will drastically affect human health and well being. Although, these elements are required in small quantity without it, plant will not complete its cycles. Water logging, eroded soil, intensive cultivation of soils and use of improve crop varieties which take up many nutrient from soil are major cause of micronutrient deficiency in Udic Kanhaplustults.

The pursuit of for sustainable food sufficiency in Nigeria through the use of more scientific intensive agriculture system has necessitated the appraisal of the nutrient status of Nigerian soils; most especially the micronutrients which was previously overlooked. Therefore, this study was conducted to appraise the status and distribution of Manganese, copper, Iron and Zinc in Udic kanhaplustults of Bauchi Local Government Area of Bauchi state, Nigeria.

MATERIALS AND METHOD

The Study Area

The study was conducted in Bauchi local government area of Bauchi state. It is situated at an altitude of 600m above sea level in the Northern guinea savannah of Nigeria [1]. The geomorphology of the area is highly variable and controlled by underlying rock types [2]. The major topographic land forms are hills, inselbergs and ridges of variable heights as well as deep entrenching river valley and gentle undulating plains [3]. The climate of the area is tropical and is based on the inter-tropical convergence zone, which gives rise to the North East and South West wind systems [3]. The soils are describe as poorly drained soils and predominantly used in cropping rice which is characterized by distinct raining (April- October) and dry (November-march) seasons with total annual rainfall range of 600-1200mm.

Soil Sampling and Preparation

Soil samples were collected from six locations (Yelwa tudu, Yelwa makaranta, Gwallameji, Lushi, Bayara and Mararaba liman kataghum) in Bauchi local government area of Bauchi state at a depth of 0-15 and 15-30cm. The soils were previously classified as Udic Kanhaplustults [4]. The soil samples were bulked

together to form a composite sample for each site. The samples were air dried, ground using porcelain pestle and mortar and passed through a 2mm sieve. The sieved soil samples were stored in polyethylene bags properly labelled and were used for all laboratory analyses using standard procedures.

Laboratory analysis

The samples were analyzed for some physical and chemical properties including some micronutrients (Fe, Cu, Zn, Mn) using standard laboratory procedures.Particle size distribution was determined using the Boyoucos hydrometer method as described by Day [5]. Soil pH was determined in both water and 0.01M$CaCl_2$ solution at 1:1 soil/water and 1:2 soil/$CaCl_2$ suspensions respectively using glass electrode pH meter while Organic carbon was determined using the dichromate oxidation method [6]. Cation exchange capacity of the soil was determined with 1N ammonium acetate, buffered at pH 7.0 [7]. The excess acetate was removed by repeated washing with alcohol. The adsorbed ammonium ions were distilled by Kjeldahl method [8]. Percentage base saturation was calculated by dividing the total exchangeable bases by the cation exchange capacity multiply by 100.The micronutrients (Cu, Fe, Mn and Zn) were extracted using hydrochloric acid extraction method as described by Osiname *et al*. [9] and their respective concentration was determined using Atomic Absorption Spectrometer at appropriate wave lengths

Data analysis

Data obtained were subjected to statistical analysis using the analysis of variance [10]. Means that were significantly different were separated using the least significant difference (LSD).

RESULT AND DISCUSSIONS

Status and distribution of Copper

The extractable copper in the soil ranged from 0.1 to 0.41mgkg^{1}, based on Osiname [9] ratings, the soils falls into low to medium categories in all the locations considered. The low to medium copper concentration in all the location considered may be attributed to high moisture content of the soil over a long period of time. It is noted, however, that soils from Yelwan Tudu (0.14 mgkg^{1}) and Lushi (0.32mgkg^{1}) fall below the critical 0.2 mgkg^{1}as opined by Osiname (1973) for optimal crop growth. These soils falling below fertility category may hence, benefit from Cu application.It is noteworthy (Table3) that soils in the upper 0-15cm contained (0.15 mgkg^{1}) below the critical value of 0.2 mgkg^{1} while those of the lower 15-30cm depth contained higher Cu content (0.34 mgkg^{1}). This also agrees with the finding of Mustapha, *et al*. [11] worked with the soils of Akko Local Government area of Gombe state in the same agro ecological zone.

Zinc (Zn)

Table 3 shows that the soils vary significantly ($P \leq 0.05$) in Zn content. The differences observed in the distribution of Zn between the soils could be attributed to the heterogeneous nature of the material and moisture content availability. The Zn content of the soils ranged from 0.15 to 0.36 mgkg^{1}. This is, in line with the ratings of Osiname as adopted by Esu [12]. The values are in agreement with the findings of Mustapha, *et al.* [11] who reported similar values for soils in Gombe State. These values fall below the 1.2 to 4.0 mgkg^{1} obtained by Kparmwang and Malgwal [13] for soils in Northern guinea savannah of Nigeria. It is pertinent to note that Zn values obtained in the soils fall below the critical 0.8 mgkg^{1} given by Esu [12]. It is therefore, follows that for successful and sustainable crop production in all the soils in the locations, application fertilizer fortified with Zn will prove beneficial (NPK_{Zn}). Although, the concentration of Zn on depth wise, had no significant ($P \leq 0.05$).

Iron (Fe)

There was significant ($P \leq 0.05$) difference in Fe distribution between the soils. The significant ($P \leq 0.05$) difference observed could be attributed to differences in pH, organic carbon level and heterogeneous nature of the alluvial material which constitute the soil parent material. Macias [14] reported that pH and organic matter influence the availability of iron and other micronutrient. The soils ranged from 1.25 to 6.4mgkg^{1}. These values ranged from medium to high. The Fe content was lower than the ones reported by Mustapha *et al.* [15] for fadama soils in Gombe state and Mustapha and, Singh [4] for some soils in Bauchi state. It was noted, that with the exception of Yelwan Tudu and Gwallameji other locations fall below the critical 4.5mgkg^{1}as suggested by Esu [12] for optimal crop growth. These soils falling in low fertility category may hence, benefit from organic manure/ Fe application. The iron content of the soils showed no significant ($P \leq 0.05$) with depth.

Manganese (Mn)

The significant ($P \leq 0.05$) difference observed in the Mn content between the soils could be due to annual deposition of materials by flood water, amount of organic carbon, clay and soil pH. AESA [16] reported that Mn is strongly affected by pH and organic matter content of a soil. The Mn values of the soils ranged from 0.85 to 3.25mgkg^{1} (Table3). It is rated low to medium in its status [12]. The value obtained are below the ones obtained for some Ustult in Bauchi, Nigeria (7.89 to 12mgkg^{1}) as reported by kparmwang [17]. The soils of Lushi (0.55mgkg^{1}) fall below the critical value of 1.0mgkg^{1} suggested by Esu [12]. Therefore Mn application will prove beneficial for sustainable crop production. However, the medium Mn content obtained for other fadama location suggest that Mn content cannot be a limiting factor to successful crop production in the area. On the other hand, the no

significant (P≤ 0.05) increase of Mn content with soil depth is in conformity with the finding of Ephraim [18], who reported increase in Mn with depth for Fadama soils elsewhere in Nigeria.

Tabl-1: Particle size distribution of Udic kanhaplustultssoils in Bauchi LGA, Bauchi state

	Sand	Silt	Clay	Texture
Location		%		
Yelwan Tudu	53.00a	32.28bc	14.72	Sandy Loam
Yelwan Makaranta	52.00a	30.28bc	18.72	Sandy Loam
Lushi	40.00ab	37.28b	22.72	Loam
Gwallameji	46.00ab	33.28bc	20.72	Loam
Bayara	33.00b	44.28a	22.72	Loam
Mararraban Liman	48.00ab	29.28c	22.72	Loam
Mean	45.33	34.28	20.39	Loam
LS	*	*	NS	
SE±	4.17	1.87	2.73	
Depth(cm)				
0-15	44	37.61	18.05	Loam
15-30	46.67	30.95	22.72	Loam
Mean	45.33	34.28	20.39	Loam
LS	NS	**	NS	
SE±	2.44	0.94	1.58	

Means followed by the same letter within a column are not statically different at (P≤ 0.05)
LS = level of significance
*= Significant at (P< 0.05) probability level
**= Significant at (P<0.001) probability level
NS = Not significant
SE ± = Standard Error

Table-2: pH, Base saturation and organic carbon of Udic kanhaplustults soilsin Bauchi LGA, Bauchi state

	pH(in water) (1:1)	pH(in $CaCl_2$) (1:2)	BS	Organic carbon
Location			%	gkg^{-1}
Yelwan Tudu	6.50a	5.78a	31.00	8.74
Yelwan Makaranta	5.90b	4.86b	26.00	10.72
Lushi	6.14ab	5.34ab	36.00	10.29
Gwallameji	6.07ab	5.31ab	28.00	8.68
Bayara	5.89ab	5.12ab	19.00	9.55
MararrabanLiman Katagum	5.65b	4.83b	19.00	12.28
Mean	6.02	5.21	26.75	10.04
LS	*	*	NS	NS
SE±	0.14	0.21	9.89	1.47
Depth (cm)				
0-15	5.97	5.12	25.83	12.93
15-30	6.08	5.29	27.67	7.15
Mean	6.02	5.21	26.75	10.04
LS	NS	NS	NS	**
SE±	0.08	0.12	5.71	0.85

Means followed by the same letter within a column are not statically different at (P≤ 0.05)
LS = level of significance
*= Significant at (P< 0.05) probability level
**= Significant at (P<0.001) probability level
NS = Not significant
SE ± = Standard Error

Table-3: Exchangeable micronutrient of Udic kanhaplustults soils in Bauchi LGA, Bauchi state

	Cu	Zn	Fe	Mn
Location		$Mgkg^{-1}$		
Yelwan Tudu	0.14	0.20ab	6.4a	2.2bc
Yelwan Makaranta	0.41	0.21ab	2.10b	2.95ab
Lushi	0.10	0.21ab	1.25b	0.85d
Gwallameji	0.30	0.36a	2.6b	2.7abc
Bayara	0.30	0.19ab	1.65b	3.25a
MararrabanLiman Katagum	0.20	0.15b	1.9 b	1.85c
Mean	0.25	0.22	2.25	1.81
LS	NS	*	*	*
SE±	0.16	0.49	0.96	0.27
Depth				
0-15	0.15	0.18	2.47	2.05
15-30	0.34	0.24	2.83	2.55
Mean	0.25	0.22	2.25	1.81
LS	NS	NS	NS	NS
SE±	0.09	0.03	0.56	0.15

Means followed by the same letter within a column are not statically different at ($P \leq 0.05$)
LS = level of significance
*= Significant at ($P < 0.05$) probability level
NS = Not significant
SE ± = Standard Error

Table-4: Micronutrients contents rating:

Parameter	Low	medium	high	Units
Zn	<0.8	0.81-2.0	>2	$mgkg^{1}$
Cu	<0.2	0.2-20	>2	$mgkg^{1}$
Fe	<2.5	2.5-5	>5	$mgkg^{1}$
Mn	<1.0	1.1-5.0	>5	$mgkg^{1}$

Source: Adapted by Esu [12].

CONCLUSION AND RECOMMENDATION

Results of the study indicated that Zn content within the locations considered fall below the critical limits as opined by Esu, [12] and would required incorporation of Zn fertilizer for nutrient balance and to maximize production. Cu, Fe, and Mn in the soils were found to be low to medium in all the locations except for Yelwa Tudu which was high. This means that crops grown are likely to develop deficiency symptoms with continuous cultivation over a lengthy period of time without been replenished. However, supplementary application of these element and proper drainage system is essential. Therefore, it is recommended that for successful and profitable crop production, supplementary application of either organic or inorganic form of fertilizers fortified/or supplemented with these micronutrients is vital.

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