Research Article

Status assessment of macronutrients in banana leaves and its associated soil in Thatta, Sindh, Pakistan

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Abstract

Macronutrients are critically essential for successful plant growth and are consumed in larger quantities from fertile soils. Most of the soil conditions all over the world can support plants with sufficient nutrition and do not need fertilizer to complete life cycle. In the meanwhile, soils have manipulated through anthropogenic means through the addition of fertilizer to promote vigorous growth and increase yield. This study was aimed to assess the status of macronutrients in the agricultural soils of District Thatta, Sindh, Pakistan. A total of 33 composite soil samples at the depths of 0-15 and 15-30 cm including exact number of banana leaves were also collected from different study sites. The macronutrients i.e. NPK, Ca, Mg, Zn and Cl were assessed their status in the soils. In addition, organic matter, Electrical Conductivity, pH and lime (CaCO_3) also analyzed. Results showed that physicochemical properties of surface and sub-surface soils were heavy in texture, non-saline, medium alkaline and moderately calcareous in nature. The analysis of soluble anions indicated that carbonates were absent and chlorides were dominant as compared to bicarbonates. Concentrations of nitrogen and zinc were remained below stipulated levels of soil standards. Whereas, phosphorus, potassium, manganese and chloride ions were recorded above critical limits. This study recommend that fertilizers dosage of nitrogen and phosphorous should be increased to get maximum banana yield.

Keywords: NPK; soil; carbonates; bicarbonates; chlorides

Introduction

Banana holds a high position in fruit and food crops of the tropical and sub-tropical regions. Being a cash crop of high value, it catches

growers heed to be a good source of agricultural income, and its fine taste and high nutritive value keep it in great demand throughout the year [1]. The global banana

production estimates 42 million tons/year [2]. Major Banana growing counties are America, Brazil, Australia, Bangladesh, and Philippines etc. [3, 4]. In Pakistan, the area planted to banana has shown progressive increase over the time. In 1989 the area under banana was 23.5 thousand hectares and yielding 209 thousand tons/year [5]. Sindh is the leading banana producing province of Pakistan having share of 86.42% in total Banana production [6]. Main banana growing districts of Sindh province are Hyderabad, Mirpurkhas, Badin, Thatta, Nawabshah, Nausharo Feroze and Khairpur etc. [7].

Banana requires more nutrients than any other commercially important crops which must be supplied through giving fertilizers to obtain maximum yields [8]. This crop requires all the essential nutrients in adequate quantity for successful growth and yield. The macronutrients i.e. nitrogen, phosphorus, and potassium are required in large quantities and soils are usually deficient of these nutrients due to excessive use of croplands [9]. Nitrogen is critically essential nutrient for banana growth due to its biochemical function in the plant body. Nitrogen participates in photosynthesis through a series of enzymes reactions as well as being part of chlorophyll molecule [10]. Phosphorus is a part of nucleic acids, phospholipids, and energy storing and transferring system in the plant. It is required high concentration at the growing points of roots and shoots [11]. Potassium is considered the most important nutrient in Banana production because; it is required for at least 60 different enzymes evolved in plant growth. Potassium is not a constitute of any plant structure or organic compound, but it is essential in nearly all the biological processes needed to sustain plant life and catalyze important metabolic reaction such as respiration, photosynthesis, starch synthesis, regulation of stomata and regulation of nutrients and water intake [12].

Different research studies have revealed that soils of banana growing areas in Sindh province are relatively deficient due to inadequate required fertilizer dosage to sustain its fertility. Therefore, this study was planned to assess the status of macronutrients in Thatta district of Sindh province and suggest the growers to provide required nutrients to deficient soils.

Materials and Methods

Soil Sample Collection

The study was conducted at privately owned different agricultural farms in Thatta district. A total of 18 soil samples at the depth of 0-15 and 15-30cm including 33 banana leaves samples were collected randomly from the selected areas. A total 50 gm soil was collected from four corners and one from centre then mixed together to get bulk sample. Soil and banana leaves samples were put in polyethylene plastic bags, labelled and preserved according to standard procedures. Soil samples were brought to laboratory on the same day and stored in the refrigerator at 4°C prior to analysis. Soil samples were sieved 2mm using mechanical shaker. Analysis were carried out in the analytical labs in the Department of Soil Science, Sindh Agriculture University, Tando Jam, Sindh, Pakistan.

Experimental Design

The physicochemical properties of soil samples were analyzed i.e. soil texture, organic matter, pH, EC, lime (CaCO_3), carbonates, bicarbonates, macronutrients (NPK, Ca & Mg.) and micronutrient (Zn). Soil texture was determined using Hydrometer method [13]. 40 g air-dried soil (2 mm) was taken and 60 ml of dispersing solution (Dissolve 40 g sodium hexametaphosphate $[(\text{NaPO}_3)_6]$, and 10 g sodium carbonate (Na_2CO_3) was added in DI water, and final volume was raised upto 1000 ml. The solution was shaken using orbital shaker (SCILOGEX Analog Orbital Shaker SK-O180-E) for 30 minutes. Then solution

was transferred into 1000 ml measuring cylinder and inserted hydrometer. Sample was stirred and noted first reading and left for 2 hrs for second reading. Soil texture was calculated using soil textural triangle.

50 g air-dried soil (< 2-mm) was taken and added 250 ml DI water and put for vertical shaker (THZ, China) for 2 hrs. EC and pH reading was noted using pH/EC Meter (2182A, Spectrum Technologies, Inc.)

Organic matter was determined using Walkley-Black method [14]. Weighed 1 g air-dry soil (0.15 mm) and added 10 mL 1 N potassium dichromate then added 20 mL concentrated H_2SO_4 using a dispenser, and swirl the beaker to mix the suspension, added 200 mL Distil water, added 10 mL concentrated H_3PO_4 and allow the mixture to cool, added 10 – 15 drops diphenylamine indicator, titrate with 0.5 M ferrous ammonium sulfate until the color changes from violet-blue to green. Prepared two blanks, containing all reagents but no soil, and treat them in exactly the same way as the soil suspensions. Organic matter was calculated using formula.

Phosphorus was analyzed using Olsen techniques [15]. Exchangeable K, Ca and Mg was determined by using flame photometer (Cole-Parmer Four-Element Flame Photometer, WU-02655-15).

10 g air-dried soil (< 2-mm) was taken and put into a 250-mL flask, pour 50 mL 1 N NH_4OAc solution (ratio 1:5), shaken for 30 minutes using reciprocal shaker (Model E5850) at 200-300 rpm, filter suspension using a Whatman No.1 filter paper to exclude any soil particles, and brought the extract to a 50-mL volume with 1 N NH_4OAc solution. Readings were expressed in mg/kg.

Carbonate, bicarbonate and chlorides were determined using titration method. Pipette out 10 – 15 mL soil saturation extract in a wide-mouthed porcelain crucible or a 150-mL Erlenmeyer flask, added 1 drop phenolphthalein indicator, If pink color develops, added 0.01 N H_2SO_4 by a burette,

drop by drop, until the color disappears, take the reading for carbonate, continue the titration with 0.01 N H_2SO_4 after adding 2 drops 0.1 % methyl orange indicator until the color turns to orange noted the reading for bicarbonate. Now for chlorides added 4 drops 5 % K_2CrO_4 solution in sample and titrate against 0.01 N $AgNO_3$ until a permanent reddish-brown color appears.

Calcium carbonate was also analyzed using titration method. 1 g of air-dried soil (0.15-mm) was taken into a 250-mL Erlenmeyer flask, added 10 mL 1 N HCl solution to the flask with a volumetric pipette, swirled and left the flask overnight, or heat to 50 – 60 °C, and let the flask cool, added 50 – 100 mL DI water using a graduated cylinder, and add 2 – 3 drops phenolphthalein indicator, titrate with 1 N NaOH solution while swirling the flask. Continue the titration until a faint pink color develops, and take the reading, R.

0.5-1.0 g air dried and ground plant material (0.15 mm) into a 300-mL calibrated digestion tube (or into a 150-ml conical flask), added 5 mL concentrated H_2SO_4 (in the fume hood), and swirled carefully and then placed tubes in the rack, placed the tubes rack in the block-digester (or hot plate), and then place a glass funnel in the neck of the tubes, slowly increase temperature setting to about 145 °C for 1 hour, added 5 mL tri-acid mixtures and heat it to 240 °C for to further 1 hour, and if possible, keep overnight to prevent excessive foaming, lift the tubes rack out of the block-digester, carefully place on a rack holder, and let tubes cool to room temperature, filter through Whatman No. 42 filter paper and bring to 50-mL volume, determined Fe, Mn, Cu, Zn, Cd, Ni, Pb, Co, and Cr using AAS (Varian Spectra AA 240, USA).

Result and Discussion

Soil texture is a qualitative classification tool used in both the field and laboratory to determine classes for agricultural soils based on their physical texture [16, 17]. Results of soil textural analysis (Table 1) showed that

surface and sub-surface soil samples were alluvial contained a high amount of clay particles and heavily compacted in nature [18, 19]. EC (Figure 1), pH (Figure 2), organic matter (Figure 3) and CaCO_3 (Figure 4) were observed that mostly of the soil samples were medium to strongly alkaline in reactions, medium to adequate in organic matter and moderately calcareous in nature respectively and investigated results also compared with soil standards, it was also investigated banana plant required more water and salt can easily leach down or due to the effect of the dolomite clay mineral in soils near coastal regions [20, 21]. Nitrogen (Figure 5), available Phosphorous (Figure 6) and exchangeable potassium (Figure 7) were analyzed in soil and plant samples and it was observed that soil samples were poor to medium in N at the surface and subsurface soil layer, low to optimum in phosphorous but optimum in exchangeable potassium, same result were also reported by [22-23].

The concentrations of Ca, Mg and available Zn in the soils samples are shown in figure (8, 9 & 10). The concentrations of bicarbonates (Figure 11) and chlorides (Figure 12) showed that mostly bicarbonates were present in minute quantitative whereas chlorides were dominates ion at both the soil layer. The concentrations of NPK and Zn in the banana leaves (Figure 13) showed that mostly N and available Zn were below the critical level whereas P and K were above the critical levels and as suggested by lava and turner. With an average value of 2.29% and 2.40%, 0.48 and 0.38%, 6.1 and 6.9 respectively, whereas analysis results of Ca, Mg and Cl (Figure 14 & 15) in the banana leaves leaf concentration of banana leaves and were above the critical levels as suggested by lava and turner with an average value of 0.68% and 0.75%, 0.67% and 0.77%, 0.83% and 0.836% respectively.

Table No. 1: Particle Size Distribution and Soil Texture

0-15 cm				16-30 cm			
Sand %	Silt %	Clay%	Textural class	Sand %	Silt %	Clay%	Textural class
21.8	33.3	44.7	Clay	24.5	33.1	42.5	Clay

Figure 1. Electric Conductivity of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 4. Calcium Carbonate of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 5. Total Nitrogen of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 6. Available Phosphorus concentration of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 7. Exchangeable Potassium of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 8. Calcium concentration of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 9. Magnesium concentration of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 10. Zinc concentration of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 11. Bicarbonates concentration of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 12. Chloride concentration of the agricultural soils of District Thatta, Sindh, Pakistan. The blue represents particle size of 0-15 and orange 16-30.

Figure 13. Nitrogen, Phosphorus, Potassium and zinc concentration in the Banana leaves.

Figure 14. Calcium and Magnesium concentration in the Banana Leaves.

Figure 15. Chloride concentration in Banana leaves.

Conclusion

This study revealed that soils of studied area were heavily compact in structure which may effect on the internal drainage of soil. Results showed that physicochemical properties of surface and sub-surface soils were non-saline, medium alkaline and moderately calcareous in nature. Concentrations of

nitrogen and zinc were remained below stipulated levels of soil standards. Whereas, phosphorus, potassium, manganese and chloride ions were recorded above critical limits. This study recommend that fertilizers dosage 20 tons/ha⁻¹ of farmyard manure should be provided to deficient soils of

nitrogen and phosphorous to get maximum banana yield.

References:

1. Abro SA (1997). NPK fertilizer management and nutrition of banana in district Hyderabad. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
2. FAO (1981). Soil and plant testing analyzing Bulletin. 38/1, food and agriculture organization of United Nations, Rome, Italy.
3. Lahav E (1972a). Factors influencing the potassium content of the third leaf of the banana sucker. *Fruits*. 27(12): 855-590.
4. Turner DCK, & Robson A (1987). Soil analysis and its relationship with leaf analysis and banana yield with special reference to study at Carnarvon. WA. In: Memoria Primer Seminario-taller Sobre Nutricion Y Fertilidad en banana San Jos'e, Costa Rica.
5. Ahmed I (2002). To evaluate the effects of K fertilizer levels on banana crop. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
6. Pakistan. Stat. year book (2001). Govt. of Pakistan Division of statistics, Islamabad, Pakistan.
7. Babar SA (1998). Soil status of N, P and S in Maize growing areas of Taluka Umerkot. M.Sc. thesis. . Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
8. Hewitt CW (1955) leaf analysis bananas, Dept. Agric. Jamaica, Bull .No. 53:10.
9. Baloch AH (1998). Micronutrient of Banana in Tehsil Hyderabad. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
10. Bertsch F (1986). Manual Para interpreter la fertilidad de los Suelos. Officinade publication de la University de Costa Rica. San Jos, Costa Rica. 81 p.
11. Bhutto MA (2001). Macronutrients status of soil Latif Farm Block-A. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
12. Melherb IDV (1963). Soil fertility. Oxford University press, London.
13. Bouyoucos, G. J. 1962. Hydrometer method improved for making particle-size analysis of soils. *Agron. J.* 53: 464 – 465.
14. FAO. 1970. Physical and chemical methods of soil and water analysis. Soils Bull. No. 10. Food and Agriculture Organization, Rome, Italy.
15. Olsen, S. R., C. V. Cole, F. S. Watanabe, and L. A. Dean. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U. S. Dep. Agric. Circ. 939, USA.
16. Korai AA (2001). Study on NPK status in soils and banana plants of districts Nawabshah. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
17. Kashmiri NA (2001). Status of NPK in soils of Taluka Tando Allahyar. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
18. Keerio A (2004). Study on Nitrogen Phosphorous and Potassium status of soils and banana plants of districts Hyderabad and Mirpukhas. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
19. Solangi IA (1995). Status of available Phosphorous, Potassium and Sulfur of district Sanghar. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
20. Brohi MA (1998). Fertility status of Soils of Dehs Kakar and Sanhro

- District Malir. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
21. Deho NA (1997). Phosphorus, Potassium and Sulphur status of Banana field. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
22. Soomro N (2003). Status of Micronutrient (NP and K) in cyclone affected soils of Badin and Thatta districts. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.
23. Samo AG (2002). Status of NPK status in soils at Quid-e-Awam Res. Inst. Larkana. M.Sc. thesis. Deptt. of Soil Science, Sindh Agri., Univ. Tando Jam.