Original Research Article

Determination and Correlation of pH and Electrical Conductivity of Assosa Agricultural Research Center Research Sites Soil

ABSTRACT

Soil pH has high impact on soil biogeochemical processes in the natural environment. Soil pH is thus referred to as the "master soil variable" because it influences a plethora of soil biological, chemical, and physical properties as well as processes that affect plant growth and biomass yield. Having the correct pH is crucial for the healthy plant growth as it will affect the amount of nutrient available to plants. This study was carried out to determine the soil pH and electrical conductivity value in acidic soil and their correlation. The soil samples were collected at two research sites at depth of 0 - 20cm. The study showed that electrical conductivity parameter had significant negative correlation to soil pH with R^2 = 0.8183.

Key Words: *Electrical conductivity**,** pH, acidity, Soil.*

1. INTRODUCTION

Soil is an important mixture of minerals, water, air, organic matter, and numerous organisms that are the decaying remains of once-living things. Soil is an essential component, a medium of unconsolidated nutrients and materials used in the formation of the plant's life layer. Soil develops as a result of a pedogenic process through weathering of rocks, is composed of inorganic and organic constituents, has distinct chemical, physical, and biological properties, varies from depth to the earth's surface, and serves as a medium for plant growth [1]. The world's agricultural productivity and sustainability are heavily reliant on soil fertility and physicochemical properties [2, 3].

Agriculture accounts for approximately 50% of Ethiopia's gross domestic product and 90% of its foreign exchange earnings [4]. It is obvious that fertile and productive soils are required for sustainable and high agricultural production, and physicochemical analysis of surface soil is critical for sustainable agricultural productivity. Soil nutrient analysis is a valuable tool for determining the inputs needed for efficient and cost-effective production on agricultural farms. An appropriate physicochemical soil test aids in meeting fertilizer application rates as well as ensuring and managing soil fertility for long-term crop production [5, 6].

As a result, the goal of this experimental analysis is to determine the pH and electrical conductivity of soils in order to predict the level of soil acidity and alkalinity so that it can be amended and managed accordingly. There are several methods for determining soil nutrient status. From those methods; visual diagnosis is the simplest method. Observing and studying deficiency or hunger symptoms on growing crops is a visual method and does not require any complicated equipment to estimate the result.

The second method is soil analysis method and provides an estimate of the soil's available nutrient level using different instruments and reagents.

1.1 Soil reaction (pH)

Soil pH analysis is a critical chemical parameter for determining agricultural land's fertility status and acidity classification. The outcome indicates whether a soil is acidic, neutral, or alkaline. It should be defined as the negative logarithm of hydrogen ion activity. When the pH is lowered by one unit, the concentration of H-ions in the solution increases tenfold [7]. The value influences soil nutrient availability, class, microorganism activity, and the method of some chemical analysis chosen.

Soil pH is a measure of the activity of hydronium ions (H_3O^+ or, more commonly, H+) in a soil suspension. This property influences many aspects of crop production and soil chemistry, including nutrient availability and toxic substance availability, as well as the activity and diversity of microbial populations. Typically, soil pH is measured potentiometrically in slurry using an electronic pH meter. In addition, an H^+ sensitive electrode and a reference electrode are used. Combination electrodes, which combine the H+ sensitive electrode and the reference electrode into a single unit, can be used if the combination electrode is strong enough to withstand repeated wear from the soil slurry. The manufacturer provides instructions for proper pH meter operation. Pure water has an activity coefficient equation:-

$K_w= [H^+] [OH^-]$.. 1

Kw= dissociation constant and has a value $1.0*10^{-14}$ at 24°c. Hence, H^+ and OH^- are equal to $1.0*10^{-7}$ in pure water.

$pH= -log^{[H+]}$..2

1.2 Electrical conductivity

Salts in soluble forms are present in all soils. These are typically salts of Na, Ca, Mg, and a trace of K. These salts are mostly in the form of chloride and sulfate, with some carbonate, bicarbonate, and nitrate thrown in for good measure. In some soils, salts are present in excess of what plants can tolerate for normal and healthy growth. These soils are known as'saline soils,' and the amount of salt in the soil can be estimated using two methods: electrical conductivity (EC) and determining the dry residue. The determination of electrical conductivity in soil serves to provide an estimate of the total quantity of soluble salts, i.e. the soil's salinity. The determination of electrical conductivity (EC) is made with a conductivity cell by measuring the electrical resistance of a 1:2.5 soil: water suspension [8].

2. MATERIALS AND METHODS

2.1 Soil sample collection and preparation

For this laboratory experiment, representative composite soil samples were collected at depths of 0-20cm from the Assosa Agricultural Research Center (AsARC) research sites (On-station and airport sites), which is represented by samples-1 (S1), sample-2 (S2), sample-3 (S3) and sample-4 (S4). The collected soil samples were freed of rubble, stones, and air dried ground and sieved in 1, and 2 mm sieve sizes before being thoroughly mixed to obtain a homogeneous envoy sample mixture [9]. The sieved soil samples were sealed in an airtight plastic bag and prepared for nutrient analysis.

2.2 Instruments used for Analysis

Electrical conductivity meter, pH meter with glass electrode, analytical balance, beaker, glass rode, measuring cylinder, mortar and pestle, and sieve were laboratory instruments used for pH and conductivity analysis.

2.3 Chemicals

Standard buffer solution: Make buffer solutions of pH 4.0, 7.0, and 9.2 by dissolving one of the above-mentioned commercially available buffer tablets in 100 ml of freshly prepared distilled water. A 0.01N potassium chloride solution is required for the conductivity meter standardization.

2.4 Methods of soil pH and conductivity analysis

The pH, and electrical conductivity of soil samples were determined by 1:2.5 soil to water ratio using pH meter and electrical conductivity meter respectively[10, 11]].

2.5 Experimental procedures

10 gm of soil sample was Weighed in 50 ml beaker, add 25 ml of distilled water and stir well by a glass-rode for 30 minutes, calibrate the pH meter with standard pH 4, 7 and 9.2 buffer solutions, kept 30 minutes and immersed the pH electrodes and conductivity cell into the solution to take pH and electrical conductivity reading respectively.

3. EXPERIMENTAL RESULTS AND DISCUSSION

Table-1 shows the results of the pH and conductivity analysis of composite soil samples collected from the research site. The results show that soil samples from different locations differ significantly from one another. The ideal recommended optimum pH range for plant growth is 6.5 to 8.0, but average pH of collected airport site and on-station soil samples were found to be between 4.69 and 5.28 respectively, and indicating that soils are highly acidic. The electrical conductivity of the collected soil varied between the two samples, ranging from 45 microsiemens per centimeter to 65 microsiemens per centimeter.

Both analyzed soil samples have less than the recommended level of pH and conductivity present in farming land soil; and the result confirm the Ethiopian agricultural transformation agency (ATA) range [12]. The experimental result showed that on-station (S3 and S4) soil sample contains better pH result than that of sample one and two.

Table.1 The pH and EC properties of collected soil samples at airport and AsARC on-station (0-20cm)

No	pH	EC (μs/cm)
Sample-1	4.69	65
Sample-2	4.78	61
Sample-3	5.28	51
Sample-4	5.19	45

3.1 Correlation between soil pH and conductivity

Lower pH corresponds to higher [H^+], while higher pH corresponds to lower [H^+]. Electrical conductivity (EC) is a measurement of the ability of a dissolved material in an aqueous solution to conduct electrical current through it. Soil pH is negatively related to soil electrical conductivity in the form of a power function and not in a linear relationship because other factors such as soil mineral, porosity, soil texture, soil moisture, and soil temperature all affect soil electrical conductivity [13].

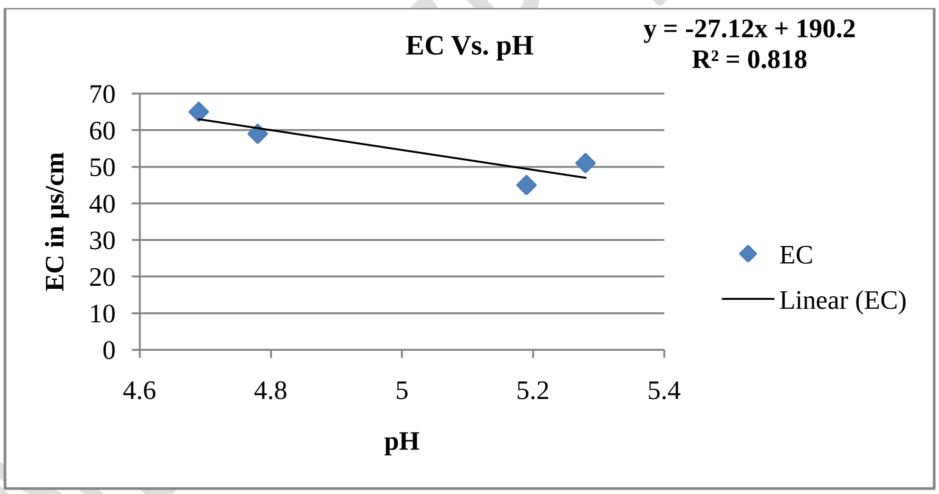

Figure 1: Graph of pH and electrical conductivity correlation.

4. CONCLUSION

The analysis of physicochemical soil parameters is critical in farming land for plant growth and soil management. Soil laboratory analysis is the measurement of nutrients in soil that are extracted from the soil using an extracting solution. The pH and electrical conductivity of four composite soil samples from two research sites show that all soil pH and electrical conductivity are unusually acidic, and that all soil pH and electrical conductivity need to be closely managed. According to the previous researcher ranges of Ethiopian soil pH and conductivity both analyzed parameters status was insufficient for plant and soil organism growth [14]. Continuous cultivation, soil erosion, burning farm lands in the dry season, clearing of forests and grasslands for annual crop production, and a consistent use of pesticides could all be contributing factors to this increase in farm land acidity.

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