Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

ISSN: 0972-6268	Vol. 11	No. 4	pp. 639-642	2012

Original Research Paper

Soil Fertility Assessment of Research and Teaching Farm of Audu Bako College of Agriculture Danbatta, Kano State, Nigeria

Sanda Ahmad R. and Ismail Y.M.*
Department of Soil Science, Kebbi State University of Science and Technology, Aliero, P.M.B. 1144, Birnin Kebbi, Kebbi State, Nigeria
***Department of Agronomy, Bayero University, Kano, Nigeria**

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com
Received: 10-5-2012
Accepted: 17-6-2012

Key Words:
Soil fertility
Leaching
Volatilization
Organic manure

ABSTRACT

The most important variables in the soil are the plant nutrient elements. But Savannah soils are known to be low in these variables. Laboratory study was conducted to evaluate the soil fertility status of Audu Bako College of Agriculture Research and Teaching Farm, aimed at assessing these variables. The results of this study shows that all the variables tested, which includes among others exchangeable bases, organic carbon, total nitrogen, available phosphorus and cation exchange capacity (CEC), were low due to high leaching and excessive volatilization, which could be arrested by some practices like mulching, application of more organic manure and supplementing with inorganic fertilizers.

INTRODUCTION

Soil fertility is simply defined as the ability of the soil to supply nutrients for plant growth. The soil is a store house of plant nutrients. The nutrients are stored in many forms, some very available to plants, while some unavailable. The concept of soil fertility includes not only the quantity of nutrients a soil contains, but how well nutrients are protected from leaching, how available the nutrients are and how easily plant roots can function. Plant nutrients are essential elements needed for plant growth. Plants absorbed at least 90 different elements, some of these elements are needed for plant growth, some are not needed by plants. Many of these elements are not needed by either plants or animals and some are even toxic to both plants and animals, like lead. The most commonly accepted rules (though not the only one) for determining if an element is essential are as follows;

- Lack of the element stops a plant from completing growth or production.
- The element is directly involved in plant nutrition, not merely "taking up space" in plant tissues.
- A shortage of the element can be corrected only by supplying that element.

Based on these rules the essential elements are identified by most scientists. Three of these elements account for 95% of all the plant needs; carbon, oxygen and hydrogen. These three elements are mostly obtained from air and water. The other 13 mineral nutrients are obtained from the soil. Plants use 6 of the 13 mineral elements in large quantity. These elements are labelled macro-nutrients and include nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. Since most soils (but not all) supply enough calcium, magnesium and sulphur, soil scientists called them secondary nutrient elements. The other three are referred to as primary nutrient elements or fertilizer elements, which are not usually available in large enough amount for best growth. The three primary nutrient elements are; nitrogen, phosphorus, and potassium, which are most likely to be added to soil by fertilization.

The other seven nutrient elements boron, copper, chlorine, zinc, molybdenum, iron and manganese are labelled as micronutrient elements or trace elements, because they are used by plants in such small quantity. The term micronutrient does not, however, mean that the elements are unimportant. Plant growth will be affected without enough of these trace elements.

The soils of Sudan Savannah of Nigeria are physically fragile because the top soil contains a large proportion of sand, causing weak aggregate and low level of organic matter content. These physical constraints are further compounded in gravel soils or soils with shallow depth or hard pan layer (Agboola 1978). The soils of Kano State, which fall within the Savannah, have low cation exchange capacity (CEC), low level of available nutrients and are moderately to strongly acidic. Most of these soils are intensively weathered and grossly leached. Similarly, fire in an attempt to burn crop residues and weeds during land clearance, further destroy the organic matter and brought other changes in the soil's physical properties that affect soil fertility. The soils of these zones are characterized by sandy entisols and elfisols that are weakly structured. These soils have very low soil organic matter content (generally less than 0.3%), low water holding capacity and are prone to water and wind erosion. Due to continuous field cultivation, aluminium toxicity and related calcium, magnesium and phosphorus deficiencies were found to limit the growth and yield of cereals and legumes in acid soils in the Sudan Savannah region. Major food crops grown in these area are; sorghum, millet, groundnut and bambra groundnut (Jones & Wild 1975). The removal of crop residues for livestock feeds, fuel and fencing as well as frequent land preparation for cultivation when soil is dry, and continuous cropping of the highly weathered soil commonly suffered from multiple nutrient deficiencies and nutrient imbalances, which leads to the decline in productivity and poor crop yield. Therefore, the need for an urgent means of assessing the fertility status of these soils is necessary, and the way to do so is by laboratory analysis of these soils, as it is a general belief among soil scientists that an hour in the laboratory worth a year in the field.

MATERIALS AND METHODS

The work was carried out at the Research and Teaching Farm of Audu Bako College of Agriculture, Danbatta, situated between latitudes 12° 27' - 12°29' N and longitude 8°51' - 8°32' E. It was believed to be developed under similar geological formation to that of Kano and exhibits the homogeneity in terms of topography, vegetation and climatic condition (Mortimore & Wilson 1987). The climate of the area was characterized by an alternate hot rainy season and cool dry season, the area is 470m (1539ft) above sea level with an estimated annual rainfall of about 464mm, and a mean temperature of 35°C (Areola 2000).

Soil samples were collected using soil auger at two different depths of 0-15cm and 15-30cm from 12 distributed sampling spots across the entire Farm, air dried, crushed and sieved through 2mm sieve and stored in polythene bags ready for the laboratory analysis, which was done at Jigawa Research Institute Laboratory, Kazaure. Particle size analysis was carried out by hydrometer method (Gee & Bauder 1986); soil pH in 1:2.5 soil:water ratio using glass electrode pH meter; organic carbon by Walkley & Black (1934) method; total nitrogen by the micro Kjeldahl digestion and distillation method (Jackson 1962); exchangeable cations after extraction with 1.0M ammonium acetate at pH 7; available phosphorus by method of Bray & Kurtz (1945) and cation exchange capacity (CEC) by the neutral NH_4OAc saturation method (Anderson & Ingram 1993).

RESULTS AND DISCUSSION

Particle size analysis: The results of the particle size analysis for the two soil depths as presented in Table 2 show some similarities in their physical characteristics as 84% was sand, 12% silt and 4% clay. According to the soil textural triangle they were said to be sandy loam, which is the typical soil type of the Sudan Savannah region.

Soil pH: The results of the pH mean values as shown in Table 2, indicate that 0-15cm soil depth has a pH value of 5.28, and that of 15-30 cm depth a value of 5.83. When compared to the values on the critical limits of interpreting levels of analytical parameters as presented in Table 1, 0-15 cm value can be regarded as strongly acidic (mean value of 5.28), while that of 15-30 cm soil depth value to be slightly acidic (mean value of 5.83). The low pH values can be as a result of low level of organic matter and leaching of some of the nutrient elements.

Exchangeable bases: The mean values of all the exchangeable bases analysed (Table 2) can be considered to be very low; this is true considering their position in Table 1. The low mean value of all the exchangeable bases can be as a result of low level of clay content, low organic matter and a high percentage of sand, which leads to their loss through leaching and a high infiltration rate.

Organic carbon: Mean value of the organic carbon (Table 2), can be considered as very low. This low level of organic carbon can be attributed to the fact that the research area suffers a problem of continuous cultivation, removal of crop residues without return, effects of water and wind erosion which preferentially removed the soil colloids including the humified organic fractions, and can as well be attributed to the rapid mineralization under a high temperature, which indicated less colloidal materials due to poorly buffered soil, leading to substantial loss of organic carbon.

Total nitrogen: Considering the values of total nitrogen of all the soil depths (Table 2), both values were very low, which can be attributed to the fact that all the factors leading to the loss of nitrogen are available within the study area which include excessive temperature leading to volatilization, erosion of all types and crop removal. Little or even no attempts were being made to curtail these.

Available phosphorus: The mean value of the available phosphorus (Table 2), can also be regarded as low irrespective of the depth. This can be as a result of low clay content and a high sand particles, which lead to loss of soluble available phosphorus either by rain or acidification; effect of phosphorus fixation by the soil flora and other soil microorganisms.

Cation exchange capacity (CEC): Comparing the values

Table 1: Critical limits in interpreting levels of analytical parameters.

Parameter	Ratings			
	Low	Medium	High	Units
Ca	< 2	2-5	> 5	Cmol/kg
Mg	< 0.3	0.3-1.0	> 1.0	”
K	< 0.15	0.15-0.3	> 0.3	”
Na	< 0.1	0.1-0.3	> 0.3	”
CEC	< 6	6-12	> 12	”
Base saturation	< 50	50-80	> 80	”
Organic carbon	< 10	10-15	> 15	”
Total N	< 0.1	0.1-0.2	> 0.2	”
Available P	< 10	10-20	> 20	”
pH				
Ultra acid	< 3.5			
Extremely acid	3.5-4.4			
Very strongly acid	4.5-5.0			
Strongly acid	5.1-5.4			
Moderately acid	5.5-6.0			
Slightly acid	6.1-6.5			

Table 2: Mean values of the analytical results of the soil at Research and Teaching Farm of Audu Bako college of Agriculture, Danbatta.

Composition	Sampling Depth	
	0-15 cm	15-30 cm
Sand	84	84
Silt	12	12
Clay	4	4
Textural Class	Sandy loam	Sandy loam
pH in H_2O (1:2.5)	5.28	5.83
Na (Cmol/kg)	0.143	0.138
K ”	0.010	0.023
Mg ”	0.067	0.083
Ca ”	14.7	22.7
Total N (%)	0.031	0.057
CEC (Cmol/kg)	3.5	3.2
Av. P (mg/kg)	6.24	5.18
Org. C (%)	1.06	0.87

of CEC of the soil with that in Table 1, it is clear that the values are low. This may be as a result of beneficial effect of organic matter which makes a substantial contribution to the CEC of a soil during decomposition and mineralization process as well as the release of nutrients into the soil physical facility, which results in better soil moisture status, and hence, to the retention of exchangeable cations, especially soils low in clay content.

CONCLUSION

Considering the above results of the soils analysed at the Research and Teaching Farm of Audu Bako College of Agriculture Danbatta, it was found that the soils have a low fertility status, hence the use of organic manure has to be intensify, crop removal has to be done in such a way that the stalks, leaves and haulms be left on the field for three to four years, and thereafter, it should be a four to five years interval so as to have a better accumulation of organic matter which can raise the fertility status and a better crop yield. More *Acacia albida* (Gawo) should be planted and it should not be cut for other purpose as they are leguminous trees and have the ability to fix a lot of atmospheric nitrogen which can be used by the growing arable crops.

REFERENCES

Agboola, A.A. 1978. The influence of organic matter on cowpea’s response to N fertilization. Agron. J.. 70: 25-28.

Anderson, J.M. and Ingram, J.S.M. 1993. Tropical Soil Biology and Fertility. A Handbook of Methods, 2nd Edition, CAB International, Wallingford, U.K.

Areola, Olusegun 2000. Certificate Physical and Human Geography for

Senior Secondary Schools. Gohchenleong. Reprinted 2000. University Press, Ibadan, pp 214-215.

Bray, R.H. and Kurtz, L. 1945. Determination of total, organic and available forms of phosphorus in soil. Soil Science, 59: 39-45.

Faniran, A. and Areola, O. 1978. Essentials of Soil Study with Special Reference to Tropical Areas. Heinemann, London.

Gee, G.W. and Bauder, J.W. 1986. Particle size analysis In: Klute, A. (eds.), Methods of Soil Analysis. Ames. Agron. Madison, Wisconsin, U.S.A.

Jackson, M.L. 1962. Soil Chemical Analysis. Prentice Hall, Inc. Eaglewood Cliffs, N.Y. pp. 219-221.

Jones, M.J. and Wild, A. 1975. Soils of West African Savannah. The maintenance and improvement of their fertility. Commonwealth Bureau of Soils. Technical Communication, No. 22, CAB, Harpenden.

Mortimore, M.J. and Wilson, J. 1987. Water Resources Development and Changes in Rural Kano Studies. Land and People of Kano Close Settlement Zone. Production No. 1, Geography Department, A.B.U. Zaria.

Walkley, A. and Black, C.A. 1934. An examination of the different methods of determination of organic matter and a proposed modification of chromic acid titration method. Soil Science, 37: 29.