Determination Of Amount Of Phosphate And Sulphate In Soil Samples From University Of Cape Coast Farm

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Abstract: The soil test analysis conducted by research on variety of crop growing soil gave values of 12- 20ppm of Phosphate which is regarded to be adequate for plant establishment and production. In the case of Sulphate, the experimental results obtained were as follows: virgin land (14.8ppm), tomato land (20.9ppm), cassava land (43.3ppm). Soil test analysis gave standard sulphate values required for growth to be between 15 – 40ppm. This is the concentration of sulphate express in ppm which is sufficient for plant growth.

Index Terms: Soil, Phosphate, Sulphate, Cassava, Tomatoes, Concentration, Plant Growth.

1.0 INTRODUCTION

In view of the increasing growth in population of humans, it has become necessary for research workers to keep the pace of food production with growth. In other to achieve this noble objective of providing food for mankind, a lot of factors that influence crop yield will have to be considered. Among such factors is the nutrition of crop plant. To be able to realize the potential yield of a crop, then the available nutrient status of the soil will have to be high. With the possible exception of nitrogen, no other element is as critical to plant growth and development as phosphorus, with sulphur also playing an important role. Phosphorus is a component of the two compounds involved in the most significant energy transformation in plant namely adenosine triphosphate and adenosine diphospate. It is an essential component of deoxyribonucleic acid, the seat of genetic inheritance in both plants and animals. It is considered essential to seed formation and has been associated with early maturity of crops particularly cereals (Brady, 1974). Adequate supply of phosphorus is associated with greater strength of cereal straws (Tisdale and Nelson, 1975). Phosphorus is also known to stimulate root development, flowering and seed formation. Due to its importance, phosphorus deficiency results in decrease in the rate of respiration before photosynthesis is retarded. Thus, phosphorus deficient plants are stunted in appearance. Deficiency symptoms are manifested in lower and older leaves of plants and hence can be redistributed from one part of the plant to another. In spite of it importance, there are problems that make phosphorus unavailable to plants.

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Phosphorus concentration is usually low in a typical soil solution compare to that of Nitrogen and Potassium, and the low availability of natural phosphorus. These make Phosphorus one of the major limiting nutrients for plant growth in the humid tropics. Sulphur is also an essential nutrient required for plant growth. Sulphur is mainly taken up by the plant as inorganic sulphate from soil and the assimilation into cystein is considered to be the key entry point of the natural sulphur cycle. Sulphate The acquisition of sulphur by plants has become an increasingly imported concern for the agricultural industry due to the decreasing trends of Sulphur-emissions from industrial sources and the consequent limitation of inputs from deposition (Mc Grath et al, 1996). The recognition of the importance of sulphate for plant growth and vigor and hence crop yield as well as the nutritional importance of sulphur for human and animal diet, has made it necessary to research on the availability of the level of sulphur in soil samples. The objective of the of the research is to determine the level of available Phosphate and sulphate in soil sample from U.C.C Farm and to compare the results with available standards this will form the basis for fertilizer recommendation.

1.1 Sources of phosphate:

Phosphates are the naturally occurring form of the element phosphorus, found in many phosphate minerals. In biological system phosphate is found as a free phosphate ion in solution and is called inorganic phosphate.

1.2 Available phosphate content of soils.

Available P is defined by (Alin, 1970) as the phosphate which is soluble and capable of entering the soil solution and is being absorbed by plants. Halm and Bampoe- Addo (1970) working on 10 representative soil series in Ghana, found high content of available phosphorus in the surface soils which decrease with depth. They reported available phosphorus range from 1.0ppm-31.5ppm. The forest soils have relatively high levels in available P due to difference in amount of leaf litter fall.

1.3 Source of Sulphate.

It is available in soil to plant and microbes mostly as sulphate. It arrives in soils through soil minerals atmospheric deposition, fertilizers and pesticides. In soil, the various reduced form of inorganic sulphur is oxidized to sulphate by a variety of microbial population including heterotrophic bacteria and fungi. Sulphate may be lost from the system through anaerobic respiration and reduction to Hydrogen sulphide.

2. 0 MATERIALS AND METHODS

Sampling was done on cassava land, tomatoe land and a virgin land (uncropped land) Soil sampling was done using the random sampling technique. A metal sampling tube 15cm in diameter was driven into the soil and removed. The core was pushed out of the tube. The samples from each plot was bulked and mixed thoroughly. Representative samples were collected from the plot at a depth of 0- 20cm. Soil samples were sieved and air dried. They were stored in a cool dry place.

2.1 Laboratory analysis (Phosphate determination)

Reagent preparation

Extraction using Ammonium fluoride (NH_4F), 1M

- **i)** 37g of NH_4F was dissolve in distilled water and diluted to 1liter and stored in a polyethylene bottle.
- **ii)** HCl, 0.5M 20.2ml of conc. HCl is diluted to 500ml with distilled water under a fume hood.
- **iii)** Extraction solution 15ml of 1M NH_4F was added to 25ml of 0.5M HCl and diluted to 460ml with distilled water.
- **iv)** Extraction procedure

1g of air dried soil sample was weighed into a 15ml centrifuge tube and 7ml of extraction solution was added. It was shaken for one minute on a mechanical shaker, after which the solution was filtered.

2.2 Determination of phosphate in soil extracts (Ascorbic acid method)

Apparatus: Electrophotocolorimeter

Reagents and Preparation: Ammonium molybdate $[(NH_4)_6MO_7O_{24}]$

12g of $(NH_4)_6MO_7O_{24}$ was dissolved in 250ml of distilled water.

Potassium antimony tartarate ($KSbOC_4H_4O_6$) - 0.2908 of $KSbOC_4H_4O_6$ was dissolved in 100ml of distilled water.

$5MH_2SO_4$ – 124ml of conc. H_2SO_4 was diluted in 500ml distilled water. Solutions (i, ii, and iii) were mixed together in a 1L volumetric flask and topped to mark with distilled water. This was labeled reagent A.

Ascorbic acid- 1.056g of ascorbic acid was dissolved in 200ml of reagent A. This was labeled reagent B

Standard phosphate stock solution- 0.4393g of potassium phosphate was weighed into a 1L volumetric flask. 500ml of distilled water was added and the content was shaken until the salt dissolved. The solution was diluted to 1L with distilled water.

A set of phosphate standard solution containing,

0, 0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0.

Procedure

5ml of the soil extract was pipetted into a 25ml volumetric flask and 10ml of distilled water was added .4ml of reagent B was added and made to the mark with distilled water. The color was allowed to develop for 15minutes and phosphate content was determined using a spectrophotometer at a wavelength of 882nm

SULPHATE (KH_2PO_4 Extraction method)

Apparatus:

Centrifuge tube, mechanical shaker, conical flask, funnel, filter paper

Reagent:

Extraction solution- KH_2PO_4 containing 500ppm of P

Procedure

5g of soil sample was weighed into a centrifuge tube and 25ml of extraction solution added .It was shaken for 30minutes on a mechanical shaker. The suspension was then filtered using a filter paper.

2.3 Determination of available sulphate in soil extract-Turbidimetric method.

Reagents: Gelatin, Barium chloride ($BaCl_2.2H_2O$)

Gelatin- Barium chloride reagent - 0.6g of gelatin was dissolved in 200ml hot (700^0C) distilled water. The solution was placed in a refrigerator for 16hrs. After which the semi gelatinous fluid was brought to room temperature. It was mixed with 2g of $BaCl_2$.

Standard Sulphate stock solution- 0.5434g of potassium Sulphate K_2SO_4 was dissolved in a volumetric flask and made up to the mark with distilled water. A set of standard sulphate solution containing 0, 25, 50, 75, 100, 125ppm was prepared.

Procedure

10ml of soil extract was pipetted into a 25ml volumetric flask. Distilled water was added to bring the volume to 20ml. 1ml of gelatin- $BaCl_2$ was added and brought to the mark with distiled water. It was allowed to stand for 30minutes and the % transmittance was determined on an electro-colorimeter.

3.0 RESULTS AND DISSCUSION

Table of results for Phosphate on January 28th 2013.

Replicate	Tomato land (T)	Virgin land(V)	Cassava land (C)
1	1.0248	1.0142	1.0238
2	1.0225	1.0091	1.0052
3	1.0195	1.0244	1.0041
Average	1.0223	1.0159	1.011

Table.1. Mass of Samples weighed

Standards Absorbance

Con (ppm)	0	0.1	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
Absorbance	0	0.088	0.167	0.318	0.453	0.591	0.687	0.822	0.957	0.095	1.233	1.371

Table.2. Standards Absorbance

Replicate	Tomato Land (T)	Virgin land(V)	Cassava land (c)
1	0.188	0.208	0.768
2	0.138	0.178	0.853
3	0.222	0.234	0.796
Average	0.183	0.207	0.806

Table.3. Sample Absorbances

Table of results for Sulphate

Replicate	Tomato land (T)	Virgin land (V)	Cassava land (C)
1	5.0014	5.0001	5.0048
2	5.0013	5.0141	5.0047
3	5.0226	5.0226	5.0014
Average	5.0084	5.0122	5.0036

Table.4. Mass of Sample Weighed

Con(ppm)	0	25	50	75	100	125
Transmittance	100	83.1	77.8	66.9	66.2	60

Table.5. Standards transmittance %

Replicate	T%	V%	C%
1	87.8	88.3	84
2	86.7	90.6	89.3
3	87.1	90.7	70.9
Average	88.1	89.9	81.4

Table.6. Transmittance of Samples

Table of Results for Phosphate on March 28th, 2013

Replicate	Tomato land	Virgin Land (V)	Cassava land (C)
1	1.0248	1.0142	1.0239
2	1.0227	1.009	1.0053
3	1.0195	1.0242	1.0042
Average	1.0226	1.0154	1.0113

Table.7. Mass of Samples weighed

Con (ppm)	0	0.1	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
Absorbance	0	0.088	0.167	0.318	0.453	0.591	0.687	0.822	0.957	1.095	1.233	1.371

Table.8. Standard Absorbance

Replicate	Tomato land (T)	Virgin land (V)	Cassava land (C)
1	0.189	0.208	0.769
2	0.139	0.178	0.853
3	0.222	0.235	0.797
Average	0.186	0.208	0.808

Table.9. Results for Transmittance of Samples.

Table of results for Sulphate on March 28th 2013

Replicate	Tomato land (T)	Virgin land (V)	Cassava land (C)
1	5.0014	5.0001	5.0048
2	5.0014	5.0142	5.0046
3	5.0227	5.0227	5.0015
Average	5.0086	5.0124	5.0034

Table.10. Mass of sample Weighed

Con (ppm)	0	25	50	75	100	125
Transmittance%	100	83.1	77.8	66.9	66.2	60

Table.11. Standard Transmittance

Replicate	T%	V%	C%
1	87.9	88.3	84
2	86.8	90.5	89.3
3	89.9	90.7	70.8
Average	88.4	89.8	81.3

Table.12. Transmitance of the Samples

Absorbance	0	0.167	0.318	0.453	0.591	0.687	0.822	0.957	1.095	1.233	1.371
Con (ppm)	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2

Table.13. Average standard Phosphate value.

Concentration	0	25	50	75	100	125
Transmittance%	60	66.2	66.9	77.8	83.1	100

Table.14. Average standard Sulphate value.

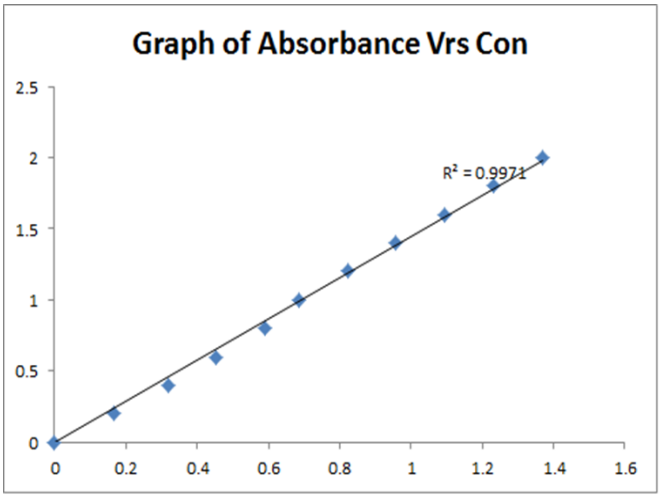

Fig.1. Graph of Absorbance against concentration

Absorbance=0.0317773+0.667682 Con (ppm)

Farm plots	Absorbance (A)/nm	Con (C)/ugml
Virgin Soil	0.183	0.226
Tomato Soil	0.207	0.262
Cassava Soil	0.806	1.159

Table.15. Table of Absorbance and Concentration

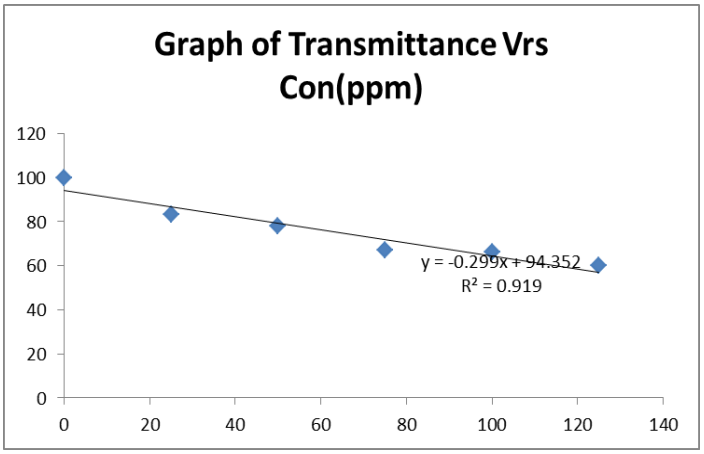

Fig.2. Graph of Transmittance vrs Concentration (ppm).

Farm plots	Transmittance%	Con(ppm)
Virgin Soil	89.9	14.8
Tomatoes Soil	88.1	20.9
Cassava Soil	81.4	43.3

Table.16. Table of Transmittance and Concentration (ppm)

3.1 DISCUSSION

From the result obtained from the soil test analysis, it was observed that the concentration of Phosphate and sulphate increased gradually from virgin (uncropped land) to tomato land and was highest in the cassava land. The phosphate concentration was as follows, virgin land (0.226ppm), tomato land (0.262ppm), cassava land (1.159ppm). The soil test analysis conducted by research on variety of crop growing soil gave values of 12- 20ppm of Phosphate which is regarded to be adequate for plant establishment and production. In the case of Sulphate, the experimental results obtained were as follows virgin land (14.8ppm), tomato land (20.9ppm), cassava land (43.3ppm). Soil test analysis gave standard sulphate values required for growth to be between 15 – 40ppm. This is the concentration of sulphate express in ppm which is sufficient for plant growth. The reason why there is increase in the amount of plant nutrient (sulphate and phosphate) in cassava soil compared to that of virgin and tomato land is that the land had previously being manured and cropped with vegetables (cabbage), and subsequently being cropped with cassava. Soil pH and texture also increased microbial activity which favored the released of these nutrients. The pH of the soil samples were cassava (7.5), tomato (8.2), virgin land (8.5). The availability of phosphates may be limited or stimulated by a variety of factor including microbial immobilization, plant uptake, temperature weathering of mineral sources and pH. The bioavailability of Phosphate is greatest when soil pH is slightly below neutral and declines with increasing pH as the result has shown. In soils, the various reduced form of inorganic sulphur is oxidized to sulphate by a variety of microbial populations including heterotrophic bacteria and fungi. The variety accounts for the soil variability are factors affecting the availability of sulphate.

4.0 CONCLUSION

Soil test analysis gave standard sulphate values required for growth to be between 15 – 40ppm. This is the concentration of sulphate express in ppm which is sufficient for plant growth. It was observed that the concentration of Phosphate and sulphate increased gradually from virgin (uncropped land) to tomato land and was highest in the cassava land.

5.0 RECOMMENDATION

From the results obtained after the soil test analysis, I recommend the incorporation of phosphate and Sulphate fertilizers before planting followed before planting followed by annual top dressing to obtain maximum crop yield.

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