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ANALYSIS OF PLANT NUTRIENT ELEMENTS OF SOIL IN POKHARA

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ABSTRACT

The study was carried out to analyse plant nutrient elements present in soil samples from different part of Pokhara metropolitan city and to compare them with standard recommended values. The plant nutrient elements of soil samples nitrogen, phosphorus, potash, zinc, iron, copper, and boron were analyzed by using specific techniques. The P^H was analysed by P^H meter, organic matter by gravimetric method, nitrogen by Kjeldal method and phosphorus by Olsen's method (1954) of analysis. Similarly, the amount of zinc, iron and copper were determined by chemical method, potassium by flame photometer method, and boron by using a spectrophotometer. The essential macronutrients nitrogen, phosphorus and potash remained within the permissible limit for most of the samples. The essential micronutrients zinc, copper and boron in four samples were within the acceptable range. The content of iron was higher than that required as an essential crop nutrient. The observed values of plant nutrient elements expressed that the sampling area could be used for agricultural cultivation and production.

Key words: Chemical properties, iron toxicity, murexide, plant nutrients, Pokhara, spectrophotometer

INTRODUCTION

The soil is defined as the weathered surface of the earth crust which is mixed with organic materials in which micro-organisms live and plants grow. On the basis of the different eco-climatic zone, types of soil in Nepal are Terai soil, Bhabar soil, Churiya soil, Valley soil and mountain soil (Lekhak and Lekhak, 2009). The composition of earth's crust (by weight) includes the following elements: oxygen (46.6%), silicon (27.7%), aluminum (8.1%), iron (5%), calcium (3.6%), sodium (2.8%), potassium (2.6%) and magnesium (2.1%) (Lutgens and Tarbuck, 2000). The principal components of the soil are soil atmosphere (20 –30%), moisture (20 –30%), organic matter (5%), and mineral matter (45%) (Ambasht and Ambasht, 2005).

The physical properties of the soil are colour, soil moisture, compactness, dispersibility, infiltration rate, bulk density, soil atmosphere, water holding capacity and soil texture. For plants, the essential micro-nutrients are boron, chlorine, sodium, copper, iron, manganese, zinc, vanadium and molybdenum. The essential macronutrients are carbon, hydrogen, nitrogen, phosphorus, potassium, sulphur, calcium and magnesium (De, 2010). The quantity of macronutrient and micronutrient elements of plants in the soil can be determined only after soil analysis. From the known nutrient elements present in the soil, the picture of soil fertility and productivity could be identified and accordingly, the suitable crop for the cultivation can be recommended.

The physical and chemical components of the soil analysis were expressed by A.K. De (2010) and Kannan (1997). Khopkar (2011) analyzed and justified the micronutrients in the soil. The physical parameters, soil p^H, organic matter, toxic metals, heavy metals, pesticides were explained by Asthana and Asthana (1998). The moisture, p^H, nitrogen, organic carbon, urease and catalyse activities were analyzed by Manandhar and Manandhar (1983).

In this research, the plant nutrient elements of soil were analyzed, by using the standard protocol developed by the agricultural experimental station, Oregon State University (1971) techniques, at the laboratory of chemistry Prithvi Narayan Campus, Tribhuvan University, Pokhara, and Regional soil testing laboratory, Pokhara-17, Kaski, Government of Nepal.

MATERIALS AND METHODS

Study sites

Pokhara city is situated almost in the central part of Nepal, 200 km west from the capital Kathmandu, in front of Machapurchhre mountain with altitude 827 m in the southern part to 1740 metre in the north. The temperature of this area ranges from 6 ˚C in winter and 34 ˚C in summer. The latitude is 28.266˚N and longitude 83.968˚E. Seven sampling sites were selected for this study in the Pokhara metropolitan city, which are given in table 1.

Soil sampling and analysis

Seven sample sites (Table 1) were selected from the agricultural farms in pokhara by random sampling method. The required amount of soil samples (100 gm) were collected by digging a hole at the depth of 20 to 30 cm. The collected soil samples were dried in a forced draft drying cabinet at a temperature less than 50˚C at about 24 hours, pulverized and then analyzed by using specific techniques. The P^H of the samples was determined by using a P^H meter. Organic matter present in the soil was determined by ashing the samples of already dried at 105^0C in ashing vessel within the muffle furnace at 400^0C for four hours and expressed in percentage.

Table 1: Sampling Site

S. No.	Sample No.	Name of Sampling Sites
1	A_1	Nadipur, Pokhara -3
2	A_2	Malepatan, Pokhara -5
3	A_3	Foolbari, Pokhara -11
4	A_4	Kundhar, Pokhara -13
5	A_5	Chauthe, Pokhara -14
6.	A_6	Biruata, Pokhara -17
7.	A_7	Hemja, Pokhara -

Available nitrogen was estimated by regular micro Kjeldal method and presented in percentage unit. Available phosphorus present in the soil samples was determined by Olsen's method for neutral or alkaline soil (Olsen *et al.* 1954) by Bray's method for acidic soil and presented in kg $hector^{-1}$ unit. For available potassium, the first sample was extracted with neutral ammonium acetate and estimated by Flame photometer method and expressed in kg $hector^{-1}$ unit (Toth and Prince, 1949). Micronutrient elements; zinc, iron, copper in the form of their divalent ions in soil samples were determined by extraction followed by chemical method (volumetric analysis) and expressed in ppm units (Coffin, 1963). Iron and zinc were extracted with ammonium acetate buffer of P^H 4.8 and 6.5 respectively. Copper is extracted with ammonium cyanate buffer (p^H = 8.5) and boron with sodium carbonate buffer at P^H 6.0. The organic contents from extract were destroyed by dry ashing with nitric perchloric acid and analyzed by atomic absorbtion spectroscopy (AAS). In the extracted sample, amount of copper was determined by bathocuporine (λ_{max}=484 nm) method, iron by bathophenanthroline method and amount of zinc by spectrophotometry method using zincon (2 carboxy, 2' hydroxyl 5' sulphormazyl). Available boron in the soil samples was determined by hot water extraction followed by the colorimetric method of analysis and presented in ppm unit (Berger and Truog,1939). The examined properties and plant nutrient elements of soil were compared with standard recommended values. The different properties, their analytical techniques and respective units are summarized in table 2. Plant nutrient elements and their method of analysis are summarized in table 3.

Table 2: Methods used for the analysis of plant nutrient elements

S.N.	Properties	Methods used for analysis	Expressed Units
1.	P^H	P^H meter	P^H
2.	Organic matter	Gravimetry	Percentage
3.	Nitrogen	Regular micro Kjeldal method	percentage
4.	Phosphorus	Olsen's or Bray's	kg hector^{-1}
5.	Potassium	Flame Photometer	ppm
6.	Zinc	Extraction followed by chemical	ppm
7.	Iron	Extraction followed by chemical	ppm
8.	Copper	Extraction followed by chemical	ppm
9.	Boron	Spectrophotometric /colorimetry	ppm

RESULTS AND DISCUSSION

Observed properties and analyzed plant nutrient elements of different soil samples in Pokhara are presented in following table 3.

Table 3: Observed properties and analysed plant nutrient elements

s.n.	Sample No.	P^H	Organic matter (%)	Nitrogen (%)	Phosphorus (kg hect^{-1})	Potash (kg hect^{-1})	Zinc (ppm)	Iron (ppm)	Copper (ppm)	Boron (ppm)
1	A_1	7.8	2.54	0.13	63.99	113.22	4.11	31.46	2.56	1.20
2	A_2	7.5	2.1	0.15	60.15	117.68	2.85	20.25	1.44	0.92
3	A_3	7.8	0.77	0.08	50.68	113.22	1.2	27.94	1.75	0.98
4	A_4	7.4	1.45	0.10	55.55	105.75	1.22	25.44	1.89	0.75
5	A_5	7.8	0.77	0.04	50.85	79.62	0.9	22.34	1.2	0.42
6	A_6	7.7	2.20	0.12	48.25	99.85	1.5	18.61	1.11	0.51
7	A_7	7.4	2.65	0.15	58.15	109.65	3.76	30.58	1.31	0.87

The observed p^H of the soil samples ranged from 7.4 to 7.8. The optimum p^H range for most of the plants lies in between 5.5 and 7.5. More p^H values of some samples of soil were due to the formation of soil from calcium carbonate, dolomite, gypsum and adding organic fertilizer in the soil. Organic matter of most of the samples was medium but that of two samples were low.

Nitrogen content of five samples was medium but two samples were very low. Nitrogenous fertilizer should be added during the plantation of crops. Phosphorus content of four soil samples was high and the remaining three samples were medium. In acidic soil, the orthophosphate ions were either precipitated or absorbed by cations like Al^{3+}, Fe^{3+}. In alkaline soil, hydroxyapatite was precipitated.

$$6HPO^{2-}_4 + 10CaCO_3 + 4H_2O \longrightarrow Ca_{10}(PO_4)_6(OH)_2^{-} + 10HCO^-_3 + 2OH^-$$

The potash content of the samples ranged from 79.62 to 117.68 kg hector^{-1}. This value for sample A_5 was low but medium for remaining samples. In most of the farms, the content of potassium was reasonable. The contents of micronutrients zinc and copper analyzed for different samples were medium. The boron content of four samples was medium, two was low and that of one was high. Boron occurs in the soil mainly in the form of boric acid $B(OH)_3$ or $B(OH)^-_4$. $B(OH)^-_4$ occurs in the soil of higher p^H conditions.

$$B(OH)_3 + H_2O \rightleftharpoons B(OH)^-_4 + H^+$$

The anion is adsorbed by Al, Fe oxides and clay minerals and the adsorption is stronger at higher soil P^H (Goldberg and Forster, 1991).

The content of zinc was medium in four samples, high in two samples and low in one sample. Zinc was important but toxic at a higher concentration for plant. The content of copper ranged from 1.11 to 2.56 ppm. Its value was medium for four samples and higher for samples. Copper acts as enzyme activator and support for photosynthesis for plants. But at the higher concentration, it also acts as poison by reducing plant growth. In the observed results iron ranged from 18.61 to 31.46 ppm. Iron was the most abundant metal in nature and earth's crust and contains 50 mg/g on an average (Kannan, 1997). Therefore, the content of iron in soil samples was higher than that required for plants. The iron content in most of the agricultural soil ranged from 2.5 to 4.5 ppm. These values were very high than theoretical values required for economically crops production. Iron was an essential micronutrient element mainly required in very small amount for chlorophyll formation, protein synthesis, enzyme activity but toxic at higher concentration. Availability of iron for the plants from the soil could be reduced by increasing P^H up to 7 or above 7 by adding carbonates and bicarbonates in soil. This makes iron unavailable and fixed in soil.

CONCLUSIONS

Plant nutrients elements of soil samples from different farm stations in Pokhara were determined. Observed essential macronutrient elements nitrogen, phosphorus and potash were within the theoretical range for most of the samples. The content of other essential micronutrient elements in most of the samples was acceptable except iron. The content of micronutrient element zinc, copper and boron were medium for four samples. The content of zinc was high in two samples and low in one sample where as that of copper was higher for three samples. The content of boron in soil was higher for one sample and lower for two samples. The amount of iron in the three samples was very high and in other four samples was high. Higher concentration (toxicity) of iron invites physiological diseases on crops mainly for rice (like bronzing, alkagara, akiochi and scana disease). Excess of iron could be locked in soil by adding carbonates and bicarbonates. Observed data of analyzed plant nutrient element of soil showed that the soil could be used for agricultural production.

The amount of gypsum, sulphur, manganese and molybdenum were not as estimated due to unavailability of required chemicals and equipment in the laboratory. To get more exact and accurate results, similar analysis by taking a large number of samples at different time of the year by using more efficient scientific equipment is recommended so that much more specific data could be available for farmers, planners, government authorities and researcher communities.

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