Micro Nutrients Analysis of Soil

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Summary: The present paper demonstrates the results of the analysis of some soil samples collected from sites located in Districts Peshawar and Laki Marwat. Micronutrients were analyzed using diethylene triamine penta acetic acid (DTPA) method. It is evident from the data that all the samples were enriched with micronutrients like Fe, K, Na, and Mn. Some of the samples i.e. ones collected from Abakhel contain lead (Pb) and cadmium (Cd) which are not desirable due to fatal effects on human health if assimilated through food chain. All the samples under study were free of lithium (Li).

Introduction

Soil is a mixture of many colloidal structures, minerals, and macronutrients as well as micro-nutrients essential for plant growth and promotion of seed maturation and plays an essential role in certain enzymatic reactions. Nutrients required in small quantities are known as micronutrients or trace elements i.e. iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), cobalt (Co) and chlorine (Cl). Soil depleted in micronutrients is considered to have poor fertility. Soil analysis is of prime importance. Testing soil properties makes sure that soil conditions are suitable for plants and that users may be able to employ such information in the decision-making. Soil analyses are expensive and require dense sampling to adequately characterize spatial variability of an area, making broad scale quantitative evaluation difficult [1]. Many methods are reported in the literature for the analysis of soil. Instrumental methods like near-infrared diffuse reflectance spectroscopy [2] are now being used for the rapid nondestructive characterization of a wide range of materials [3]. In spite of the availability of modern instrumental techniques, the conventional methods are still enjoying popularity. Diethylene triamine penta acetic acid (DTPA) [4] method is one of them.

In the present work, DTPA method was used to analyze the samples collected from sites located in Districts Peshawar and Laki Marwat for evaluating their fertility.

Results and Discussion

The physicochemical properties like pH, conductivity and the micronutrient status of various soil samples were investigated. The data is compiled in Table-1 and 2. It is evident from the Table-1 that samples under study have the pH in the range of 7.6-8.6. The pH of Opazi Bala, Chagar Matti and Regi was found to be 8.6, 8.3, and 7.9 respectively. The pH of Abakhel soil was found to be 7.6. The highest pH was found in the case of Opazi Bala. This may be due to its high lime content. The lowest value was found for Abakhel which indicates its low lime content. The pH scale runs from 0 to 14 and is used to indicate the relative acidity or alkalinity of the soil. A pH less than 7 is for acidic, while that above 7 is for

Table-1: pH and Electrical Conductivity of Soils Under Study

S. No.	Sample	pH	Electrical Conductivity (us)
1	Opazi Bala	8.6	58
2	Chagar Mattie	8.3	52
3	Regi	7.9	54
4	Abakhel	7.6	48

Table-2: Total Micronutrients (ppm) Profile of the Soil Samples Under Study

S. No.	Sample	Fe	Zn	Cu	Cd	Pb	Mn	Na	Li
1	Opazi Bala	6	2.87	1.23	0.002	0.6	3.54	3.2	BD
2	Chagar Matti	4	3	0.90	0.001	0.3	3.67	4.3	BD
3	Regi	7	5	0.75	0.004	0.5	4.481	2.6	BD
4	Abakhel	23	3.7	1.18	0.058	1.2	26	5.4	BD

BD: Below Detection

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alkaline soils. A pH of 7 indicates a neutral soil. The pH is an important parameter because it influences the availability of essential nutrients. Most horticultural crops will grow satisfactorily in soils having a pH between 6 (slightly acidic) and 7.5 (slightly alkaline). The pH adjustment in turn has many advantages i.e., (i) fertilizer applications are more effective (ii) crops become even better absorbers of nutrients and water (iii) reduced soil acidity will minimize the opportunity for nitrate leaching into the ground water (iv) soil conditions will promote increased root growth (v) maintaining a near neutral soil pH will speed up decomposition of surface organic residues (vi) lime cannot penetrate deeper than where it is supplied. Many acid soils also have acid sub soils where plant roots will not penetrate. Such soils may have hard compact layers. Gypsum added to such soil can correct the subsoil acidity and soften the hard layers; gypsum leaches to the subsoil. Plants can then use nutrients and water present in the subsoil.

Liming is usually done by the farmers. The lime content of the soil has a vital role in maintaining the pH of the soil and fertility [5-6]. Liming materials include ground limestone which is mainly calcium carbonate ($CaCO_3$) and dolomitic limestone which contains $CaCO_3$ and magnesium carbonate ($MgCO_3$). Most liming materials are agricultural limes (calcium carbonate) or dolomites (calcium and magnesium carbonates). Other forms include burnt lime, quick lime and hydrated lime. High concentration liming is unwanted due to some problems like the addition of lime can raise the soil pH to excessively high levels, reducing the availability of plant nutrients and thus leading to poor plant growth.

The pH data indicates that the samples are mostly basic in character which in turn establishes that the samples are depleted in H^+, NH_4^+, Cl^-, NO_3^-, PO_4^- etc. For the effective growth of crops in these soils, rejuvenation with fertilizers particularly nitrogen proved beneficial [7].

The conductivity data is also compiled in Table-1. It is evident from the Table that the conductivity reported for Opazi Bala, Chagar Matti and Regi soils was found to be 58, 52, 54 µs/ cm respectively and that reported for Abakhel soil was found to be 48 µs. The difference in the conductivity might correspond to the variation in the concentration of ions/ cm like Cl^-, SO_4^{-2}, PO_4^{-2} Ca^{+2}, Na^+ and K^+ etc.

Micronutrients in samples were also determined. Soil fertility is essential for enhanced crop yields. A good soil should have macro and micro elements considered essential for plant growth. Soil depleting in essential elements always give poor crop yields. The most essential micronutrients for humans are Zn, Se, Fe, I, F, Cr, B, Cu, Mn and Mo [8].

Copper (Cu)

The Copper (Cu) content of the soil samples studied varied from 0.75 to 1.81 ppm (Table-2). The soil sample, Abakhel contains the highest quantity of Cu (1.81 ppm). Cu is naturally present in the soil. Contents occurring naturally range from 2 to 60 mg/ kg. Cu is not very mobile and it binds strongly to soil organic matter and clay. Excess copper induces a decrease in microbial biomass. It is an essential nutrient needed for the normal growth and develop-ment of cereal crops. Its availability is reduced as pH increases to 7 and above. Copper deficiency of soil can be overcome by fertilization with products like copper sulphate, and copper chelate. Its availability to crop is carbonate dependent [9].

Zinc (Zn)

The total zinc content of the soil samples studied varied from 2.87 to 5 ppm (Table-2). The soil sample of Regi contains the maximum amount of zinc while that of Opazi Bala contains the minimum amount of zinc content which may be an effect of some local geologically determined anomalies. Zinc is regarded as one of the most important minor elements in human nutrition, being part of several enzymes and taking part in the formation of many more, and in synthesis of the biological building block, RNA. Zn is assimilated by the human bodies from many cereal crops [10]. Its deficiency may lead to a number of diseases [11] and can be corrected with fertilization [12].

Cadmium (Cd)

The Cd content of the soil samples studied ranges from 0.001 to 0.058 ppm (Table-2). Abakhel soil contains the maximum amount of Cd whereas

Chagar Matti soil contains the minimum amount of Cd. Cadmium pollution of soil is particularly of concern with the food chain transfer of cadmium to humans [13]. It has been reported as toxic constituent in soil [14].

Iron (Fe)

The iron content of the soil samples studied varied from 4 to 23 ppm (Table-2). Abakhel soil contains the maximum whereas Chagar Matti sample contains the minimum amount of iron. Iron oxide content of soil determines the yellowish, orange, and reddish color of a soil. Color may be caused by Fe-bearing minerals including iron oxides, hydroxides, oxyhydroxides, and hydroxysulfates. Color is important as being a fundamental indicator to delineate, classify, and sample soil units [15]. Although required in very small amounts, iron (Fe) is an essential nutrient and plays a major role in plant growth and development. The trend to more intensive crop production with a higher yield and heavier use of nitrogen (N), phosphorus (P) and potassium (K) fertilizers increases the need for Fe and other trace elements in soil. Iron availability is strongly dependent on certain factors. The various researchers have investigated the availability of Fe, Cu, Zn, and Mn as micronutrients with regards to soil characteristics like pH, organic matter, calcium carbonate contents and clay, cation exchange capacity (CEC) [16].

Manganese (Mn)

The total Manganese (Mn) content of the soil samples studied varied from 3.54-26 ppm (Table-2).The soil of Abakhel contains the maximum amount while the soil of Opazi Bala contains the minimum amount of Mn (3.54 ppm). Mn deficiency is a common and recurring problem of many sandy soils, but the deficiency rarely occurs on the finer textured soils. The coarse textured soils are often low in Mn content. One of the reasons contributing to this deficiency may be the heavy application of lime [17].

Lead (Pb)

The total amount of lead (Pb) in the studied soil samples varied from 0.3 to 1.2 ppm (Table-2). The maximum amount of Pb is found in Abakhel soil (1.2 ppm) and the minimum amount of Pb is found in Chagar Matti soil (0.3 ppm). Lead is potentially a toxic element detrimental to humans and other living beings, a fact which has raised concerns about the presence of elevated lead levels in the environment. Soil lead level usually depends on the sources existing around. Soil lead levels are the highest around building foundations and within a few feet of busy streets [18]. Once lead has been deposited, it moves very little through the soil and can persist for a long time. Therefore, lead contamination of soils continues. Plant may assimilate lead from soils. Higher concentrations are more likely to be found in leafy vegetables and on the surface of root crops (e.g., carrots). The risk of lead poisoning through the food chain increases as the soil lead level rises.

Sodium (Na)

The sodium content of the soil samples studied varies from 2.6 to 5.4 ppm (Table-2). The highest amount of Na is found in Abakhel soil and the lowest content is found in Regi soil sample. Water and air penetrate through the soil depending on its porosity which in turn counts on the individual components of soil, minerals and organic material, remaining amassed. Sodium destroys this soil structure by causing the individual soil particles to repel each other, similar to the repulsion between like poles of a magnet. The particles migrate into the soil pores and hinder water and air transport. The effect of sodium on soil respiration has already been reported [19].

Lithium (Li)

No lithium (Li) was found in Peshawar as well as in Laki Marwat District soil samples, which means that the soil of these two Districts lack Li content.

Experimental

Collection of Samples

Soil samples were collected from Opazi Bala, Chagar Matti, Regi; District Peshawar and Abakhel; District Laki Marwat from 0-15 cm depth of the surface.

Identification of Soil Texture

The texture of each soil sample collected was identified according to the method reported in literature [20].

Preparation of Soil Samples

All the samples were air-dried, ground, and sieved through a mesh with aperture size 850 μm. The samples were tightly stoppered in reagent bottles for use.

Preparation of Soil Extracts

10 g soil was weighed into a 50 ml extraction flask. 20 ml DTPA extracting solution was added. The contents were shaken for 2 hours. The contents were filtered using Whatman filter paper # 42 and the filtrates were kept for analysis.

Determination of Physico-Chemical Properties

Soil pH was determined in soil water slurry. A pH meter, calibrated with pH 4.00 and pH 7.00 buffers, was used for this measurement. pH was determined using the method reported elsewhere [21-22]. Electrical conductivity of each sample was determined using the routine method [23-24].

Determination of Cu, Zn, Mn, Cd, Fe, Pb

Soil samples were tested for extractable elements using DTPA (Diethylene triamine penta acetic acid) extraction method (4). Cu, Zn, Mn, Cd, Fe, Pb were determined in the extracts spectrophotometrically using Spectronic-20 (Milton Ray Company) according to the method described in literature [25].

Determination of Na and Li

Na and Li were determined by flame photometry.

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