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Analysis on Selected Physical Properties in Soil Sample of Modibbo Adama University, Yola, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Soil is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical and biological properties. Soil testing is the only way to determine the availability of moisture, texture, pH, and nutrient status in soil. Results of physical and chemical tests provide information about the capacity of soil to supply mineral nutrients. Soils in the garden may have been deposited some thousands of years ago by volcanoes, glaciers, floods, or other processes or were delivered to the site by truck or other mechanical device, but little or no research was carried out (no documents) to determine and ascertain the soil properties or nutrient elements found in the area. The aim of the study is to analyse some selected physical elements from soil samples obtained in the botanical garden of Department of Plant Science with objectives as to determine soil texture, moisture and

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pH of samples in the area. Results in the physical analysis of selected soil samples showed that the soil sample with highest amount in percentage in soil texture is clay soil with 60%, followed by silt with 21% and sandy with 19% respectively. Furthermore; the analysis revealed soil moisture (0.998%) and pH is neither acidic no alkaline i. e neutral (7.10) and this type of soil pH indicates the ability of a soil to favour some agricultural practices. It is concluded from the results obtained that soils in the area are composed of clay (60%), silt (21%) and sandy (19%) which are good for few crop's cultivation but can be better by addition of organic and (or) inorganic fertilizers. It is recommended to amend the area with organic fertilizers as they are biodegradable and don't cause harm to humans as well as the environment.

Keywords: Soil horizon; physicochemical properties; pH; calcium; volcanoes; glaciers.

1. INTRODUCTION

"Soil is an unconsolidated mineral matter influenced by genetic and environmental factors and acts as a thin layer of earth's crust which serves as a natural medium for the growth of plants" [1]. "It is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical and biological properties" [2]. "Soil is composed of particles of broken rocks that have been altered by chemical, mechanical or biological processes that include weathering and erosion, almost all living things are directly and indirectly dependent on soil for day to day needs and 95 % of the human food is derived from the earth. Soil has complex function which is beneficial to human and other living organism" [1]. "The physicochemical properties such as moisture content, specific gravity, nitrogen as fertilizer required for the growth of plant. Potassium is used for flowering purpose; it is also required for building of protein, photosynthesis, fruit quality and reduction of diseases. Calcium is an essential part of plant cell wall, which provides normal transport and retention of other elements" [1]. "Soil is one of the most significant ecological factors, on which plants depend for their nutrients, water and mineral supply" [3]. "Soil testing is the only way to determine the available nutrient status in soil and the only way one can develop specific fertilizer recommendations. Results of physical and chemical tests provide information about the capacity of soil to supply mineral nutrients" [4]. "Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agricultural production" [5,6]. "Nitrogen, phosphorous, potassium and sulphur are important soil elements that control its fertility and yields of crops" [7]. "The productivity of agricultural soil depends largely on its physicochemical properties. The soil condition is important because it is a universal medium for plant growth, which supplies essential nutrients to the plants. In Ethiopia now a day, large number of fertilizers are used instead of manures due to this the crop productivity increases speedily but the quality of the soil decreases. So it is essential to analyse the physicochemical characteristics of soil because as with the increasing use of chemical fertilizer to the soil, it is difficult to control the adverse effect of the chemicals fertilizer to the soil, plants, animals and human beings" [8].

1.1 Statement of Problems

Soils in the garden may have been deposited thousands or millions of years ago by volcanoes, glaciers, floods, or other processes or were delivered to the site by truck or other mechanical device, or several months ago but little or no research was carried out (no documents) to determine and ascertain the soil properties or nutrient elements found in the botanical garden of department of plant science, Modibbo Adama University, Yola. These facts illustrate why soils are very complex and essential. It is the interface between the earth's atmosphere and bedrock or ground water. It has either formed in place or has been transported to its present location by wind, water, ice, gravity, or humans. Soil functions as part of a natural ecosystem, they are also very complex and diverse. Basic knowledge about soil allows us to use it wisely. This research is to help understand some selected physical properties of soil and to help know where and how to get information about soil sample at the botanical garden.

1.2 Aim and Objectives

The aim of the study is to analyse some selected physical elements from soil samples obtained in

the botanical garden of Department of Plant Science with the following specific objectives:

- to determine soil texture in the study area.
- to determine soil moisture in the botanical garden of Department of Plant science.
- to determine soil pH of the soil sample in the study area.

2. MATERIALS AND METHODS

2.1 Study Area

"The research was conducted at the Department of Plant Science Modibbo Adama University Yola. It is located along Yola-Mubi road, Girei Local Government Area of Adamawa state, North-Eastern Nigeria which lies between Latitude 9.3^{o}N and Longitude 12.5^{o}E with an average altitude of 175m above mean sea level covering a total area of 1700ha" [9]. The area has a tropical climate, marked by dry and raining seasons. The raining season commence around April and ends in the middle or late October. The rainfall is characterised by mean of 1113.3mm/annum. August and September are usually the months with high rainfall which constitute about 25% of the total annual rainfall. "The dry season usually starts in late October and ends in late April. Maximum temperature in the area reaches about 45^{o}c around April while minimum temperature could be as low as 15^{o}c between December and early January. Relative humidity in the area is about 26% in the month of January while February is the lowest with 10%" [9].

2.2 Sample Collection

"The study methods involved collection and characterization of soil samples from the study area. Soil characterization was based on their physico-chemical parameters and characters. Soil sample (consisting of composite samples each) was collected from the points of collection at the department of Plant science garden, proportion of sample was collected after dividing the site into four equal halves (quadrant) in each study site for laboratory determination of soil physico-chemical properties. At each sampling point soil samples was collected at the depth of 0 - 20 cm by using soil auger" [10]. This depth was considered because the garden plant roots are mostly localized within 0 to 20 cm depth. The soil samples from each sampling point was thoroughly mixed up, and soil sample was sprayed on a card board paper, sprayed and divide diagonally into four equal halves, two portions was collected diagonally into sterile air tight container with lid before taken to the laboratory for further analysis. In the laboratory the soil physico-chemical properties was determined soil texture, moisture and soil pH were determined.

2.3 Soil Texture

Method of [11] was modified, where 0.5kg of soil sample was weighed using weighing balance and poured unto beaker; 1000mls of water was added, vigorously stirred using a glass rod and allowed to settle for 24hrs. Different soil types (sand, silt, and clay) were measured using standard soil texture triangle (Fig 1). The percentage of each soil particle was determined by dividing the particle depth by the total soil depth and multiplying by 100 [11].

2.4 Moisture Content

"Soil moisture content was determined by air drying method modified method of [11]. 1kg of soil sample was taken, the sample was air dried by heating method for 30 minute. Dry weight of the sample was taken till it showed a constant weight. The loss in weight corresponds to the amount of water present in the soil sample. The formula below was used to calculate the percentage of moisture content in each of the soil samples" [12].

$$(MCF) = \frac{100 - \%\,MC}{100}$$

MCF: Moisture correction factor
MC: Moisture content

2.5 pH

"The pH of the soil samples was measured in water suspension as described by modified method" [13]. "Air dried soil of 0.5 kg was taken in a beaker and to this 500 ml of water was added. The mixture was stirred with glass rod for 10 min and was allowed to stand for 30 min" [13]. The pH litmus paper was deeped into the soil solution for 5-10 seconds the litmus paper was removed and allowed for 5-10 seconds (Fig 2). Different colour change determined acidity, alkalinity and (or) neutrality of the soil sample.

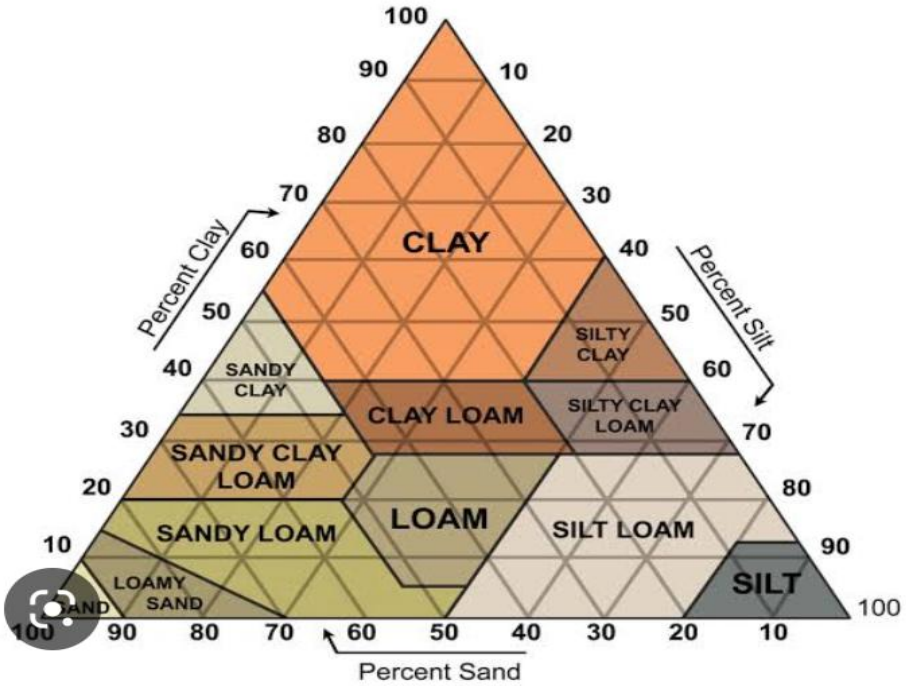

Fig. 1. Soil Texture Triangle Showing different proportion of soils

Fig. 2. Soil Sample showing different pH test with litmus paper

3. RESULTS

The physical analysis of selected soil samples represented in the tables below showed that the soil sample with highest amount in percentage in soil texture is clay soil with 60% (Table 1), followed by silt with 21% and sandy with 19% respectively, but all the soil properties tested with equal amount of weight measured in kilogram (kg) which is 0.5kg. Sandy had the least percentage with 19% (Table 1). These indicates that the sandy soil texture at the department of plant science botanical garden is less abundant (Table 1), but clay soil has more.

Findings in table 2 of the analysis of selected physical properties of soil, moisture and pH showed that in soil properties soil moisture was

Table 1. Analysis of Selected Physical Properties of Soil Texture

Soil properties	Tested Components Amount in weight Measured (kg)	Percentage (%)
Sandy	**0.5**	19
Silt	0.5	21
Clay	0.5	60

Table 2. Analysis of Selected Physical Properties of Soil Moisture and pH

Soil properties	Tested Components Amount in weight Measured (kg)	Percentage (%)
Soil Moisture	**1.0**	0.998
Soil pH	0.5	7.10

measured with high amount in kilogram (1.0kg) and has 0.998% at the percentage level (Table 2), but the soil pH value of the botanical garden is neutral (7.10) which is neither acidic no alkaline (Table 2) this type of soil pH indicates the ability of a soil to favour some Agricultural Practices.

4. DISCUSSION

The results obtained from the analysis of the soil at the Botanical garden of the Department of Plant Science MAU, Yola, revealed its soil type. The soil texture analysis showed that the soil is Clay with mean composition of 60.0%, 0.998% and 7.10% for texture, moisture and pH respectively. The water holding capacity ranged from 1kg to 0.5kg. The pH of the sample taken ranged from 7.00-7.10. The moisture content ranged from 1% to 0.998%. The soil type was found to be Clay soil; this is in accordance with the works of [14] and [15] held that the moisture content of a soil is one the most important factors that determines the survival of the soils' micro flora. "The differences in texture can affect many other physical and chemical properties of the soil. Soil texture plays a prominent role in soils' plant production and propagation. 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" [16]. "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 maintained that soil particles tend to bound together into large units referred to as aggregates" [17]. "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" [18].

Fundamental needs of human beings food, clothes and shelter fulfil through the medium of soil. Soil is an important part of agriculture, an eminent position in global cultivation of wheat, rice, pulses, sugarcane, vegetables and fruits. An understanding of physical and chemical condition of any soil is essential for proper implementation of the other management practices. Therefore the physico-chemical study of soil is very important because both physical and chemical properties may affect the soils' agricultural productivity. This physico-chemical study of soil is based on various parameters like pH, electrical conductivity, texture, moisture, temperature, soil organic matter, available nitrogen, phosphorus and potassium. This knowledge will create awareness among the farmers which in turn can affect Agro-economic productivity.

"pH is a most important physical properties of soil, it has great effects on solute concentration and absorption in soil" [19]. "Soil pH is an important consideration for farmers and gardeners for several reasons, including the fact that many plants and soil life forms prefer either alkaline or acidic condition" [20]. "If the pH is less than 6 then it is said to be acidic soil, the pH range from 6-8.5 it's a normal soil and greater than 8.5 then it is said to be alkaline soil". [20] According to report by [21] "the pH of cotton soils was found to be in the range of 7.5-8.4". "It is a good indicator of balance of available nutrients in the soil" [22]. "pH is an important parameter as it help in ensuring availability of plants nutrients example Fe, Mn, Zn and Cu are more available in acidic than alkaline soils" [23]. "It also helps in maintaining the soil fertility and to quantify the amendments used for amelioration. pH is a good sign to maintain equilibrium

between nutrients in soil. It is also an indicator of plant and other living organism, available nutrients, cation exchange capacity and organic matter content" [23].

"Texture soil has different textural groups, on basis of the proportion of different sized particles. Soil texture directly influences soil-water relation, aeration and root penetration. It also has effect on the nutritional status of soil. Soil texture can be expressed significantly by its electrical conductivity. Clay textured soil is highly conductive while sandy soil are poor conductors" [24]. "Soil texture also affects the nutrient supply of the. Sandy soils are light soils having low nutrient concentration, low in ability to retain moisture, low in cation exchange capacity and buffer capacity, and rapidly permeable. The main problems to deal with sandy textured soil are maintaining moisture retention capacity and nutrient deficiency" [25]. Sandy soil contains low organic matter [26] reported that sandy textured soil increased the squash crop productivity by addition of clay deposits.

"Moisture is also important physical property of soil, the absorption ability of nutrients depends on the moisture of the soil. The water content of soil is also much related to its texture and structure. The soil moisture commonly depends on void ratio, particle size, clay minerals, organic matter and ground water condition" [27]. "Wetness depends largely on the porosity of a soil, and for that reason clay soil, which have a high porosity generally have larger water content than sandy soils. Good water holding capacity shows the good physical condition of soil. Knowledge of the soil water holding capacity is essential to the evaluation of regional soil water balance". [27] [28] reported "maximum water holding capacity of red and black soils". "The sandy soil can quickly be recharged with soil moisture but it enable to hold as much water as the soils with heavier textures" [28]. Decomposition of organic matter is mainly depending on soil moisture, water becomes too low, and plant becomes stressed [29,30]. observed "moisture content 13.81-26.27% from rain forest and plantation in Ondo state, Nigeria".

5. CONCLUSION

The result of this study indicated that the soil in botanical garden of the department of Plant Science, Modibbo Adama University, Yola are composed of clay (60%), silt (21%) and sandy (19%) which are good for few crop's cultivation but can be better by addition of organic and inorganic fertilizers. Soil sampling and testing are done to provide an estimate of the capacity of growing crops and information to its nature and estimates of field. pH analysis was done to ascertain the available proportion. This research provides the knowledge gap so as to know the type of crops to be grown and cultivated in the study area. However other crops can be grown but with amendments of organic or inorganic fertilizers as the need may be.

6. RECOMMENDATION

It is recommended to amend or improve the fertility, moisture, probably the pH and nutrient condition of the study area by addition of synthetic and organic fertilizers like chicken droppings, cow dung or leave compost but the latter is more environmentally friendly and biodegradable naturally.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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