Soil Quality Assessment for Agriculture Potential in Philippine Science High School- Central Visayas Campus

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***Abstract*—Soil quality is important in the alleviation of the rising need of agriculture due to the depleting lands caused by industrialization. The purpose of this study is to assess the soil quality of the different areas in PSHS-CVisC in accordance to its indicators of soil quality. Furthermore, it is also for the benefit of the Agriculture Elective offered in PSHS – CVisC as a result of the newly implemented K-12 curriculum. The data collected will be provided to the Department of Agriculture's National Color-Coded Agriculture Guide Map database, and Department of Environment and Natural Resources, Argao, Cebu. The indicators include moisture content, soil pH, total phosphorus, and organic matter content. The four areas with three trials each were analyzed using tests for the said indicators. The findings show that the soil samples have low quantities of total phosphorus, with average values ranging from 6.10-18.00 ppm and organic matter, with average values ranging from 1.13-1.91 %. They are all neutral to slightly basic, with pH values ranging from 7.03-8.02, and have moisture contents within the range of 15-16%, which indicated soil moisture stress. All the four areas are not suitable for agricultural plants. Statistical analysis showed that in the test for organic matter content, pH, and available phosphorus, all sample areas had a significant difference between each other. For the moisture content test, the four areas had no significant difference between each other. In conclusion, the soil samples are in need of additives/fertilizers to enhance the soil quality for optimal crop growth.**

Keywords*—*Agriculture, Life Science, Soil Quality.

I. Introduction

Agriculture is an important part of the lives of human beings. Because of it, humans are able to avoid hunting for the food that we eat, mass produce preferred crops, and modify plant properties for convenience. Farm lands are utilized by farmers every day in order to produce food that can be consumed by the people.

With the advent of decreasing farmable lands due to industrialization, there is a need to do researches and innovations in the field of agriculture to maximize yields and lessen and prevent major problems in the production of crops. One of the major factors that affect the growth of crops is the soil's quality.

Soil quality is the most important factor in the flourishing of plants in the remaining lands that are not utilized for purposes other than agriculture. Soil has different types and therefore, has different inherent properties, but it can be affected by several factors, both natural and by human activities. The growth of different plants depends on these properties.

With these in mind, this research aimed to investigate four free areas in PSHS-CVisC that can possibly be utilized for agricultural purposes.

The tests conducted were: water moisture content, total phosphorus content, soil pH, and organic matter content.

Phosphorus is one of the most important nutrients for plants to flourish. It is a major element and is one of the main contributors in agronomy and biogeochemical cycles. It is also involved in the fundamental transfer processes from radiant electromagnetic energy to chemical energy (photosynthesis) and sustains the development of the radicular systems of the plants. ("The nature of phosphorus in soils: Nitrogen: University of Minnesota Extension", 2016)

The measurement of pH (potential of the H+ ion) is certainly one of the most important characteristics/properties of soil (Kahl, 2004). It measures the alkilinity or acidity of the soil. Most plants grow in the near-neutral areas, with a pH ranging from 6.5-7.0, though there are plants that prefer other ranges.

Soil organic matter defines soil fertility and soil structure and its pesticide and water retention (Arshad & Martin, 2002). It plays a very significant role in the formation and development of soil, and can significantly modify the vital properties of soil.

In this research, the soil quality or fertility of the selected areas in the campus was assessed. The areas to be assessed are limited only to 4 areas in the campus. The soil samples were also oven dried and quartered so as to remove biases in the sampling. For the pH test, total phosphorus content test, and % OM test, three trials were done and the average of these results were recorded.

A. Research Design

The research design was observational. It covers quantitative analysis on the soil samples from Philippine Science High School – Central Visayas Campus grounds. The pH and Organic matter tests, withthree trials each, were patterned after the corresponding methods in the "Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods" by Marc Pansu and Jacques Gautheyrou. The test for the water moisture content, and soil pH were conducted in PSHS-CVisC science laboratory. The test for organic matter and extractable phosphorous of the soil samples were conducted in the Regional Soils Laboratory in Department of Agriculture, Mandaue City, Cebu.

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https://doi.org/10.17758/URUAE.AE09172019

B. Collection of Samples

The soil samples were obtained in the PSHS – CvisC terrain using a shovel. The soil samples were taken 30-50 centimeters below ground surface. The soil samples per area were obtained randomly. This was done in each of the predetermined four sampling areas. The samples obtained were then quartered.

C. Soil Quartering of the Field Samples

The samples were mixed thoroughly through turning over for several times. On the last turning, the samples were shoveled into a conical pile by depositing each full shovel on top of the preceding one. Then, each corner of the canvas was lifted alternatively, pulling it over the sample toward the diagonally opposite corner causing the samples to be rolled. The conical pile was flattened carefully to a uniform thickness and diameter by pressing down the apex with a shovel so that each quarter sector of the resulting pile contained the material originality in it. The diameter was fixed in approximately four to eight times the thickness. The flattened mass was then divided into four equal quarters with a shovel or trowel. When the surface beneath the blanket was uneven, a stick or pipe was inserted underneath the blanket and under the centre of the pile, and then both ends of the stick were lifted, separating the sample into two equal parts. The stick was removed, leaving a fold of the blanket between the divided portions. The stick was inserted under the centre of the pile at right angles to the first division and again both ends of the stick were lifted, separating the sample equally in four parts. Two diagonally opposite quarters were removed, carefully cleaning the fines from the blanket. The remaining material was mixed successively and will be quartered until the sample was reduced to the desired size. Should the retesting be necessary, the remaining two quarters were saved and kept.

D. Determining Soil type

The soil type of the samples was determined using the feel method. The flowchart in Figure 1 was used.

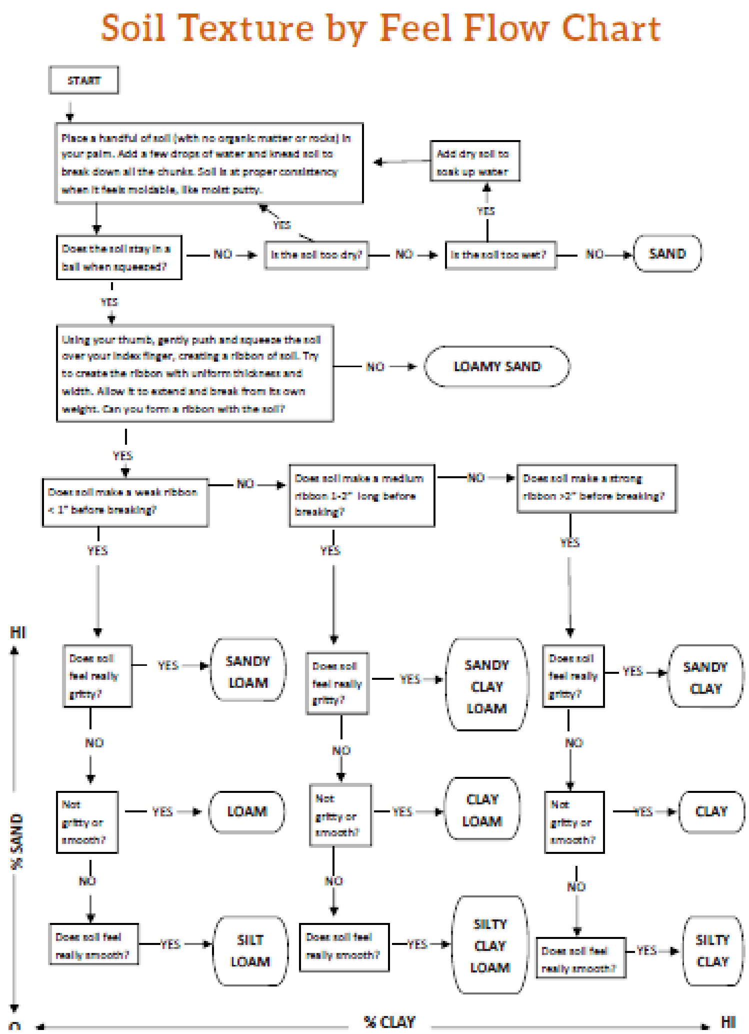

Fig. 1. Soil Type determination flowchart using feel method (www.treepeople.org)

E. Determining the Moisture Content in the Samples

Four sheets of aluminum foil were folded to form four trays. The trays were initially weighed. The samples were then placed separately in the trays then weighed. The weights of the samples minus their tray were noted. Then the samples were oven-dried overnight at 100℃. After drying the samples were weighed again and their weights minus their tray were noted.

The moisture content per sample was calculated using the formula:

$$\frac{mass\ of\ dried\ sample}{initial\ mass\ of\ sample} x100 = \%moisture$$

F. Preparation of Samples

The samples were oven-dried overnight at 100℃. Afterwards the samples were allowed to cool then sieved. The samples were placed separately in Ziploc bags and were labeled accordingly. The samples were stored at room temperature and away from sunlight.

G. Soil pH Test

The electrometric method is the most frequently used method for soil analysis as it is more precise than the colorimetric method. First, 10.0 g of soil sample was weighed and was placed into a 100mL beaker. Next, 50.0 mL of distilled water was added in the beaker with constant mixing using a stirring rod. The mixture was let to stand for 30 minutes with occasional stirring. The pH meter was calibrated at pH 7. The electrode of the pH meter was then inserted into the beaker and the suspension was swirled. The pH of the supernatant was recorded after 15 seconds of settling or when the reading had settled down. The electrode was rinsed with distilled water after each measurement and the calibration was checked periodically.

H. Determination of Total Phosphorous Content in the Samples

First, 2.5 grams of soil sample was weighed using an analytic balance to ensure a more accurate and precise measurement. The sample was then placed in a labelled container. Then, 50 mL of 0.5 N Sodium Bicarbonate ($NaHCO_3$) @pH 8.5 was added. Using a recipro shaker, the sample was shaken for 30 minutes. Afterwards, the sample was filtered using a cellulose-based filter paper with corrugations for a more efficient rate of filtration. The obtained supernatant after filtration was transferred to a test tube and was added with 8 mL of distilled water. In separate test tubes, Potassium Hydrogen Phthalate (KHP) with different concentrations (2, 4, 6, 8 and 10 ppm respectively) was placed and the test tubes were labelled accordingly. 10 mL of water was added to a separate test tube. These served as the standard and the blank. Then, 2 mL ascorbic acid was added to the samples and the standard concentrations. The test tubes were then shaken using a vortex mixer. The blank and standard concentrations were separately transferred to a qivet then placed in the spectrophotometer to establish an absorbance vs concentration graph. Then the samples were separately placed in a qivet and were placed in the spectrophotometer. Then the absorbance readings were noted.

I. Soil Organic Matter

0.25 g of soil for each trial was weighed and was placed in properly labelled flat-bottomed test tubes. 2 mL of 10% Potassium Dichromate (K2Cr2O7) was then added to each trial. Afterwards 5 mL of concentrated Sulfuric Acid was added to each trial then the samples were left to stand overnight. The blank and standard concentrations were separately transferred to a qivet then placed in the spectrophotometer to establish an absorbance vs concentration graph. Then the samples were separately placed in a qivet and were placed in the spectrophotometer. Then the absorbance readings were noted.

J. Data Analysis

One-way Analysis of Variance (ANOVA) and Tukey test were the statistics used to determine the significance of results of the different tests. The software called Statistical Package for the Social Sciences (SPSS) was used for the ANOVA.

II. Results And Discussions

These results were interpreted, and indicated if plants are suitable for that area and how to improve its quality.

The soil samples were sieved after collection and drying. The soils, initially containing several rocks, yielded filtered soil particles only about 20% of its original weight.

Using the feel method, all soil samples were determined to be sandy clay.

The moisture content of the sample areas are shown in Table 1.

TABLE 1.PERCENT MOISTURE OF THE SOIL SAMPLES

Sample area	% moisture
1	15.12 ± 0.129
2	14.38 ± 0.267
3	15.96 ± 1.628
4	16.76 ± 4.618

All sample areas had moisture content within the range of 15-16%. For sandy clay soils, this indicates soil moisture stress. As can be seen from table 1, area 4 reported to have the highest moisture content in percent means among the four areas; while area 2 had the lowest. The results for the soil moisture content determination analyzed using One-way ANOVA showed a p-value of .761, which means that there is no significant difference between the results of the four areas.

Soils under moisture stress are in need of irrigation to support plant growth. Sandy clay soils need to have a moisture content of 23-27% for optimal plant growth (Zotarelli, Dukes, &Barreto, 2012).

The pH readings of the soil samples are shown in Table 2.

TABLE II.PH READINGS OF THE SOIL SAMPLES PER TRIAL

Area	pH
1	7.29± 0.237
2	7.66± 0.362
3	7.30± 0.262
4	7.59± 0.374

The pH of the soil samples were all within the range of pH 7.03-8.02, and are therefore neutral to slightly basic. The results analysed using One-way ANOVA showed a p-value of 0.384, which means that there is no significant difference between the results of the four areas.

Most plants prefer a pH range near neutral, within the range of pH 6-8 (Perry, 2003). Additives such as ammonium sulfate and sulfur can be added to lower this pH (SPargo, Allen, &Kariuki, 2013).

The total phosphorus content of the soil samples are shown in Table 3.

TABLE III.TOTAL PHOSPHORUS CONTENT IN SOIL SAMPLES USING SPECTROPHOTOMETER

Area	Total Phosphorus Content, ppm P
1	6.10 ± 1.43
2	13.90 ± 1.56[a]
3	13.50 ± 1.32
4	18.00 ± 1.00[a]

Columns with the same letter superscript have no significant difference with respect to each other at α> 0.05

The results for the test showed that the areas had available phosphorus content within the range of 6-18 ppm. The results analyzed using One-way ANOVA showed a p-value of .000, which means that there is a significant difference between the results of the four areas. The Tukey test showed that area 2 and 4 had no significant difference between the two groups. Areas 1 and 3 had significant difference with all other groups. The available phosphorus content of the soil samples are shown in Table 8.

TABLE IV.PHOSPHORUS SOIL TEST CATEGORIES AND FERTILIZER RATE RECOMMENDATIONS

	ppm P	g P_2O_5/m^2
Low	<10	0-33.63
Medium	10-25	0-22.41
High	25-50	0-3.36
Excessive	>50	0

Based on the phosphorus soil test categories in Table 4 (Horneck, Sullivan, Owen, & Hart, 2011), area 1 contains low amounts of P, while the other areas contain medium amounts of P. In order to improve soil conditions for crop growth, 0-33.36 g of P_2O_5 fertilizer is recommended to be added in area 1, and 0-22.41 g of P_2O_5 fertilizer is recommended to be added in area 2,3, and 4.

The results for the soil organic matter test are shown in Table 5.

TABLE V.% ORGANIC MATTER OF SOIL SAMPLES

Area	Organic matter % OM Ave ± SD[a]
1	1.36 ± 0.064[a]
2	1.13 ± 0.049[a]
3	1.91 ± 0.110[a]
4	1.70 ± 0.230[a,b]

Columns with the same letter superscript have no significant difference with respect to each other at α> 0.05

All samples had % organic matter of 1-2%. The results analyzed using One-way ANOVA showed a p-value of 0.002, which means that there is a significant difference between the results of the four areas. The Tukey test showed that areas 1 and 3, 2 and 3, and 2 and 4 had a significant difference between each pair. Areas 1 and 4, 1 and 2, and 3 and 4 had no significant difference between each pair. The results for the soil organic matter test are shown in table 5.

Organic matter content less than 4% is considered low (Harvey, Harris, & Sebesta, 2010). Medium levels are desirable for ideal plant growth. To improve soil conditions for crop growth, dead leaves or other organic matter are recommended to be added, until organic matter content reaches a medium or high amount.

III. CONCLUSION

The soil samples are generally alkaline, minutely too basic for most plants to grow. All sample areas had moisture content within the range of 15-20%, which is too low or sandy clay soils. Area 1 contains a low amount of P, while area 2, 3, and 4 contain medium amounts. Finally, all area samples contained low amounts of organic matter.

In conclusion, the soil areas are sufficient for the growth of a few plants such as grass and other common plants but they are of low quality and in need of additives/fertilizers to enhance soil quality for optimal plant growth. The results of this research provided sufficient data for the agriculture elective in PSHS-CVisC and will be forwarded to the Department of Agriculture, Mandaue, Cebu, and Department of Environment and Natural Resources, Argao, Cebu.

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