



DETERMINATION OF SOME PHYSICOCHEMICAL PARAMETERS OF SOIL SAMPLES COLLECTED FROM SOME LOCAL GOVERNMENT AREAS OF JIGAWA AND KANO STATES NIGERIA

**NURA MUHAMMAD BELLO; KABIRU BASHIR AHMAD; & AMEH
OHIGA EBUNE**

*Department of Chemistry, Federal University Lokoja, P.M.B. 1154, Kogi
State, Niger*

ABSTRACT

Soil fertility is the most important factor to be considered in determining the type of crop to be planted in a particular soil. Most important fertility determinants are soil minerals content (ammonium ions, total nitrogen content, total phosphorus and exchangeable bases), acidity and alkalinity of soil (soil PH), soil texture and soil type. Physicochemical parameters of soil samples were determined by volumetric method of analysis. The samples were collected from some local government areas of Jigawa and kano states of Nigeria.

Keywords: *Soil fertility, mineral content, soil PH, physicochemical.*

INTRODUCTION

SOIL

Soil is a natural body consisting layers (soil horizon) of mineral constituents of variable thickness, which differ from the parent material in their morphological, physical, chemical and mineralogical characteristics.

Soil can also be defined as natural loose, unconsolidated materials, which consist of thin layer several meters deep in the earth's surface (Olaitan and Lombin, 1984).

Soil is composed of particles of broken rock that have been altered by chemical and environmental process that include weathering and erosion. Soil differs from its parent rock due to interaction between the lithosphere, hydrosphere, atmosphere and the biosphere. It is a mixture of mineral and organic constituents that are in solid, gaseous and aqueous state.

Soil Formation

Soil formation or pedogenesis is a combined effect of physical, chemical, biological and anthropogenic process on soil parent materials. These processes involve additions, losses, transformation and translocation of materials that composed the soil. The weathering of bedrock produced the parent materials from which soil is from. How the soil “life” cycle proceeds is influenced by at least five classic soil forming factors that are dynamically intertwined in shaping the way soil is developed, they include:

- a) Parental materials
- b) Regional climate
- c) Topography
- d) Biotic potential
- e) Time

Parental Materials:

The material from which soil forms is called parent materials, it include; weathered primary bedrock, secondary material transported from other locations e.g. colluviums and alluviums’ deposits that are already present but mixed or altered in other ways; organic materials including peat or alpine humus and anthropogenic materials like landfill or mine waste.

Climate

Soil formation greatly depends on the climate, and soils from different climate zones show distinctive characteristics temperature and moisture affect weathering and leaching. Temperature and precipitation rates affect biological activity, rates of chemical reactions and type of vegetation cover. Wind moves sand and other particles, especially in arid regions where there is little plant cover. The type and amount precipitation influence soil formation by affecting the movement of ions and particles through the soil, aiding in the development of different soil profiles.

Biotic Factor

Plant animals, fungi, bacteria and humus affect soil formation. Animal and microorganism mix soil to form burrows and pores allowing moisture and gases to seep in to deep layers. In the same way plant roots open channels in the soil,

especially plant with deeper taproots micro-organism including fungi and bacteria, affect chemical exchange between roots and soil and act as a reserve of nutrients.

Time

Time is a factor in the interactions of all the above factors as they develop soil. Overtime, soils evolve features dependent on the other forming factors and soil formation is a time responsive process depends on how the other factors inter play with each other. Soil is always changing. It takes about 800 to 1000 years for a 2.5cm thick layer of fertile soil to be formed in nature ([w/http://en.wikipedia.org/wiki/soil](http://en.wikipedia.org/wiki/soil)).

SOIL CHARACTERISTICS

Soil Color:

Soil colour is often the first impression one has when viewing soil colour and contrasting patterns are especially memorable. The development and distribution of color in a soil profile result from chemical and biological weathering, especially redox reaction. As the primary minerals in the soil parent materials combine into new and colorful compound.

Soil Structure:

Soil structure is the arrangement of soil particles into aggregates. These may have various shapes, sizes and degrees of development or expression soil structure affects aeration, water movement, resistance to erosion and plant root growth.

Soil Texture:

Soil texture refers to sand, silt and clay composition. Sand and silt are the product of physical weathering while clay is the product of chemical weathering.

Soil Resistivity:

Soil resistivity is a measure of a soil ability to retard the conduction of an electric current. The electric resistivity of soil can affect the rate of galvanic corrosion of metallic structure in contact with soil.

SOIL CLASSIFICATION

Soil is classified into categories in order to understand relationship between different soils and to determine the usefulness of a soil for a particular use. The different classes are:

- Sand soil
- Silt soil
- Clay soil
- Loamy soil
- Peaty soil
- Chalky soil

(www.buzzle.com/article/different_types-of-soil/html 1963)

USES OF SOIL

- Agriculture
- Construction
- Mining
- Preservation and cleaning of water
- Habitat for many organisms

PHYSICOCHEMICAL PARAMETERS OF SOIL

These parameters tell us about the status of soil, that is how fertile the soil is and they include the following:

- Soil PH
- Total nitrogen content
- Particle size
- Electrical conductivity (ECe)
- Exchangeable based
- Total and available phosphorus
- Toxic metals

Soil pH

Soil pH refers to the acidity or alkalinity of the soil. Its measure of the concentration of free hydrogen ions (H^+), that are in the soil. Soil pH is measured using pH meter, and can be measured in water (pH_w) or in a weak CaCl solution (pH CaCl). The soil pH value indicates.

- Strong acidity < 5.5
- Moderate acidity 5.0 – 6.0
- Neural 6.5 – 7.5
- Moderate alkalinity 7.5 – 8.5
- Strong alkalinity ≤ 8.5

Total Nitrogen Content

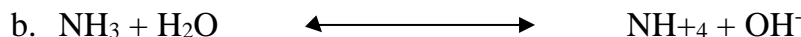
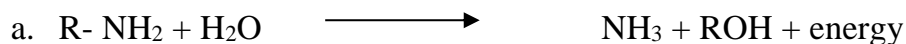
Nitrogen is essential in maintaining the balance of life in natural ecosystem. However, undesirable nitrogen in the form of nitrate and ammonium ion as a result of means activity is not only pollutant but potential health hazard (spectrometric method determination of NH_4^+ v4 (2): pg 313).

Soil organic matter is the major source of nitrogen available to plant (Ado, 2009). According to Agbenin (1995), deficiency of nitrogen is the most widespread in soil, hence it's remaining probably the most studies soil nutrient through all aspect of nitrogen cycling in soil have been elucidate and thoroughly documented. In the mineralization process, organic forms of nitrogen such as complex protein and allied compound are converted to mineral form (NH_4^+ and NO_3^-) largely through the activities of micro-organism. Organic compound are converted to amino acids are themselves converted to NH_4^+ ions by ammonifications. Any excess NH_4^+ is converted to NO_3^- by enzymes oxidation and nitrification process (Awotundun, 1973). The reaction involve are as follows:

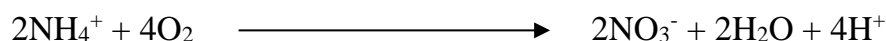
I. Aminization/mineralization



II. Ammonification



III. Nitrification



Particle Size

Soil consists of an assembly of ultimate soil particle (discrete particles) of various shapes and size. The objective of particle size analysis is to group these partiles in to separate ranges of sizes and so determine the relative proportion

by weight of each size range. The method employ involved sieving and sedimentation (Nicholas, 2004).

Exchangeable Bases:

Exchangeable bases such as Ca, Mg, Na and K are extracted from soil by leaching with ammonium acetate solution and analyzing the individual action in leachate by flame atomic absorption spectrometer or emission spectrometry (FAAS or FES).

Electrical Conductivity:

The electrical conductivity of the soil, measured in dsm^{-1} , is used as a basis for the classification of salt-effect of soil (Rowell, 1994). Mass, in 1986 has reviewed extensively on tolerance and crop sensitivity. Crops differ in their tolerance to salinity (FAO, 1973). For medium tolerance crops including many of the field crops, an EC of 4.0 to 10.0 is the range in which a 50% yield declined is expected (FAO, 1985).

EXPERIMENTAL

APPARATUS AND EQUIPMENTS

- ✓ Measuring cylinder (5, 10, 50, 100, 100 cm^3)
- ✓ Volumetric flask (50, 100, 250 cm^3)
- ✓ pH meter
- ✓ Conductivity meter (Jenway 4010) and cell
- ✓ Multimix machine with bulled “milkshake” cups.
- ✓ Hydrometers
- ✓ Thermometers
- ✓ Burette
- ✓ Digestion flask
- ✓ Uv-visible spectrophotometer
- ✓ Centrifuge
- ✓ Mechanical shaker
- ✓ Macro-kjeladahl digestion-distillation apparatus.
- ✓ Macro-kjeladahl flasks, 500ml and 750ml capacity
- ✓ Funnels
- ✓ Buchner funnel

- ✓ Analytical balance
- ✓ Vacuum line
- ✓ Filter paper (whatman 1,2).
- ✓ Suction flask

Reagents

- ✓ Sodium hydroxide (NaOH)
- ✓ Potassium chloride (KCL)
- ✓ Conc. H₂SO₄ (SG, 1.83, 98% v/v 98 gm ol⁻¹)
- ✓ Distilled water
- ✓ Potassium dichromate (K₂Cr₂O₇)
- ✓ O-phenanthroline-ferrous complex
- ✓ Ferrous sulphate (FeSO₄ (0.5)
- ✓ Sodium Hexametaphosphate
- ✓ Brucine
- ✓ Mercury catalyst tablets
- ✓ Boric acid indicator
- ✓ Sodium nitroprusside
- ✓ Ammonium chloride

SAMPLE COLLECTION AND PRE-TREATMENT

The soil samples were collected from various parts of Kano and Jigawa State by grid or point sampling method. The samples were dried. Grounded and passes through a 2mm sieve to remove stones vegetables other large particle. The samples were finally kept in a sample bag.

PREPARATION OF REAGENTS SOLUTIONS

Preparation of 10M Sodium Hydroxide

2.1kg of NaOH pallets was weighed in a heavy walled 5 later glass bottles or flask, and 2 litres of distilled water was added and the flask was swirled until the alkali dissolved.

Preparation of Mix Boric Acid Indicator.

80g boric acid (H₃BO₃) was dissolve in 3800ml of distilled or deionised water by heating on a hot-plate at low heat, the solution was allowed to cold 80ml of

mixed indicator (prepared by dissolving 0.99g of bromocresol green and 0.66g of methyl red in 100ml of 95% ethanol) was added. 0.1M NaOH was added through a burette until the solution is reddish-purple tint (pH 5.0). It was then diluted with 4 litres of deionised water and shaken well.

Preparation of Sodium Hexametaphosphate

50kg of sodium hexametaphosphate and 7g of sodium carbonate (anhydrous) was dissolved in a 1 litre flask and the volume was made up to the mark.

Preparation 0.167M Potassium Dichromate

4.9g potassium dichromate ($K_2Cr_2O_7$) was weighted and transferred in to 100cm³ volumetric flask and dissolved with de-ionised water and the volume was made up to the mark.

Preparation of 0.1M KCL

Dissolve 0.7456g of dehydrated KCl in water and make up to 1 litre at 25°C.

Preparation of 0.5M HCL

20.2ml of conc. HCl to 500ml was dissolved to 500ml of distilled water under fume hood.

Preparation of 0.4M $(NH_4)_2SO_4 \cdot FeSO_4 \cdot 6H_2O$

39.2g of ammonium ferrous sulphate was accurately weighted and transferred in to 100cm³ volumetric flask and dissolved with deionised water and made up to the mark.

Preparations of 1.5M H_2SO_4

8.2cm³ of conc. H_2SO_4 was accurately measured and transferred in to 100ml volumetric flask and diluted with deionised water and the volume was made up to the mark.

Preparation of 0.2% Sodium Nitroprusside

Sodium nitroprusside stock solution was prepared by dissolving 0.2g of sodium nitroprusside in 100ml of water, stored in a brown bottle in refrigerator.

Preparation of 2.5% Brucine

2.5g of brucine or brucine sulphate was dissolved in 100ml of glacial acetic acid. The solution was stored in the dark. The solution was handle with care as it is very toxic.

PROCEDURE FOR PHYSICOCHEMICAL TESTS

Procedure for some preliminary tests such as:

- Particle size
- Soil pH
- Organic carbon
- Total Nitrogen content are given below.

Procedure for Particle Size Analysis

51g was of air-dry soil was weight and transferred in bolted cup. The cup was half filled with distilled water and 50ml of sodium hexometaphosphate was added to it. The mixture was allowed to stand over weight.

The mixture was stirred in a stirrer for 10-15 minutes, until apparatus of soil are broken the suspension was transferred in to 100ml of distilled water, while the hydrometer was in the suspension.

The hydrometer was removed and cylinder was covered and mixed thoroughly. The hydrometer was inserted at the end of 20 seconds and the reading was recorded at the end of 40 seconds. The hydrometer was removed and the temperatures of the suspension recorded. The hydrometer was calibrated so that the corrected reading gives the grams of soil materials in suspension.

The 40 seconds hydrometer reading actually gives the amount of silt and clay in suspension while the weight of the sand was obtained subtracting corrected hydrometer reading from the total weight of the sample and the percentage of the sand was obtained by dividing the weight of the sand by weight of the sample and multiplied by rendered.

The suspension was re-sharked aging after 2hrs and hydrometer was inserted and the reading was recorded, ensuring that the temperature of the suspension was recorded just before the hydrometer was inserted the reading was corrected for temperature.

Procedure for Determination of Soil pH

20g of air-dry soil was weighted in to a 50ml beaker and 20ml of distilled water was added to it. The mixture was allowed stand for 30 minutes, it was then

stirred with a glass rod and electrode pH meter was inserted in to the partially settled suspension and the pH was measured ensuring that the suspension was not stirred during the measurement.

The pH was reported as soil pH measured in water, pH (H₂O).

Procedure for the Determination of Organic Carbon

The portion of the soil sample was ground and passed through 0.5mm sieve, 1g of the sample in duplicate was transferred in the 250ml of Erlenmeyer flask 10ml of 1N K₂Cr₂O₇ solution was accurately pipette and transferred in each flask and the flask was swirled gently.

20ml of concentrated H₂SO₄ was added rapidly using an automatic pipette. The flask was swirled gently until the soil and reagent was mixed, after which it was swirled vigorously for one minute. The beaker was rotated again and the flask was allowed to settle on a sheet of asbestos for about 30 minutes, after which 100ml of distilled water was added.

3-4 drops of indicator was added and the mixture was titrated with 0.5N ferrous sulphate solution. As the end point was approached solution changed to dark green. The ferrous sulphate was added drop by drop, where there was changing from blue to red or maroon colour in reflect light against a white background.

The dichromate was standardized by blank titration in the same manner but without soil (step 3, 4, 5 and 6).

The result it was calculated using the falling formulae.

$$\% \text{ organic carbon} = \frac{(B-T) \times M \times 0.3 \times F}{W}$$

(Agbenin, 1995).

Where:

B	=	Blank titre = 13.80
T	=	Sample titre
M	=	Morality of (NH ₄) ₂ 2Fe(SO ₄) ₆ H ₂ O = 0.50
F	=	Correction factor = 1.3
W	=	Sample weight

Procedure for Determination of Total Nitrogen

2g of soil sample was measured and transferred into 500 macro Kjeldahl flask and 20ml of conc. H₂SO₄ and mercury catalyst tablet was added. He the flask

was heated until the solution become cleared and the residue was further heated for few minutes so that complete digestion was achieved.

The flask was allowed to cold and about 50ml of deionised water was added. The content was mixed thoroughly, after which it was filtered. The filtered was transferred into 100ml volumetric flask and the deionised water was added making it 100ml.

The blank digestion was made by mixing all the reagents without the sample, making it to 100ml.

Distillation unit was set and 5ml of boric acid indicator was added into the 100ml filtered, this was followed by three (3) drops of mixed indicator (bromocresol green + methyl red + alcohol). 10ml the digest was transferred into the reaction chamber and 10ml of 40% of NaOH was added and the distillation was commence immediately.

The distillation was stopped when 150ml of the distillate was collected and nitrogen was determined by titrating with 0.1M of HCL (H_2SO_4).

The nitrogen was calculated using the following formula:

$$\% N = T \times M \times 0.014 \times \frac{V_1}{V_2} \times \frac{100}{W}$$

Where:

T = Titre value

M = Molarity of acid

V1 = Volume of the digest used in the distillation

V2 = Final volume

W = Weight of soil used in for digestion

PROCEDURE FOR DETERMINATION OF AMMONIUM AND NITRATE IONS

Prosedure for Determination of Ammonium ion in a Soil

5g of soil sample was weighted and transferred into 250ml flask. 100ml of 1M sodium acetate (pH 8.2) was added. The suspension was shaken for about two hours. The solution was then filtered with filter paper, and sodium acetate was added and made up of 100ml. Steam distillation unit was set and 5ml of boric acid indicator was added into the 100ml filtrate, this was followed by three (3) drops of mixed indicator (bromocresol green + methyl red + alcohol). 10ml the digest was transferred into the reaction chamber and 10ml of 40% of NaOH was

added and the distillation was commence immediately. The distillation was stopped when 150ml of the distilled was collected and nitrogen was determined by titrating with 0.1M of HCL (or H₂SO₄). Nitrogen was calculated using the formula:

$$\% N = T \times M \times 0.014 \times \frac{V1}{V2} \times \frac{100}{W}$$

Where:

T = Titre value

M = Molarity of acid

V1 = Volume of the digest used in the distillation

V2 = Final volume

W = Weight of soil used in for digestion

Ammonium ion was calculated from the relation:

$$NH_4^+ (\mu g g^{-1}) = \%N \times 1.216$$

(Udo, 1996).

Procedure for Determination of Nitrate ion in Soil

10g of soil was accurately weighted and transferred into 250ml flask. 100ml of 2M KCl was added and shaken on a mechanical shaker for about an hour. The suspension was filtered through filter paper and two molar KCl was added again and the volume was made up to 100ml.

Steam distillation unit was set and 5ml of boric acid indicator was added into the 100ml filtered, this was followed by three (3) drops of mixed indicator (bromocresol green + methyl red + alcohol). 10ml the digest was transferred into the reaction chamber and 10ml of 40% of NaOH was added and the distillation was commenced immediately. The distillation was stopped when 150ml of the distilled was collected and nitrogen was determined by titrating with 0.1M of HCL (or H₂SO₄). Nitrogen was calculated using the formula:

$$\% N = T \times M \times 0.014 \times \frac{V1}{V2} \times \frac{100}{W}$$

Where:

T = Titre value

M = Molarity of acid

V1 = Volume of the digest used in the distillation

V2 = Final volume

W = Weight of soil used in for digestion

Ammonium ion was calculated from the relation:

$$\text{NH}_3 (\mu\text{gg}^{-1}) = \%N \times 4.427$$

(Udo, 1996).

RESULT AND DISCUSSION

Results of various parameters

Table 3.1.1: Particles size distribution in soil samples.

S/N	Code	CHR1	CHR2	%Sand	% Silt	% Clay
1.	A	4	1	92	6	2
2.	B	4	3	92	2	6
3.	C	9	2	82	14	4
4.	D	12	3	76	18	6

Where: CHR1 and CHR2 are 1st and 2nd hydrometer reading respectively.

Percentage of sand, silt and clay are calculated from the relations;

$$\% (\text{Silt} + \text{Clay}) = \frac{\text{CHR}_1 \times 100}{\text{Sample weight}} \quad (1)$$

$$\% \text{ Sand} = \frac{\text{Weight of sample} - \text{CHR}_1}{\text{Weight of sample}} \times 100 \quad (2)$$

(Agbenin, 1995)

Sample A

$$\% (\text{Silt} + \text{Clay}) = \frac{4 \times 100}{50}$$

$$= 8\%$$

$$\% \text{ Clay} = \frac{1}{5} \times 100\%$$

$$= 2\%$$

$$\% \text{ Sand} = \frac{50-4}{50} = 100$$

$$= 92\%.$$

The above percentage corresponds to a textural range obtained from a textural triangle. (Olaitan and Lumbin, 1988).

Table 3.1.2 Textural ranges and soil types of various sample.

S/N	Sample Code	Textural Range	Soil Type
1.	A	0.02 – 2	Sand

2.	B	0.02 – 2	Sand
3.	C	0.002 – 0.2	Sandy loam
4.	D	0.002 – 0.2	Sandy loam

Table 3.1.3: Result of soil pH

S/N	Sample Code	pH Values (Mean \pm SDV)
5.	A	7.06 \pm 0.84
6.	B	7.06 \pm 0.41
7.	C	6.93 \pm 0.23
8.	D	6.66 \pm 0.24

Where SDV = Standard Deviation

Each result is a mean value of three replicate measurements.

Calculation of percentage organic matter

% organic matter = % organic carbon x 1.724

% organic carbon = $\frac{(B-T) \times M \times 0.3 \times F}{W}$

(Agbenin, 1995)

Where:

B = Blank titre = 13.80

T = Sample titre

M = Morality of $(NH_4)_2Fe(SO_4)_6H_2O$ = 0.50M

F = Correction factor = 1.33

W = Sample weight

SAMPLE "A"

S/N	Sample Code	Initial reading (cm ³)	Final reading (cm ³)	Titre value (cm ³)
1.	A ₁	13.80	24.60	10.80
2.	A ₂	15.80	26.20	10.40
3.	A ₃	0.60	11.80	11.20

Therefore

$$\begin{aligned} \text{\% Organic carbon of A}_1 &= \frac{(13.80 - 10.80) \times 0.5 \times 0.3 \times 1.33}{1g} \\ &= 0.599 \end{aligned}$$

$$\begin{aligned} \text{\% Organic matter of A}_1 &= 0.599 \times 1.724 \\ &= 1.033 \\ \text{\% Organic carbon of A}_2 &= \frac{(13.8-10.4) \times 0.5 \times 0.3 \times 1.33}{1g} \\ &= 0.678 \\ \text{\% Organic matter of A}_2 &= 0.678 \times 1.724 \\ &= 1.169 \\ \text{\% Organic carbon of A}_3 &= \frac{(13.8-11.2) \times 0.5 \times 0.3 \times 1.33}{1g} \\ &= 0.518 \\ \text{\% Organic matter of A}_3 &= 0.518 \times 1.724 \\ &= 0.8948 \\ \text{Mean organic matter} &= 1.021\% \\ \text{Standard deviation} &= 0.138 \end{aligned}$$

Result of Percentage Organic Matter

S/N	Sample Code	% Organic Matter (Mean \pm SDV)
1.	A	1.021 \pm 0.13
2.	B	0.747 \pm 0.03
3.	C	0.641 \pm 0.07
4.	D	1.482 \pm 0.04

Each result is mean value of three replicate measurements

Calculation of percentage total Nitrogen

$$\% \text{ N} = M \times T \times 0.014 \times \frac{V_1}{V_2} \times \frac{100}{W}$$

(Ibitoyi, 1992)

Where:

T = Control titre value

M = Morality of the acid = 0.01

V2 = Volume of digest = 100ml

V1 = Final volume = 10ml

W = Weight of the sample = 2g

Table 3.1.5 Sample "A"

S/N	Sample Code	Initial reading (cm ³)	Final reading (cm ³)	Titre value (cm ³)
1.	A ₁	0.00	0.73	0.73

2.	A ₂	0.73	1.44	0.71
3.	A ₃	1.44	2.13	0.69

Therefore:

$$\begin{aligned} \% \text{ total N of A1} &= 0.01 \times 0.73 \times 0.014 \times \frac{100}{10} \times \frac{100}{2} \\ &= 0.051\% \end{aligned}$$

$$\begin{aligned} \% \text{ total N of A2} &= 0.01 \times 0.71 \times 0.014 \times 10 \times 50 \\ &= 0.050\% \end{aligned}$$

$$\begin{aligned} \% \text{ total N of A3} &= 0.01 \times 0.69 \times 0.014 \times 10 \times 50 \\ &= 0.048\% \end{aligned}$$

Mean total Nitrogen = 0.050%

Standard deviation = 0.0012

For other samples, results are given in the table below:

Table 3.1.6: Result of total Nitrogen

S/N	Sample Code	% Nitrogen (Mean \pm SDV)
5.	A	0.050 \pm 0.0012
6.	B	0.071 \pm 0.0014
7.	C	0.032 \pm 0.0021
8.	D	0.073 \pm 0.0028

Each result is a mean value of three replicate measurements.

Results of NH₄⁺ AND NO₃⁻

Calculation of NH₄⁺

$$\begin{aligned} \text{NH}_4^+ (\mu\text{gg}^{-1}) \text{ of A}_1 &= 0.051 \times 1.216 \\ &= 0.062 \end{aligned}$$

$$\begin{aligned} \text{NH}_4^+ (\mu\text{gg}^{-1}) \text{ of A}_2 &= 0.050 \times 1.216 \\ &= 0.061 \end{aligned}$$

$$\begin{aligned} \text{NH}_4^+ (\mu\text{gg}^{-1}) \text{ of A}_3 &= 0.048 \times 1.216 \\ &= 0.058 \end{aligned}$$

$$\text{Mean NH}_4^+ = 0.060 (\mu\text{gg}^{-1})$$

$$\text{Standard deviation} = 0.0016$$

For all samples, the results are given in the table below:

Table 3.1.7: Ammonium (NH₄⁺) content of soil samples

S/N	Sample Code	NH ₄ ⁺ (μgg ⁻¹) (Mean ± SDV)
1.	A	0.060 ± 0.0016
2.	B	0.087 ± 0.0027
3.	C	0.037 ± 0.0026
4.	D	0.089 ± 0.0026

Each result is a mean value of three replicate measurements

Calculation of NO₃⁻

The NO₃⁻ in a soil sample is calculated from the relation:

$$\text{NO}_3^- (\mu\text{gg}^{-1}) = \text{total nitrogen} \times 4.427$$

(Udo, 1996).

Sample B

$$\text{NO}_3^- \text{ of sample B}_1 = 0.071 \times 4.427$$

$$= 0.0314$$

$$\text{NO}_3^- \text{ of sample B}_2 = 0.070 \times 4.427$$

$$= 0.0310$$

$$\text{NO}_3^- \text{ of sample B}_3 = 0.073 \times 4.427$$

$$= 0.0323$$

$$\text{Mean NO}_3^- = 0.315 (\mu\text{gg}^{-1})$$

$$\text{Standard deviation} = 0.0111$$

For other samples, results of NO₃⁻ are given in the table below:

Table 3.1.8 of NO₃⁻ Content of soil samples

S/N	Sample Code	NO ₃ ⁻ (μgg ⁻¹) (Mean ± SDV)
1.	A	0.220 ± 0.0066
2.	B	0.315 ± 0.0067
3.	C	0.134 ± 0.0111
4.	D	0.323 ± 0.0090

Each result is a mean value of three replicate measurements

Table 3.1.9 Parameters of various soil samples

S/N	Sample Code	Textural range	Soil pH	Soil Organic Matter (%)	Total Nitrogen (%)	NH ₄ ⁺ (μgg ⁻¹)	NO ₃ ⁻ (μgg ⁻¹)
1.	A	0.02 - 2	7.06 ± 0.73539	1.021 ± 0.03606	0.050 ± 0.00123	0.060 ± 0.0016	0.220 ± 0.0066
2.	B	0.02 - 2	7.60 ± 0.41421	0.724 ± 0.02546	0.071 ± 0.00142	0.087 ± 0.0027	0.315 ± 0.0067

3.	C	0.002 - 2	6.93 ± 0.2335	0.641 ± 0.06718	0.032 ± 0.00212	0.037 ± 0.0026	0.134 ± 0.0111
4.	D	0.002 - 2	6.66 ± 0.24041	1.482 ± 0.04203	0.073 ± 0.00283	0.089 ± 0.0026	0.323 ± 0.0090

DISCUSSION

Result from preliminary test shows that the soil with highest pH value is simple collected from Dambatta (sample B) of Kano State followed by sample collected from Hadejia (sample D) of Jigawa State, then sample collected from Dutse (sample C) of Jigawa State, while sample collected from Kura (sample A) of Kano State has the lowest pH value. With regards to the texture of the soil sample, the result shows that, sample collected from Hadejia and Dambatta (sample D and B) are sandy soil, while sample collected from Dutse and Kura (sample C and A) are loamy sand. Result of total Nitrogen shows that sample collected from Kura (sample A) has the highest Nitrogen, this is followed by soil sample collected from Dambatta (sample B), then sample collected from Hadejia (sample D) while soil sample collected from Dutse (sample C) has the lowest Nitrogen content. However result of percentage organic matter shows that sample collected from Kura (sample A) has the highest percentage organic matter, this is followed by sample collected from Dambatta (sample B), then (sample D) of Hadejia and (sample C) collected from Dutse has the lowest percentage organic matter.

The result of the analysis shows that soil sample collected from Kura of Kano State has the highest content of ammonium ions (NH_4^+), this is followed by soil sample collected from Dambatta (sample B), then sample collected from Hadejia (sample A), while the soil sample with lowest ammonium ion (NH_4^+), content is sample collected from Dutse (sample C) of Jigawa State.

The order of (NH_4^+) concentration is as follows:

Kura > Dambatta > Hadejia > Dutse

With regards to nitrate (NO_3^-) of the soil samples, the results shows that sample collected from Kura (sample D) has the highest Nitrate content, followed by soil sample collected from Dambatta (sample B), then sample collected from Hadejia (sample A) and sample collected from Dutse (sample C) has the lowest Nitrate (NO_3^-) content.

The order of (NO_3^-) content is as follows:

Kura > Dambatta > Hadejia > Dutse

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