Study on the Characteristics of Soil from Nwe-Yon Village, Vicinity of Sink-Gu Gold Mines, Mandalay Region

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Abstract

Advanced soil science technology can determine the expected growth potential of the soil and indicate nutrient deficiencies, possible toxicities from excessive fertility and inhibitions from the presence of non-essential trace minerals. Farmers increasingly demand more information about soil characteristic because they need better knowledge for monitoring the sustainability of their agricultural management. In this research, soil quality of three samples from different sites of Nwe-Yon village, in the vicinity of gold-mines from Sinkgu Township was investigated and presented as a part of anthropogenic background concentration (ABC) of this area. The parameters determined for this study are some physical condition (pH, moisture, organic matter, electrical conductivity (EC), color), texture (sand, silt, clay), major nutrients (NPK), secondary nutrient such as Ca, minor nutrients (Fe, Zn, Cu), toxic mineral constituents (As, Cr, Cd, Hg, Pb) and exchangeable cations (Ca^{++}, Mg^{++}, Na^{+}, K^{+}, Al^{+++}, H^{+}). Interpretation of soil quality data was carried out and then it should be performed by respective proper soil management for agricultural land use.

Keywords : electrical conductivity (EC), texture ,major nutrients (NPK), secondary nutrient , minor nutrients , toxic mineral constituents and exchangeable cations

Introduction

The world consists of 71% water and 29% land. Of the 29%, 58% are dry, cold ice deserts; 87% of land with an approximately 1m deep layer of soil is to feed, house and sustain all the people of the earth. Life on earth depends critically on the soil resource. Soil is not only an important medium for plant growth but also a treatment filter for maintaining water quality. It is also a key component in the regulation of the global biogeochemical cycles and an important medium for the disposal and delegation of wastes. Despite the importance of these functions, we often treat soil with contempt, often referring to it as 'dirt' and describing things as 'soiled' when no longer saleable. While soils are essential to human society as air and water, soil degradation has not received nearly as much attention as the threats to these other two elements. It is commonly accepted today that the chemical and physical properties of soils determine their capacity to support plant growth. Throughout most of recorded historical data concerning to these properties have not been available for the soils to be commonly used for crop production, thus soil fertility practices have been based upon empirical knowledge.

With the advance of science, and more specifically, with the support of soil science, men begin to accumulate data which is more adequately characterized soils. The process of data collection has been slow because of the problems involved in identifying the complete list of soil properties which influence plant growth. For example, it is not yet known what exact role aluminium plays in plant growth, although its role has been under investigation for a great many years. Agricultural soil analysis is a chemical analysis that is used to asses the plant-availability of essential nutrients and/of toxic elements. It is generally agreed that twelve

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elements are essential for normal plant growth. These nutrient elements are phosphorus, potassium, calcium, magnesium, iron, manganese, boron, copper, zinc, sulfur, sodium, and nitrogen`. Myanmar is agricultural country and therefore they need to do soil research more and more. Natural background concentration is defined as the ambient concentrations of chemical in soils without human influence, which depicts an idealized situation (i.e pristine soil). Anthropogenic background concentration is defined as both natural and man-made substances present in the environment as a result of human activities not specifically related to point sources. Nwe-Yon village is situated 55 miles north from Mandalay and 10 miles north east far from Sink-Gu. It is located in the vicinity of Tha-Yet- Chaung and Nga-Bya-Bay gold-mines from Sink-Gu township and therefore heavy metals from these gold-mines can affect on its agricultural soil. In this research, the characteristics and properties of soil utilizatiion in agriculture of Nwe-Yon village were investigated and informed the results as a part of anthropogenic background concentration (ABC) of this area.

Aim and Objectives

Aim

The aim of this research is to determine the effect of gold-mines on physicochemical properties of agricultural soil from New-Yon area.

Objectives

- To collect representative soil samples
- To analyze the collected soil samples
- To interpret the resulting analytical data
- To give recommendations based on interpreted analytical results

Experiments

Sample Collection

Soil samples were collected from 15 cm depth from three different sites of New-Yon agricultural land.

Preparation of Multi-increment Soil Samples

The individual soil increment collected was spaced out across each site as shown in Figure 2. Ten individual soil samples or "increments" collected from each site were combined in one container to make up a multi-increment soil sample. Other two soil increments were also combined into two separate sample containers. Then the soils were allowed to dry in air. Large lumps were broken up by hand and then the soil was grounded by milling with wooden roller. After grinding, the soil was screened through a 2 mm (10 meshes) sieve. The greater than 2 mm soil retained on the sieve was not be analyzed. The sample is allowed to dry in an electric oven at 105-110°C for about 8 hours. From the loss in weight, the percentage of moisture of sample was calculated. The pH was measured by pH meter. The electrical conductivity of the samples was determined electrometrically with a calibrated electrical conductivity meter. Determination of texture of 500 g air dried collected soil sample was done by sieve analysis and Hydrometer test.

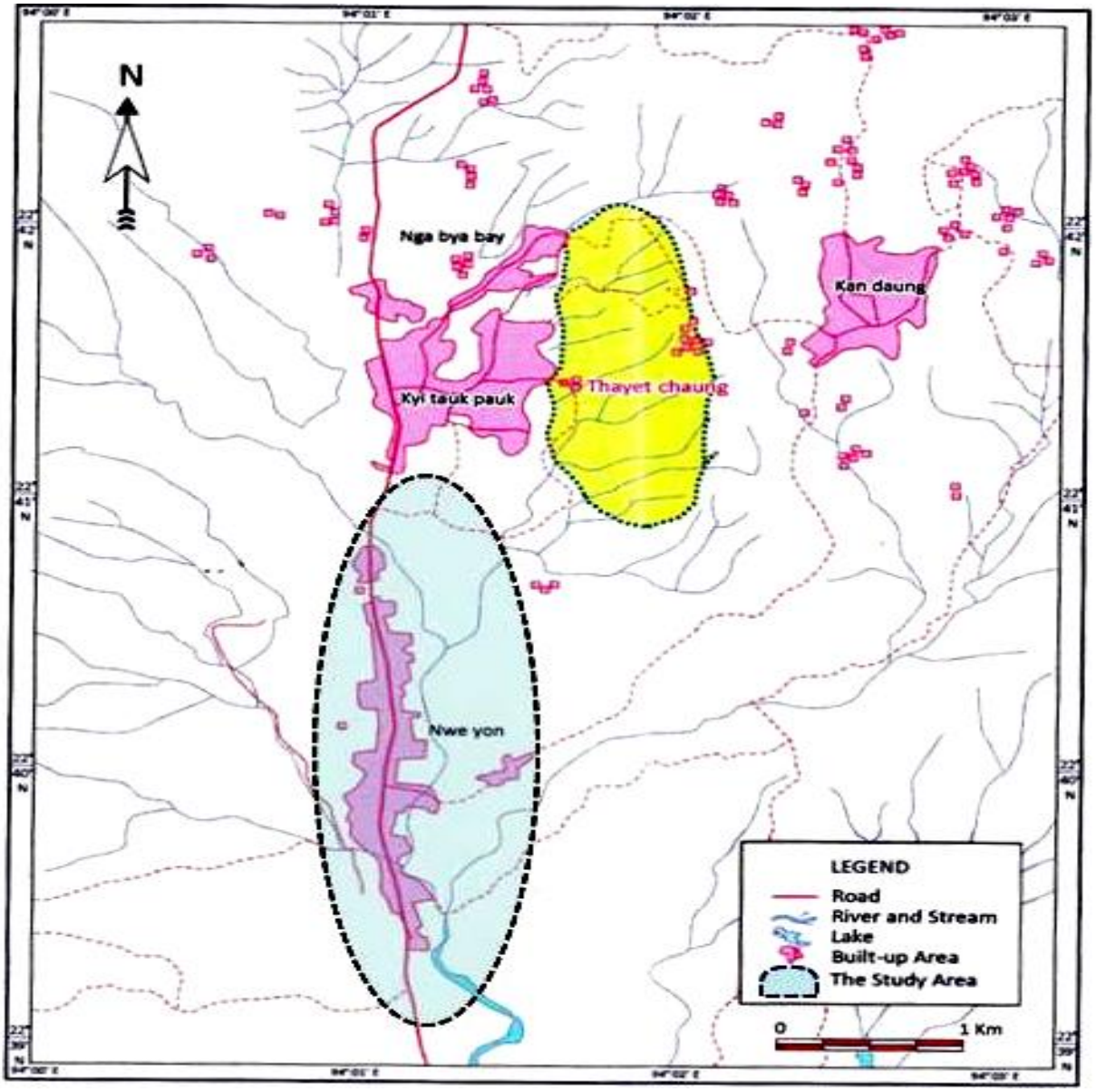

Figure 1. Location Map of Nwe -Yon in Sink-Gu Township

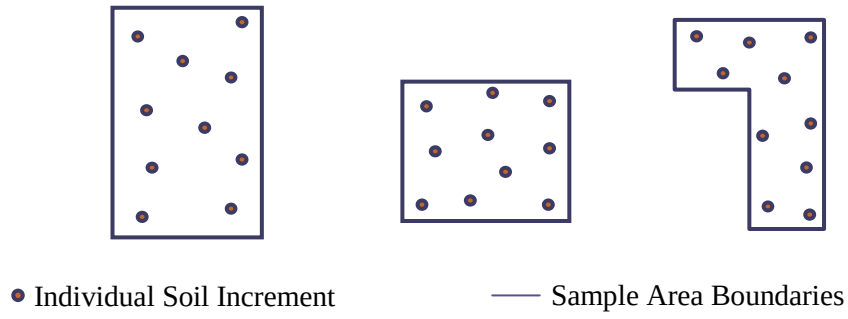

Figure 2. Three Examples with Approximate Locations of Ten Soil Sample Increments Spread Across the Specific Sample Areas

Determination of Available Nitrogen by Alkaline Permanganate Method

The amount of soil nitrogen released by alkaline permanganate solution is estimated by distillation procedure, the distillate is collected in known amount of standard acid and the sulphuric acid is titrated against standard alkali solution by suing methyl red as an indicator. The estimated nitrogen is designated as available nitrogen. This determination was carried out at the Soil Science Department, Agricultural Research Center, Yezin.

Determination of Available Phosphorus by Truog's Method

This determination was performed by Truog's method and the intensity of the colour of resulting filtrate was measured by spectrophotometer at the Soil Science Department, Agricultural Research Center, Yezin.

Determination of Available Potassium

About 5 g of sample was weighed accurately and placed in a 100 cm^3 of shaking bottle containing 50 cm^3 of 1 M ammonium acetate solution. The bottle was shaken for an hour and the solution was filtered. The amount of potassium in the filtrate was measured by flame emission spectrophotometer in Soil Survey Section, Irrigation Department Yangon.

Determination of Exchangeable Calcium and Magnesium

About 2.5 g of sample was weighed accurately and placed in a 500 cm^3 shaking bottle containing 250 cm^3 of 1 M solution. The bottle was shaken for 3 min and kept overnight and then filtered. To determine calcium and magnesium, 25 cm^3 of filtrate was added into conical flask and then 5 cm^3 of ammonium buffer solution (pH = 10) was added. Eriochrome Black T was used as an indicator. It was titrated with 0.02N EDTA solutions and the end point colour was violet. The amount of exchangeable calcium and magnesium was determined at Soil Survey Section, Irrigation Department Yangon.

Determination of Exchangeable Sodium

About 5 g of sample was weighed accurately and placed in a 100 cm^3 of shaking bottle containing 50 cm^3 of 1 M ammonium acetate solution. The bottle was shaken for 1 hr and the solution was filtered. The amount of sodium in the filtrate was measured by using the atomic absorption spectrophotometer AA-6200 SHIMADZU in Soil Science Department, Agricultural Research Center, Yesin.

Determination of Toxic Mineral Constituents by Atomic Absorption Spectrophotometer (AAS)

A measured quantity of the samples was transferred into a Kjeldahl flask; 20 cm^3 of concentrated nitric acid (HNO_3) was added and the sample was pre-digested by heating gently for 20 minutes. More acid was thereafter added and digestion was continued for 30-40 minutes. Digestion was stopped when a clear digest was obtained. The flask was cooled and the content was transferred into a 50 cm^3 volumetric flask and made to the mark with distilled water. The resulting solution was analyzed for heavy metals constituents by atomic absorption spectrophotometer at Applied Geology Department, Yangon.

Determination of Organic Matter

Total organic matter content in soil sample can be determined by titrimetric method.

Results and Discussion

Table 1. Some Physical Parameters of Soil Samples

Sample	pH	Moisture Content (%)	Organic matter (%)	EC (mmhos/cm)	Color
1	7.91	5.92	4.12	340	Light brown
2	7.77	4.65	4.03	381	Light brown
3	7.87	5.88	3.52	460	Light brown

Table 2. Textural Results of Soil Samples

Sample	Composition				
	Sand (%)	Silt (%)	Clay (%)	Gravel (%)	Texture
1	32.0	56.3	11.7	0.0	Silt loam
2	35.9	54.1	10.0	0.0	Silt loam
3	18.1	65.5	16.4	0.0	Silt loam

Table 3. Major Nutrients of Soil Samples

Sample	N	P	K
	($mgkg^{-1}$)	($mgkg^{-1}$)	($mgkg^{-1}$)
1	56	25	84
2	98	23	91
3	73	13	67

Table 4. Secondary Nutrient of Soil Samples

Sample	Ca
	(mgkg-1)
1	88.56
2	46.09
3	74.82

Table 5. Minor Nutrients of Soil Samples

Sample	Cu ($mgkg^{-1}$)	Zn ($mgkg^{-1}$)	Fe ($mgkg^{-1}$)
1	0.280	1.088	2.164
2	0.161	1.166	3.224
3	0.214	1.121	2.806
Canadian Soil Quality Guidelines for Agriculture	63	200	-

Table 6. Toxic Mineral Constituents of Soil Samples

Sample	Cd ($mgkg^{-1}$)	As ($mgkg^{-1}$)	Hg ($mgkg^{-1}$)	Pb ($mgkg^{-1}$)	Cr ($mgkg^{-1}$)
1	0.153	13.37	2.916	1.069	0.329
2	0.180	9.865	2.172	0.867	0.344

3	0.186	11.238	2.463	0.965	0.436
Canadian Soil Quality Guidelines for Agriculture	1.4	12	6.6	70	64

Table 7. Exchangeable Cation Contents of Soil Samples

Sample	m.eq/100 g of soil					
	Na^+	Ca^{++}	Mg^{++}	Al^{+++}	K^+	H^+
1	1.51	29.73	2.29	N.D	0.83	N.D
2	1.47	35.62	2.41	N.D	0.62	N.D
3	1.69	37.42	0.76	N.D	0.66	N.D

Determination of texture was carried out and the resulting data was summarized in Table (2). Soil texture refers to the relative proportion of sand, silt and clay on weight basis. These soil samples contain silt (56.3 %, 54.1 %, 65.5 %), sand (32.0%, 35.9%, 18.1%) and clay (11.7%, 10.0%, 16.4%) respectively. They are silt loam soil and have good condition for plant growth. pH values of these soil samples are 7.91, 7.77 and 7.87 and they are moderately alkaline. Therefore requirement to adjust the soil pH to a desired level is not determined in the tested soil samples. Moisture contents of soil samples are 5.92%, 4.65% and 5.88% respectively and these soils retain much more water than coarse soils. High and medium organic matter values of 2.83, 3.43 and 2.59% belong to three tested soil samples. Electrical conductivities (EC) of soil sample extracts showed the level of soluble salts in these soils as 340, 392 and 460 µmhos/cm. The four major exchangeable cations determination for K, Ca and Mg informed the estimates of plant available levels of these nutrinents. 100 g of soil sample contain 29.73, 35.62,37.42 m.eq of Ca^{++} and it gave as very high amount in the detected cations and then followed by medium and low Mg^{++} , 2.29, 2.41, 0.76 m.eq/100 g and high Na^+, 1.51, 1.47, 1.69 m.eq/100 g. Na is not a plant nutrient and therefore is not necessary for the plant growth. High level of sodium is detrimental to soil tilt and plant growth. Among the exchangeable cations analysis, K^+ value response as higher plant available level of 0.83,0.62 and 0.66 m.eq/100 g. In addition, these soils resist to permeability and lechability by having good exchangeable cations data except Na^+. Therefore these soils are suitable for cultivation. In the determination of available nitrogen (N), three soil samples possess the low and medium values of 56, 98 and 73 mg kg^{-1}. High and medium amounts of available phosphorous (P) can be observed as 25, 23 and 13 mg kg^{-1}. Low values of available potassium (K) were obtained as 84, 91 and 67 mg kg^{-1}. Al^{+++} and H^+ were not detected in these soil samples. As micronutrients, the amount of copper (Cu), zinc (Zn) and iron (Fe) were also measured and shown in Table (5). Although the concentration of arsenic (As) was found to be high, the results of other heavy metal concentrations in Table (6) lies under the Canadian soil quality guideline values for agriculture land use.

Conclusion

Soil is a complex mixture of inorganic material, decaying organic matter, water, air and living organism. This study was conducted in the agricultural land of nearest village from artisanal and mechanical gold-mines to detect the amount of soil nutrients and pollutants. Physical properties had good relation with the requirements for cultivation. Textural results informed these soils as silt loam. Medium and high contents of available N, P and low amount of K were observed. It is pointed that these soils were necessary to add humus and potassium rich fertilizer such as potash to increase the amounts of nitrogen and potassium. Concentration of Cu, Fe and Zn are obtained as lower levels, (0.280, 0.161, 0.214), (2.164, 3.224, 2.806), (1.088, 1.166, 1.121) $mgkg^{-1}$ respectively. Toxic mineral constituents of As, Cr, Cd, Hg and

Pb are likely to be found as acceptable values because they fall under the Canadian soil quality guideline values for agricultural usage. In addition, the values of exchangeable cations for Ca^{++}, Mg^{++} and K^{+} were higher. Al^{+++} and H^{+} were not investigated in the soil samples. These soil samples needed physical and chemical properties for agricultural purposes and heavy metal concentrations fell under guideline values. There were no significant effects from the nearest Sink-Gu gold mines on these soils and therefore it can be used for agricultural purposes.

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