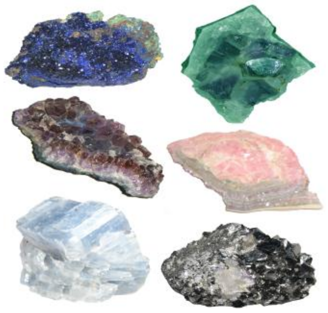
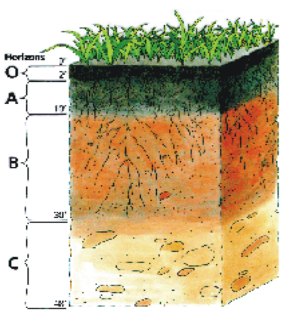
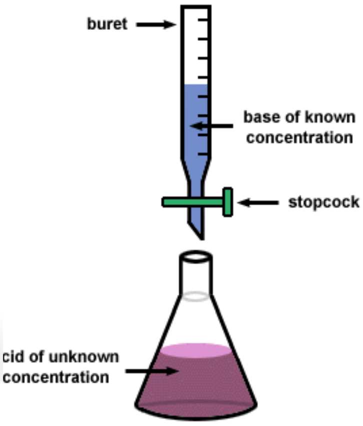
Soil Fertility and Plant Nutrition

ES 2202

Laboratory Manual







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LABORATORY EXERCISE - 01

Soil Sampling for Laboratory Analysis

Introduction

Various methods are available to evaluate soil fertility. Among these methods, soil testing is commonly used. By testing soils, it is possible to determine their properties, and the level of plant nutrients. This information is useful in making recommendations for appropriate land-use and sustainable productivity. The soil sample tested need to be a representative sample of the area under study. A poor sample would result in recommendations that are misleading or inaccurate.

Materials

One of the following may be used for soil sampling. If micronutrient elements are to be determined, the sampling tools should be of stainless steel or coated with plastic to avoid contamination. Wooden implements are also suitable.

1. **Soil augers**

Soil augers are commonly used for soil sampling. There are several types of soil augers which are used for sampling from different types of soils.
E.g.: Edelman clay auger, Riverside auger, Soft soil auger, Spiral auger, Stony auger etc.
However, for dry sandy soil, auger is not suitable. When take samples, care need to be taken to prevent contamination with soils from upper layers when withdrawing.

2. **Sampling tube**

Sampling tubes are also widely used in soil sampling. It consists of a hollow tube with a cutting edge at one end and a handle at the other. It is a good tool for sampling moist, stone free friable soils.

3. **Spade/ Shovels**

A sharp narrow spade is a good tool for taking soil samples. When using a spade, care should be taken to obtain a constant volume of the soil from each sampling point.

4. **Trowel / Mammoty**

This is a convenient tool for soil sampling in wide range of soils.

The other equipment necessary are plastic buckets of about 3-4 liter capacity, plastic bags (20cm x 30cm), labels, waterproof pens and a meter ruler.

Procedure

1. **Sampling area**

The first step in taking a soil sample is to divide the land under study to different sampling areas. A sampling area should have one or more similar properties such as productivity, topography, texture, drainage, past management etc. If these properties are uniform or homogenous throughout the area, one composite soil sample may be taken from 4-5 hectares. If there is a greater variation in the above characteristics, the land under study should be divided to homogenous areas. In a rough sketch of the field, mark the different homogenous areas, which are to be sampled separately, and allocate suitable letters/numbers to identify them.

2. Sample sites

Sample sites should be away from buildings, roads, pathways, fences, manure pits, trees or plants. If there is a crop in the land, take samples in between the rows. Samples should be taken when the soil is in a moist condition, not too wet or dry.

3. Sample depth

At each sampling point, scrape away the surface litter and take a sample of about 50 g of the soil to a depth of 0-15 cm and 15-30 cm. In salt affected areas, a soil sample at 30-60cm depth need to be taken.

Transfer the soil sample to the plastic bucket. Collect about 20 sub-samples, into the bucket from each homogenous area, by sampling over the area in a zigzag manner. After sampling the whole area, mix the contents of the bucket thoroughly. The composite sample for the area should be at least 1000 g. Transfer the composite to a plastic bag.

Write the identification mark/number for the area and the depth from which the soil sample was collected on a label with a waterproof pen. Tie the label to the neck of the soil bag. Transfer the soil bag to another plastic bag and write the mark/number of the soil sample on the second bag.

After collecting the sub-samples from a homogenous area, clean the implements used thoroughly to prevent contamination of the soil samples to be collected from the next area. Send the collected soil samples for analysis as early as possible.

It is desirable to evaluate the fertility of cropped lands every 3 years. Sampling should be done at least two months before planting crop/s.

In addition to collecting soil samples, the following information on the land under study needs to be obtained. For each composite sample, there must be a completed soil information sheet.

1. Crops grown previously and if deficiency or toxicity symptoms were observed in them.
2. Drainage characteristics of the land.
3. Topography and elevation.
4. Annual rainfall and intensity.
5. Average temperature and range.
6. Previous management practices.

Edelman Augers

The typical design of thr Edelman auger allows for a minimun of friction during penetration into the soil, and the extraction of the auger from the soil which means less physical effort.

There are 4 types, namely the clay,sand coarse sand as well as an auger for a combination of these soils

Riverside auger

Very suitable for augering in hard stiff soils, mixed with fine gravel.

Stony soil auger

For soils with a large gravel content. The Jamming effect of the auger blades make it very suitable for soils with small stones.

Spiral auger

The spiral auger operates similar to a corkscrew and does not cut off the soil. The auger is usually applied when hard layer need to be penetrated.

Soft soil auger

This is very special type of Edelman auger has an extended auger body and is suitable only for sampling very soft soil. (Clay)

Gouge auger

The gouge auger can be used for sampling with a minimal disturbances of more or less soft cohesive layers.

Stone catcher

This auger type is used to remove loose stones from the auger blades

Riverside Auger

Stony soil Auger

Spiral Auger

Soft Soil Auger

Gouge Auger

Stone Catcher

LABORATORY EXERCISE - 02

Preparation of Soil Sample for Chemical Analysis

Introduction

Preparation of soils samples after bringing to the laboratory for subsequent analysis for determination of physical, chemical and biological properties is an important step and a laboratory routine.

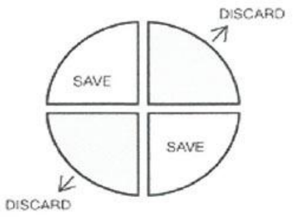
Procedure

1. After bringing soils to the laboratory, air-dry the soils samples at room temperature. Polythene, blank paper sheets, wooden or plastic boxes can be used for spreading the soil samples. For speedy drying, use oven set at 40 ^{0}C or below.

2. Remove all visible organic debris, stones, plant roots and other impurities by hand picking.

3. After air-drying, pass soils through 2mm sieve. If necessary dry weight of soil should be recorded.

4. If the soil sample is too large reduce it to a desired amount by using quartering technique. Spread the soil on a sheet and divide it in to four quarters. Discard the two opposite quarters and mix remaining two portions. Repeat the process until you reduce the amount of soil to the required.



QUARTERING A SAMPLE
(TOP VIEW)

5. Store the soil sample in plastic or glass bottle or in polythene bags until analyses begin.

Comments

For the analysis of available N (ammonium –N, nitrate-N) and assimilable phosphorous, potassium and sulfur, soil should not be air-dried and should be analyzed immediately or stored in deep freezer conditions. In microbial biomass analysis, soil should not be dried completely and 4mm screen should be used for sieving.

LABORATORY EXERCISE – 03

Determination of Electrical Conductivity (EC)

Introduction

Since soils are being formed as a result of accumulation of excess soluble salts which impairs soil productivity in numerous ways. Exact identification of such soils will provide a guideline to adopt reclamation measures as well as a key for identification of salt affected soils.

Objective

To determine the electrical conductivity of a soil sample and to interpret the level of salinity of the soil.

Principle

Salty water suspension conducts more electricity than pure water has a high electrical conductivity. This fact is used to identify and classify salt affected soils.

When two electrodes having equal cross sectional areas (A) are kept at a given distance (L), in an ionic solution/suspension, the resistance (R) established in passing a current through the solution/suspension is:

1. Directly proportional to '**L**'
2. Inversely proportional to '**A**'

Therefore,

$$\mathbf{R = \rho \times L/A}$$
$$\mathbf{\rho = R \times A/L}$$

$\boldsymbol{\rho}$ = Resistivity (ohm/cm)

$\mathbf{1/\rho}$ = Conductivity (m mohs/cm or ds/m)

Increase in the ionic concentration increases the conductivity values.

Procedure

Preparation of the soil: water suspension:

1) Take a clean and dry 100 ml beaker.
2) Add 10g of soil to be tested (organic matter content should be<10).
3) Add 50 ml of distilled water.
4) Stir the mixture vigorously for about 30 minutes
5) Let the suspension stand about a minute until the large particles settle to the bottom.

Measuring the EC of the suspension:

1) Switch on the Electrical Conductivity meter and select the required mode.
2) Wait until the clock mark disappears.
3) Wash the electrode with distilled water to keep the meter pointer exactly at zero.
4) Insert electrode into the soil solution. Submerge at least one inch and shake the electrode slightly to expel any air bubbles.
5) Wait until the clock mark disappears.
6) Note the EC reading and temperature of the soil solution.

Interpretation:

Relative level	EC (m moh/cm or ds/m) in 1:5 Soil Water Suspension
Very Low	<0.15
Low	0.15-0.4
Medium	0.8- 2.0
High	>1.5
Very high	>2

Soil Salinity Class	EC (dS/m)	Effect on crop
Non Saline	<2	Salinity effect neglegible
Slightly Saline	2-4	Yields of sensitive crops may be resrticted
Moderately Saline	4-8	Yields of many crops are restricted
Srongly Saline	8-16	Only tolerent crops yield satisfactory
Very Strongly Saline	>16	Only a few tolerent crops yield satisfactory

LABORATORY EXERCISE - 06

Determination of Cation Exchange Capacity (CEC)

Introduction

Cation Exchange Capacity (CEC) is the amount of exchangeable cation per unit weight of dry soil. It is measured in centimoles of cations per kilogram of soil ($cmol_c$ /kg). CEC of a soil is important for the retention of cationic nutrients such as potassium, ammonium, calcium, magnesium etc. and therefore is considered as a major factor related to soil fertility.

Objective

To determine the Cation Exchange Capacity of field soil by ionic replacement.

Principle

1. Replacement of all the exchangeable cations by ammonium ions.
2. Distillation of retained ammonium using a base and trapping ammonium released in Boric acid.

$$NH_4^+ + OH^- \longrightarrow NH_3$$
$$NH_3 + H_3BO_3 \longrightarrow NH_4^+ + H_2BO_3^-$$

3. Titration of formed Ammonium borate against a standard acid.

$$NH_4^+ + H_2BO_3^- + HCl \longrightarrow H_2BO_3 + NH_4CI$$

Procedure

1. Weigh 10 g of air dried soil into a conical flask.
2. Shake the soil with 250 ml of neutral 1M Ammonium acetate for 5 minutes and allow standing overnight.
3. Filter the suspension using a Buchner funnel.
4. Leach the soil with more Ammonium acetate until no calcium is detected in the filtrate (test for calcium qualitatively - flame test).
5. Wash the soil with 100 ml – 200 ml of Isopropyl alcohol to remove excess ammonium.
6. Transfer the soil in to a conical flask and add 50ml of 2M KCl
7. Shake it for 30 min and pipette out 20 ml
8. Transfer it in to a Kjeldahl flask and add 0.25 g of MgO and 0.25 g of Devarda's alloy and 100ml of distilled water.
9. Distill the contents into 50 ml of 4% Boric acid plus mixed indicator (Bromo cresol green + Methyl red) until the volume of the distillate becomes about 100ml.
10. Titrate the distillate against 0.1M HCI until the color changes to neutral gray.

Calculation

1 Mole of HCI = 1 mole of NH_4^+
Molarity of HCI = x M
Used volume of HCI = y ml
Moles of HCI = x * y milimoles
Moles of NH_4^+ = x * y milimoles
Total moles of NH_4^+ = x * y milimoles * (50/20)
= x * y * (50/20) / (10) centimoles
Weigh of soil = w g
CEC = x * y * (50/20) *1000/ (10*w) $cmol_c$ /kg of soil
= x * y * (50/20) *100/w $cmol_c$/kg of soil

Comments/ Interpretation

The frequent range of CEC in soil is 2-80 $cmol_c$ /kg. A possible grading to assess nutrient retention ability of soil is given below.

Retention ability	CEC ($cmol_c$ /kg)
Extremely low	<3
Low	3-10
Moderate	10-25
High	25-50
Very High	>5

LABORATORY EXERCISE - 05

Determination of Available Phosphorus

Introduction

Phosphorous in soil predominantly immobilized in forms organically bound and inorganically precipitated. There are many methods available for the extraction of available phosphorous in soil. Out of them, sodium bicarbonate extraction that was developed by **Olsen in 1954** is widely used in assessing available phosphorous in soil. However, this method is suitable only for slightly acidic to alkaline soil and not for acidic soils.

Objective

To determine the plant available phosphorus content in the given soil.

Principle

1) Extraction of available phosphorus fraction in soil with 0.5 M $NaHCO_3$ extractant.
2) Measurement of extracted phosphorus in solution using an appropriate method.

   Molybdate blue color method proposed by Murphy and Riely (1962) is used in this practical.
   Phosphorous react with molybdate to form heteropolymolybdate complex.
   $H_3PO_4 + 12H_2MoO_4 = H_3P(Mo_3O_{10})_x + 12H_2O$

   This complex is yellow in color. But in the **presence of ascorbic acid, some of the Mo^{6+} ions are partially reduce to Mo^{2+} and / or Mo^{5+} ions which giving a blue color** to the mixture.

3) Measurement of color intensity of the solution at 880 nm wave length using a spectrophotometer to determine the phosphate ions in the mixture.

Procedure

1). Extraction

1. Weigh 5g of soil air dried soil into a 250ml conical flask.
2. Add 100ml of 0.5 M $NaHCO_3$ (pH=8.5) and a teaspoonful of phosphorus free activated carbon.
3. Seal the flask with parafilm and shake the soil-solution mixture for 30 min on a mechanical shaker at 180 rpm.
4. Filter the soil-solution mixture and collect the extract (use No. 1 filter paper).
5. Do the blank extraction at the same time.

2). Color Development and Measurement

1. Pipette out 20ml of soil extractant into a 50ml volumetric flask.
2. Add 8ml of molybdic acid reagent mixture solution to the flask and make up to the volume by adding distilled water.
3. Keep the flask for 15 min. for the color development.
4. Measure the color intensity of the solution at 880nm wavelength using a spectrophotometer (standards required for the calculation of the phosphorus content is given to you.)

Calculation

X ppm = X µg/ml = X mg/kg

(% = ppm/1000)

Concentration of phosphorus (PO_4^{3-}-P) of the extraction =X ppm =X µg/ml
(Obtain the P concentration of sample from the standard curve)

Available phosphorus in soil (ppm) $= (X)/1000 \times (50/20) \times (1000/5)$

Parameter	Detail
Weigh of soil (g)	
Volume of extract ant (Y ml)	
Volume taken from attractant to color development (ml)	
Volume taken from reagent mixture (ml)	
Final volume of color development solution (z ml)	
Intensity of color at 880 nm wavelength	
P content in Z ml (ppm or X µg/ml)	
P content in Y ml (µg)	
P content of soil (ppm)	
%P of soil (%)	

Comments

In calcareous, alkaline or neutral soils containing calcium phosphates, $NaHCO_3$ (pH=8.5) extractant decrease the concentration of calcium in solution by causing precipitation of calcium as calcium carbonates. So, that the concentration of phosphorus in solution increases. In acid soils containing aluminum and iron phosphates phosphorus concentration in solution increase as pH rises. Molybdate ions give same color as with phosphorus.

LABORATORY EXERCISE - 06

Determination of Exchangeable Potassium in Soil

Introduction

Exchangeable potassium is the fraction that can exchange freely with cations of salt solution added to soil. The water soluble potassium that content is so small especially in non-saline soils and there is no much error is made by including it when extracting exchangeable potassium with a salt solution. In most soils, this exchangeable Potassium fraction is an approximately 1 to 2% of total Potassium in soil.

Objective

To determine exchangeable Potassium in soil using flame photometer.

Principle

1. Extraction of exchangeable Potassium with neutral 1N ammonium acetate solution.
2. Measurement of displaced potassium ions in ammonium acetate solution by using flame photometer.

Procedure

1. Weigh 5 g of air dried soil sample into a conical flask.
2. Add 100 ml of 1N ammonium acetate solution.
3. Place the flask on the shaker and shake for one hour.
4. Collect the filtrate passing through a Whatman No.1 filter paper.
5. Determine the K^+ content using flame photometer.

Calculation

Concentration of potassium (K) of the extractant = X ppm = X μg/ml
(Obtain the K concentration of sample from the standard curve)

K content of the 100ml ammonium acetate solution = (Xμ g/ml) (100)
K content of the soil (as ppm) = (X μg/ml) (100)/5
K content of the soil (as %) = (X μg/ml) (100)/5 (1000)

Parameters	Value
Weigh of air dried soil (g)	
Volume of 1N ammonium acetate (ml)	
Potassium (K) concentration (X μg/ml) of extracted solution	
K in 100ml extractant (μg)	
K content of soil (ppm)	
K content of soil (%)	

LABORATORY EXERCISE - 07

Determination of Available Sulphate – S in Soil

Introduction

Plants utilize sulphur in the form of $SO_4{}^{2-}$ -S. Therefore, $SO_4{}^{2-}$ – S is extracted as the plant available form of sulphur. Available $SO_4{}^{2-}$ – S form is frequently used in the assessment of soil fertility form in soil.

Objective

To determine the plant available sulphur content in the given soil.

Principle

1. Soil is treated with a chemical extracting solution (Ammonium Acetate/ Acetic Acid buffered at pH 4.8) to extract available sulphate – S.
2. To the soil extract, Barium chloride is added to form barium sulphate precipitate that gives turbidity to the solution.
3. Turbidity of the solution is measured using Spectrophotometer at 440 nm wavelength.

Procedure

1. Weigh 20 g of soil into a 250 ml conical flask.
2. Add 100ml of extracting solution in to the flask.
3. Seal the flask with parafilm and place the flask on the shaker and shake for 30min at 180 rpm.
4. Allow the particles to settle down and separate the supernatant by filtering.
5. Transfer 10ml of supernatant solution in to a 50ml beaker.
6. Add 10ml of 6.25% HNO_3, 5ml of gum acacia and 0.5g of $BaCl_2$ power to the beaker.
7. Mix the contents and let it stands for about 10mins.
8. Measure the turbidity.
9. Plot absorbance vs. concentration of the standards and find out the sulphate – S content of soil sample.

Calculation

X ppm = X µg/ml = X mg/L = X mg/Kg

(% = ppm/100)

Concentration of sulphate –S (SO_4^{2-} -S) of the extraction = Xppm = Xµg/ml
(Obtain the (SO_4^{2-} -S) concentration of sample from the standard curve)

Available (SO_4^{2-} -S) in soil (ppm) = (X) (25/10) (100/20)
Percentage of available (SO_4^{2-} -S) in soil = (x) (25/10) (100/20)/1000

Parameter	**Value**
Weight of soil (g)	
Volume of extractant (Y ml)	
Aliquot use in turbidity development (ml)	
Amount of HNO_3 used (ml)	
Amount of gum acacia used (ml)	
Final volume of the solution (ml)	
Absorbance at 440 nm wavelength	
Concentration of (SO_4^{2-} -S) of solution (ppm)	
Content of (SO_4^{2-} -S) in soil (ppm)	
% of (SO_4^{2-} -S) in soil (%)	

Comments

Sulphate ions form a fine precipitation with barium ions that is kept in suspension with Gum Acacia. The density of the turbidity depends on the concentration of sulphate ions at sufficiently low pH. Nitric acid is added to ensure the low pH.

LABORATORY EXERCISE - 08

Determination of Soil Organic Matter (OM)

Introduction

Soil organic matter is a very active and important portion of the soil. Although most cultivated soils contain only 1-5% organic matter, which is mostly in the top 25cm of the soil that small amount, can modify a soil's physical properties (structure, retention of water) and strongly affect its chemical (adsorption of ions, supply and availability of nutrients) and biological (population and activity of organisms) properties.

Objective

To determine the soil organic matter by a Titrimetric **(Walkley and Black, 1934)** method.

Principle

(a) Oxidation of organic carbon into CO_2 using acid dichromate.

(b) Determination of unreduced chromic acid by titration against a standard ferrous ammonium sulphate solution.

Procedure

1. Transfer 1 g of finely ground soil into a 500 ml conical flask.
2. Add 10 ml of 1/6 M Potassium dichromate followed by 20 ml of concentrated Sulfuric acid.
3. Shake the flask for 1 minute and leave it to stand on a sheet of asbestos for 30 minutes.
4. Add about 200 ml of water, 10 ml of Phosphoric acid and 1 ml Diphenylamine indicator solution.
5. Titrate the solution by adding ferrous ammonium sulphate solution drop by drop until the color flashes to green (This color change occurs with little or no warning).
6. Add 0.5 ml of 1/6 M $K_2Cr_2O_7$ to restore and excess of dichromate and complete the titration adding Ferrous ammonium sulphate.
7. Conduct a blank titration simultaneously, to calculate the morality of ferrous ammonium sulphate solution.

Calculation

$2\ Cr_2O_7^{-2} + 3\ C + 16\ H^+ \longrightarrow 4\ Cr^{+3} + 3\ CO_2 + 8\ H_2O$

According to the balanced equation,
2 moles of $K_2Cr_2O_7$ will oxidize 3 moles of carbon.

Volume of Potassium dichromate used = 10.5 ml
Molarity of Potassium Dichromate = 1/6 M
Burette reading (with soil) = V_1
Burette reading (blank) = V_2

$Cr_2O_7^{-2} + 6Fe^{+2} + 14\ H^+ \longrightarrow 2\ Cr^{+3} + 6Fe^{+3} + 7\ H_2O$

Moles of Dichromate used = 1/6 * 10.5/1000
= X moles
Moles of ferrous ammonium sulphate = 1/6 * 10.5/1000 * 6
Molarity of ferrous ammonium sulphate = 1/6 * 10.5/1000 * 6/V2 * 1000
= M1
Moles of Dichromate reacted with ferrous = M1/1000 * V1 * 1/6
= Y moles
Moles of Dichromate reacted with C = X – Y
= Z moles

2 moles of Dichromate will react with 3 moles of carbon.

Moles of Carbon reacted with Dichromate = 3/2 * Z
Grams of Carbon reacted with Dichromate = 3/2 * Z * 12
Organic Carbon percentage (C %) = 3/2 * Z *12 * 100
Organic matter % = C % * 1.724

(**1.724**; Vam Bemmelens Factor)

Comments / Interpretations

According to the content of organic matter percentage, soil could be classified as follows with respect to soil texture.

Classification	**Content of organic matter (%)**		
	Sandy soil	**Loamy soil**	**Clay soil**
Very low	<0.5	<1.0	<1.5
Low	0.5 – 1.0	1.0 – 1.5	1.5 -2.0
Moderate	1.0 – 1.5	1.5 -3.0	2.0 -4.0
High	1.5 – 3.0	3.0 -5.0	4.0 -8.0
Very High	>3.0	>5.0	>8.0

LABORATORY EXERCISE - 09

Determination of Available Nitrogen

Introduction

Available nitrogen is the fraction of soil nitrogen that plants take up from soil. Generally it is an inorganic form of nitrogen (NH_4 – N and NO_3 – N) present in both soil solution and exchangeable forms adsorbed to soil colloids. This nitrogen fraction can be extracted by using numerous extractants such as water, salt solutions and weak acids etc. and shows a very good correlation with the plant uptake of nitrogen. Hence, this extractable nitrogen fraction is termed as plant available nitrogen in soils. This method of assessing available ammonium nitrogen was developed by Bremner in 1965.

Objective

To determine the available nitrogen fraction in soil.

Principle

1. Extraction of available nitrogen fraction using a suitable extractant – 1 M KCI solution.
2. Distillation of nitrogen with magnesium oxide and Devarda's alloy to a boric acid solution. During distillation, ammonia is liberated as ammonium hydroxide.

$$NH_3 + H_2O = NH_4OH$$

Ammonium hydroxide then reacts with boric acid to form ammonium borate.

$$NH_4OH + H_3BO_3 = NH_4H_2BO_3$$

3. Titration of ammonium borate with a standard acid (HCI) to determine the nitrogen in the distillate.

$$NH_4H_2BO_3 + HCI = NH_4CI + H_3BO_3$$

Procedure

1. Weigh 5 g of soil into a 250 ml conical flask and add 50 ml of 1 M KCI solution.
2. Seal the flask with parafilm and shake on a shake for 30 minutes at 350 rpm.
3. Allow the suspension to settle and then filter.
4. Transfer 20 ml aliquot of soil extract to a distillation flask and add 50 ml distilled water, 0.2 g of MgO and 0.2g of Devarda's alloy. Connect the flask to the distillation apparatus.
5. Place the receiving flask containing 10 ml of 4% boric acid + indicator solution under the cooling condenser of distillation apparatus and distill the extract until the volume of distillate is about 100 ml. Titrate the distillate against 0.01 M HCI until the color changes from green to pink.

Calculation

1 mol of HCI = 14 g of N

1 mol of HCI reacts with 14 of N

1 ml of IM HCI reacts with 14 mg of N

X ml of 0.01N HCI = (14) (0.01) (X) mg of N

This amount of N is in 20 ml aliquot, therefore the N in 50 ml extract is
= (14) (0.03) (X) (50/20) mg of N

The available N content in 100 g soil = (14) (0.01) (X) (50/20) (100/5) mg of N

Therefore N% = (14) (0.01) (X) (50/20) (100/5)/1000

Parameter	Value
Weight of soil (g)	
Volume of extractant (ml)	
Amount taken to distillation (ml)	
Strength of HCI	
Volume of HCI used in titration (X ml)	
1 mol of HCI reacts with	
1 ml of 1M HCI reacts with	14 g of N
X ml of 0.01 N HCI neutralized	14 mg of N
The available N (mg N/100g soil)	
% of available N in the soil	

Comments:

The available nitrogen content in soils is highly varied. For example, one study showed that the available nitrogen in Sri Lanka soils ranges from 0.8 to 3mg/100 g soil. The available nitrogen fraction may be a significant fraction when recommending nitrogen fertilizer in fertilizer management practices in intensive agriculture.

LABORATORY EXERCISE – 10

Properties of Inorganic Fertilizers and Formulation of Fertilizer Mixture

Introduction

Colour, texture, volatility, odor, hygroscopy and specific gravity are some of the properties used in identification of inorganic fertilizers.

In most cases of fertilizer management practices, balanced mixture of major nutrient (N-P-K) are required. Generally, this is done by mixing straight fertilizers. However, all the straight fertilizers cannot be mixed together. In mixing straight fertilizers following rules should be followed.

1. Fertilizers containing ammonium cannot be mixed with basically reactive fertilizers such as basic slag, rock phosphates and calcium cynamide etc. as losses of nitrogen may occur through the escape of gaseous ammonia.
2. All the water soluble phosphate fertilizers i.e. ammonium phosphates, super phosphates and triple super phosphates cannot be mixed with those fertilizers which contain free lime as this fixes part of the soluble phosphates.
3. Various easily soluble and hygroscopic fertilizers tend to cake or form lumps after mixing. Therefore, these fertilizers should mix with one another shortly before use.

Slightly acid super phosphates may liberate the acids from certain fertilizers (nitrates and chlorides) and this may cause damage to sacks, containers and distributing instruments.

Objective

To identify given fertilizers and formulate fertilizer mixtures.

Materials

Inorganic Fertilizer samples: Urea
Ammonium sulphate
Muriate of potash
Triple super phosphate
Dolomite
Rock phosphate
Zinc sulphate
Magnesium sulphate
Potassium sulphate

Procedure

Observe the following properties of fertilizers.

Odor: Smell E.g.: Ammonia smell
Color: Visual observation

Texture: Observe the size (e.g.: small, medium, large) and shape (e.g.: granules, crystals, needle like, cubic etc.).

Volatility: Weigh the fertilizer sample and leave it exposed to the atmosphere. Any reduction of in the weight observed in a certain period can be accounted due to losses via volatilization.

Hygroscopy: Any increase in the weight of fertilizer exposed to humid conditions can be attributed to adsorbed water.

Solubility: Dissolve in water.

Comments

The changes in the weight of a fertilizer within a short time period may not be significant to make a conclusion about volatility and hygroscopy.

What would be the outcome if a fertilizer possesses both volatile and hygroscopic properties?

Preparation of a fertilizer mixture with a definite formula / grade

Fertilizer grade indicates the percentage nutrients content of fertilizer mixture. For example, 100 kg of fertilizer mixture of 10:06:10 grade contains 10 kg of N, 06 kg of P_2O_5 and 10 kg of K_2O. This is designated as an N-P-K mixture having 10:06:10 fertilizer grade.

The quantities of Ammonium sulphate, Triple super phosphate (TSP) and Muriate of potash (MOP) required to formulate a 100 kg of fertilizer mixture of 10:06:10 grade is calculated as follows.

Amount of Ammonium sulphate required for 10 kg N = (10 * 100)/21 = 47.62 kg

Amount of TSP required for 6 kg P_2O_5 = (6 * 100)/45 = 13.33 kg

Amount of MOP required for 10 kg K_2O = (10 * 100)/60 = 16.66 kg

Total quantity of fertilizer used in the mixture = 77.61 kg
Amount of filling material that should be added = 100-77.61 kg
= 22.39 kg

- 22.39 kg of filler material (sand, etc.) should be added to the 77.61 kg of fertilizer mixture.

Fertilizer		% of Nutrients
Urea	$CO(NH_2)_2$	46 %-N
Ammonium sulphate	$(NH_4)_2 SO_4$	21 %-N
TSP	$Ca (H_2PO_4)_2 2H_2O$	44-48 (45 %- P_2O_5)
MOP	96 % KCl + 3.5 %NaCl	60 %- K_2O

Calculate following fertilizer mixtures using above given fertilizers.

(Urea based)		**(Ammonium sulphate based)**	
Leafy vegetables	14:12:14	Chili	13:11:06
Banana and Mango	11:08:26	Ground nut	07:14:10
Pineapple	10:06:31	Soybean	09:17:10

Generally, in fertilizers, P and K contents are given in oxide forms even though there is no meaning.

Conversion factors are,

$P*2.2386 = P_2O_5$ $K*1.2046 = K_2O$

APPENDIX I – LABORATORY REPORTS

It will be a rewarding practice if you can conduct the practical, complete the calculations and enter the practical in the record book during the time provided. When oven drying is involved you may take longer time to submit your record books.

Format of Laboratory Reports

1. Date
2. Practical Number
3. Title
4. Introduction
5. List the objectives of the experiment
6. Procedure
   Report only any deviations from the procedure outlined in the laboratory handout. There is no need to copy information in your handout to record books.
7. Results/ Observations
   Present your findings in graphical and tabular forms if possible. If calculations are involved list the steps of a typical computation. Use one replicate as your sample calculation. To obtain complete marks you have to include appropriate SI units.

8. Discussion/ Comments
   a. Comment on the nature of experimental results.
   b. List any sources of experimental error.
   c. Discussion should also include the value of application of this experiment and results.

9. Conclusion
10. References