Journal of Environmental Issues and Agriculture in Developing Countries
Volume 10, Number 2, August 2018
ISSN: 2141-2731

Trace Elements in Soil of Farming Communities of Jigawa State, Nigeria

Abubakar, K. S.
Ibrahim Yusuf

ABSTRACT

The savannah soils especially the ferrallitic and ferruginous types have peculiarities associated with soil color, texture, parent-rock formations that make them unique. Investigation is carried out on trace elements in soil of some farming communities of Jigawa State, Nigeria. The aim is to examine the accurate nutrients removal and replacement, crop production statistics and soil analysis that result will help the producer manage fertilizer applications to grow good crops. Instrumental Neutron Activation Analysis (INAA) is used to determine five essential elements (Cl, Fe, K, Mg, Mn) useful in plant nutrition and several others commonly found in association in the soil mineralogy of savannah region of Nigeria. Trace elements concentration determined from the three farming communities' shows that the soils are acidic. But they are rich in essential elements such as Chlorine, iron, potassium, manganese and magnesium. The three farming communities lack calcium. Therefore, the soils need to be neutralizing by adding lime to it. The farmers need to add fertilizers in order to get a good yield from their farms.

Keywords: *Savannah, Elements, Analysis, Farming, Activation, farming*

INTRODUCTION

The Savannah soils in Nigeria cover an extensive landmass that support agrarian activities for the socio-economic development of Nigeria and therefore need continuous investigations, as new techniques unfold and are available for the study region. Agricultural land is primarily required for the production of food for human and animal consumption, agricultural activities also include the growing of plants for fibre and fuels (including wood) and for other organically derived products (pharmaceuticals etc.) for use by humans and his animals (Kenk and Cotic, 1983; Hovenkonnou et al. 2006). A major factor limiting agricultural development in Nigeria is the lack of information on

Abubakar, K. S. *is a Lecturer in the Department of Physics, while* ***Ibrahim Yusuf*** *is of the Department of Chemistry, both of Umar Suleiman College of Education, Gashu'a, Yobe State, Nigeria. Contact via E-mail: karanssa@yahoo.com*

soil and land characteristics. Soil topography plays a major role as one of the factors influences pathogenesis and in the process dictates the distribution and use of the soils on the landscape (Hoosebeek et al. 2009, Esu, Akpan-Idio and Eyong, 2008). Land use aerial photographs for the Nigerian Savannah have been identified without reference to soil element content by (Field and Collins, 1989). The study of the soil has fostered peoples' interest in plants growth and food production (Hinrich, Brain and George, 1985). The ability to produce food is the fundamental factor in societal development, therefore there is need to know the kind of element or nutrient for a better production (Siidou et al, 2004). One of the most important natural resources that cover much of the Earth's surface is Soil. Most life on earth depends upon the soil as a direct or indirect source of food. Plants are rooted in the soil and obtain nutrient from it. Animals also get nutrients from eating the plants on the soil.

Soil is home of many organisms, such as seeds, spores, insects, and worms. The contents of soil changes constantly and there are many different kinds of soil. Our soil resources can be compared to a bank account where continued withdrawal without deposit (repayment) cannot help the bank to grow effectively. As nutrients are removed by one crop and not replaced for subsequent crop production yields will decrease accordingly. Accurate accounting of nutrient removal and replacement, crop production statistics and soil analysis result will help the producer manage fertilizer applications to grow good crops, most farmers need to fertilize the soil. Soil analysis is used to determine the level of nutrients found in the soil. As such, it can only be as accurate as the sample taken in a particular field. The results of a soil analysis provide the agricultural producer with an estimate of the amount of fertilizer nutrients needed to supplement those in the soil (Baker et al, 1956, Adjei-Nsiah et al. 2004). High yields of top quality crops require an abundant supply of 19 essential nutrient elements which are as follows: Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur, Boron, Chlorine, Cobalt, Copper, Iron, Manganese, Zinc, and Molybdenum (Stenley 1995). But the most beneficial element in the soil is Sodium and Selenium (Samuel et al 1985).

MATERIALS AND METHOD

Jigawa State lies within the savannah plains of Northern Nigeria. The samples were collected from three farming communities of the State, namely Hadejia, Gumel and Kafin-Hausa. Mostly the root penetration of cereals grown within the savannah ranges from 20 to 50cm depth. The top 20cm of the soil were scrapped off in order to remove traces of surface contamination due to human activities. Around one kilogram of soil sampled was taken to the laboratory for homogenization and quartering. The samples collected from the three different farming communities were exposed to ambient air in a dust free environment before drying to constant weight in a monitored oven at a temperature of 50°C. Soil samples were then pulverized with an agate mortar into fine powder, reducing them to about 80 mesh size (IAEA, 1990). The major aim of this was to allow a representative sample to be chosen as an aliquot for the analysis. Polyethylene vials and bags were washed in Nitric acid and rinsed in purely distilled water and dried. The samples were weighed into the bags wrapped, heat-sealed and placed into 2/5 dram vials. The rapped samples were plugged with cotton wool in the 2/5 dram vials so as to maintain a fixed geometry. Standard were prepared and packaged in the same manner as the samples. The international Atomic Energy Agency (IAEA)-soil-7 was used as the comparator standard Reference material (SRM).

Table 1: A typical profile of one site of the savannah soil sampled.

Depth (cm)	Description
0-11	Very pale brown (10YR 7/3, dry). Loam: Weak medium sub-angular blocky structure, slightly hard, moist firm, few grass roots, few quartz gravel, clear wavy boundary
11-27	Very pale brown (10YR 8/3, dry). Light loam: weak medium sub-angular blocky structure, dry slightly hard, few grass roots, few quartz gravel, clear wavy boundary
27-75	Light gray (10YR 7/3, dry). Mottled reddish yellow loam: moderate, medium sub-angular blocky structure, dry hard few quartz gravel, few ant holes, gradual wavy boundary
75-129	Light gray (10YR 7/3, dry). Mottled reddish yellow loam, moderate medium sub-angular blocky structure, dry hard, few quartz gravel and iron concretions, few medium ant holes, gradual wavy boundary. Neutron activation analysis of the samples was performed using Miniature Neutron

Source: (MNSR) in Center For Energy Research and Training (CERT) Ahmadu Bello University, Zaria

Trace Element Detection: In activation analysis, an element is always bombarded with neutrons, charged particles or Protons. The excited intermediate is formed by the induced nuclear reaction of which it may be de-excited via the emission of prompt γ-rays. Trace element detection in neutron activation analysis consists of first irradiating a sample with neutrons from a source (for example, a nuclear reactor) to produce specific radio nuclides of the elements of interest. The sample to be analyzed is exposed to a flux of thermal neutrons. Some of the neutrons are captured by isotopes of elements in the sample, the result in the formation of a nuclide with the same proton number, but with one more mass unit of weight. Then a prompt gamma ray is immediately emitted by the new nuclide, hence the term (n,ã) reaction, expressed as:

where Z = refers to the proton number, and
M = the mass number.

But usually the product nuclides ($^{m+1}_{z}A$) are radioactive, and by measuring its products one can identify and quantify the amounts of target element in the sample.

RESULTS AND DISCUSSION

The preliminary investigation shows that the farming communities where the samples were collected have the following elements (Al, Ba, Br, Ca, Ce, Co ,Cl, Cr, Cs, Dy, Eu, Fe, Hf, K, La, Lu, Mg, Mn, Na, Rb, Sb, Sc, Sm, Ta, Th, Ti, V, and Yb). The significance of soil pH is that it affects various soil properties including conductivity (Ghidyal and Tripathi, 1987), soil mineral formation and soil structure. According to the pH values of the farming communities under investigation it shows that the soils are either very strongly acidic or strongly acidic. This may be as a result of either leaching or high soil temperature during the arid months leading to evaporation of soil water leaving residues strong undiluted salts. Soil amendment process such as addition of lime (CaO) will be preferable in order to reduce the acidity (Miller and Donahue, 1997). Conductivity range gives the range of tolerance of the plant root system to salt solutions. Miller and Donahue (1977) give the range of electrical conductivity as it affects growth of plants. According to the analysis on table 3, the soil communities under the investigation, only few plants may be affected, because the conductivity falls in between (0-20) $\mu S cm - 1$. Trace elements concentration determined from the three farming communities shows that the soils are acidic. But they are rich in essential elements such as Chlorine, iron, potassium, manganese and magnesium. The three farming communities lack calcium. It was found also that the soil conductivity falls in between (0-20) cm. From the analysis of the three farming communities of Jigawa State, it was found that the soils of the areas are so acidic. Therefore the soils need to be neutralizing by adding lime to it. The farmers need to add fertilizers in order to get a good yield from their farms.

Table 2: Soil pH values for the samples investigated at a temperature of 27°C

S/N	Site	pH	Remarks
1	Gumel	5.27	Strongly acidic
2	Hadejia	4.88	Very Strongly acidic
3	Kafin-Hausa	5.10	Strongly acidic

Source: Fieldwork, 2015

Table 3: Conductivity range and plant tolerance

Conductivity (μScm-1)	Growth reduction by salt in soil
0-20	Few plants are affected
20-40	some sensitive plants affected (Strawberries)
40-80	many plants are affected
80-160	most crop plants are affected
160 and above	Few plants grow well

Source: Fieldwork, 2015

Table 4: Conductivity values for the samples investigated

S/N	Soil Location	Savannah region	Conductivity (μScm^{-1})
1	Gumel	Sudan	14 ± 1.1
2	Hadejia	Sudan	18 ± 1.5
3	Kafin Hausa	Sudan	20 ± 1.2

Source: Fieldwork, 2015

Table 5: Elemental Abundances in the farming Communities units in ppm otherwise stated

Elements	Gumel	Hadejia	Kafin-Hausa
Al	0.60	1.75	1.00
Ba	97.92	380.20	198.3
Br	BDL	BDL	1.08
Ca	BDL	BDL	BDL
Ce	NA	NA	55.29
Cl	319.80	BDL	BDL
Co	9.35	10.22	13.9
Cr	22.76	34.98	31.65
Cs	0.67	1.92	BDL
Dy	1.47	2.54	1.84
Eu	0.58	1.18	BDL
Fe	0.51	1.29	1.07
Hf	18.34	24.82	32.81
K	BDL	1.91	BDL
La	BDL	34.30	22.18
Lu	0.23	0.36	0.43
Mg	0.11	0.34	0.10
Mn	241.30	138.50	132.40
Na	BDL	0.29	BDL
Rb	BDL	62.05	49.00
Sb	BDL	BDL	BDL
Sc	2.59	4.59	3.90
Sm	2.10	5.95	3.90
Ta	0.62	1.39	1.97
Th	4.99	19.61	15.10
Ti	0.12	0.22	0.18
V	7.47	16.05	19.08
Yb	1.63	4.34	3.57

BDL=below detection limit ***Source:*** Fieldwork, 2015

CONCLUSION AND RECOMMENDATIONS

In conclusion therefore, soil element data and their physical parameters were obtained for the three farming communities (Hadejia, Kafin-Hausa, and Gumel), tested for elemental contents. Data reported in this investigation will serve as base-line information on trace elements in Jigawa State. As an extension of the work, the data will be useful as preliminary investigation results for the purpose of monitoring trace element levels. The government should encourage research through financing it from time to time in order to monitor trace elements level in the State and around. The study of the entire State should be carried out using a grid point system in order to obtain a comprehensive data for elemental abundances.

REFERENCES

Adjei-Nsiah S., C. Leeuwis, K. E. Giller, O. Sakyi-Dawson, J. Cobbina, T. W. Kuyper, M. Abeko and **W. Vander Werf** (2004). Land tenure differential soil fertility management practices in Wenchi, Ghana: implication for interdisciplinary action research NDAS-Wageningen J. life sci; 52:331-348.

Baker, R. D, T. B. Shame and **F. Robert,** (1956). A key to soil management. New York: Macmillan Publishing Company.

Esu I. E, Akpan-Idio K. A U and **Eyong M. O** (2008). Characterization and Classification of soils a typical Hillstope in Afikpo Area of Ebonyi State. *Nigeria Journal of soil and Environment,* 8, 1-6

Field, N. J. and **Collins, W. G.** (1989). Land use from Aeria photography. A case study, in Nigerian Savannah international symposium Remote sensing for resource development and environmental management Rotterdam, Netherlands.

Ghildyal B. P. and **Tripathi R. P.** (1987). *Soil physics.* New Delhi: Wiley Easter limited.

Hinrich, L.B, L.M Brain and A.O. George (1985). *Soil chemistry* (2nd Edn). New Delhi: A. Wiley-Interscience Publication.

Hoosebeek M. R., Amudson G. R. and **Boyant R. B.** (2009). Pedological modeling In. Handbook of Soil Science. Sommer, M. E (ed) CRC Press. Boca Rition. Pp E77-E116.

Hounkonnou D., D. Kossou, T. W. Kuyper, C. Leeuwise, P. Richards, N. Röling, O. Sakyi-Dawson and **A. Van Huis** (2006). Convergence of Sciences: The Management of Agricultural research for small-scale farmers in Benin and Ghana. *NJAS-Wageningen Journal of Life Science,* 53(3/4), 343-367.

IAEA (1990). International Atomic Energy Agency. IAEA-TECDOC-564, Vienna, p. 119.

Kenk E. and **I. Cotic** (1993). *Land capability classification for Agriculture in Britain.* England: Blackwell Scientific publishers Oxford.

Miller, R. W. and **Donahue, R. L.** (1997). *Soils in our Environment* (seventh edition). New Delhi: Prentice Hall of India.

Saiidou A. T. W. Kuyper, D. Kossou, R. Tossou and **Richards** (2004). Sustainable soil fertility Management in Benin, Learning from farmers NJAS. *Wageningen Journal of Life Science*, 52, 349-369.

Samuel L. T., L. N. Werner and **D. B. James** (1985). *Soil fertility and fertilizers* (4th Edn). New York: Macmillan Publishing Company.