CHEMICAL ANALYSIS OF THE TREATED SOIL USING BIO-FERTILIZER (*NOSTOC MUSCURUM*) FOR PADDY CULTIVATION

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Abstract

The present project paper presents, chemical investigation of two types of soil: natural soil and treated soil (by algae) from Sintgaing Township . It is located near Mandalay City and it has become one popular township for paddy cultivation with the help of irrigation system. Because of the increasing use of chemical fertilizers for the growth of population, there is considerable problem which is side-effect by using chemical fertilizers. Using bio-fertilizer in the land for cultivation may reduce partly the environmental degradation. The main aim of this project paper is to investigate the chemical constituents of treated soil using bio-fertilizer and natural soil. To identify the effect of bio-fertilizer for paddy cultivation, the experimental works have been done in two portions: physical examination such as, electrical conductivity, soil colour, soil texture, soil moisture and pH, and chemical properties such as, available values of essential elements: nitrogen, phosphorus and potassium in plant nutrition, the exchangeable capacity of the secondary nutrients (Ca, Mg, Na, and the organic matter) contents were also examined.

Keywords: Bio-fertilizer *(NOSTOC MUSCURUM)*, chemical properties, physical properties

Introduction

Plants require soil to obtain water and nutrients for growth, anchorage and stability. Seeds will germinate; seedlings emerge and grow to produce a crop under a great variety of conditions. Plant growth in the context of crop production demands adequate conditions to yield a crop which is economically worthwhile. For efficient crop production, it is important to understand soil environment in which plants grow, to recognize the limitations of that environment and to ameliorate the soil where possible without damaging its quality. Soil is one of the most important natural resources for crop production. It is estimated that the rate of soil formation is about 2.5 cm every 150 years. That is why soil is non- renewable within the human life-span. It is in the interests of the farmer and the population as a whole, to ensure that good soil management is practiced so that this resource is preserved for continual use by the current and future generations.

Myanmar is an agricultural country and therefore it is still needed to do more and more soil researches. Rice is staple food for Myanmar and therefore rice production is vital in agriculture. To determine physicochemical properties and to perform chemical characterization, the soil samples are collected from Sesone Village Tract, Sintgaing Township, Mandalay Region. This sample site area is located in the Mandalay – Kyaukse plain of Myanmar. It has become one popular township for paddy cultivation with the help of irrigation system. The use of chemical fertilizers is increasing with the growth of population. There is considerable environmental problem because of the use of chemical fertilizers. Using biofertilizer in the land for cultivation may reduce partly the environmental degradation.

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The aim of this research is to do the chemical analysis of the treated soil using bio-fertilizer (*Nostoc muscurum*) for paddy cultivation.

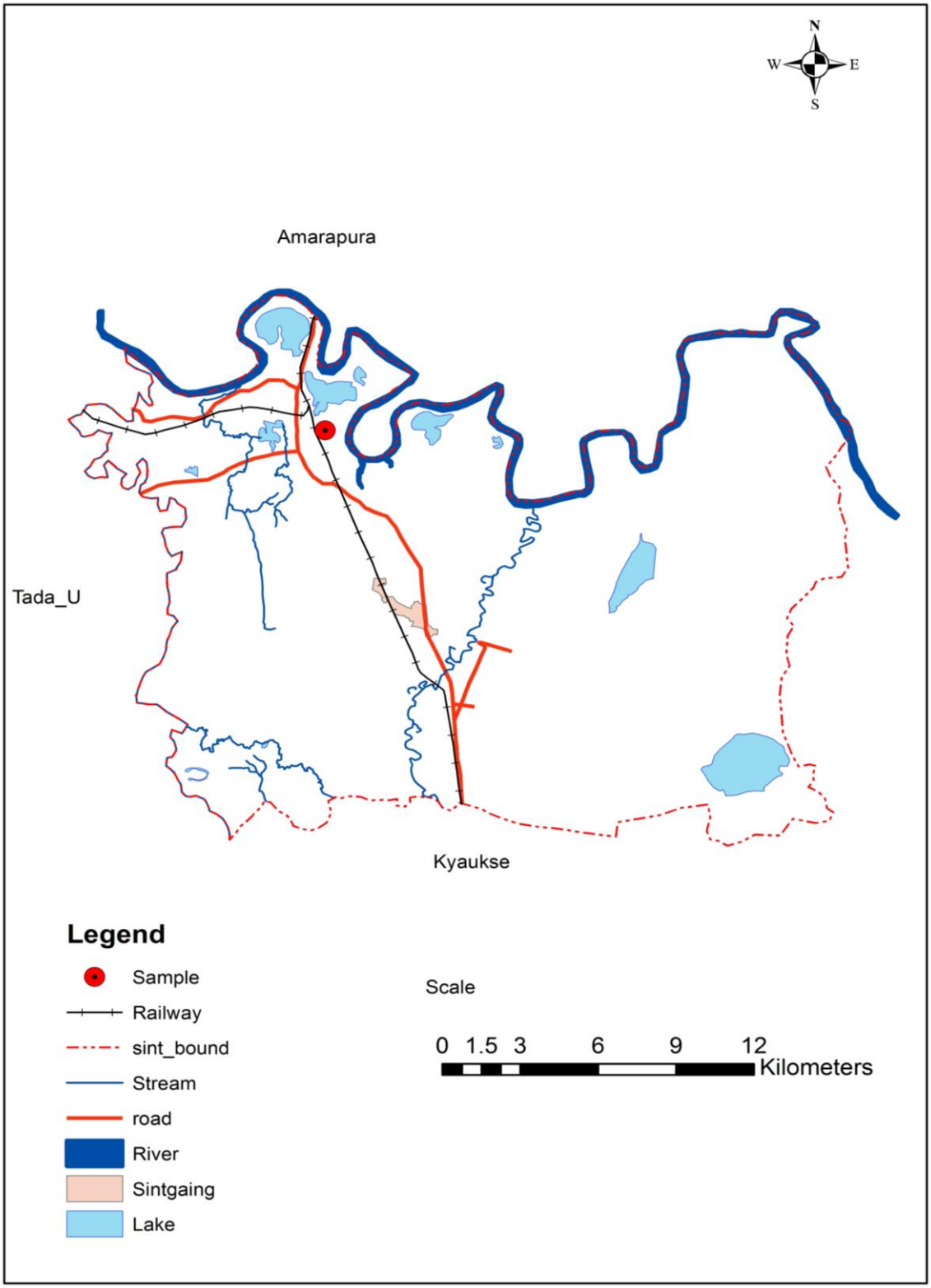

Figure: Soil Sample Site in Sesone Village Tract of Sintgaing Township

Nostoc muscurum

Nostoc muscurum : Cyanobacteria is the most important organism (algae) due to its different classical activities like nitrogen fixation, which is the most prevailing function of cyanobacteria. ***Nostoc muscurum*** is a species of cyanobacterium belonging to the family Nostocace which contains different bioactive components like phenolics, phycoayanin, triterpenoids, amino acids, polyunsaturated fatty acids, sulphates polysaccharides and carotenoids. These components are specific for antimicrobial, antioxidant and antibacterial activity. However, different chemical compounds make it incredible and highly significant algae.

Literature survey

pH is a measure of the acidity or alkalinity in the soil. It is also called soil reaction. Soil pH affects many micro-organisms. The type and population densities change with pH. A pH of 6.6 to 7.3 is favorable for microbial activities that contribute to the availability of nitrogen, sulfur, and phosphorus in soils.

Potassium has much to do with the vigor and vitality of the plant, encouraging the development of a healthy root system and offsetting the harmful effect of excessive nitrogen. Potassium also tends to counteract a delay in ripening and thereby exerts a balancing effect on excessive nitrogen levels.

Nitrogen is the element which stimulates above-ground growth and produces the rich green color that is characteristic of a healthy plant. It also influences the quality of the plant's fruit and it increases the fruit's protein content.

Phosphorus is abundant in the fruits of plants and seeds and also in the parts of the root which are involved in the rapid uptake of water and nutrients, such as the root hair section. Phosphorus plays a major role in plants in those processes requiring a transfer of energy.

Soil texture refers to the proportions of clay, silt and sand in a sample of soil.

Experimental

Sample Collection

The soil samples were collected from Sintgaing Township, Mandalay region for this research work. The two samples which were dug the depth 18cm from the earth surface in the study areas were put in thick plastic bags , labeled suitably both outside and inside the bags and brought to the laboratory. At the laboratory, the soil samples were emptied from their bags and spread out on paper sheets. The soil samples were allowed to dry in air. Stones and pieces of micro organic matter were picked out and the remainders were crushed into fine powder. Large lumps were broken up by hand and then the soils were ground. After grinding, the soils were screened by 2 mm sieve. Soil remaining on the sieve which is greater than 2 mm was not used for analysis. The samples were stored in screwed capped glass jars and labeled properly as sample 1 and sample 2.

Determination of Soil pH

Theory

Soil pH is the most widely measured soil parameter. This pH measurement determines the degree of acidity or alkalinity in soil materials suspended in water. It influences a large number of environmental mechanisms such as leaching of nutrients from soil; the provision of nutrients and water to plant. It is not possible to measure the pH of a dry soil and we need to add water to soil prior to pH determination. It is not easy to decide how much water to add to soil.

Reagents

1. Distilled water- redistilled water

2. Buffer solution: pH 4.0 at 25˚C and pH 10 at 25˚C

Apparatus

Balance, pH meter

Procedure

About 10 g of sample was transferred into a shaking bottle and 25 cm^3 of distilled water was added (the ratio of sample to water was 1 : 2.5) and shaken for half an hour. Then pH was measured by pH meter using glass electrode. The pH meter was standardized with buffer solutions before use.

Determination of Moisture

Principle

The sample was allowed to dry in an electric oven at 105˚C for about eight hours. After cooling it in desiccator it was weighed. Heating, cooling and weighing were carried out until constant weight was reached. From the loss in weight, the percentage of moisture of the sample was calculated.

Apparatus

Electric oven, desiccators, porcelain basin, analytical balance

Procedure

Constant weight of weighing bottle was first determined. About 5g of sample was transferred into weighing bottle and weighed accurately. It was allowed to dry in an electric oven at 105˚C. Then it was dried to constant weight. From the loss in weight the percentage of moisture of the sample under analysis was calculated.

Percentage of moisture was calculated by using the formula shown in Appendix.

Determination of Texture by Pipette Method

Reagent

10% of sodium pyrophosphate solution

10 g of sodium pyrophosphate was dissolved in distilled water and made up to 100 cm^3.

Procedure

About 10 g of sample was weighed accurately and placed in a 500 cm^3 conical flask and some amount of distilled water was added. The flask was heated till boiling 10 cm^3 of 10% sodium pyrophosphate solution was added to disperse the soil colloids and heating was continued for about 15 minutes. Then it was cooled. After cooling , the contents were transferred to a 1000 cm^3 graduated cylinder and the solution was made up to the mark with distilled water and then kept overnight to allow the soil colloids to settle.

The next day, the contents were stirred for about four minutes; the solution from 9 cm depth was pipetted with 25 cm^3 pipette into a porcelain basin and evaporated. From this residue, the percentage of clay and silt was calculated. After four hours of the stirring, the solution was pipetted with 25 cm^3 pipette from 4 cm depth and evaporated. From this residue, the percentage of clay was calculated. Then the percentage of silt was obtained by difference. To determine the amount of sand, the remaining solution was poured into 50 µm sieve and the clay and silt were washed with water. The sand , silt and clay percentage of these soil sample 1 and 2 were obtained.

Determination of Nitrogen Content

Reagents

Sulfuric acid-Salicylic acid mixture, $Na_2S_2O_3$, 30% NaOH , indicator, boric acid indicator mixture and catalyst selenium mixture.

Procedure

Treat exactly 100 g of dried sample in a 200 ml kjeldahl digestion flask with

7 ml sulfuric acid- salicylic acid mixture. After 30 minutes, 0.5 g of $Na_2S_2O_3$ was added and shaken. Wait for 25 minutes, 3 ml of H_2SO_4 and about 200 mg catalyst mixture were added. Heat the flask on a digestion rack until the solution turns clear. After cooling it, 30 ml of H_2O was added, and then alkalize with 30 ml of 30% NaOH solution and start the steam distillation immediately, taking care that the glass receiver tube was immersed into the collecting solution. The distillate was put into a 100 ml Erlenmeyer flask containing 10 ml boric acid indicator mixture was collected. After distillation of all NH_3, the boric acid solution was titrated with 0.01N HCl. At the end point, the indicator turns green to red. The available nitrogen contents of the samples were obtained.

Determination of Available Phosphorus by Truog' s Method

Reagents

1. Ammonium sulphate and sulphuric acid buffer solution (pH=3)

2 g of ammonium sulphate was dissolved in some amount of distilled water. Then 2 cm^3 of 1N sulphuric acid was added and the mixture was diluted to 1dm^3 with distilled water.

2. 2.5% ammonium molybdate solution

25 g ammonium molybdate was dissolved in 200 cm^3 of distilled water and warmed to 60˚C. Then 275 cm^3 of concentrated sulphuric acid was diluted to 750 cm^3 with distilled water. After both solutions had been cooled, the ammonium molydate solution was added slowly to the sulphuric acid solution with stirring. After the combined solution had been cooled to room temperature, it was diluted to 1 dm^3 with distilled water.

.3. Chlorostannous acid solution

0.2 g of tin foil was placed into the 4 cm^3 of concentrated HCl. Then it was put on the water –bath till the tin foil was dissolved in acid. After cooling it , it was diluted to 20 cm^3 with distilled water.

4. Standard phosphate solution

0.1917 g of potassium dihydrogen phosphate was dissolved in distilled water and made up to 1 dm^3. 100 cm^3 of above solution was taken and diluted to

1 dm^3 with distilled water. This solution contained 0.01 mg of P_2O_5 / 1cm^3.

Procedure

About 2 g of sample was weighed accurately and placed into shaking bottle. 400 cm^3 of ammonium sulphate and sulphuric acid buffer solution (pH =3) was added and the bottle was shaken for half an hour. After that, it was filtered 50 cm^3 of filtrate was pipetted into 100 cm^3 volumetric flask. Then 4 cm^3 of 2.5% ammonium molybdate solution was added. This was followed by the addition of 6 drops of freshly prepared chlorostannous acid and made up to mark with distilled water. Within 15 minutes after adding the chlorostannous acid to the filtrate, the intensity of color was measured at wavelength 660 nm by using spectrophotometer. Amounts of available phosphorus for soil samples were shown in Table(1).

Determination of Available potassium by Flame photometer

Reagents

1N ammonium acetate solution

77.09 g ammonium acetate was dissolved in distilled water and made up to 1 dm^3.

Procedure

About 5 g of sample was weighed accurately and placed in a 100 cm^3 shaking bottle containing 50 cm^3 of 1N ammonium acetate solution. The bottle was shaken for one hour and the solution was filtered .The amounts of potassium and sodium in the filtrate were measured by using the fame photometer.

Determination of Exchangeable Calcium and Magnesium

Reagents

1. 1N sodium chloride solution
2. 0.02 N EDTA solution
3. ammonium buffer solution (pH =10)
4. 10% NaOH solution
5. murexide indicator

Procedure

About 2.5 g of sample was weighed accurately and placed in a 500 cm^3 shaking bottle containing 250 cm^3 of 1N NaCl solution. The bottle was shaken for three minutes and kept overnight and then filtered.

To determine calcium and magnesium, 25 cm^3 of filtrate was pipetted 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 0.02 N EDTA solutions until the color changed to blue.

To determine calcium, 25 cm^3 of filtrate was pipetted into conical flask and then 2 cm^3 of 10% NaOH solution was added. Murexide was used as an indicator. It was titrated with 0.02N EDTA solutions and the end point color was violet. The amount of calcium and magnesium were calculated.

Results and Discussion

The electrical conductivity (EC) of the two soil samples contain 0.14 ds/m [sample (1), treated soil] and 0.15 ds/m [sample(2) : Natural soil]. Therefore, both were non-saline. The content of available N of sample (1) and (2) were 87 mg/kg [medium content] and 17 mg/kg [very low content]. The available P contents of both samples were 7 and 6 mg/kg (low content) .The measurement of available K contents of both samples were the same 190 mg/kg (medium content). The amount of organic matter were found to be 1.5 % (low) and 0.6% (very low) . The value of exchangeable Ca of the samples were 78 and 12 cmol(+) /kg (high content). The high content of exchangeable Mg were found to be 9.2 and 13 cmol(+) /kg. The measurement of exchangeable Na were 0.32 (medium) and 8 cmol(+) /kg (very high). The high content of Cl^- were 73.9 and 54 mg/kg. The content of total N of both samples were the same (0.2 %) The pH value of the samples were 7.2 and 6.8 respectively.The value of moisture content in sample (1) was 30.63% and sample (2) was 21.94%. The yield production of paddy were found to be the same (65 Basdets/Acre). There are no significantly changes in colour and texture. The results were shown in table (1).

Table (1) Results of the determination of Soil Samples

No.	Description	Sample (1)(Treated Soil)		Sample (2) (Natural Soil)	
			rating		rating
1	EC(ds/m)	0.14	non-saline	0.15	non-saline
2	Available N(mg/kg)	87	medium	17	very low
3	Available P(mg/kg)	7	low	6	low
4	Available K(mg/kg)	190	low	190	medium
5	Organic matter mg/kg	1.51	low	0.6	very low
6	Exchangeable Ca (cmol(+)/kg)	78	high	12	high
7	Exchangeable Mg (cmol(+)/kg)	9.2	high	13	high
8	Exchangeable Na (cmol(+)/kg)	0.32	medium	8	Very high
9	Cl^- (mg/kg)	73.9	high	54	high
10	Total N% (Oven Dry Basic)	0.2%	-	0.2%	-
11	pH	7.1	Slightly alkaline	6.8	
12	Moisture	30.63%		21.94%	
13	Sand%	26%		28%	
14	Silt%	72%		69%	
15	Clay%	2%		3%	
16	Textural Type	Sandy silt trace gravel trace clay		Sandy silt trace clay trace gravel	
17	Colour	7.5R4/4 (dusky red)		7.5R4/4(dusky red)	
18	Paddy production	65 Baskets/Acre		65 Baskets/Acre	

According to the experimental data, the increase in the N content can be a result of nitrogen fixation and nitrate reductase activities of cyanobacteria or to uptake of the amino acids and peptides produced by cyanobacteria.

Na content was decreased due to cyanobacterial exudates, which remove Na from the aqueous medium due to bio sorption. Thus the osmotic as well as ionic effect of Na, which otherwise have an inhibitory effect on growth , get a big drop owing to betting bound to the cyanobacterial secretion. Na ions are no more available as free ions in the medium.

The content of exchangeable calcium was also increased in the treated soil by the use of cyanobacteria.

Conclusion

In this research , physical characteristics and chemical properties were carried out. According to the results of the experimental data, the moisture content, pH, EC and texture of the two samples were suitable for gardening. In addition, the available value of P and K of both samples did not differ quite much but the value of N was quite different between the two samples. This is due to the effect of treated soil (***Nostoc muscurum***) . Moreover, the amount of exchangeable Mg and Na of sample (1) were lower than the value of sample (2) but the value of Ca of sample (1) was higher than that of sample (2). Furthermore, the rate of yields per acre is the same for treated soil and natural soil. But the advantage is that the crop of treated soil does not require insecticides.

Therefore, the sample of treated soil increased the values of pH, nitrogen , calcium and organic matter relative to the control (Natural soil). This could be due to enhanced microbial activity that led to enhanced production.

The outcome of the above experiment proved that cultivation of *N.muscurum* in non sterile soil substrates was the best way of cultivation of nitrogen fixing cyanobacteria at low cost. The technique can be exploited for the commercial production of biofertilizers which is much efficient and environment friendly. This technology can be promising for enriching the soil fertility and improving crop yields.

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