STUDY ON THE PHYSICOCHEMICAL PROPERTIES OF NATURAL SOIL FROM THE SELECTED AREAS OF LOIKAW TOWNSHIP, KAYAH STATE

Thin Thin Nwe[1], Win Win Htay[2], Naw Aye Aye Thein[3]

Abstract

This study focuses on physicochemical properties of soils from the selected areas of Loikaw Township, Kayah State where many cereal fields have and the farmers always cultivate the subsidiary crops. In this work, soil samples were collected from the surrounding areas of Lin Phone Lay Village, Moh Pyar Village and Law Pi Ta Village in Loikaw Township, Kayah State at the depth of 0-6 inches in a zigzag manner. Physical parameters like moisture content, water holding capacity, pH, electrical conductivity, texture, organic carbon and humus and chemical parameters such as available P_2O_5, available K_2O, total nitrogen, exchangeable Ca^{2+}, Mg^{2+}, K^+, Na^+, H^+ and Al^{3+} were determined according to standard procedures. From this study, it revealed that the Moh Pyar soil sample was moderately acidic nature, Lin Phone Lay soil sample was alkaline nature and Law Pi Ta soil sample was neutral. The soil texture from Moh Pyar and Law Pi Ta soil samples were found to be sandy clay loam and Lin Phone Lay soil sample was silt loam. The contents of electrical conductivity, organic carbon and humus were found to be low level in Moh Pyar and Law Pi Ta soil samples. Among these three samples, the high content of macronutrients like available phosphorus (97.53) and available potassium (803 ppm) were found in Lin Phone Lay soil sample which were found to have sufficient value for agricultural use. The relative abundances of elements of selected soil samples were aslo analyzed by energy dispersive X-ray fluorescence (EDXRF) technique. The results obtained from this analysis revealed that seventeen elements in Moh Pyar soil, sixteen elements in Lin Phone Lay soil and Law Pi Ta soil were contained in these soil samples. The results from this research work indicate the types of soil as well as the nutritional values of selected soil samples needed for crop production.

Keywords: Soil samples, soil types, physical parameters, chemical parameters, agricultural use

Introduction

The word soil represents one of the most active and complex natural systems on the earth's surface. It is essential for the existence of many forms of life and provides medium for plant's growth and also supplies the organisms with most of their nutritional requirements (Gaur, 1997). The physicochemical properties of soil play a big role in the plant's ability to extract water and nutrients. High quality soils not only produce better food and fiber, but also help to establish natural ecosystems and enhance air and water quality (Griffith, 2010). The physical properties of the soil depend upon the amount, shape, structure, size, pore spaces, organic matter and mineral composition of soil. The chemical properties of the soil are the interactions of various chemical constituents among soil particles and the soil solution. These physicochemical properties are soil texture, bulk density, soil structure, soil colour, pH, electrical conductivity, cation exchange capacity, organic carbon, organic matter and soil nutrients. All soils have different properties and working with them requires understanding of these properties. The knowledge of the physicochemical properties of soil helps in managing resources while working with a particular soil (Brady, 2002). They need to be studied for agricultural purpose, to increase

[1] Dr, Associate Professor, Department of Chemistry, Loikaw University
[2] Dr, Associate Professor, Department of Chemistry, Loikaw University
[3] Dr, Lecturer, Department of Chemistry, Yangon University

the productivity and to improve the workability of the soil mass. The study of up-to-date status of soil properties is a very important tool to enhance production on a sustainable basis. Therefore, the study was aimed to find out the difference in health of the soil under different location systems.

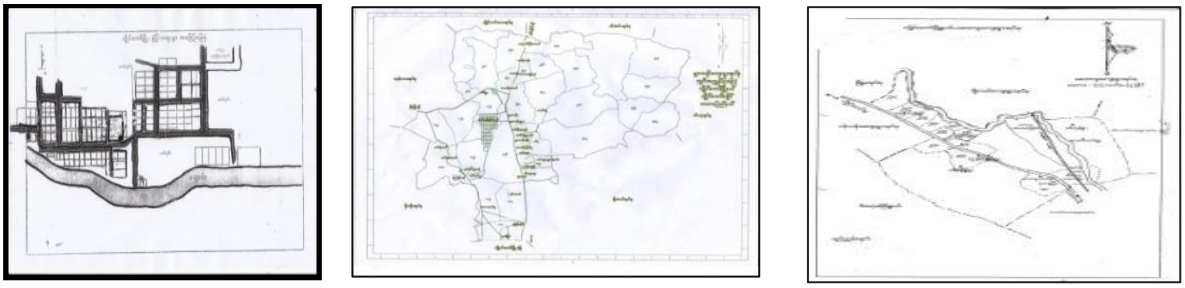
Materials and Methods

This part deals with all experimental procedures. The chemicals used were from the chemical suppliers; 'British Drug House Chemicals Ltd., Poole, England' and 'Kanto Chemical Co., Ltd., Tokyo, Japan', unless otherwise stated.

Various conventional and modern techniques and instruments were used throughout the experimental procedures. All analytical works were according to recommended standard texts (Vogel, 1968). All experimental data were computed on the statistical basis. The apparatus consists of both conventional labware and glassware and modern equipment.

Sample Collection and Handling

Soil samples were collected from the surrounding areas of agriculture farm near Moh Pyar Village, Lin Phone Lay Village and Law Pi Ta Village in Loikaw Township, Kayah State in December, 2018. All soil samples were taken from the depth of 0-6 inches of the surface in a zigzag manner by using GPS (Global Positioning System), mixed thoroughly to homogenize and dried in the shade before sieving. Afterwards, gravel, roots, etc, were discarded. Then, the collected soil samples were passed through the mesh size (2 mm) and stored in polyethene bags and then clearly labeled. The sampling sites are presented in Figure 1.



(i) (ii) (iii)

Figure 1 Sampling sites(i) Moh Pyar Village (ii)Lin Phone Lay Village(iii) Law Pi Ta Village

Determination of Physicochemical Properties

The texture of the soil sample was determined by pipette method (Vogel, 1968). Soil pH was measured in water (1:1.25 w/v) using pH meter (Nathan, 1998). Moisture was determined by using oven-dried method. Organic carbon content in the sample was determined by Walkey - Black method (Nathan and Beegle, 1998). Total nitrogen was determined by the Micro-Kjeldhal digestion - distillation method, available phosphorus was determined by using UV- visible spectrophotometry and available K_2O was determined by flame photometer. The exchangeable cations were extracted with 1M ammonium acetate solution. The extract was then analyzed for calcium (Ca) and magnesium (Mg) by EDTA titration method (Gupta, 2000), and for potassium K and sodium Na, by flame photometer. Total aluminum was determined by Sokoiov's Method (Bower and Fireman,1952).

Results and Discussion

This study focuses on soil properties from the selected areas of the Moh Pyar Village, Lin Phone Lay Village and Law Pi Ta Village in Loikaw Township, Kayah State. In this work, the surface horizon of soil samples were collected from cultivated areas in Loikaw Township, Kayah State in December, 2018. The samples were collected during this period because it was the time when the field was being prepared to cultivate the subsidiary crop after the harvest of corn. It was the time when the nutrients in the soil can be stable.

Physicochemical Properties of Soil Samples

Texture of the selected soil samples

Texture indicates the relative contents of particles of various sizes, such as sand, slit and clay in the soil. Soil texture is an important soil characteristic that influences storm water infiltration rates. In this research, the soil types of selected soil samples are shown in Table 1. According to data, the soil texture for Moh Pyar soil sample was sandy clay loam which contains (41.76 % sand, 24.00 % silt and 34.24 % clay), Lin Phone Lay soil sample was slit loam (13.00 % sand, 65.60 % silt and 20.30 % clay) and Law Pi Ta soil sample was sandy clay loam (69.76 % sand, 10.00 % silt and 20.24 % clay). Generally, the best agricultural soils contained 10-20 % clay. Clay particles tend to retain or fix nutrient in soil.

Table 1 Physicochemical Properties of the Selected Soil Samples

Parameter	Results of different soil samples		
	Moh Pyar	**Lin Phone Lay**	**Law Pi Ta**
Moisture (%)	3.24	1.46	1.12
pH	5.61	8.43	6.94
Electrical conductivity ($mScm^{-1}$)	0.09	0.23	0.05
Texture	sandy clay loam	slit loam	sandy clay loam
Sand (%)	41.76	13.00	69.76
Silt (%)	24.00	65.60	10.00
Clay (%)	34.24	20.30	20.24
Water holding capacity (%)	52.00	58.00	50.00
Organic Carbon (%)	1.54	2.39	1.37
Humus (%)	2.65	4.13	2.35

The effect of pH and electrical conductivity on soil

The soil pH is a measure of the acidity or alkalinity in soil. Soil pH is considered variable in soil as it controls many chemical processes that take place. It specifically affects availability by controlling the chemical forms of the nutrient. The optimum pH range for most soil falls between 5.5 and 7.0, however many plants have adapted to thrive at pH value outside. Soils with high acidity tend to have toxic amounts of aluminium and manganese. Plants need calcium with moderate alkalinity, but most minerals are more soluble in acid soils. Soil organisms are hindered by high acidity, and most agricultural crops do best with mineral soils of pH 6.5 and organic soils of pH 5.5 (Hazelton, 2007).

The pH value of the selected soil samples from Moh Pyar Village, Lin Phone Lay Village and Law Pi Ta Village in Kayah State are shown in Table 1. The data indicated that the soil pH

range from 5.6 to 8.4. Soil sample from Moh Pyar Village was moderately acid nature (pH 5.61), Lin Phone Lay Village was alkaline nature (pH 8.43) and Law Pi Ta Village was neutral (pH 6.94). From this result, it was seen that soil sample from Lin Phone Lay Village had higher pH as compared to the soil samples from Moh Pyar Village and Law Pi Ta Village. Soil electrical conductivity measures the dissolved material in an aqueous solution which relates to the ability of the material to conduct electric current through it. The values of electrical conductivity of selected soil samples were observed to be in the range from 0.05 mS cm^{-1} to 0.23 mS cm^{-1} which was not very high. Hence, suitable fertilizers should be added to the soils for ensuring the maximum crop production.

The moisture contents, organic carbon and humus of the selected soil samples

Humus is the dark organic matter that forms in the soil when plant and animal matter decay which contains many useful nutrients for healthy soil, nitrogen being the most important of all. Humus can participate in aggregate stability and nutrient and water holding capacity. The contents of moisture, organic carbon and humus of the selected soil samples are shown in Table 1. In this research, the moisture content of the soil samples from the Moh Pyar Village, Lin Phone Lay Village and Law Pi Ta Village were found to be 3.24 %, 1.46 % and 1.12 %. The values of organic carbon and humus were 1.54 % and 2.65 % in Moh Pyar Village, 2.39 % and 4.13 % in Lin Phone Lay Village, 1.37 % and 2.35 % in Law Pi Ta Village. From this result, it was found that soil sample from Lin Phone Lay Village has high fertility due to the highest percentage of humus and organic carbon. This implies that the higher the organic carbon content of a soil, the higher the nitrogen content of the soil, and the higher fertile the soil will be. The contents of humus and organic carbon of the soil samples from Moh Pyar Village and Law Pi Ta Village were found to be low which was suggested that the soils can be classified as low level organic soil (3 to 19 % humus) (Magdoff, 2000).

Distribution of cation exchange capacity and water holding capacity in the selected soil samples

The cation exchange capacity is the number of exchangeable cations per dry weight that soil is capable of holding. It is very important soil property influencing soil structure, stability, nutrient availability, soil pH and soil's reaction toward fertilizers. The exchangeable cations of the collected soil samples are summarized in Table 2 and Figure 2. Result of the study indicated that the soil samples were contained Ca^{2+} (13.10 meq/100 g), Mg^{2+} (1.38 meq/100 g), Na^{+} (0.50 meq/100 g), K^{+} (0.19 meq/100 g), H^{+} (0.05 meq/100 g) and Al^{3+} (0.08 meq/100 g) in Moh Pyar Village, Ca^{2+} (79.11 meq/100 g), Mg^{2+} (4.06 meq/100 g), Na^{+} (0.42 meq/100 g) and K^{+} (1.71 meq/100 g) in Lin Phone Lay Village and Ca^{2+} (6.01 meq/100 g), Mg^{2+} (1.50 meq/100 g), Na^{+} (0.66 meq/100 g) and K^{+} (1.12 meq/100 g) in Law Pi Ta Village. The result reveals that high cation exchange capacity (85.3 meq/100 g soil) from Lin Phone Lay soil sample indicated that the soil contained more organic matter and also had high water holding capacity. The water holding capacity increases with increasing level of organic carbon and with increasing percentage of silt and clay particles in the soil because silt and clay particles have much higher surface area to hold greater quantity of water. The greater water holding capacity was recorded in Lin Phone Lay soil sample (58.00 %). Cations Al^{3+} and H^{+} were detected in soil sample from Moh Pyar Village. It indicated that the problem associated with acidic soil (pH 5.6) due to aluminium toxicity (Hazelton, 2007).

Table 2 Exchangeable Cation Contents in the Selected Soil Samples

Cation	Contents (meq/100 g)		
	Moh Pyar	Lin Phone Lay	Law Pi Ta
Ca^{2+}	13.10	79.11	6.01
Mg^{2+}	1.38	4.06	1.50
K^{+}	0.19	1.71	1.12
Na^{+}	0.50	0.42	0.66
H^{+}	0.05	Not detected	Not detected
Al^{3+}	0.08	Not detected	Not detected

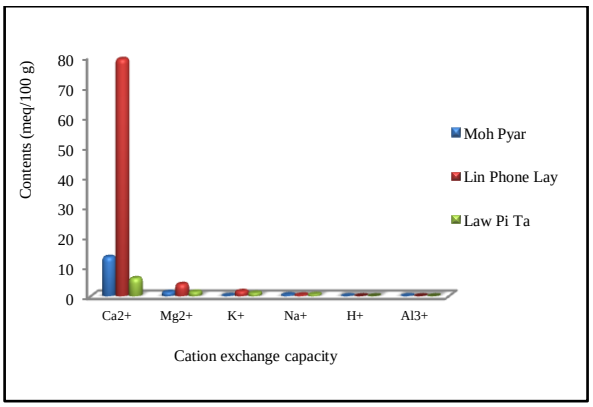


Figure 2 Histogram of exchangeable cations contents in the selected soil samples

Macronutrients (N, P, K) contents of the selected soil samples

Total nitrogen (N), available phosphorus (P_2O_5) and available potassium (K_2O) are referred to as the primary macronutrients of soil and most important to provide the vitality and performance of plant grown. Therefore, it is a vital work to analyze these elements not only in qualitative but also in quantitative. Macronutrients contents in soil samples are shown in Table 3. Total nitrogen (N) contents of the selected soil samples were found to be 0.18 % in Moh Pyar Village, 0.23 % in Lin Phone Lay Village and 0.14 % in Law Pi Ta Village. The contents of available phosphorus (P_2O_5) and available potassium (K_2O) in Moh Pyar Village, Lin Phone Lay Village and Law Pi Ta Village were (1.25 ppm and 869 ppm), (97.53 ppm and 803 ppm) and (1.69 ppm and 527 ppm), respectively. From these results, the soil samples contained a good amount of potassium contents. Significant positive correlation has been observed between available potassium and clay contents which might be due to the presence of most of mica in the finer fraction. Soil that has adequate potassium allows plant roots to proliferate, increasing the plants' ability to grow rapidly.

Table 3 Contents of Macronutrients in the Selected Soil Samples

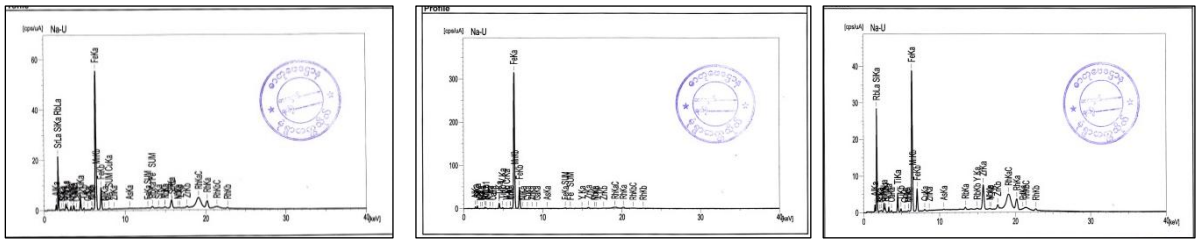
Parameter	Results		
	Moh Pyar	Lin Phone Lay	Law Pi Ta
Total Nitrogen (%)	0.18	0.23	0.14
Available Phosphorus (ppm)	1.25	97.53	1.69
Available Potassium (ppm)	869	803	527

Relative abundance of some elements in the selected soil samples

The relative abundance of some elements in the selected soil samples were analyzed by EDXRF technique. The resultant compositions of the elements in the selected soil samples are presented in Table 4 and Figure 3. According to EDXRF data, the selected soil samples contained the high amounts of silicon 72.346 % (Moh Pyar soil), 47.962 % (Lin Phone Lay soil) and 79.054 % (Law Pi Ta soil). It was followed by Al, Fe, Ti, S, K, Ca, Mn, Zr, Pd, Cr, Y, Zn, Rb, Ni, Sr, Nb, Ga and Cu.

Table 4 The Relative Abundance of Elements in the Selected Soil Samples by EDXRF Technique

Elements	Relative Abundance of Elements in soil samples (%)		
	Moh Pyar	**Lin Phone Lay**	**Law Pi Ta**
Si	72.346	47.962	79.054
Al	21.390	28.007	16.745
Fe	3.093	20.090	1.823
Ti	0.949	2.112	0.873
S	0.810	0.836	0.636
K	0.726	0.359	0.562
Ca	0.539	0.201	0.148
Mn	0.051	0.116	0.014
Zr	0.051	0.070	0.088
Cr	0.018	0.046	0.011
Y	0.006	0.012	0.003
Zn	0.006	0.013	0.004
Rb	0.006	-	0.007
Ni	0.005	0.024	-
Sr	0.004	-	-
Nb	0.002	0.006	0.002
Cu	0.002	0.028	0.011
Pd	-	-	0.020
Ga	-	0.010	-



(i) (ii) (iii)

Figure 3 EDXRF spectra for the selected soil samples
(i) Moh Pyar (ii) Lin Phone Lay (iii) Law Pi Ta

Conclusion

The study of physicochemical parameters is important to agricultural chemists for plant growth and soil management. From the present work, on the study of physicochemical properties of soil from the selected areas of Loikaw Township in Kayah State, the following inferences could be deduced. The results of pH value showed that the soil sample from Moh Pyar Village was moderately acidic (5.61), Lin Phone Lay Village was alkaline nature (8.43) and Law Pi Ta Village was neutral (6.94). Soil types were found to be Moh Pyar and Law Pi Ta soil samples were sandy clay loam and Lin Phone Lay soil sample was slit loam. According to EDXRF data,

high amounts of silicon were present in the selected soil samples. This study indicates that the physicochemical properties of the soil such as electrical conductivity, humus, organic carbon, cation exchange capacity, available nitrogen and available phosphorus are negatively affected in Moh Pyar and Law Pi Ta soil systems as compared to the Lin Phone Lay soil due to frequent tillage practices. The high quantities of water holding capacity, available nitrogen, available phosphorus and available potassium in the Lin Phone Lay soil indicate that this soil ecosystem has considerable impact on soil nutrient build up and accumulation by reducing the loss through soil erosion and leaching due to dense canopy. Results show that the selected soil samples have medium as well as high mineral contents. This information will help the villagers who cultivated in this area to solve the problem related to soil nutrients which amount of fertilizer to be added to increase the yield of crops.

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