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Distribution of Some Macro Nutrients and Chemical Properties in Some Semi-arid Soils of Borno State

M. K. Sandabe[1], A. M. Zubairu[1*] and M. I. Yusuf[1]

[1]University of Maiduguri, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author MKS designed the study and performed the statistical analysis. Author AMZ managed the experiment, analyses of the study and wrote the first draft of the manuscript and Author MIY managed the literature searches and interpretation of the result. All authors read and approved the final manuscript.

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ABSTRACT

The research was carried out to study the distribution of some macro nutrients and chemical Properties in some semi–arid soils of Borno state. Three composite soil samples were collected at different locations at depth of 0-20 cm which were analysed for some macro nutrients and chemical properties. University of Maiduguri (Unimaid) soil is slightly acidic to neutral in reaction, low in electrical conductivity (EC), high base saturation, low in percent organic carbon, moderate in calcium, high in magnesium, low in potassium, high in sodium, low in available phosphorus. Dalori soils were neutral in reaction, low in EC, high base saturation low in percent organic carbon, low in calcium, high in magnesium, low in potassium, high in sodium, low in available phosphorus. Gongulong soil was moderately acidic in reaction, moderate in EC, high base saturation, moderate in percent organic carbon, high in calcium, very high in magnesium, moderate in potassium, high in sodium, low in available phosphorus.

Keywords: Soil chemical properties; macro nutrients; Borno.

**Corresponding author: E-mail: abbazubairu@gmail.com;*

1. INTRODUCTION

Knowledge of soil chemical properties are highly important to be studied. The chemical study of parameters is important to agricultural chemists for plants growth and soil management [1].

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out with the soils of Borno state with coordinates 11º30′N 13º00′E and about 350 m above sea level. Borno state is located in North Eastern Nigeria with a total land mass area of 70,898 km^2 (27,373.9 sq mi) which occupies a large part of the Chad Basin and an estimated population of 4,171,104 as at the 2006 census with an average population density of 37/km^2(95/sq mi). Borno state has borders with Yobe (west), Gombe (South), and Adamawa states and also with the republic of Niger, Chad and Cameroon (East) [2].

2.2 Climate and Soil

Borno state is characterized with annual mean rainfall and temperature of 650 mm and 32ºC respectively. The month of March and April are the hottest periods of the year with temperatures ranging between 30ºC and 40ºC and it is usually cold and dry during the harmattan, November to January being the coldest months. The state witnesses rainfall around June/July-September.

The soils of Borno State vary in colour, texture, structure, physico-chemical and other essential characteristics from the hilly south to the northern dune landscape. Vertisols dominate the flat plains close to Lake Chad; and also in the depressions. These are heavy dark clay soils (Firki) which develop wide cracks during the dry season. On the dunes are regosols which are shallow with weakly developed profiles. The volcanic and Basement Complex areas have fertile clayey loamy soils in the valley bottoms, but skeletal soils and rock outcrops occur along the gentle and steep slopes [3].

2.3 Vegetation

The vegetation is a mixture of Sudan Savannah and Sahel Savannah, the former stands in areas close to the Northern limits of Sudan vegetation in the country and the latter the Southern part of the Sahelian vegetation in West Africa. The vegetation includes *Acacia nilotica, Acacia senegal*, and *Acacia seyal*, the last two are major sources of gum arabic and grown in semi-arid areas, and the vegetation also includes the non-leguminous *Ziziphus spp* and *Balanites aegyptiaca*. A large portion of the state is classified as semi- arid or arid. Major geographic features of the area include the Borno plains, Biu plateau, and the swamps located south and west of Lake Chad.

2.4 Soil sampling and Handling

Composite soil samples (0-20 cm) were collected from three different locations namely; University of Maiduguri (Unimaid) (11.79728ºN and 13.19903ºE), Dalori (11.78574ºN and 13.27079ºE) and Gongulong-Lawanti Agricultural Area (11.89629ºN and 13.19534ºE). The composite soil samples were labelled according to the name of the location. The soils were air dried, ground to pass through 2 mm stainless steel sieve and used for routine chemical properties determination.

2.5 Determination of Chemical Properties and Some Macro Nutrients

The 3 soils pH was determined in 0.01M $CaCl_2$ (1:2.5) soil water ratio using glass electrode pH meter. The suspension was also used in the determination of pH was also used for the determination of EC following the same process with the use of an EC meter.

Percentage organic carbon of the soil was determined by the use of [4] dichromate wet oxidation method. Cation exchange capacity of the soils was determined by using 1N NH_4OAc (pH7.0) saturation method [5]. Sodium and potassium were both determined using flame photometric method. Exchangeable acidity was extracted with 1N KCl and measured according to the procedure of [6]. Exchangeable basic cations(Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) were extracted with neutral ammonium acetate (NH_4OAC) [7]. While available phosphorus was determined using Bray II method as described by [8] for all the soils.

3. RESULTS AND DISCUSSION

The result is presented in Table 1.

3.1 Soil pH

Soil pH is a measure of soil acidity. Soil from Dalori had the highest pH of 7.06 which is neutral followed by that of University of Maiduguri (Unimaid) which was 6.61 which is also slightly acidic to neutral. They are satisfactory for most

Table 1. Chemical properties and some macro nutrients of the soil samples in the three locations

S/N	Locations	Sampling depth(cm)	pH	EC(ms/cm)	Meq/100g Soil							%		P(ppm)
					Total acidity	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	CEC	ECEC	Base saturation(%)	O.C(%)	
1	Unimaid	0-20	6.61	0.049	0.4	5.4	3.6	0.14	1.04	10.18	10.58	96.22	0.47	6.3
2	Dalori	0-20	7.06	0.22	0.2	4.4	7.4	0.18	0.87	12.85	13.05	98.47	0.49	5.6
3	Gongulong	0-20	5.85	0.268	0.2	10.2	11	0.4	1.39	22.9	23.19	99.14	1.21	15.4
		SD	0.61	0.12	0.12	3.10	3.70	3.10	0.27	6.71	6.68	1.53	0.42	5.467175

crops. While soil from Gongulong had the lowest pH of 5.85 which is moderately acidic. The optimum pH range for most plants is between 5.5 and 7.0 [9].

3.2 Electrical Conductivity

It is an important indicator of soil health. Soil electrical conductivity (EC) is a measure of the amount of salts in soil [10]. Electrical conductivity was read as 0.049 ms/cm for soil of Unimaid and 0.220 ms/cm for soil of Dalori which are low. While soil from Gongulong had a value of 0.268 ms/cm which is moderate.

3.3 Effective Cation Exchange Capacity (ECEC)

ECEC is the sum of exchangeable bases (Ca^{2+}, $Mg^{2+,}$ Na^{+}, and K^{+}) plus exchange acidity (Al^{3+} + H^{+}) Meq/100 g. Desired range is 5-25 Meq/100 g soil. This was found to be highest for soil of Gongulong with a value of 23.19 Meq/100 g soil followed by the soil from Dalori with a value of 13.05 Meq/100 g soil and 10.58 Meq/100 g soil for soil of Unimaid. They are all within the range desired. Where ECEC is less than 5, is indicative of low soil fertility.

3.4 Percentage Organic Carbon

Soil from Gongulong had the highest organic carbon content among the three soils with a value of 1.21% and regarded as moderate. While soils from Unimaid and Dalori had values of 0.47% and 0.49% which are low.

3.5 Exchangeable Acidity

The highest exchangeable acidity was recorded for the soil of Unimaid which was 0.40 Meq/100 g soil, and 0.20 Meq/100 g soil for both Gongulong and Dalori.

3.6 Percentage Base Saturation (% B.S.)

This is obtained by mathematical calculation as the ratio of total exchangeable bases to the total cation exchange capacity multiplied by 100. Soil from Gongulong had the highest % B.S. of 99.14%, followed by soil from Dalori with 98.47% and lastly Unimaid soil with 96.22% which are all very high.

Calcium: Soil from Gongulong had the highest Calcium concentration of 10.20 Meq/100 g soil which is high. Soil from Unimaid had calcium concentration of 5.40 Meq/100 g soil which moderate. While soil from Dalori had calcium concentration of 4.40 Meq/100 g soil which is low.

Magnesium: Magnesium in the soil of Gongulong had the highest concentration with a value of 11.0 Meq/100 g soil which is very high. Magnesium in both soils of Unimaid and Dalori are high with values of 3.60 and 7.40 Meq/100 g soil respectively.

Potassium: The soil from Gongulong had a value of 0.40 Meq/100 g soil as the highest among the three soils and is moderate. Soils from Unimaid and Dalori are having 0.14 and 0.18 Meq/100 g soil which were generally regarded as low.

Sodium: The soils from Gongulong, Unimaid and Dalori are high in sodium with concentrations of 1.04, 0.87 and 1.39 Meq/100 g soil respectively.

Available phosphorus: Available phosphorus was 6.30 mg/g for soil of Unimaid, 5.60 mg/g for soil of Dalori and 5.40 mg/g for soil of Gongulong which are all generally classified as low. The chemical properties and some micro Nutrients were given in Table 1.

4. CONCLUSION

The chemical study of soil parameters is important to agronomist, for plants growth and soil management. Chemical studies of the composite soil samples from the three different locations of Borno shows that all the soil parameters differ in terms of ph, ca, mg, p, k, ec, % base saturation and % carbon. These studies had revealed information about the chemical nature of the soils, present nutrient in the soils. This information will aid the farmer to budget the amount of which fertilizers and nutrients needed by the soil for increase performance of crops and as well can be used as reference information for other research purposes and classification.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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