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Physiochemical Analysis of Agricultural Soil Samples in Bhaktapur District, Nepal

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Abstract

The study of physicochemical parameters of soil is important for soil management and proper plant growth.In the present study, soil samples were collected from six places of Bhaktapur to analyze the physicochemical parameters such as: moisture content (%), pH, Electrical Conductivity (EC), Chloride (Cl^-), Sulphate (SO_4^{--}), Phosphate (PO_4^{---}). Moisture content of different soil samples were determined by oven-drying method and value ranges from 16.20%–26.93%. The pH obtained using pH meter ranged from 4.47– 6.37 indicating nearly neutral to acidic nature of soil. Electrical Conductivity ranged from 0.1001 mS/cm– 0.3730 mS/cmwhich showed all soil samples were non-saline. Chloride and Sulphate was analyzed by argentometric titration and gravimetric method with value ranged from 10142.8 ppm–18684.2 ppm and 1440.1 pp– 3907.1 ppm. Phosphate concentration was analyzed spectrophotometrically using molybdenum blue method. Maximum wavelength was obtained at 860 nm and value of phosphate concentration ranged from 2.1 ppm – 3.5 ppm respectively. Analysis of these parameters provides information about nature of soil, nutrients presents in soil which helps farmers to take proper mitigation measures to maintain soil fertility.

Keywords: *Chloride, Electrical conductivity, pH, Phosphate, Sulphate*

Introduction

Soil as a medium of unconsolidated nutrients and materials, forms a top thin layer of earth's crust that is biologically active and provide a medium for plant growth (Addis & Abebow, 2014; Iram & Khan, 2018). Soil is a valuable natural resource which is composed of various minerals, organic matters, air, water, mass of micro and macro organisms and broken rocks which have been altered by environmental reactions (Edori&Iyama, 2017). The composition of soil has significant role in storing and holding nutrients, uptake nutrients in plants and help micro-organism to undergo biological process (Gomez et al., 2015).

Bhaktapur although being smallest district, majority of its land is suitable for agriculture. Out of 11,900 hectors of land in Bhaktapur 11,106 hectors of land is suitable for agriculture but only 8,077 hectors have been cultivated. Practice of commercial vegetable production, cereal production, stable crops of rice and organic agriculture are also found in Bhaktapur. Although soils are intensively cultivated, soil quality needs to be measured through the analysis of soil physicochemical and biological properties that serves as quality indicators (Haritha &Raja Sekhar, 2018).

In Bhaktapur, now a day's large amounts of fertilizers are used in many places. Farmers are not applying the fertilizers in balance amount due to which crop production is increasing speedily for certain period but leads to soil degradation resulting deficiency of micro and macro elements in soil and plants (Karki & Dacayo, 1990; Karki et al., 2000; Borkar, 2014). So, it becomes essential to carry out the physicochemical analysis of soil to control adverse effects of fertilizers. To agricultural chemist, the study of soil physicochemical parameters such as: moisture content, pH, organic matter, phosphorous, nitrogen etc. is important for proper plant growth and soil management (Addis &Abebow, 2014).

Materials and Methods

Study Area

The study was conducted in selected sites of six different agricultural locations of Bhaktapur district

namely Thimi, Sallaghari, Suryabinayak, Sipadol, Dekocha, Bramhayani. The study areas are located in between 10.8 km – 18.3 km east of Kathmandu, the capital city of Nepal. Thimi lies between latitude 27.6852018 °N and longitude 85.361413 °E and elevation 1319 meter. Sallaghari lies between latitude 27.6724328 °N and longitude 85.4043844 °E and elevation 1332 meter. Suryabinayak lies between latitude 27.6481918 °N and longitude 85.4246622 °E and elevation 1338 meter. Sipadol lies between latitude 27.6448504 °N and longitude 85.4174564 °E and elevation 1513 meter. Dekocha lies between latitude 27.6769393 °N and longitude 85.4306872 °E and elevation 1400 meter. Bramhayani lies between latitude 27.6738621 °N and longitude 85.4423778 °E and elevation 1260 meter.

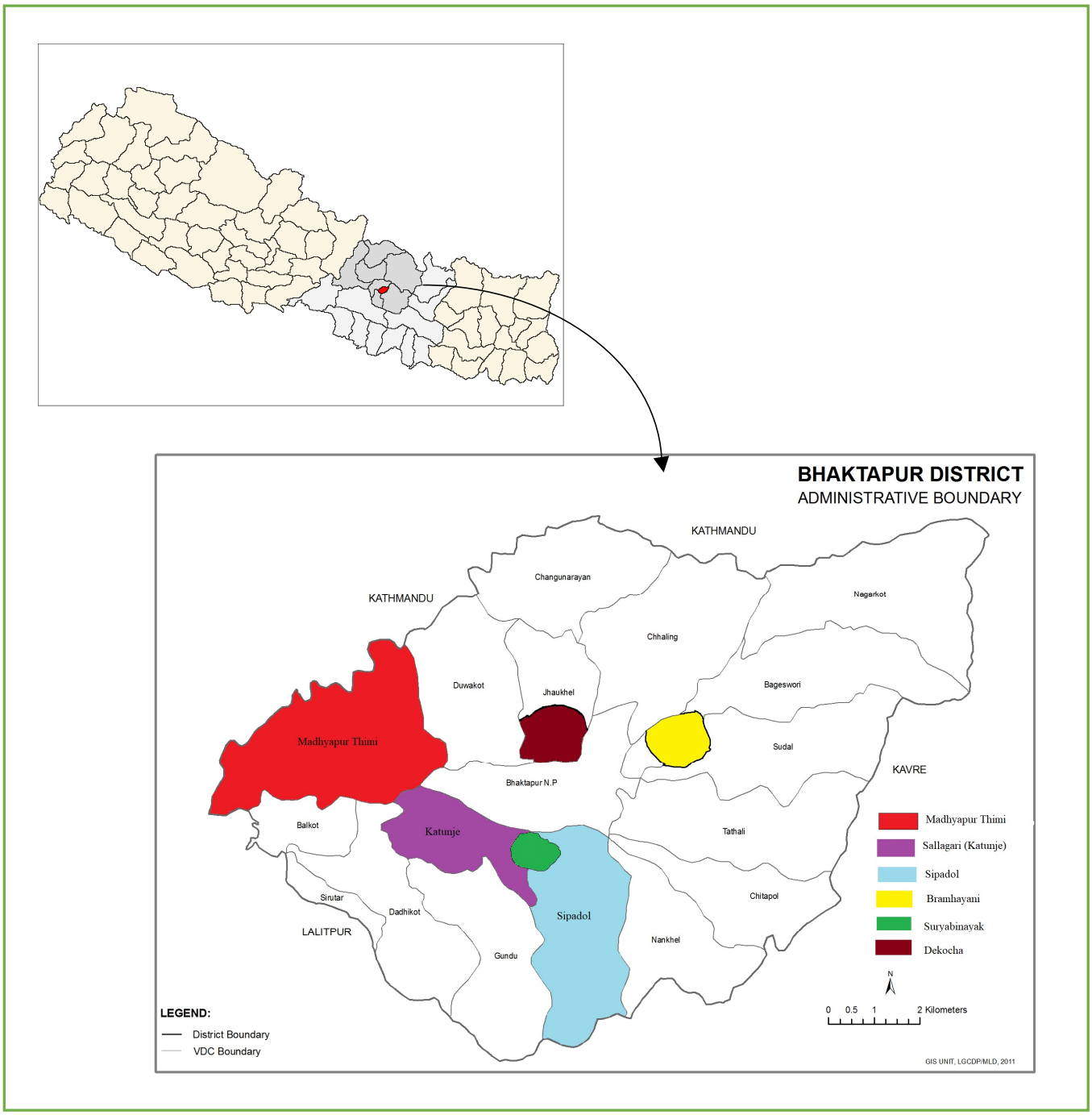

Figure 1: Map of the sample area

The main objectives is to study physicochemical parameters of different soil samples of different agricultural field.

Soil Sampling

Sample of different places were collected from the surface of soil in depth of 10-15 cm and bulked together in polythene bag. Soil particles were crushed, sieved, stored in air tight plastic bag.

Instrumentation

The spectral measurements were made using UV-visible spectrophotometer, model ELICO SL 177. The pH readings were obtained by using pH meter, model DELUXE pH METER – 101 and electrical conductivity by conductivity meter, model MAX ME – 75.

Reagents

For Chloride: 5% Potassium Chromate Indicator and 0.01 N Silver Nitrate Solution

For Sulfate: 10% Barium Chloride Solution

For Phosphate: Di-sodium Hydrogen Phosphate Dihydrate (1000 ppm), Ammonium Molybdate Solution (0.5%), Sulphuric Acid Solution (1.5 M) and Hydrazine Hydrate (0.5 M)

Results and Discussion

Soil Moisture

Soil moisture is an indicator of the amount of water present in soil. Soil moisture content in the six areas ranges from 16.20% to 26.93% (Figure 2). Soil collected from Suryabinayak has relatively high moisture content than the other studies sites. Due to high moisture, nutrients may be over mobilized affecting soil fertility.

Soil pH

Soil pH is a measure of the concentration of hydrogen ions in the soil solution. Plant growth and most soil processes including nutrient availability and microbial activity are favored by a soil pH range 5.5-7.0 (Aktar et al., 2009). The soil pH of the collected soil samples ranges from 4.47-6.37 (Figure 2). This indicates that the nature of soil ranges from acidic to neutral.

Soil Electrical Conductivity

Soil EC is a measure of ion contents in the soil solution. EC below 0.4 mS/cm are regarded as non-saline while above 0.8 mS/cm are considered severely saline (Wagh et al., 2013). The EC value ranges from 0.1001 mS/cm – 0.3730 mS/cm, showing high EC value in Sipadol (Figure 2). The soil under analysis was found to be non-saline.

Table 1: Determination of Some Physicochemical Parameters of Soil Samples

S.N.	Parameters	Method	Formula used
1.	Moisture	Oven drying method (Jackson, 1967)	$\text{Moisture content}(\%) = \frac{\text{Loss in weight on drying (g)}}{\text{Initial sample weight (g)}} \times 100$ (Joel &Amajuoyi, 2009)
2.	pH	pH meter	
3.	EC	Conductometry	
4.	Chloride	Argentometric method	$\text{Chloride content}\left(\frac{\text{gm}}{\text{lit}}\right) = \frac{\text{Normality of } AgNO_3 \times \text{Eq. wt of } Cl^- \times 100}{\text{Volume of Aliquot Taken in ml}}$ $\text{Chloride content (in ppm)} = \frac{\text{gm}}{\text{lit}} \times 1000$
5.	Sulphate	Gravimetric method	$\%\text{of } SO_4^{--} = \frac{\text{Weight of Residue}}{\text{Weight of sample taken}} \times \frac{96}{233.399} \times 100$ SO_4^{--} (in ppm) = % sulphate content in soil X(10000)
6.	Phosphate	Spectrophotometric method	

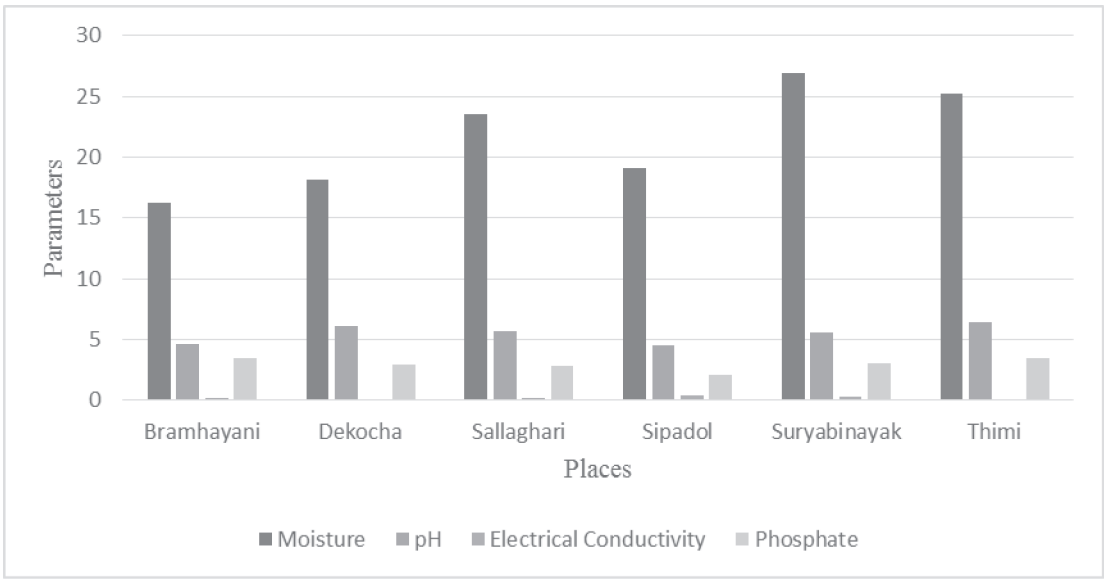

Figure 2: Moisture, pH, EC, Phosphate

Figure 3: Chloride and Sulphate

Chloride(Cl^-)

Chlorine occurs in soil in the form of Chloride ion. The optimum level of Cl^- is unknown for most plants. The data in the above figure showed that the concentration of Cl^- is high in Sipadol soil 18684.2 ppm and low in Dekocha soil 10142.8 ppm (Figure 3). High Cl^- ion concentration in soil cause toxicity and affect the plant and fertility.

Sulphate (SO_4^-)

0.3 percent (3000 ppm) soluble sulphate by mass is safe limit for sulphates in soils (Mitchell & Dermatas, 1992) whereas sulphate concentration as low as 0.1 to 0.2 percent capable of causing expansive reactions (Pappula et al, 2002). The sulphate concentration ranges from 1440.1 ppm to 3907.1 ppm (Figure 3) with maximum value in Thimi area. With the safe limit of sulphur in soil of Thimi, it indicates the presence of required amount of organic matters in soil.

Phosphate (PO_4^{3-})

Phosphorous occur in soil as phosphate ion. Plants uptakes phosphorous as HPO_4^{2-} or $H_2PO_4^-$(Jeschka, 2017). Molybdenum blue method was used to determine the phosphate content in soil samples.

Determination of λ_{max};

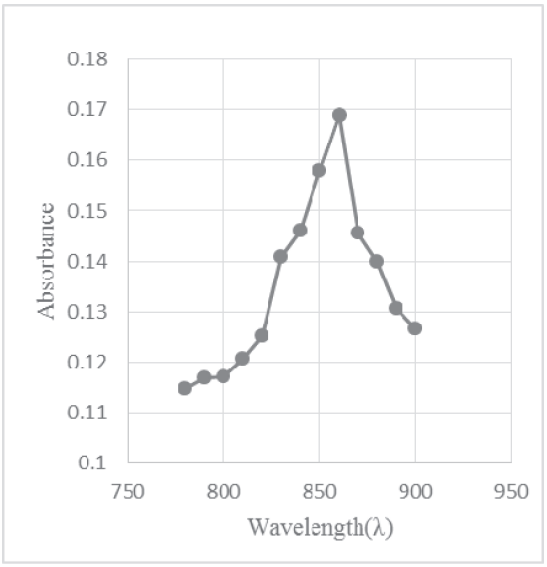

Figure 4: Plot of absorbance against wavelength

Determination of phosphate concentration in soil samples;

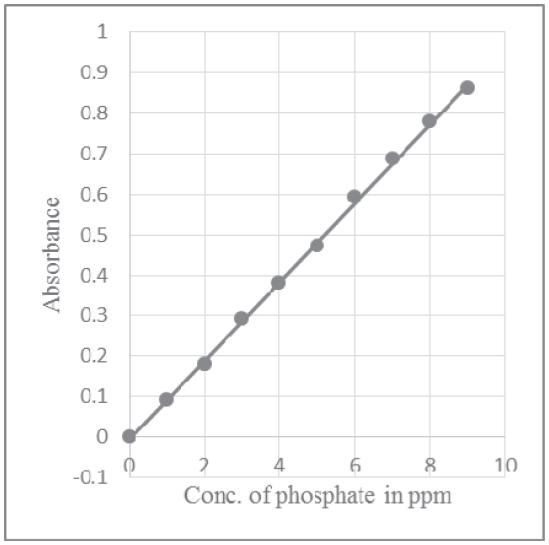

Figure 5: Calibration curve (plot of absorbance against concentration of phosphate)

Table 2: Phosphate concentration in soil samples determined by molybdenum blue method

Location	Sample Number	Absorbance	Concentration (ppm)
Bramhayani	1	0.3326	3.4
Dekocha	2	0.2878	2.9
Sallaghari	3	0.2738	2.8
Sipadol	4	0.1949	2.1
Suryabinayak	5	0.2965	3.0
Thimi	6	0.3481	3.5

From the table above, different phosphate concentration for different samples was observed. The highest concentration 3.5 ppm as obtained in soil of Thimi and low value 2.1 ppm in soil of Sipadol. High value of phosphate indicates thatsoluble phosphate compounds are available in soil as pH range of greatest phosphorous availability is 6.0 – 7.0.

Conclusion

The physicochemical characteristics of agricultural soil were analyzed. The results indicate that the soil pH is slightly neutral to acidic, electrical conductivity value shows that soils are non-saline. High value of Sulphur indicates presence of organic matters in soil and that of chloride indicate toxicity in soil. In soil soluble phosphates are available when soil is not acidic and when soil is acidic insoluble phosphate compounds are available. After the analysis of physicochemical parameters of soil samples collected from six different places of Bhaktapur, the result shows that soil of Thimi have nutrients in normal range compared to other soil studied. That means soil is more fertile and production yield in this soil is high than other. Study of these parameters gives information about nature of soil, nutrients present in soil; according to this information farmers get helps to take proper mitigation measures to main agricultural soil fertility.

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