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Physicochemical Analysis of a Soil near Microbiology Laboratory at The University of Ilorin, Main Campus

Oyeyiola G.P.[1], *Agbaje A.B.[2]

[1]Department of Microbiology, University of Ilorin, P.M.B 1515, Ilorin, Nigeria.
[2]Department of Biological Sciences, Al-Hikmah University, P.M.B 1601, Ilorin, Nigeria.

*Corresponding Author: Email: *tundeag@yahoo.com Mobile Phone Nember: +2348034265972

ABSTRACT
In this study the physico-chemical analysis of a soil near microbiology laboratory at the University of Ilorin, main campus was carried out. The objectives of the study were to determine the soil parameters such as pH, moisture content, organic matter content, water holding capacity, temperature and soil texture in consideration of the soil's suitability for microbial growth and plant development. Six soil samples were collected with interval of two weeks between two samples. pH range value was 7.10 to 7.82, the range of water holding capacity was from 0.28 ml per gram to 0.53 ml per gram of soil. The organic matter content of the soil samples ranged from 3.42% to 4.70%. The moisture content was discovered to range from 2.10% to 5.23%. The texture was discovered to be loamy sand with average composition of 89% sand, 7% silt and 4% clay.
Keywords: soil texture, Organic Matter Content, Water Holding Capacity, Moisture content, Sand, Silt, Clay

1. INTRODUCTION

Soil is the naturally occurring, unconsolidated or loose covering on the earth's surface. Soil is made up of broken rock particles that have been altered by chemical and environmental conditions, such as weathering and erosion (Bridges, 1997). Soil is a mixture of mineral and organic constituents that are in solid, gaseous and aqueous states (Buol, Hole, & McCracken, 1989).

The amount of moisture found in soil varies greatly with the type of soil, climate and the amount of humus in that soil (Miles & Broner, 2011). The types of organisms that can survive in a soil is largely determined by the amount of water available to them, since water acts as a means of nutrient transport and it is necessary for cell survival (Greg & Percy, 2005). Soil moisture can be estimated visually although this is quite imprecise. Soil moisture content can be determined by drying a soil sample in an oven at about 107^0 C for 24 hours and compare the weight of the soil before drying to the weight after drying (Fawole & Oso, 2001).

Soil pH varies and can be determined using universal indicator solution, pH paper or pH meter. Some plants such as rhododendron, camellias, azaleas, blueberries, ferns, spruce, pines, firs and red cedar prefer soil that is more acidic, with pH of 4.0 to 5.0. Other plants, such as beech, mock orange, asparagus and sagebrush tolerate soils with a pH 7.0 to 8.0. Above a pH of 8.5, the soil is too alkaline for most plants, while if the soil pH is below 3.5 it will be too acidic for most plants (David, Adrian, Carl, & Jean, 2011). Each layer of soil may have a different pH, which means that pH can vary within the soil, although the differences are usually not too great (Mark, McMinnville, Donna, & Willard, 2012).

Soil structure is the arrangement of soil particles into aggregates. These may have various shapes, sizes and degrees of development or expression. Soil texture refers to sand, silt and clay composition. Sand and silt are products of physical weathering while clay is the product of chemical weathering (Brown, 2003).

Soil bacteria and fungi play pivotal roles in various biogeochemical cycles (BGC) and are responsible for the cycling of organic compounds (Molin & Molin, 1997). Soil microorganisms also influence above-ground ecosystems by contributing to plant nutrition, soil structure, soil texture and soil fertility (George, Marchner, & Jakobsen, 1995).

It is therefore the aim of this study to verify the physical analysis and chemical analysis of a soil near microbiology laboratory at the University of Ilorin, main campus and to consider the suitability of the soil for microbial growth and plant development.

2. MATERIALS AND METHODS

2.1 <u>Collection of soil samples</u>

The soil samples were collected on six different occasions using two weeks interval. On each occasion, soil samples were taken from three distinct points with five meters between two points. Soil samples were taken from all the sides of the Microbiology laboratory of the University of Ilorin, main campus.

Debris was removed from the topsoil and the ground was dug to about 20cm depth before samples were taken with sterile trowel. The samples were packed in sterile polythene bags and properly tied. The samples were taken to the laboratory for analysis. Samples were kept in the fridge until needed.

2.2 Sterilization of Materials

Glassware such as conical flasks, measuring cylinder were washed thoroughly with detergent, rinse with water and sterilized in the oven at 140^0C for 180 minutes. They were then wrapped properly with aluminum foil before sterilization (Fawole and Oso, 2001).

3. DETERMINATION OF PHYSICO-CHEMICAL PROPERTIES OF THE SOIL

3.1 Determination of Moisture Content

Two crucibles were dried in the oven for 24 hours at 105^0C. They were cooled in the desiccators and their weights were taken separately. 1 gram of soil sample was weighed with each of the crucibles. The samples were dried in an oven at105^0C for 24 hours. The crucibles were then transferred into a desiccators and the sample were allowed to cool down. The crucibles and the samples they contained were weighed. The weight of each dried sample was calculated. The samples were heated repeatedly to constraint weights (AOAC, 1990). The formula below was used to calculate the percentage of moisture in each of the soil samples.

$$\frac{\text{Loss in weight of sample}}{\text{Initial weight of the sample}} \times 100\%$$

3.2 Determination of pH

20 gram of each soil sample was weighed and put in a 100 ml beaker. 20 ml of distilled water was added to the sample. The suspension was left for 2 minutes, with occasional stirring using glass rod in order to enable it reach equilibrium. The pH of the suspension was determined using a pH meter (AOAC, 1990).

The determination of the pH was carried out in duplicate and the average results were recorded.

3.3 Determination of Water Holding Capacity

Two empty milk tins were opened at one end of each of the tins was opened leaving the other end sealed. A medium sized nail was used to make hole at the sealed end of each milk tin. A circle of filter paper was cut to size and it was placed on the inside of the unopened end of each milk tin. The filter paper was moistened with a jet of distilled water from a wash bottle. Each tin was weighed and given a designation. Each milk tin was filled to about 75% with oven dried soil. The unit was compacted by dropping each milk tin from the height of about 2.5 cm. The soil surface was leveled, the milk tin was reweighed and the unit was given a designation. Each milk tin was placed in a 250ml beaker containing water deep enough to wet the soil column. Water was drawn through the soil by capillary action, until the soil became saturated.

Each milk tin was removed and placed in an empty Petri dish for 2 minutes in order to allow the draining off of excess water. Each milk tin was removed and weighed. The quantity of moisture retained per unit weight of the oven dried soil samples contained in each milk tin was determined using the formula below:

$$\frac{\text{Weight of water absorbed}}{\text{Weight of oven dried soil}} = \text{quantity of moisture absorbed per gram of soil}$$

The determination was done in duplicate using the two milk tins and the average value was recorded as the water holding capacity of the original soil sample.

3.4 Determination of Organic Matter Content

Two crucibles were dried in an oven at 105^0C for 24 hours. They were cooled in desiccators and their weights were taken separately. 1 gram of oven dried soil sample was weighed within each of the two crucibles. Each sample was heated on a Bunsen burner for 30 minutes, with occasional stirring using a mounted needle. The crucibles were transferred into desiccators and the sample in it was cooled down. Each crucible was weighed together with the sample in it. The weights of the heated soil samples were determined using the formula below:

$$\frac{\text{Loss in Weight of Sample}}{\text{Initial Weight of Sample}} \times 100\%$$

The determination was done for the two samples and the average value was recorded as the organic matter content of the original soil sample.

4. RESULTS

4.1 Physicochemical Characteristics of the Soil

The physicochemical analysis of the soil samples included pH, organic matter content, moisture content, temperature, water holding capacity, and texture. Table 1 shows the changes in pH, water holding capacity, organic matter content and moisture content. The pH was highest at ninth week and lowest at first week. The moisture content ranged from 2.10% to 5.23%. Table 2 shows the percentage mineral composition of the soil over the sampling periods. The soil texture remained unchanged throughout the sampling periods.

Table 1: Physicochemical Characteristics of the Soil

Sampling Periods (weeks)	pH	Water holding capacity(ml/g)	Organic Matter (%)	Moisture Content (%)
1	7.10	0.41	4.12	4.31
3	7.32	0.36	3.84	2.10
5	7.25	0.28	4.54	3.42
7	7.53	0.53	4.30	5.23
9	7.82	0.50	4.70	3.10
11	7.61	0.46	3.42	4.15

Table 2: Texture of the Soil

Sampling periods (week)	% Sand	% Silt	% Clay	Temperature (^{0}F)	Soil type
1	89	7	4	87.80	Loamy sand
3	89	7	4	87.80	Loamy sand
5	89	7	4	86.90	Loamy sand
7	89	7	4	86.90	Loamy sand
9	89	7	4	87.80	Loamy sand
11	89	7	4	86.90	Loamy sand

5. DISCUSSION

The results obtained from the physicochemical analysis of the soil near microbiology laboratory at the University of Ilorin, main campus revealed its soil type. The pH of all the samples taken ranged from 7.10 to 7.81. The soil texture analysis showed that the soil is loamy sand with mean composition of 89%, 7% and 4% for sand, silt and clay respectively. The water holding capacity ranged from 0.28 ml/g to 0.53 ml/g. the moisture content ranged from 2.10% to 5.23%. The soil type was found to be loamy sand. This is in accordance with the works of Brown, 2003. Molin and Molin, 1997 held that the moisture content of a soil is one the most important factors that determines the survival of soil microflora. The differences in texture can affect many other physical and chemical properties of the soil. Soil texture plays a prominent role in soil production. Soils with predominantly large particles tend to drain quickly and have lower fertility. Very fine texture soils may be poorly drained, tend to become waterlogged, and are therefore not well-suited for agriculture (Wayne, *et al*., 2007).

Considering the composition of sand, clay and silt in the soil of the project site and other related parameters such as organic matter content, moisture content and pH it can be said that it was versatile, productive and can support microbial growth and plant lives. Buol, *et al*., 1989 maintained that soil particles tend to bound together into large units referred to as aggregates. Soil aggregation occurs as a result of complex chemical forces acting on small soil components or when organisms and organic matter in soil act as glue binding particles together.

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