ISSN: 6109 – 5942
Volume 8, Number 2, 2023
International Journal of Agricultural Extension and Technology

ZINC CONTENT IN SOILS OF PLATEAU STATE COLLEGE OF AGRICULTURE GARKAWA FARM.

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ABSTRACT
An investigation on the content of zinc at college of Agriculture Garkawa Farm in Northern Guinea savannah of Nigeria was carried out in April, 2022. A total of sixty (60) composite soil samples were collected from 0-15cm 30-45cm and 45-60cm depths of purposively selected representative locations in the study area and analyzed according to the pedogenic horizons using standard procedures. Particle size distribution of the soils showed sandy loam texture; soil pH was strongly acidic with a mean of 4.93; exchangeable bases (Ca, Na, Mg and K) were observed to be medium and in some cases high and did not differ significantly (p>0.05). Low content values were observed for zinc with a mean of 5.4gkg^{-1} which did not differ significantly. The low value for zinc was due largely to soil conditions and unhealthy practices at the site. Growing zinc-rich crops and addition of organic manure like compost were recommended to fix zinc deficiency and increase the level.

Key words: zinc, content, soils.

INTRODUCTION
Zinc is one of the eight trace elements which are essential for the normal healthy growth and reproduction of crop plants, the other elements are boron, chlorine, copper, iron, manganese molybdenum and nickle. These elements are referred to as essential trace elements or microelements because they are only required in relatively small concentrations in the plant tissues (5-100mgkg^{-1}) (Brian and Alloway, 2008).

All soils contain measurable concentrations of all the essential trace elements as well as other trace elements which are not for plants and or animals, but the concentrations can vary considerably, in some cases they can be very low. Trace elements in soils are derived from geochemical weathering of the rock fragments on which the soil has formed (the soil parent materials).

In plant, zinc is involved in several key physiological functions (membrane structure) photosynthesis, protein synthesis and drought and disease tolerance) and is required in small nevertheless critical contents. Zinc plays a substantial role in many biological processes and is an essential trace element for proper growth and reproduction of plants, and health of animals and humans, it has also been reported to cause contamination of soil, water and food chains.

Generally, micronutrients were first recognized as a limiting factor in crop production in the United States in Florida during the 1920's and deficiencies have seldom been reported as limiting crop production in tradition system of subsistence farming (Tisdale *et al,* 1975).

The content of zinc in natural soil is related to the chemical composition of the parent rock and the extent of weathering processes. In Agricultural soils zinc is mostly unevenly distributed and its content ranges between 10 and 300mgkg$^{-1.}$ The range of total zinc content in soils reported in the literature tends to show an overall mean of around 50-55mgkg$^{-1.}$ Other researches indicate that typical total zinc contents in uncontimated soils vary widely and can range from 10 to 100mgkg$^{-1.}$ The lowest zinc values were found in sandy soils and the highest in calcareous and organic soils where as some researchers indicated a mean zinc content for worldwide soils of 64mgkg$^{-1.}$ In Agriculture soils zinc is bound to the soil factors mainly pH and organic matter content. These factors determined the solubility of zinc content in soils and consequently, its bioavailability for uptake by plants. In acidic soils, zinc content above 10mgkg$^{-1.}$ is considered harmful. Total zinc contents in soils usually fall in range 10-300mgkg$^{-1.}$ with contents above 150mgkg$^{-1.}$ regarded as very high and likely to result in reduced plant growth.

The main symptoms of zinc deficiency in plants is stunted growth and reduced yield. Other common deficiency symptoms include yellow flowers and distorted shapes or sizes of fruits or vegetables. Zinc deficiency can be caused by any of the following: certain pesticides, fungicides and other chemicals can eliminate zinc from soil; poor soil can have low level of nutrients like zinc; and over-fertilization –too much fertilization can remove zinc from the soil, which becomes unavailable to plants.

Problem Statement

Almost half of the world's cereal crops are grown on zinc-deficient soils as a result, zinc deficiency in humans is a widespread problem. Consequently, it is essential to investigate its content in any given soil for sustainable agricultural crop production and improve human health.

Also zinc deficiency is becoming a severe agricultural concern due to its poor availability in arable soils globally, resulting in decreased crop output and nutritional quality.

More so zinc deficiency in agricultural soil is considered to be the most geographically widespread micro nutrient deficiency constraint limiting crop production (yield loses can exceed 40%).

Aims and Objectives

To investigate the level of zinc at the college farm with the view to recommending measures that will fix any unhealthy deviation for its optimal uptake by plants owing to either toxicity or deficiency, as the case may be.

Justification / Significance

It was found that among other trace elements zinc content in soil was well correlated to agricultural activities. Also past researchers recorded that maize is a cereal crop that is most susceptible to zinc deficiency and since the college farm is heavily cropped with maize, it is justifiable to determine the zinc content of the farm.

MATERIALS AND METHODS

The Study Area

The study was carried out between April, 2022 at the College of Agriculture farm Garkawa, Northern Guinea Savannah Zone of Nigeria. Garkawa is located between longitude 9^{o}40′ N and 9^{0}45′E and latitude 8^{0}50′N and 9^{0}00′E. The climate of the area is characterized by high temperature and seasonal rainfall, with a temperature range of between 32^{0}c to 40^{0}c and an annual mean rainfall range between 1100-1400mm.

Soil Sampling and Handling

A total of sixty (60) composite soil samples were collected according to the pedogenic horizons and kept in labeled polythene bags for easy identification. The collected samples were air-dried in the laboratory until a constant weight was obtained. The samples were then ground using porcelain pestle and mortar and sieved though a 2mm stainless steel sieve. The fine ground soil samples, collected in separate polythene bags, were used for analyses at the Soil Science Laboratory of Federal College of Land Resources Technology, Kuru Jos.

Laboratory Analyses

The processed soil fractions were subjected to laboratory analyses according to the procedure outline by Page *et al.*, (1982). Particle size distribution and micro aggregate stability, which involved the determination of the amounts of silt and clay in calgo – dispersed as well as water – dispersed samples using the Bouyoucos hydrometer method of particle size analyses, was done according to the procedure described by Gee and Or, (2002). Soil pH was determined in water at a 1:1 soil to water ratio using glass electrode pH meter. Organic carbon was determined using the wet oxidation method (Walkley and Black, 1934). Micro – Kjeldhal digestion method (Juo, 1979). Exchangeable bases (Ca, Mg, K and Na) were extracted in 1NNH4AC (1 normal ammonium acetate) and Ca and Mg in the extracts were determined using Atomic Absorption Spectrophotometer, while K and Na were determined using flame photometer. The CEC was determined by saturating the soil with INNH4AC solution, and all the cations displace into the soil solution were summed up. The available Zn and Cu were extracted using 0.1 MHCL solution and the element in the soil solution were determined by atomic absorption Spectrophotometer (Juo, 1979).

Data Analyses

The data obtained were analyzed using Genstat Discovery edition 4.2. Significantly different means were separated using the least significant difference (LSD). Simple descriptive statistics including mean and range were also used.

RESULTS AND DISCUSSION

Particle size distribution and organic carbon content of the soils of the study area are presented in Table1. The particle size distribution of the soils indicates sandy loam texture, with the percentage mean values of sand, silt and clay contents being 52.3, 24.6 and 23.1 respectively, sand content did not differ significantly ($p>0.05$) and somewhat decreased with depths; silt and clay also did not differ significantly but increased down the soil profile (Table1). The organic carbon content of the soils did not differ significantly ($p>0.05$) with depths, with a mean value of 2.7gkg^{-1}. The mean values of organic carbon were low according to the ratings of Esu, (1991) in Appendix1. Lombin, (1979) and Mustapha, 2007, reported similar low values of organic carbon for soils in Guinea Savannah zones of Nigeria.

The chemical properties of the soils at the site on Table 2 showed that soil pH (1:1) in water had a mean of 4.93, which is an indication of strongly acidic, (appendix2). Though generally acidic, the pH values did not differ significantly ($p>0.05$) with depths. The acidic nature of the soils may be connected to continuous use of acid-forming fertilizers such as UREA and NPK as their applications are a common practice in the area.

Mean values for N, P and K which are 1.55, 7.21 (gkg^{-1}) and 0.05 cmol(+)kg^{-1} respectively' did not differ significantly ($p>0.05$) with depths (Table 2). According to the ratings in Appendix 1, the N and P contents of the soils were low but K was high. Also Ca, Mg and Na with mean values 2.44, 3.81 and 0.29 (cmol (+) kg^{-1}) respectively, did not differ significantly($p>0.05$) with depths (Table 2) the rating showed that both the Ca and Na contents of the soils were medium which Mg was high as also reported by Mustapha *et al* (2011) in a similar study.

The zinc content of the soils had a mean value of 5.4mgkg^{-1}, which suggest low values for zinc at the study site. This finding is not unconnected to the fact the sandy characteristics of the soils. Sandy and highly leached acid soils generally have low plant available zinc. Mineral soils with low soils organic matter also exhibit zinc deficiency as found in the study area. Also common practices as seen which resulted in low zinc content in the study area include the incessant use of chemicals which can eliminate zinc from the soils. The yearly over-fertilization of the soils might have also resulted in reduced content of zinc in the study area.

The distribution of the zinc content slowed an increase with depths meaning that the upper soil layer has lesser contend. This same finding was reported by several authors who reported that zinc deficiency of plant may occur in the upper soil layer which are drier compared to deeper soil layer and prohibit zinc transport to the plant root by diffusion. In these areas the application (injection) of liquid form zinc fertilizer is rather recommended instead of the applying granular fertilizers.

CONCLUSION/RECOMMENDATION

The zinc content investigated at Plateau State College of Agriculture Farm revealed low content. Several factors and unhealthy agronomic practices earlier mentioned were observed to have reduced the content of zinc in the study area. However, the hope of sustained crop production the area is not lost as soil amendment for zinc can be possibly done.

To fix this zinc deficient situation and also keep balance between nutrient interaction in the soil in the study area, the following measures are hereby recommended:

1. Grow crops that are high in zinc content. Zinc corps include; Beans, peas, nuts, onions, mushrooms.
2. Fix zinc -deficiency through addition of organic matter like compose or manure.

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Table 1: Physical Properties and Organic Carbon (O C) Content of the Farm Soil.

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	O.C (gkg^{-1})	Textural Class
0-15	54-2	24.7	21.1	2.6	Sandy Loam
15-30	51.5	23.9	24.6	2.8	Sandy loam
30-45	50.1	24.2	25.7	2.8	Sandy Loam
45-60	53.4	25.6	21.0	2.6	Sandy Loam
Grand mean	52.3	24.6	23.1	2.7	
LSD (P>0.05)	NS	NS	NS	NS	

Key: LSD= (least significant difference); NS= Not significant

Table 2: Chemical Properties of the Farm Soil

Depth (cm)	pH (1:1) Water	N	P	Ca	Mg	K	Na	Zn
		(gKg^{-1})		(		$Cmol(+)Kg^{-1}$	)	($mgKg^{-1}$)
0 – 15	4.75	1.99	6.99	2.38	4.0	0.52	0.34	4.1
15 – 30	4.98	0.20	7.55	2.40	3.88	0.49	0.29	5.5
30 – 45	5.01	1.99	6.98	2.50	3.65	0.50	0.27	5.8
45 – 60	4.96	2.0	7.33	2.48	3.72	0.48	0.25	6.2
Grand Mean	4.93	1.55	7.21	2.44	3.81	0.50	0.29	5.4
LSD	NS	NS	NS	NS	NS	NS	NS	NS

Appendix I: Ratings for Soil Fertility Classes

Parameter	**Very Low**	**Low**	**Medium**	**High**	**Very high**	**Units**
Zn	<1,0	1.0-1.5	1.6-3.0	3.1-5.0	>5.0	Mgkg-1
Cu	<1.0	1.0-2.0	2.1-4.0	4.0-6.0	>6.0	Mgkg-1
Fe		<2.5	2.5-5.0	>5.0		Mgkg-1
Mn	<1.0	1.0-2.0	2.1-3.0	3.1-5.0	>50	Mgkg-1
N		<1.5	1.5-2.0	>2.0		gkg-1
P		<10	10-20	>20		Gkg-1
K		<0.15	0.15-0.30	0.30		Cmol(+)kg-1
Ca		<2	2.5	>5		Cmol(+)kg-1
Mg		<0.3	0.3-1.0	>1.0		Cmol(+)kg-1
Na		<0.2	0.2-0.3	>0.3		Cmol(+)kg-1
O.C		<10	10-15	>15		gkg-1

Source: Esu, (1991)

APPENDIX 2: Soil Reaction (pH) and CEC Ratings

Soil Reaction (pH)		Cation Exchangeable Capacity (CEC)	
Extremely acid	4.5	Very low	<6.0 cmol (+) kg^{-1}
Very strongly acid	4.6-5.0	Low	6.0-11 cm0l (+) kg^{-1}
Strongly acid	5.1-5.5	Moderate	12-25 cmol (+) kg^{-1}
Moderately acid	5.6-6.0	High	26-40 cmol (+) kg^{-1}
Slightly acid	6.1-6.5	Very high	>40 cmol (+) kg^{-1}
Neutral	6.6-7.3		
Slightly alkaline	7.4-7.8		
Moderately alkaline	7.9-8.4		
Strongly alkaline	8.5-9.0		
Very strongly alkaline	> 9.0		

Source: Black, (1965)