Bayero Journal of Pure and Applied Sciences, 7(1): 52 – 55
Received: December 2013
Accepted: January 2014
ISSN 2006 – 6996

EVALUATION OF SOIL REACTION, EXCHANGEABLE ACIDITY AND CATION EXCHANGE CAPACITY OF SOILS FROM KANO UNIVERSITY OF SCIENCE AND TECHNOLOGY WUDIL TEACHING, RESEARCH AND COMMERCIAL FARM, GAYA

[1*]Adamu, U.K., [2]Muhammad, A. and [1]Adam, I.A.
[1]Department of Soil Science, Kano University of Science and Technology, Wudil, Kano State, Nigeria
[2]Department of Crop Science, Kano University of Science and Technology, Wudil, Kano State, Nigeria
Correspondence author: ukadamu@gmail.com

ABSTRACT
This study evaluates the soil reaction, CEC and exchangeable acidity of some soils in the newly established Teaching, Research and Commercial Farm of the University of Science and Technology Wudil. Four profile pits designated as EPU, RU, CPU and HORTU were sunk at each representative unit. Soil samples were taken from the profile according to the pedogenic horizons identified and used for laboratory analysis. The fertility capability classification (FCC), system was used to evaluate the soils. Result obtained indicated that all soil profiles were found to be slight to neutral in acid content. The exchangeable acidity and CEC were low in all the locations. The study concludes that, the exchangeable acidity and CEC of the soils of the study area are generally low with slightly acidic to slightly alkaline in reaction. Adequate application of both organic and inorganic fertilizers will improve the organic matter content which will increase the level of CEC of the soils and also liming was recommended to rise the pH of the soils for enhanced production capacity in the study area.
Keywords: Exchangeable Acidity, Soil, Pedons and Fertility Status.

INTRODUCTION

The availability of nutrients to plants is determined by the forms and chemical properties of the elements, the soil pH interactions with soil physical conditions such as aeration, compaction, temperature and moisture (Hodges, 2011).

The term soil reaction is used to indicate the nature of the soil in terms of acidity or alkalinity. Many procedures for the determination of the Cation Exchange Capacity (CEC) of soil have been described in the literature. The most common methods require the saturation of the soil with ammonium ions followed by determination of the de-sorbed ammonium ions by acid-base titration, by spectrophotometry, by infrared spectroscopy or other methods. Cation exchange capacity (CEC) is the measure of a soil to retain readily exchangeable cations which neutralize the negative charge of soils. This method involves saturation of the cation exchange sites with ammonium, equilibration, removal of the excess ammonium with ethanol, replacement and leaching of exchangeable ammonium with protons from HCL acid (Homeck, *et al,* 1989).

The Cation Exchange Capacity (CEC) of a soil is simply a measure of the quantity of sites on soil surface that can retain positively charged ions (cations) by electrostatic forces. The cations on the CEC of the soil particles are easily exchangeable with other cations and as a result, they are plant available. Thus, the CEC of a soil represents the total amount of exchangeable cations that the soil can adsorbs (Brady, 2002).

Soil acidity disadvantages as it affects the availability of nutrients element in the soil. Some nutrients under acidic environment would dissolve completely to form a concentrated solution that would be toxic to the plants. The fertile soil must have an even distribution of pores that must be connected to allow free movement of air and water.

An optimum condition would therefore, be neither very acidic nor very basic. Some areas have a high concentration of soluble salts or some metallic salts and those are some of the places that may be infertile as a result of injurious substances (Weil, 2004). The aim of the research was to evaluate soil acidity, exchangeable acidity and CEC of soils from KUST Research farm and provides an information that would be a basic for developing appropriate soil management strategies to maintain the productivity of the farm at reasonable level.

MATERIALS AND METHOD

The study area is situated in Gaya Local Government Area of Kano State. The entire area falls within the Sudan Savannah and is located between latitude 11°N to 14°N and longitude 7°38 to $8^0$38E. The area has a mean annual rainfall of 773.4mm. The soil of the area was generally sandy loam, dark brown with high content of silt. Millet, maize, sorghum and cowpea were the major crops in the farm.

Fieldwork and Soil Sampling

Four (4) profile pits were sunk, one in each of the representative site. The research sites are: LPU – 1, RU – 2, CPU 3, and HORTU – 4 respectively. Where LPU = Livestock Production Unit (Pedon 1), RU = Range Unit (Pedon 2), CPU = Crop Production Unit (Pedon 3) and HORTU = Horticultural Unit (Pedon 4).

Samples were collected according to the pedogenic horizons identified in each of the profile pits sunk (replication) which were properly labeled in polythene bags after drying, grinding and sieving (Brady, 2002).

Laboratory Analysis

All soil samples collected were analyzed for: particle size by the Buoyoucos (1992) hydrometer method as modified by Udo *et al.,* (2009). Soil pH was determine in 1:1 soils to water ratio and 1:2 soils to 0.01m $CaCl_2$ by using a glass electrole pH meter (Jenway UK bench type digital complete model 3510, Longanathnan, 1984). Exchangeable acidity was determined by titration method of Mclean as described by Udo *et al.,* (2009). The Cation Exchange Capacity (CEC) was determined as the total exchangeable bases plus exchangeable acidity. (Udo *et al.,* 2009).

Rating for Soil Fertility

The method adopted by Sanchez (1982) was employed for assessing the capability of the soils in terms of their soil physioco chemical properties.

RESULTS AND DISCUSSION

Table 1 shows the physical properties of soils in all the four pedons. The texturally classes of the soils ranged from sandy to sandy clay loan at the top down to the bottoms/sub-soils in all the profile. This result agrees with the findings of other authors who reported that very fine soil particles tend to leach down from the top soil to subsoil with the percolating water and thus making the surface soil a coarser than the underlying soil (Lekwa, 1992).

Sand, silt and clay content ranged from 71 - 88%, 1 - 9% and 12 - 26% with 76.85%, 4.8% and 18.9% means respectively. The sand value appeared to decrease with depth at all locations. The nature of these soils could be attributed to the sandy nature of their parent materials from which they developed (Lekwa, 1992). Pedon 2 tends to be dominated by sand fraction than the other pedons (77.4%, 3.8% and 18.8%) sand, silt and clay respectively.

The chemical properties of the soils were presented in Table 2. The results showed that the pH in water (pHw) ranged from 6.0 - 7.7 at all the pedons. The soils could therefore be classified as slightly acidic to slightly alkaline. This could be partially attributed to the low rainfall, burning, slow removal of bases and low cropping intensity. It may be due to leaching of exchangeable bases especially Ca^{2+} and its replacement by Al^{3+}. (Hodges, 2011).

Soil pH value in water (pHw) of the soils within the study area in all the profile of different units were found to be slightly acidic, neutral to slightly alkaline in reaction and values ranged from 6.72 -7.5 Tropical soil mostly is slightly acid to neutral in reaction values from 5.5 - 6.5 are common. Soil of humid areas are mostly acidic and required liming. Infertility is due to Al^{3+} (Table 3).

Exchangeable acidity (H^+Al^{+3}) in the study area were found to be very low in all the units which ranged from 0.40 - 2.20ppm and average 1.05 respectively (Table 3). This may lead to the increase in acidity of soil which causes toxic affect to plants. This conforms with the finding of George, (2009) which represented that Hydrogen and Aluminium ions will come into contact with plant roots and may have an adverse effect on root development. The adverse effects of soil acidity may include the Aluminium toxicity, Manganese toxicity, Nutrient deficiencies and decreased microbial activity. However soil pH can influence the availability of many of the essential elements needed for healthy crop production. Certain elements can become deficient or toxic depending on the pH level. The low CEC values may be attributed to the very low clay and organic matter contents of the soils. Singh (2002) reported that, soil with high organic matter content is expected to have higher, CEC than the soil with low organic matter (Table 3).

Table 1: Particle Size Distribution of Soils in Kano University of Science and Technology, Wudil Teaching Research and Commercial Farm, Gaya

Location	Horizon	Depth (Cm)	Particle Size Distribution (%)			Textural Classes
			Sand	**Silt**	**Clay**	
Animal Production Unit	O	0 – 20.4	74a	9a	16a	Sand loam
	A	20.4 – 62.4	73a	7a	20a	Sand loam
	E	62.4 – 103.5	77a	5a	18a	Sand loam
	B	103.5 – 150	83a	5a	12a	Loamy sand
			(77)	**(6.5)**	**(16.5)**	
Range Unit (RU)	O	0 – 9	75a	7a	18a	Sandy loam
	A	9 – 59	81a	1a	18a	Loamy sand
	E	59 – 90	77a	1a	22a	Sand clay
	B_1	90 – 126	79a	5a	16a	Sand loam
	B_2	126 – 150	75a	5a	20a	Sand loam
			(77.4)	**(3.8)**	**(18.8)**	
Crop Production Unit	O	0 – 9	77a	3a	18a	Sandy loam
	A	9 – 29	73a	3a	24a	Sandy clay
	E	29 – 77	75a	3a	22a	Sandy clay
	B_1	99 – 121	77a	5a	18a	Sandy loam
	B_2	121 – 150	79a	7a	16a	Sand loam
			(76.2)	**(4.2)**	**(19.6)**	
Horticultural Unit	O	0 – 10	71a	5a	22a	Sandy clay
	A	10 – 31	69a	5a	26a	Sandy clay
	E	31 – 67	75a	5a	20a	Sandy loam
	B_1	67 – 117	81a	5a	16a	Sandy loam
	B_2	117 – 150	88a	3a	18a	Sandy loam
			(76.8)	**(4.6)**	**(20.4)**	
Overall Range			**71 – 88**	**1 – 9**	**12 – 26**	
Overall Mean			**(76.85)**	**(4.78)**	**(18.9)**	

Values in parenthesis represent means. Sand, silt and clay soils.

Table 2: pH and Cation Exchange Capacity (CEC) of Kano University of Science and Technology, Wudil Kano Research and Commercial Farm, Gaya

Location	Horizon	Depth (Cm)	pH in Water (pHw)	C E C (cmol/kg)
Animal Production Unit	O	0 – 20.4	6.6	5.3
	A	20.4 – 62.4	6.9	5.2
	E	62.4 – 103.5	7.1	5.7
	B	103.5 – 150	7.3	10.7
			(6.78)	**(6.7)**
Range Unit (RU)	O	0 – 9	7.7	6.0
	A	9 – 59	7.0	6.2
	E	59 – 90	7.4	7.9
	B_1	90 – 126	6.0	9.0
	B_2	126 – 150	6.6	6.5
			(6.94)	**(7.12)**
Crop Production Unit	O	0 – 9	6.1	6.2
	A	9 – 59	6.2	14.3
	E	59 – 90	6.5	10.2
	B_1	90 – 126	6.4	10.2
	B_2	126 – 150	6.2	10.2
			(6.26)	**(9.4)**
Horticultural Unit	O	0 – 10	6.4	9.1
	A	10 – 31	6.3	8.5
	E	31 – 67	6.5	5.5
	B_1	67 – 117	7.2	4.9
	B_2	117 – 150	7.1	9.0
			(6.7)	**(7.4)**
Overall range			**6.0 – 7.7**	**52 – 14.3**
Overall mean			**(6.72)**	**(7.8)**

Values in parenthesis represent means of pH and CEC of the soil.

Table 3: Exchangeable Acidity (H^+ AL^{3+}) of Soils at Kano University of Science and Technology, Wudil Kano Research and Commercial Farm, Gaya.

Location	Horizon	Depth (Cm)	H^+ and AL^{3+} (mg/kg^{-1})
Animal Production Unit	O	0 – 20.4	0.80
	A	20.4 – 62.4	0.40
	E	62.4 – 103.5	1.40
	B	103.5 – 150	2.20
			(1.2)
Range Unit	O	0 – 9	1.00
	A	9 – 59	0.40
	E	59 – 90	0.60
	B_1	90 – 126	1.40
	B_2	126 – 150	2.00
			(1.08)
Crop Production Unit	O	0 – 9	0.60
	A	9 – 29	1.40
	E	29 – 77	2.00
	B_1	77– 121	0.60
	B_2	121 – 150	1.40
			(1.2)
Horticultural Unit	O	0 – 10	1.40
	A	10 – 31	0.40
	E	31 – 67	0.40
	B_1	67 – 117	1.00
	B_2	117 – 150	0.40
			(0.72)
Overall range			**0.40 – 2.20**
Overall mean			**(1.05)**

Values in parenthesis represent means H^+ and Al^{3+} of the soil.

CONCLUSION

The results of this study revealed that, the soils of the study area were predominantly sandy loam, slightly acidic to slightly alkaline with low CEC. It was suggested that liming should be done to improve the soil fertility and reduce the acidity of the soils. As a pre-requisite to the efficient utilization of these soils and hence achieving the target of improved research and sustained agricultural food production, the characteristics of these soils must of necessity be evaluated such evaluation includes the soils reaction, CEC and exchangeable acidity.

REFERENCES

Brady, N.C. and Weil, R. R. (2002). *The Nature and Properties of Soils.* 13th edition. Pearson Edition. India.

Homeck, D.A., Hart, J. M., Topper K. and Koespell, B. (1989). *Methods of Soil Analysis Used in the Soil Testing Laboratory at Oregon State University* Ag. Expt. Station SM 89:4.

Sanchez, P.A., Conto, W. and Boul, S. W. (1982). The Fertility Capability Soil Classification. Geoderma, 27:283-309.

Buoyouces, C. J. (1992). Hydrometer Method Improved for Making Particle Size Analysis of Soils. *Agron*. 1.54:464 - 465.

Geoge R., (2009) Land Evaluation for Rainfed Agriculture Food and Agricultural Organization of United Nations. Rome pp.237.

Hodges, S.C. (2011), Soil Fertility Basic Manual Pg. 1 - 5.

Lekwa, A. (1992) Characteristic and Classification of Soil Sequence of Kano State Nigeria Journal of Soil Science 3:73-84.

Longanathan, P. (1984). *A Laboratory Manual on Soil and Plant Analysis* R/S University of Science and Technology Port Harcourt, Nigeria.

Singh, B.R. (2002). Fertility and Sodality State of Fadama Soil in Kebbi State North Western Nigeria. Kebbi State *Nigeria Journals of Basic and Applied Science,* 8:1-14.

Udo, E. J., Ibis, T. O., Ogunwale, J.A., Ano, A. O. and Esu, I. E. (2009) *Manual of Soil, Plant and Water Analysis*. Sibon books Ltd. Flat 15, BK6 Fourth Avenue Festas, Lagos.

Weil, R.R. (2004) *Nature and Properties of Soil* 11th Edition, Prentice Hall International. McMillan Publishing Company, New York Pg.143-147.