A STUDY ON THE PHYSICOCHEMICAL PROPERTIES OF SOIL SAMPLES FROM THE SELECTED AREA IN HPA-AN TOWNSHIP, KAYIN STATE

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Abstract

In this research, the physicochemical properties of soil samples from three sites of cultivated areas (Ta-yoke-hla village, Kaw-kyite village and Kha-loug-noh village) in Hpa-an Township, Kayin State were studied. The physicochemical properties of the collected soil samples such as moisture, pH, temperature, bulk density, texture, organic matter, major nutrients (N, P and K) and the exchangeable calcium and magnesium were determined by the conventional methods and modern techniques. The elemental compositions of soil samples were detected by EDXRF method. The moisture percent of the soil samples was found as 2.56 % for sample (1), 1.15 % for sample (2) and 1.80% for sample (3) and the pH value of soil samples was found as 7.8, 5.1 and 6.1 respectively. From the determination of soil texture, it was observed that, sample (1) is silty clay loam whereas sample (2) and sample (3) are silty clays. The major nutrients, nitrogen percent were found as a medium level, 1.23 % for sample (1), 0.14% for sample (2) and 0.44% for sample (3). The content of available phosphorus was found as a high level, 19.10 ppm for sample (1), low level 4.33 ppm for sample (2) and low level 8.87 ppm for sample (3) respectively. The potassium content for all soil samples was observed in low level. The contents of exchangeable calcium and magnesium were found as 6.67 ppm and 3.33 ppm for sample (1), 0.67 ppm and 2.02 ppm for sample (2) and 6.67 ppm and 4.05 ppm for sample (3) respectively. The content of silicon in all soil samples is the highest relative to that of other elements and aluminium is the second highest by EDXRF method. The heavy metals such as arsenic, iron, cadmium, lead and zinc were also detected by Atomic Absorption Spectrometry. It was found that, the contents of arsenic, iron and zinc were lower than that of reference value but sample (1) was higher lead content than the other two samples due to the geological condition of this sampling site.

Keywords: soil samples, pH, texture, major nutrients (N, P and K), exchangeable calcium and magnesium, EDXRF method, AAS method

Introduction

Soil is a thin layer of material on the Earth's surface in which plants have their roots. It is made up of many things, such as weathered rock, decayed plant and animal matter. Soil is formed over a long period of time. Soil formation takes place when many things interact such as air, water, plant life, animal life, rocks and chemicals. Soil is also made up of a variety of different sized particles then it will be a fine soil. But if a soil is composed of larger particles, it would be a coarser soil. In term of soil texture, soil type usually refers to the different sizes of mineral particles in a particular sample. The soil profile generally consists out of three main layers (horizons) the top soil (100-200 mm deep) or darker layer, where air, water and humus allow plants to grown in, the sub-soil, a more clay-like layer which acts as a reservoir (water store) for the plants, and the bedrock or parent material which is the underlying layer from which the first two horizons are formed.

Compositions of Soil

The layer of natural materials on the earth's surface contains both organic and inorganic materials and capable of supporting plant life. The material covers the earth's surface in a thin layer. It may be covered by water, or it is exposed to the atmosphere. The composition of soil is shown in Figure (1) (Brady & Weil, 2001).

Soil Horizons

Soil horizons are set apart from other soil layer by differences in physical and chemical composition, organic structure, or combination of those properties. The simple mixture of

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sands, silts, clays and organic matter will evolve into soil profile which consists of two or more layers. O-Horizon, A-Horizon, E-Horizon, B-Horizon, C-Horizon, R-Horizon, etc. The soil layers are shown in Figure (2) (Johnson, et al., 2005).

Physical Properties of Soil

Soil texture and soil structure are the two important physical properties of soils. Some of the other important physical properties are moisture, colour, density, porosity and temperature (Brady & Weil, 2001).

Soil texture

Soil texture describes the proportion of three sizes of soil particles and the fineness or coarseness of a soil. Soils with different amounts of sand, silt, and clay are given different names. For instance, a soil containing 40 percent sand, 40 percent silt, and 20 percent clay is called loam soil. Texture of soil is shown in Figure (3) (Jackson, 1962).

Soil pH

Acidity of soil is associated with the presence of hydrogen and aluminum in exchangeable form. Whereas the pH values of soil are fairly variable and the pH values of most cultivated soils range from 5.5-7.5 but for each crop there is fairly narrows range.

Bulk density

Bulk density is the weight of soil in a given volume. Soils with a bulk density higher than 1.6 gcm^{-3} tend to restrict root growth. Sandy soils are more prone to high bulk density.

Chemical Properties of Soil

Soil are chemically different from the rocks and minerals from which they are formed. Soils contain less of the water soluble weathering products, calcium, magnesium, sodium and potassium, and more of the relatively insoluble elements such as iron and aluminum. Soil organic matter is composed chiefly of carbon, hydrogen, oxygen, nitrogen and smaller quantities of sulfur and other elements (Brady & Weil, 2001). Nitrogen occurs in soils in several forms as organic compounds, nitrate and nitrite ions, and ammonium ions. Plants absorb nitrogen either as the ammonium or the nitrate ion (Pandas, 1985). Phosphorous is found in soil, plants and in micro-organisms in a number of organic and inorganic compounds (Alexander, 1961). The potassium content, K_2O, range between 0.05 % and 3.5 % for mineral soil. Most of the agricultural soils contain amounts ranging from 1 % to 2 %. Potassium is absorbed by plants as the K^+ ion. The calcium content, CaO, is generally in the low range of about 1 % in soils except when calcium occurs in carbonate or sulphate form. The magnesium content of soils, MgO, is frequently less than 1% in noncalcareous soils. Magnesium is necessary for all green plants as it is a constituent of chlorophyll (Millar & Turk, 1958).

Organic Matter

Organic matter is defined as a grouping of carbon containing compounds which have originated from living beings and been deposited on or within the earth's structural components. A fertile soil should contain from 2-8 percent organic matter, most soils contain less than 2%. In acid leached soils, which are often sandy, substantial portions of the organic matter are in the form of plant debris and fulvic acid (FAs). In neutral and alkaline soils, a large percentage of the organic matter is the form of humic acid (HAs) and humus.

Heavy Metals in Soil

The metals with a density greater than a certain value, usually 5 gcm^{-3} or having atomic number greater than iron. Heavy metal by-products result from many activities including are extraction and smelting, fossil fuel combustion, dumping and land filling of industrial wastes, exhausts from leaded gasolines, steel, iron, cement and fertilizer production, refuse and wood combustion. Arsenic is a naturally occurring element that is widely distributed in the Earth’s

crust. Iron is an element relatively abundant in many cultivated soils with, on average, a total concentration of 20- 40 gkg^{-1}. Cadmium occurs in trace quantities less than 1 ppm through the Earth's crust. Lead is a heavy metal found in association with zinc, silver and other minerals in the earth's crust. The background concentration of lead in soil is approximately 15 $mgkg^{-1}$. Zinc is mobile and available in acidic mineral soils. Zinc appears to occur in more readily soluble forms. The zinc content of soil varies from 10 to 300 ppm (Pandas, 1985).

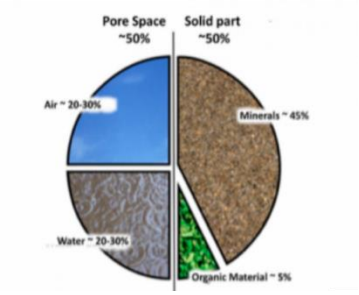


Figure (1) Composition of soil

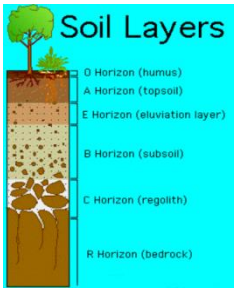


Figure (2) Soil layers

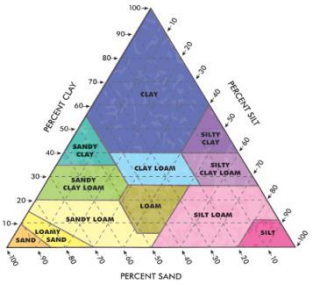


Figure (3) Classification of soil texture

Materials and Methods

Sample Collection and Handling

The representative soil samples were collected from three different sites of cultivated area in Hpa-an Township, Kayin State. These samples are Sample (1) watercress plantation site in Ta-yoke-hla village, Sample (2) flower bed in Kaw- kyite village and Sample (3) banana plantation site in Kha-loug-noh village respectively. The location map and sampling sites are shown in Figure (4) and Figure (5). These samples were dug the zigzag lineation from the depth of twenty centimeter of the surface and were broken up into small lumps and spread out in the sheds for air dried (Figure 6). Then the collected soil samples were passed through the (80) mesh and stored in polyethylene bags.

Methods of Analyses

In all analytical procedure of the experiments, recommended standard methods and techniques were applied. Various conventional modern techniques and instruments were used throughout the experimental procedures. The chemicals were used from British Drug House (BDH), England (Vogel, 1968). The moisture content of the soil samples was measured by oven dried method. The pH was measured by using pH meter. The bulk density was measured by bulk density bottle (Figure 7).The texture class of soil samples was determined by pipetting method. The content of total nitrogen by Kjeldahl's method (Figure 8) and exchangeable calcium and magnesium were determined by EDTA titration (Yu May, 2001). Available phosphorus was determined by spectrophotometer and available potassium was determined by flame photometer. The elemental compositions of soil samples were detected by EDXRF method. Trace elements (arsenic, iron, cadmium, lead and zinc) of soil samples were detected by atomic absorption spectrophotometer (Perkin Elmer AAS, Germany) in universities Research Centre (Yangon).

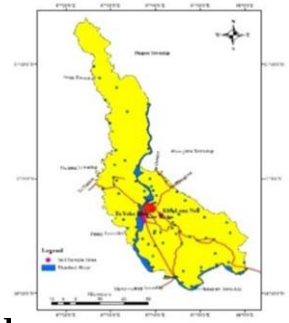


Figure (4) Location Map

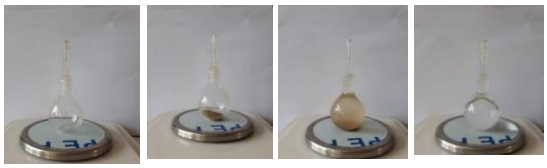
Ta-yoke-hla village
Sample (1)

Kaw-kyite village
Sample (2)

Kha-loug-noh village
Sample (3)

Figure (5) Photographs of collected soil samples

Figure (6) Photographs of dried soil samples



W_0 W_1 W_2 W_3

Figure (7) Photographs of the determination of bulk density

Figure (8) Photographs of the determination of total nitrogen by kjeldahl's method

Results and Discussion

Physicochemical Properties of Soil Samples

In the research work, soil samples were collected from three different sites of cultivated areas (watercress plantation site, flower-bed and banana plantation site) in Hpa-an Township, Kayin State. The moisture percent of soil sample (3) is higher than sample (1) and (2) due to high rainfall. The visual colour of soil sample (1) is dark brown, sample (2) and sample (3) are light brown. The temperature of all soil samples was observed 31℃. The bulk density of the soil samples was found to be in the range of 2.10 to 2.49 gcm^{-3}. It is in accordance with the literature value (> 1.6 gcm^{-3}). Increasing bulk density make organic matter loss from soil (Table 1 and Figure 9). The type of soil sample (1) is silty clay loam (4.15 % sand, 60.08 % silt and 30.92 % clay) sample (2) is silty clay (3.60 % sand, 47.22 % silt and 45.80 % clay) and sample (3) is also silty clay (8.50 % sand, 41.36 % silt and 45.64 % clay)(Table 2 and Figure 10). Soil acidification may also occur by addition of hydrogen ion due to decomposition of organic matter, acid forming fertilizers, exchange of basic cations for H^+ by the roots and high rainfall (Brady & Weil, 2001).

Soil sample (1) is alkaline soil and sample (2) and (3) are acidic in accordance with the literature value (acidic soil have pH 4-6.5). Organic carbon of soil samples was found to be 0.61 % for sample (1), 1.17 % for sample (2) and 0.69 % for sample (3). The distribution of organic carbon content of the soil samples were found to be very low level. In tropical area, most soils are inherently low in organic matter because warm temperature and high rain fall speed up decomposition (Figure 11). Total nitrogen of soil samples was found to be in the range of 0.41 to 1.23%. Available phosphorus of soil samples was found to be in the range of 4.33 to 19.10 ppm. Available potassium of soil samples was found to be low level, sample (1) is 0.12 ppm , sample (2) is 0.14 ppm and sample (3) is also 0.14 ppm (Figure 12). In soil samples (1) and (3) have higher level of Ca^{2+} and Mg^{2+}ions. Exchangeable calcium is necessary not only to preserve desirable physical, chemical and biological properties in a soil but also to serve as a source of calcium as a plant nutrient (Figure 13 and Table 3).

Table (1) Physical Properties of the Collected Soil Samples

Sr No.	Parameter	Sample (1)	Sample (2)	Sample (3)	Literature value*
1.	Moisture (%)	2.56	1.15	1.80	1-10
2.	pH	7.8	5.1	6.1	5.0-7.5
3.	Temperature (℃)	31	31	31	25-35℃
4.	Bulk density(g/cm^3)	2.48	2.10	2.49	> 1.6

* (Jackson, 1962)

Table (2) Texture of Soil Samples

Sample	Composition (%)				Texture Class
	Sand	Silt	Clay	Total	
Soil sample (1)	4.15	60.08	30.92	95.15	Silt clay loam
Soil sample (2)	3.60	47.22	45.80	96.62	Silty clay
Soil sample (3)	8.50	41.36	45.64	95.50	Silty clay

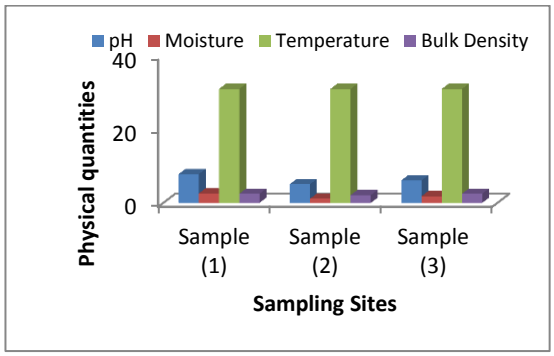


Figure (9) Physical parameters (pH, moisture, temperature and bulk density)

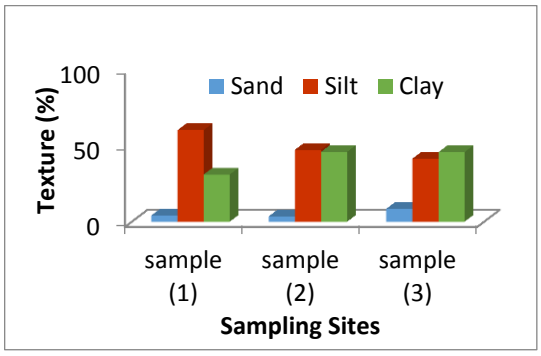


Figure (10) Texture (sand, silt and clay) percent of soil samples

Table (3) Chemical Properties of the Collected Soil Samples

Sr No.	Chemical Parameter	Sample (1)	Sample (2)	Sample (3)	Literature value*
1.	Organic carbon (%)	0.61	1.17	0.69	1-4
2.	Total nitrogen (%)	1.23	0.41	0.44	0.1-1
3.	Available phosphorus (ppm)	19.10	4.33	8.87	20-40
4.	Available potassium (ppm)	0.12	0.14	0.14	
5.	Exchangeable calcium (ppm)	6.67	0.67	6.67	
6.	Exchangeable magnesium (ppm)	3.33	2.02	4.05	

* (Jackson, 1962)

Contents of Elements by EDXRF Analysis

The content of silicon in all soil samples is the highest value relative to that of other elements and aluminium is the second highest. The microelements such as Fe, Ti, Zr, Mn, V, Cr, Cu, Zn and Sr were also determined (Table 4).

Contents of Heavy Metals by Atomic Absorption Spectrophotometry (AAS)

The heavy metals such as arsenic, iron, cadmium, lead and zinc were also detected by Atomic Absorption Spectrometry. It was found that, the contents of arsenic, iron and zinc were lower than that of the reference value but sample (1) was higher lead content than other two samples due to the geological condition of this sampling site (Table 5).

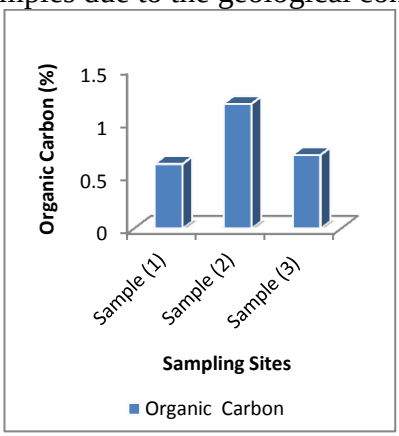


Figure (11) Organic carbon contents of soil samples

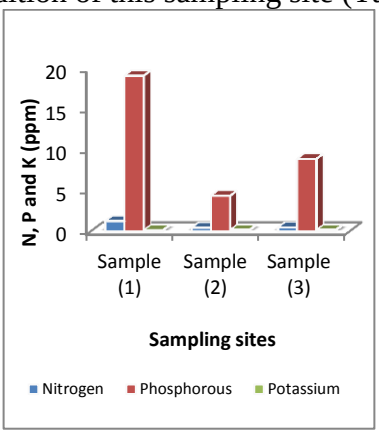


Figure (12) N, P and K contents of soil samples

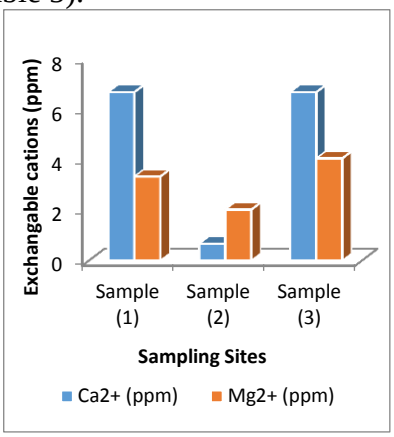


Figure (13) Exchangeable Ca^{2+} and Mg^{2+} ions of soil samples

Table (4) Contents of Elements by EDXRF Analysis for Soil Samples

Elements	Relative abundance (%)		
	Sample (1) (%)	Sample (2) (%)	Sample (3) (%)
Si	69.519	65.266	76.064
Al	24.453	25.449	19.303
Fe	2.959	4.964	2.182
Ti	0.724	0.741	0.867
Zr	0.046	0.031	0.038
Mn	0.025	0.097	0.032
V	0.024	0.035	0.027
Cr	0.011	0.014	0.011
Cu	0.006	0.007	0.005
Zn	0.005	0.010	0.004
Sr	0.003	0.006	0.002

Table (5) Contents of Heavy Metals by Atomic Absorption Spectrometry (AAS) for Soil Samples

Element	Determinant Values (ppm)			Literature values*
	Sample (1)	Sample (2)	Sample (3)	
As	0.069	0.052	0.051	0.4
Fe	869.4	740.7	760.3	10-1000
Cd	ND	ND	ND	0.07-1.1
Pb	26.80	7.132	7.979	15
Zn	0.131	0.107	0.216	10-300

ND = not detected

* US EPA

Conclusion

From this research, the properties of soil samples from three sites of cultivated area in Hpa-an Township (Ta-yoke-hla village, Kaw- kyite village and Kha-loug-noh village) Kayin State was collected. The pH value of soil sample (1) is alkaline soil and samples (2) and (3) are in acidic soil condition. The moisture content of the soil samples are found to be in the range of 1.15 to 2.56 %. Sample (1) is higher than other two soil samples (2) and (3). The texture class of soil sample (1) is silty clay loam, sample (2) and (3) are silty clay forms. The temperature of all soil samples is observed at 31℃. The bulk density of soil sample are 2.48 gcm^{-3}, 2.10 gcm^{-3} and 2.49 gcm^{-3} and organic carbon contents are 0.61%, 1.17% and 0.69% respectively. From the determination of nutrients content of three samples are medium level of total nitrogen, very low available phosphorus and potassium in the soil from the cultivated area. The content of nitrogen in sample (1) is 1.23 %, in sample (2) is 0.41 % and in sample (3) 0.44 %. Available Phosphorus and Potassium values are 19.10 ppm and 0.12 ppm for sample (1), 4.33 ppm and 0.14 ppm for sample (2) and 8.87 ppm and 0.14 ppm for sample (3) respectively. Exchangeable Ca^{2+} and Mg^{2+} values are 6.67 ppm and 3.33 ppm for sample (1), 0.67 ppm and 2.02 ppm for sample (2) and 6.67 ppm and 4.05 ppm for sample (3) respectively. In this research, the content of silicon in all soil samples is the highest value compared to that of other elements and aluminum is the second highest by EDXRF analysis. From these observations, the studied areas are suitable for plantation of fruits, crops and flowers. The contents of arsenic, iron and zinc are lower than that of the reference value but sample (1) has higher lead content than other two samples due to the geological condition of this sampling site.

Acknowledgement

I would like to express my gratitude to Rector, Dr Mya Mya Aye and Pro-rector, Dr Than Than Myint, Hpa-an University, for their permission of writing this research paper. I also thank to Dr Khin Thu Thu Min, Professor and Head, and Dr Moe Thu Zar, Professor, Department of Chemistry, Hpa-an University, for providing valuable guidance and kind help. Special thanks are extended to Rector, Dr Win Naing and Pro-rectors, Dr Nay Thwe Kyi and Dr Nu Nu Yi, Dagon University for their kind help.

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