ANALYSIS OF THE PHYSICAL AND CHEMICAL PROPERTIES OF SOIL IN BANTAY, ILOCOS SUR

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ABSTRACT

The ability of the soil to support the growth and development of the plants depends on its properties, hence there is the need to sample and analyze soil, especially in agricultural areas. The study was conducted to gauge the physical and chemical properties of the soil found in Bantay, Ilocos Sur. Generally, the soil in the town is classified as the Bantay series, a soil characterized by poor internal drainage because of its shale substratum. Results show that the soil has a dark color – between yellow and yellow- red – and a saturated chroma. The soil sample has a sandy clay loam texture. The soil has a relatively high percentage of sand, an adequate amount of silt, and a low percentage of clay and it is composed mostly of silt and clay, followed by gravel, fine sand, and coarse sand. Moreover, the soil sample is slightly acidic. It is also worth noting that the soil has a small amount of chloride, enough to sustain the life of plants. There is an adequate amount of calcium in the soil, providing an equilibrium among the constituents that could affect the fertility of the soil. The amount of iron in the soil sample is quite high. Iron is needed to satisfy the needs of most plants. There is a very low amount of aluminum in the sample. Such results indicate that the soil is efficient for plants that are acid tolerant. The soil sample has very low ppm ammonia nitrogen and nitrite nitrogen. Such results are expected in fertile soil.

Keywords: *soil, soil properties, physical and chemical properties*

INTRODUCTION

The ability of the soil to support the growth and development of the plant depends on the physical, chemical, and biological properties that are found to play crucial roles in crop production (Umeri, et al, 2017). Hence, there is a need for the sampling and analysis of soil, especially in agricultural areas.

Soil sampling and analysis are vital efforts that could help intensify agricultural productivity (Jain, et al, 2014). The process includes a set of various processes aimed to determine the amount of plant nutrients in the soil, as well as its physical, chemical, and biological soil properties important for plant nutrition (Folnovic, n.d.). Achieving and maintaining the appropriate levels of soil fertility implies that the land can sustain the production of crops at an acceptable level (Johnston, 2011).

Soil analysis would involve taking soil samples, laboratory analysis of these samples, and the interpretation of the results using tools (Folnovic, n.d.). The results of the analysis could serve as the basis for farmers to improve their mode of production and to optimize the present nutrients present in soil (Jain, et al, 2014).

The study was conducted to gauge both the physical and chemical properties of the soil found in Bantay, a town of Ilocos Sur. Generally, the soil found in the town is classified as the Bantay series, a Typic Eutrustepts soil with poor internal drainage because of the massive shale substratum (Carating, et al, 2014). The soil also has a slow to moderate permeability, hard to moderate tilth, and moderate erosion (PhilRice, 2014). Because of this, Bantay soil is not agriculturally important (Government of Laoag, 2015).

Specifically, the study aimed to identify and analyze the following: (1) the physical properties of soil such as its color, texture, and particle size, and (2) the chemical properties of soil such as its pH and nutrient content. The nutrients which were identified in the study are the following: calcium, chloride, iron, aluminum, ammonia nitrogen, and nitrite.

Gauging the different physical and chemical properties of the soil could be beneficial to the farmers of Bantay so that

they could address the needs of their crops by looking into the physico-chemical characteristics of the soil which could be identified based on the results of this study. Because of this process, they could find ways to increase soil productivity and decrease its degradation. This could include increasing the composition of the nutrients that could be lacking in the area or decreasing the amount of some nutrients that could be detrimental to the plants if they are already high in number.

METHODOLOGY

The study was conducted at St. Louis University at Baguio City on March 2018. The study was limited to gauging and analyzing the physical and chemical properties of soil derived from St. Paul College of Ilocos Sur in the town of Bantay in Ilocos Sur.

Preparation of the soil sample

Samples were derived from the grounds of Saint Paul College of Ilocos Sur in Bantay, Ilocos Sur in March 2018. The soil was ensured to be dry during the transport from Ilocos Sur to Saint Louis University in Baguio City to avoid any vapor from mixing with the soil that may affect the results of the test.

Soil Color Test

Soil color is a physical property that is influenced by some important characteristics of the soil, such as mineral composition, soil processes, presence of water, and age (Jordan, 2014). The Munsell System is used for the test. According to the Natural Resources Conservation Service Soils (n.d.), this system consists of three components: value (lightness or darkness of the color), hue (specific color of the soil), and chrome (saturation or brilliance of the color), all of which are arranged in books of color chips.

For the test, 15 g. of the soil sample were taken using a triple beam balance. The color of the sample soil was determined using the Munsell soil chart. The soil sample is held next to a copy of the chart to find its visual match.

Soil Texture Test

Twenty grams of the soil sample were retrieved and placed on the palm. Drops of water were added. The soil and water suspension were to break down all aggregates. The soil texture of the sample was then determined using the flow chart for determining the textural class.

Soil Particle Size Test

The particle size test consists of determinations of the sand, silt, and clay components of the soil by using a sand sieve test (PennState College of Agricultural Science, n.d.)

For the test, the soil sample was weighed using a triple beam balance. After which, it was subjected to sieving using three screen sieves of varying screen sizes. The sieve with the largest screen size was placed on top while the sieve with the smallest screen size was placed on the bottom portion. The sieves were meant to separate the different components of the soil including gravel, coarse sand, fine sand, and silt and clay. The soil sample was placed in the uppermost sieve. The three containers were shaken until the particles of the soil were separated. The percentage particle of each of the components was gauged after.

Soil pH Test

Soil pH test is a tool that helps point out if the soil sample has nutrient deficiencies or surpluses, which could allow for the proper selection of appropriate fertilizers to help correct deficiencies and optimize uptake of fertilizer nutrients by the plant (Vaughan, 2014). Three tests were done to gauge the pH of the soil.

For test 1, the colorimetric method was used. In this method, the soil dropped with four pH indicators (Bromocresol green, Congo red, Bromothymol blue, and Phenolphthalein) to saturate the soil sample. The solution was mixed thoroughly using a wooden stick. The change in the color of the soil due to the indicator was gauged.

For test 2, the electrometric method was used. Ten grams of the soil were placed in a small beaker. Twenty milliliters of distilled water were added to the sample. After thoroughly mixing it using a stirring rod. The pH meter was submerged in the suspension. After ten minutes, the pH value was recorded.

For test 3, the pH paper was used. The pH paper was submerged into the soil suspension for a moment before

being retrieved. The change of the color of the pH paper was compared with the available chart.

The La Motte Soil Kit Manual served as the basis in the conduct of the tests for Calcium, Chloride, Iron, Aluminum, Ammonia Nitrogen, and Nitrite.

Calcium and Chloride Soil Test

For the calcium soil test, a test tube was filled with Universal Extracting Solution up to line 7. Using a 0.5 g spoon, four-level measures of soil were added to the solution. The suspension was mixed for one minute. The suspension was filtered using filter paper. The clear soil extract was used for the test.

Five drops of the extract were placed in a small test tube using a transfer pipet. A drop of the Calcium test solution was mixed with the extract. The presence of calcium in the solution was gauged by placing the solution above the Calcium Color Chart. Viewing down through the tube, the sample turbidity was matched to a turbidity standard.

For the chloride soil test, a test tube was filled with deionized water up to line 5. Using a 0.5 g spoon, four-level measures of soil were added to the solution. The suspension was mixed for one minute. The suspension was filtered using filter paper. The clear soil extract was used for the test.

Five drops of the extract were transferred to a test tube using a pipette. A drop of the chloride test solution was mixed with the extract. After which, the solution was placed above the black background in the center of the Chloride Color Chart. Viewing down through the tube, the sample turbidity was matched to a turbidity standard.

Iron and Aluminum Soil Test

A test tube was filled with Universal Extracting Solution up to line 7. Using a 0.5 g spoon, four-level measures of soil were added to the solution. The suspension was mixed for one minute. The suspension was filtered using filter paper. The clear soil extract was used for the two tests.

For the iron test, four drops of the clear filtrate were added to a large depression on a spot plate. A level measure of the Iron Reagent Powder was added to the spot plate using a 0.05 spoon. The solution was stirred using a stirring rod. A drop of the Ferric Iron Test Solution was added to the solution. It was stirred using a rod. The color of the sample solution was matched to a color standard on the Ferric Iron in Solution Color Chart.

For the aluminum test, two drops of the clear filtrate were placed in a large depression on the spot plate. Two drops of the Universal Extracting Solution were added using a plastic pipette. A drop of the Aluminum Test Solution was also added to the spot plate. The solution was stirred using a stirring rod. The color of the sample was matched on the Active Aluminum color chart.

Ammonia Nitrogen and Nitrite Soil Test

For the following tests, the manner of taking the soil extract using the Universal Extracting Solution was done. Four drops of the soil extract were placed on a spot plate. Two drops of the Ammonia Nitrogen Test Solution were added. The solution was stirred using a stirring rod. After a minute, the color of the solution was matched with the Ammonia Nitrogen Color Chart. Five drops of the soil extract were placed in another depression of the spot plate. Two drops of the Nitrite-Nitrogen Reagent #1 and two drops of the Nitrite-Nitrogen Reagent #2 were added to the extract. The solution was stirred using a stirring rod. After which, ten drops of the Nitrite-Nitrogen Reagent #3 were added and stirred to the solution. After a minute, the color of the solution was matched with a color standard on the Nitrite Nitrogen Color Chart.

RESULTS AND DISCUSSION

The results of the physical and chemical analysis of the soil sample are presented here.

Soil Color

Based on the Munsell Soil Color Chart, the color of the soil sample is 10 YR 4/6. This finding means that the hue of the soil is between yellow and yellow-red. Since its value is 4, it has a relatively dark color. On the other hand, the chroma is 6, hence it is somewhat saturated.

Soil Texture

In terms of texture, the soil sample has a sandy clay loam. This finding means that it has a relatively high percentage of sand, an adequate amount of silt, and a low percentage of clay.

Additionally, the soil sample is characterized by its gritty feel when rubbed on the palm using the forefinger. The soil formed a ribbon with uniform thickness and width.

Soil Particle Size

Table 1 shows the particle size of the soil sample. Gravel has a mass of 58 g. with a percentage of 28.02%. Coarse sand has a mass of 23.8 g. and a percentage of 11.50%. Fine sand has a mass of 34 g. and a percentage of 20.77%. Silt and clay have a mass of 82 g. with a percentage of 39.61%. The total mass of the soil sample is 207 g.

Table 1. Particle Size of the Soil Sample

Soil Particle/ Component	Mass of the soil particles	Percentage of the soil particle
Gravel	58 grams	28.02%
Coarse sand	23.8 grams	11.50%
Fine sand	43 grams	20.77%
Silt and Clay	82 grams	39.61%
Total	207 grams	99.9%

Based on the results, it could be noted that silt and clay have the most amount of mass, followed by gravel, fine sand, and coarse sand. It could be inferred that the mass of the silt and clay is higher than the other particles because it is a mixture of two soil components.

Soil pH

Three tests were done to determine the pH of the soil: the electrometric method, colorimetric method, and the pH paper method.

Using the electrometric method, the soil sample has a pH of 6.5. The pH paper showed that the pH of the soil is 6. Both results show that the soil sample is slightly acidic.

Table 2 shows the pH indicator, the change in the color of the indicator, and its corresponding pH. Bromocresol green stayed green, hence the pH is 4.5. Congo red remained red hence the pH is 5.0. Bromothymol blue indicated a blue color hence the pH is 7.5. The Phenolphthalein indicator showed a colorless hue hence the pH is 8.3. The average pH using the colorimetric method is 6.325. This finding means that the soil is slightly acidic.

Table 2. pH of Soil Using Colorimetric method

pH Indicator	Color	pH of the soil
Bromocresol green	Green	4.5
Congo red	Red	5.0
Bromothymol blue	Blue	7.5
Phenolphthalein	Colorless	8.3
Average		6.325

Table 3 shows that the average pH of the soil based on the three tests done was 6.275. This finding means that the soil is slightly acidic.

Table 3. Average pH of the Soil Using the Three Methods

Method	pH	Indication
Colorimetric method	6.325	Slightly Acidic
Electrometric method	6.5	Slightly Acidic
pH paper	6	Slightly Acidic
Average	6.275	Slightly Acidic

Calcium and Chloride Soil Test

In terms of chloride content, the soil sample has a 25 ppm chloride. According to the La Motte Soil Analysis Kit Manual, the small amount of chloride in the soil is enough to sustain the life of plants. This is because a large amount of chloride present in the soil could be hazardous to growing plants.

In terms of the amount of replaceable calcium in the soil, the soil sample contains 700 ppm calcium. Such amount is close to the standard amount of calcium in normal sandy soils which is 500 ppm. The amount of calcium extracted from the soil helps provides an equilibrium among the constituents that could affect the fertility of the soil.

Iron and Aluminum Soil Test

In terms of the amount of iron in the soil, the data shows that that soil has 50 lbs. per acre of Ferric Iron. Because the soil is slightly acidic, the amount of iron is also quite high. According to the La Motte Soil Analysis Kit Manual, the quantity of the iron could satisfy the needs of most plants.

In terms of the presence of aluminum in the soil, there is a very low amount of aluminum in the sample. Low aluminum content is to be expected for soils whose plants are acid-tolerant, such as the sample.

Ammonia Nitrogen and Nitrite Nitrogen Soil Test

Data show that the soil sample has a very low ppm Ammonia Nitrogen and 1ppm Nitrite Nitrogen. It is worth noting that a low test for ammonia is expected in fertile soil. On the other hand, well-drained soils – such as the sample – contain small amounts of nitrite nitrogen. High amounts of nitrogen – both for ammonia and nitrite – could indicate that the condition of the soil is not favorable for plant growth.

CONCLUSION

Based on the results, the following conclusions have been made. The soil has a dark color – between yellow and yellow red – and a saturated chroma. The soil sample has a sandy clay loam. The soil sample has a relatively high percentage of sand, an adequate amount of silt, and a low percentage of clay. The soil sample is composed mostly of silt and clay, followed by gravel, fine sand, and coarse sand. Moreover, the soil sample is slightly acidic.

It is also worth noting that the soil has a small amount of chloride, enough to sustain the life of plants. There is an adequate amount of calcium in the soil, providing an equilibrium among the constituents that could affect the fertility of the soil. The amount of iron in the soil sample is quite high. Iron is needed to satisfy the needs of most plants.

There is a very low amount of aluminum in the sample. Such results indicate that the soil is efficient for plants that are acid tolerant. The soil sample has very low ppm ammonia nitrogen and nitrite nitrogen. Such results are expected in a fertile soil.

RECOMMENDATION

Based on the results, the researcher recommends the following: (1) that the physical and chemical properties of Bantay soil should be compared to other types of soils present in the Philippines, (2) that amount of sulfate in the soil sample should be tested. The sulfate test was not done due to the lack of reagents necessary for the test, (3) that all tests should be done in three trials to arrive at more reliable and precise results, and (4) other physical and chemical properties of the soil such as bulk density and salinity should also be gauged.

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