Physicochemical Characterization of Nasarawa State College of Agriculture Soil Lafia, Nigeria.

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ABSTRACT
In this study, the physico-chemical properties of soil of Nasarawa State College of Agriculture, Lafia were determined using physico-chemical methods of analysis. Parameters determined are soluble salts (12.1±0.02-14.1±0.01%); Soil air (16–28%); organic matter (1.4±0.00 - 3.8±0.01%); availability water capacity (9.0 - 18.1%) and Ph (6.36-7.58%). Other parameters included saturation percentage (30±0.00-35.6±0.01%); moisture percentage (0.33±0.02-0.52±0.01%) percentage loss in ignition (1.10±0.01-1.42±0.01%) and texture (sand, 50.1±0.20-71.2±0.20; silt, 17.4±0.02-26.4±0.03 and clay, 13.8±0.03-22.2±0.01%). Phosphorus, Nitrogen and exchangeable cations were also determined. Results indicate low values for all parameters determined compared with earlier workers and FAO specification.

KEYWORDS: *Soil, Physicochemical, Characterization.*

INTRODUCTION

The history of the study soil is intimately tied to our urgent need to provide food for ourselves and forage for animals. Throughout history, civilization have prospered or declined as function of the availability and productivity of their soils. Soil is an environmental (system) component used by man and other living organisms like plants, animals and micro-organisms and can be studied in terms of links between its properties, process and other environmental component include air, water, mineral elements and other abiotic components (Courtney and Trudgill, 1984). They defined soil physical properties as the arrangement or grouping of individual soil particles into units or aggregate forming a porous medium. Examples include soil texture, colour, structure, organic matter content, moisture, consistency and air contents. The characteristics of soil require the investigation of both the insoluble organic matter and the extractable soluble organic matter using different experimental techniques including spectroscopy and infra-red (Rullkotter and Michealis, 1990). Soluble organic matter (SOM) is isolated by treating the soil sample with organic solvents while the insoluble type is insoluble in non-oxidising acids, bases and organic solvents. The moisture holding capacity of soil is significantly influenced by temperature and as the soil moisture increases from the air-dry state, soil thermal diffusivity increased sharply to a point and then decreases thereafter. Although, soil temperature is one of the commonly measured meteorological parameters, relatively little or no work seems to have been done on its relationship with soil moisture and soil compactness (Yangodin, 1996).
Organic and inorganic fertilizers are employed to improve soil fertility and agricultural yield. The fertilizers increase the content of available nutrients in soil; changing the soil chemical and

physical composition. Furthermore, agricultural practices affect the environment on, near and beyond the farm; and it is necessary to examine some of the different impacts that agriculture may have on the environment such as change of land use, chemical pollution and global warming (Carter, 1993). The structure of the soil influences it water retention capacity, root development, free air movement, proper uptake of food and its utilization for an enhanced yield of the grown plants (Kowal and km 1978).

Soil survey paves a way to soil characterization, soil classification and evaluation. Soil characterization, soil classification and soil mapping; provide a powerful resource for the benefit of mankind especially in the area of food security and environmental sustainability (Esu, 2004). Soil characterization provides the information for our understanding of the physical, chemical, mineralogical and microbiological properties of soil. Based on its characteristics has a predictable response to management or any kind of manipulation, (Ogunkule, 2004).

Olusola (2009) was right to say that soil analysis is done to predict the behaviour of the soil when put into various uses like cropping, road construction, and so on. This work was aimed at characterizing the Polytechnic soils at different locations and determining the most ideal for enhanced farming.

MATERIALS AND METHODS

Soil samples were collected from five different locations in and around the Nasarawa State College of Agriculture, Lafia, including department of basic sciences, Engineering, Agriculture, Home economics, Works and college central farm. The soil samples were collected with the aid of hand auger at different horizons at each point in the field. Twelve random samples were collected at a depth of 0-15cm and mixed together to give a complete sample for each site. The samples were numbered according to each field. Consideration was given to time of sampling since chemical content variations occurs with seasonal changes. However, Winder (1974), reported that special variability is likely to conceal seasonal changes and testing should be done on a continuous basis from the month of April to September of the same year.

Sample Treatment

15g of air- dried soil was crushed with pestle and mortar and sieved through a 2mm and 150mm sieves respectively 1.0g of air-dried was mineralized with nitric acid per chloric and sulphuric acid mixture (5:4:1) and heated at 120^0Cfor 2hrs in a fume cupboard prior to analysis. All samples were run in triplicates.

Physico-chemical characteristic of Soils

The routine physic-chemical analyses were carried out using established procedures described by (1984), Scott (1997) and Yangodim (1996) respectively. Soil pH, Soil air, Organic matter content, Soil moisture content, extractable cat ions and available water holding capacity (AWC), were the parameters determined. The pH was determined using a glass and reference electrodes with a pH meter 1:1 suspension of 5g scoop of soil to 5ml water.

Soil Texture and Organic Matter

The relative amounts of sand, silt and clay were estimated by the feel of the soil in a moist condition while organic matter was determined by ashing a 5g scoop of the soil sample at 360^0C for 2hours in a muffle furnace. The loss in mass of the sample on ignition is

$$\text{Percent clay} = \frac{A \times 100}{(50\text{- moisture mass})g} \quad \ldots\ldots (1)$$

$$\text{Percent silt} = (\text{Silt} + \text{clay})\% - \text{Clay} (\%) \quad \ldots\ldots (2)$$

A = Hydrometer reading (g^{-1})

Reported as percent organic matter by mass in the soil.

Loss Ignition

1.0g oven dried soil sample was ignited in a muffle furnace at 450^0C for 4hours. The percent loss on ignition as calculated from mass loss during combustion.

$$\textit{Loss on ignition} = \frac{\textit{mass loss(g)x} \; X \; 100}{\textit{Oven dry mass (g)}} \quad \ldots\ldots (3)$$

Moisture Retention

10g soil was dried in an electric oven at 105^0C for 2hours, then cooled reweighed.

$$\textit{Percent moisture} = \frac{M_1(g)x \; X \; 100}{M_{2(g)}} \quad \ldots\ldots (4)$$

Saturature Percentage

5g of air dried sample was saturated with distilled water in a plastic container and mixed. The saturated paste was left to stand for 16hours

$$\textit{Saturature percentage} = \frac{100 (M_3 + M_2)}{M_3 + M_2} \quad \ldots\ldots (5)$$

M_1 = Mass of dish alone; *M_2 = Mass of dish + soil paste*

M_3 =Mass of dish + dried soil sample.

Determination of Soluble Salts.

the total dissolved solid (TDS) was determined according to modified AOAC method (1990) and is given.

$$TDS = \frac{\textit{mass of extracts}}{\textit{vol of } H_2O \times 100} \quad \ldots\ldots (6)$$

Available Water Holding Capacity (AWC)

$$\%AWC = \frac{\textit{mass of drained soil - mass of dry soil}}{\textit{mass of dry soil}} \times 100 \quad \ldots\ldots (7)$$

Extractable Elements (Ca, N, P, Mg, K, Na)

These were determined by modified established methods of Allen, (1984) and Scott (1997)

$$\%Calcium = KMnO_4 \times \textit{molarity of } KMnO_4 \times \frac{100}{\textit{mass of soil}} \quad \ldots\ldots (8)$$

$$\% \text{ exchangeable cations (Na, K)} = \text{mlHCl} \times \text{molarity of HCl} \times \frac{100}{\text{mass of soil}} \quad \ldots\ldots(9)$$

$$\%\text{total nitrogen} = \frac{0.04 \times V_D \times M_A \times 100}{\text{mass of soil} \times A_D} (T_v - B_V) \quad \ldots\ldots (10)$$

V_D = vol of digest; M_A = molarity of acid; T_v = titre value;

B_V = blanck value; and A_D = aliquot of digest

RESULTS AND DISCUSSION

Chemical analysis of soil is important for environmental monitoring and legislation (Carter). It provides information on the fertility status, index of the nutrient availability and bases for fertilizer recommendation (for a given crop) as well as planning of nutrient management programme. In Table 1, the mass of soluble salts of sodium and potassium vary from 12.1g to 14.1g. The essence of this determination is to know whether the salt contain of the soil is alkaline or saline. The values are much lower than the average value of 10.00 -15.00g for most soils reported in the literature (Winder, 1974; Scott. 1997). Air is present in the pore spaces between soil particles and this is important for plant survival. The highest value of 28 percent in E indicates that it has the largest pore spaces and loose structure. It also has the least water retention capacity of 9 percent. Soil that holds a great amount of water are usually low or lacking in oxygen, thus plants grown in saturated soils have their roots starved of oxygen.

The soil pH determines the availability of many nutrients for plant growth and maintenance. In organic matter or humus, the carboxylic, phenolic, amino sulphuhydryl functional groups can undergo ionization to release their hydrogen ions, into the soil. The study by Agbim and Adeoye(1991) revealed that cassava peel (CP) had positive effect on the pH of acid soil which had low buffer solution, the same studies showed that rice husk depressed soil pH. If the pH is too high or low, the nutrient are either locked onto the soil particles or washed out of the soil by rain; and the application of fertilizer to such soils a waste. The pH of soils analysed were more or less neutral or slightly alkaline, with the highest pH of 7.58 in F and 6.36 in A respectively. This may be a consequence of the presence of ionisable materials or dissolved carbon dioxide absorbed from air or released onto the soil due to nitrifying activities of plant cereals of these farm lands.

According to Zakari (1986), most soils in arid climate contain less than 10 percent organic (Mo) fraction and hold only one or two percent. The organic matters results from decaying plant materials brought about by the action of bacteria, proteomes, nematodes and fungi. The most fertile soil as depicted by Table 1 is E with an average value of 3.8±0.01 percent. The residue contains humus, composed of a variety of carbohydrates, protein lignin, cellulose and other materials for plant growth. The nutrient holding capacity and permeability is expected to be highest in soil sample E. The average soil air in this case amounting to 30 percent may be adducted to humic acid effect which helps aeration improvement. This observation is consistent with that of Winder (1974). These values are within the FAO (1990) guideline.

Table 2: shows the percentage physicochemical properties of College of Agriculture soil on dry weight basis. The particle size analysis expresses the proportion of the various sizes of particle present in a soil (sand, silt and clay). The soil texture is loamy sand and from results, no adverse effect of soil textural properties is envisaged on growing crops.

However, the physical status of the soil was slightly better in D and E; than in sites A, B, C and F. Sandy soils hold the least amount of soil particle surface area (The smaller the particles in a soil, the larger the internal surface area) while clay soils have excellent water retention property due to greater number of particles (electrical) and low surface area onto which water molecules can easily cling.

The saturation percentage of soil indicates the total mass of water that a given dry soil can hold because of the nutrient content of the soil. Site has the highest value probably due to the high clay and organic matter contents. The trend is observed for percent moisture. The percentage moisture of the soil determines its fertility status. The highest values are shown by sites E and D respectively probably due to higher thermal and electrical conductivity associated with tension (Courtney and Trudgil, 1984).

Loss in ignition of soils arises from the quantitative ashing and a rough indication of the amount of organic matter present in the soil. Site C has the highest percentage value 2.40±0.02 while E has the lowest value of 1.10±0.01 respectively. This means that sample E is easily volatizes or oxidized.

Table 3: shows the mineral composition of the College soil on dry weight basis. Nitrogen forms 80 percent of the earth's crust atmosphere and gives plants healthy dark-green foliage and promotes the growth of vegetative parts of the plant. However, too much nitrogen causes rapid growth and low yield. High nitrogen levels are needed for true vegetables like unlike fruits crop likes beans, corn, peas, and straw berries. Essiel, (1987) in his earlier work obtained a total nitrogen percent of 0.03 and concluded that most West Africa soils are low in nitrogen content. The low values (0.28±0.02 0.15±0.02) obtained in this work may be ascribed to the farming system using residue for domestic purposes after harvest and the burning of the leftovers in farm clearance preparatory for the next planting season.

Phosphorous is essential for flowering fruit and seed production as well as seed germination and resistance to disease. Its soil supplies are often limited (Fixen and Grove, 1990). Plants lacking phosphorous have purplish leaves, petioles and stem. It will be most desirable to apply phosphorous (in form of fertilizer) to the soil analyzed because of their neutrality and slightly acidic nature (Table 1). The low value of phosphorous in Table 3 may be adduced to the fact that it is readily absorbed by Iron, Magnesium, Calcium and Aluminum compounds and organic matter; which forms are rarely soluble and easily assimilated by plants.

Potassium is important for the manufacture of carbohydrates by plant. It produces stiff, erect and vigorous stems in plants; but insufficient or excess potassium in the soil will make the plant susceptible to frost injurt and reduced growth; with spotted or streakes leaves (Matejovic and Durakova, 1984). The average potassium from soil colloids (Gary et al., 2001). The low value of potassium in Table 3 will lead to low crop yield; in all the sites analyzed.
The low concentration of the exchangeable cat ions of Na, Mg, and Ca may probably mean that there is little or low build-up of pollutants in these soils.

CONCLUSION

The essence of physico-chemical analysis of soil is to offer greater understanding of our environment and resources and their best uses physically, chemically, morally and ethnically. Of prime importance is the wise use of soil and its resources for sustainable development. The present study covered only a small portion of the College and a more extensive study to accumulate a more comprehensive data for proper evaluation is urgently required.

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Table 1: Soluble salts (gram) and percentage values of soil air, soil pH, organic matter content and available water capacity(AWC).

Soil Samples	Soluble salt	Soil Air	Organic matter	Available water capacity	pH
A	12.1±0.02	19	3.4±0.01	10.0	6.78
B	12.9±0.01	16	2.9±0.0I	9.0	6.60
C	13.8±0.0	26	3.7±0.01	18.1	6.36
D	14.1±0.01	23	1.4±0.00	9.3	7.01
E	13.5±0.01	28	3.8±0.01	15.7	6.58
F	13.1± 0.01	21	3.2±0.01	12.9	7.58

All values are mean of triplicate determinations ± standard deviations. A (Basic sciences) B (Engineering) C (Agriculture) D (works) E (Home Economics) F (college central farm).

Table 2: Percentage physicochemical properties of College (dry) soil , Lafia, Nigeria.

Sample	Saturature	Moisture	Loss Ignition	On Clay	Silt	Sand
A	30.1±0.00	0.38±0.00	1.42±0.01	13.8±0.03	26.4±0.03	50.1±0.20
B	32.8±0.00	0.41±0.00	1.25±0.01	15.9±0.02	18.6±0.02	59.2±0.30
C	35.2±0.02	0.33±0.02	2.40±0.02	19.1±0.01	20.2±0.01	60.4±0.35
D	34.9±0.01	0.49±0.01	2.10±0.01	22.2±0.01	17.4±0.02	71.2±0.20
E	35.6±0.01	0.52±0.01	1.10±0.01	20.5±0.00	21.7±0.00	64.9±0.25
F	30.5±0.01	0.39±0.00	1.35±0.01	21.2±0.01	24.6±0.02	59.4±0.30

A (Basic sciences) B (Engineering) C (Agriculture) D (works) E (Home Economics) F (college central farm)

Table 3: Percentage mean and relative standard deviation values for mineral composition of soil on dry weight basis.

Sample	**Calcium (Ca)**	**Sodium (Na)**	**Magnesium (Mg)**	**Nitrogen (N)**	**Phosphorous (P)**	**Potassium (K)**
A	0.12±0.01	4.82±0.50	0.18±0.04	0.18±0.12	3.68±0.50	0.68±0.00
B	0.21±0.02	3.56±0.34	0.12±0.03	0.15±0.02	3.12±0.41	0.30±0.00
C	1.04±0.01	2.50±0.12	0.17±0.02	0.26±0.01	3.30±0.48	0.26±0.01
D	0.23±0.02	4.56±0.41	1.20±0.01	0.28±0.02	3.88±0.44	0.36±0.00
E	0.04±0.02	2.59±0.70	1.80±0.02	0.22±0.12	3.10±0.18	0.42±0.00
F	0.16±0.03	3.54±0.56	1.60±0.01	0.24±0.07	2.98±0.16	0.52±0.00

A (Basic sciences) B (Engineering) C (Agriculture) D (works) E (Home Economics) F (college central farm).