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Research Article

Physicochemical Parameters of Soils in Tepi Campus South Western Parts of Ethiopia

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Abstract

Soil is an important part of agriculture applications. An understanding of physical and chemical condition of any soil is essential for proper implementation of the other soil management practices. Therefore the physico-chemical study of soil is very important because both physical and chemical properties which affect the soil productivity. This physico-chemical study of soil is based on various parameters like pH, electrical conductivity, moisture, soil organic matter, and soil organic carbon. This knowledge will create awareness among the farmers about economic productivity. In this study the physicochemical properties of soil samples obtained from Tepi campus was determined. Their value could be pH 6, Electrical conductivity 7.31 µS/m, moisture content 5.038%, organic matter content 4.1% and organic carbon content 3.3%. Physical and chemical properties listed above indicate that this soil sample is productive and suitable for agricultural use. Based on the result in this study soil sample in the Tepi campus garden is slightly acidic, wet, and high organic matter content. Most of the south western parts of Ethiopia get high rain fall through the year more than eight month and its forest area. This makes the soil in this area high moisture content and organic matter content. Corn, maize, sugar cane and coffee are the most cultivated crops in this area.

Keywords

Physic-Chemicals, Soil Pollution, Organic Matter, Organic Carbon, Soil Analysis, Moisture Content

1. Introduction

Soil is one of nature's most important non-renewable, dynamic resources that are a natural medium for plant growth. On the earth's surface, soil is a combination of living organisms, organic materials, minerals, gases, and water [1]. Those above soil content affects soil texture, structure, and porosity. Soil is essential to 95% of the world's food production, feeds 25% of all terrestrial species, and is essential for storing water and carbon, which reduces the effect of climate change and prevents flooding. In addition to this soils serve, groundwater recharge, and nutrient cycling. The structure of soil afects its capacity to provide advantages. Therefore, the significance of encouraging healthy soil structure in agricultural and environmental policy is becoming more widely recognized [2].

The variability of physical and chemical properties must be known for soil analysis, including the degree to which they are affected by different agricultural uses. Similarly, properties must be understood as a function of different processes that are influenced by formation factors, such as parent material, climate, relief, organisms, and time [3]. Multivariate analyses are an adequate statistical technique to assess relationships between soil properties. On the other hand, principal component analyses (PCA) have made it possible to differentiate man-

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agement systems and soils by reducing the number of original variables to new potential variables [4].

Soil physicochemical properties are basic indicators of soil nutrient content and characteristics, including pH, electrical conductivity, cations exchange capacity, soil mineralogy, microbiological and biological conditions, soil texture, moisture content, total organic carbon, organic matter, and total nitrogen [5]. To evaluate soil quality, we selected edaphic parameters (physical and chemical qualities). Soil microorganisms utilize different types of waste such as industrial, domestic, and agricultural to increase soil enzyme activity (such as protease, amylase, and catalase). Soil microorganisms exerted an impact on various soil physicochemical parameters, including silt, clay, and electrical conductivity, water holding capacity, organic matter, total nitrogen levels, and microbial population [6]. Soil physicochemical properties and enzymatic activity together obtain the main indicators of soil quality. Moreover, it contains high amounts of mineral nitrogen (60–70% total nitrogen) compared with organic fertilizers (e.g., compost and cattle manure, contain around 6–30% of total nitrogen). The important parameters that reflect soil quality: quantity and quality of OM, soil structure, pH, and physicochemical properties [7]. In addition, the formation and decomposition of SOC are regulated by almost all enzymes, so they are comparatively vital in soil carbon cycling [8]. The combined selected indicators reflect the physical and chemical characteristics of soil. Our main objectives were to better understand the characteristics of soil through chemical and physical characteristics [2].

2. Methodology

2.1. Study Area

This research was conduct in Mizan Tepi University at Shaka zone which is one of Ethiopian

Universities in southern western nations and nationalities and peoples of Ethiopia. Located at 611 Km of south west of Addis Ababa with an elevation of 1,932 meters above sea level.

2.2. Material and Methods

2.2.1. Materials

Laboratory instruments like a measuring cylinder, burette, funnel, Whitman Filter paper, conical flask, beaker, fume hood (model: FH1800(x)), 50-mL volumetric flask, refrigerator (model: BXC-FW300), hot plate, and hot air oven were used in the in the grinder.

2.2.2. Chemicals and Reagents

The reagents that will be used in the analysis are all analytical grade. Potassium heptaoxodichromate (VI) ($K_2Cr_2O_7$), 99.9%; sulfuric acid (H_2SO_4), 98.8%; ferrous sulphate ($FeSO_4$), 99.8%, ferrous indicator.

2.3. Samples Collection and Preparation

Soil samples were collected from Tepi campus from a depth of 10 to 15 cm. Then the collected soil sample were homogenized and air-dried in a circulating air in the oven at 30 ℃ overnight and then passed through a 2 mm sieve. The sieved soils were placed in polythene bags ready for analysis.

Figure 1. *Soil sample sampling.*

2.4. Measurement of Physico-Chemical Parameters

2.4.1. Soil pH

A 20 g of air-dried soil was weighed into 50 ml beaker and 20 ml of distilled water was added. It was stirred with a glass rod and allowed to stand for 30 minutes and then filtered. pH recorded by calibrated pH meter [9].

2.4.2. Electrical Conductivity of Soil

A 25 g of air dried soil sample was placed into a 250 ml beaker. Distilled water was added slowly drop by drop uniformly over the entire soil surface until the soil appears to have been wetted. A stainless steel spatula was used to form a homogeneous soil saturated paste. The beaker was then covered with a petri-dish. 50ml distilled water was added and shaken for 1 hour. 40ml of the diluted extract was placed into 100ml beaker and the conductivity meter was inserted and the electrical conductivity of the soil recorded in μSm^{-1}.

2.4.3. Determination of Moisture Content

Two crucibles were dried in the oven for 24 hours at 105 ℃. 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 ℃ for 24 hrs. 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) [10]. The formula below was used to calculate the percentage of moisture in each of the soil samples.

$$\text{Moisture content} = \frac{\text{loss in weight of sample}}{\text{Initial weight of sample}} \times 100\ \% \quad (1)$$

2.4.4. Determination of Organic Matter content

Two Crucibles were dried in an oven at 105℃ 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 [11].

$$\text{Moisture content} = \frac{\text{loss in weight of sample}}{\text{Initial weight of sample}} \times 100\ \% \quad (2)$$

2.4.5. Organic Carbon Content

The organic carbon content of the soils were determined by wet oxidation of Walkley and Black in which organic carbon is oxidized by $K_2Cr_2O_7$ in the presence of sulphuric acid ($H_2S_2O_4$) according to the following reaction [12, 13].

A 1.0g of sieved soil was weighed into a 500 ml Erienmeyer flask. Exactly 10 ml of 1 m potassium heptaoxodichromate (VI) ($K_2Cr_2O_7$) was pipetted into flash and swirled gently to dispose the soil followed by adding 20 ml concentrated sulphuric acid. The flask was swirled gently until soil and reagents were thoroughly mixed. The mixture was thus allowed to stand for 30 minutes on a glass plate. 100ml of distilled water was added followed by addition of 3-4 drops of ferrois indicator, after which it was titrated with 0.5 m, ferrous sulphate solution. A blank titration was similarly carried out. The percentage organic caution is given by the equation

Formula used to calculate SOC,

$$Percentage\ Organic\ Carbon\ (R) = \frac{(B-T)X\ S\ X\ 0.003x100}{W}$$

Where,

B = volume of Ferrous Ammonium Sulphate solution used for blank titration

T = volume of Ferrous Ammonium Sulphate solution consumed with soil

S = strength of Ferrous Ammonium Sulphate

W = Amount of soil sample taken in gm.

$$Total\ Organic\ Carbon\ (\%) = R \times 1.3$$

$$Organic\ Matter\ (\%) = R \times 1.3 \times 1.724$$

Figure 2. *Organic Carbon content determination.*

3. Result and Discussion

3.1. Soil pH

Soils can be naturally acid or alkaline, and this can be measured by testing their pH value. Having the correct pH is important for healthy plant growth [14]. Being aware of the long-term effects of different soil management practices on soil pH is also important. Research has demonstrated that some agricultural practices significantly alter soil pH. Most soils have pH values between 3.5 and 10. In higher rainfall areas the natural pH of soils typically ranges from 5 to 7, while in drier areas the range is 6.5 to 9.The pH value in the soil sample collected from Tepi campus compound is conducted and found in the between 5.5 to 6.0. This implies that all the soils studied were found to be acidic in nature. This result implies that Tepi found in southern part of the country which is rainfall areas due to this it's found between 5 to 7 ranges.

3.2. Soil Electrical Conductivity

Soil electrical conductivity (EC) measures the ability of soil water to carry electrical current. While soil EC doesn't directly affect plant growth, it plays a vital role in plant health as it indirectly indicates nutrient availability and salinity levels. Too low or too high EC values can both have detrimental effects on plants [15, 16]. The EC values in the soil in this study is 7.31 μS/m. This result is moderate.

Table 1. *Physicochemical properties of soil.*

Physicochemical properties	Their values
pH	6.02
EC	7.31 μS/m.

Physicochemical properties	Their values
MC	5.038 %.
SOM	4.1%
SOC	3.3 %

3.3. Determination of Moisture Content

Soil moisture content was calculated by the following procedure suggested by Buckman and Brady [17, 18]. Then dry weight of the soil sample was measured. The soil moisture content in Tepi campus is 5.038 %.

3.4. Determination of Organic Matter Content

Soil organic matter is the fraction of the soil that consists of plant or animal tissue in various stages of breakdown (decomposition) [19]. Most of our productive agricultural soils have between 3 and 6% organic matter. The soil organic matter in this study is found to be 4.1%.

3.5. Organic Carbon Content

The determination of soil organic carbon is based on the Walkley & Black chromic acid wet oxidation method [20]. Oxidizable organic carbon in the soil is oxidised by 1 M potassium dichromate ($K_2Cr_2O_7$) solution in concentrated sulfuric acid. The heat of reaction raises the temperature which is sufficient to induce substantial oxidation. Soil organic matter (SOM) usually makes up 1–5% of soil mass, but it's important for soil health because it affects soil properties and function. The amount of organic matter in mineral soils ranges from 1% to over 5%, while "muck" or organic soils can be 30–40% organic matter. The organic carbon content determined in this study is 3.3%. Thus the result is in the provided ranges.

4. Conclusion

Soil is one of nature's most important non-renewable, dynamic resources that are a natural medium for plant growth. On the earth's surface, soil is a combination of living organisms, organic materials, minerals, gases, and water. In these study soil physicochemical properties like pH, moisture content, electrical conductivity, organic matter content and organic carbon content was studied. The soil sample was taken from Tepi campus. The values become pH 6, Electrical conductivity 7.31 µS/m, moisture content 5.038, organic matter content 4.1, and organic carbon content 3.3%.

Abbreviations

AOAC	Association of Official Analytical Chemistry
EC	Electrical Conductivity
MC	Moisture Content
PCA	Principal Component Analysis
SOC	Soil Organic Carbon
SOM	Soil Organic Matter

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Author Contributions

Gamada Begna Sisay: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Software, Writing – original draft

Eskedar Getachew Feleke: Project administration, Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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