

Practical Manual
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Fundamentals of Soil Science
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Department of Soil Science and Agriculture Chemistry
M. S. Swaminathan School of Agriculture
Centurion University of Technology and Management, Paralakhemundi
www.cutm.ac.in

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Department of Soil Science and Agriculture Chemistry
M. S. Swaminathan School of Agriculture
Centurion University of Technology and Management Paralakhemundi

Certificate

Certified that this is a bonafide record of practical work done by

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Regd. No. _____ in B. Sc. (Hons.) Agriculture degree programme,

*Course No. ASAC 1101 entitled "Fundamentals of Soil Science" during 1st semester of the academic
year 2022-23.*

Date:

Faculty In charge

Evaluation System
Fundamentals of Soil Science
Course No.: ASAC 1101

Sl. No.	Marks distribution*	Total marks (25)	Marks obtained
1	Record	5	
2	Attendance	5	
3	Lab work	10	
4	Presentation/ Viva	5	

***NB: Marks distribution will vary department wise**

Signature of Faculty In-charge

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Experiment No: 01

Study of Soil Sampling Tools, Collection, Processing and Storage of Soil Sample

Principle:

Soil testing is an essential component of soil resource management. Each sample collected must be a true representative of the area being sampled. Utility of the results obtained from the laboratory analysis depends on the sampling precision. Hence, collection of large number of samples is advisable so that sample of desired size can be obtained by sub-sampling. In general, sampling is done at the rate of one sample for every two hectare area. However, at-least one sample should be collected for a maximum area of five hectares. For soil survey work, samples are collected from a soil profile representative to the soil of the surrounding area.

Materials required:

1. Spade or auger (screw or post hole type)
2. Khurpi
3. Core sampler
4. Sampling bags
5. Plastic tray or bucket

Points to be considered and Precautions taken during Soil Sampling:

1. Collect the soil sample during fallow period.
2. In the standing crop, collect samples between rows.
3. Sampling at several locations in a *zig-zag* pattern ensures homogeneity.
4. Fields, which are similar in appearance, production and past-management practices, can be grouped into a single sampling unit.
5. Collect separate samples from fields that differ in color, slope, drainage, past management practices like liming, gypsum application, fertilization, cropping system *etc.*
6. Avoid sampling in dead furrows, wet spots, areas near main bund, trees, manure heaps and irrigation channels.
7. For shallow rooted crops, collect samples up to 15 cm depth, for deep rooted crops up to 30 cm depth and for tree crops collect profile samples up to 1- 1.5 m.
8. Always collect the soil sample in presence of the farm owner who knows the farm better

Procedure:

1. Divide the field into different homogenous units based on the visual observation and farmer's experience.
2. Remove the surface litter at the sampling spot.
3. Drive the auger to a plough depth of 15 cm and draw the soil sample.
4. Collect at least 10 to 15 samples from each sampling unit and place in a bucket or tray.
5. If auger is not available, make a 'V' shaped cut to a depth of 15 cm in the sampling spot using spade.
6. Remove 2.5 cm thick slices of soil from top to bottom of exposed face of the 'V' shaped cut and place in a clean container
7. Mix the samples thoroughly and remove foreign materials like roots, stones, pebbles and gravels.
8. Reduce the bulk to about half to one kilogram by quartering or compartmentalization.
9. Quartering is done by dividing the thoroughly mixed sample into four equal parts. The two opposite quarters are discarded and the remaining two quarters are remixed and the process repeated until the desired sample size is obtained.
10. Compartmentalization is done by uniformly spreading the soil over a clean hard surface and dividing into smaller compartments by drawing lines along and across the length and breadth. From each compartment a pinch of soil is collected. This process is repeated till the desired quantity of sample is obtained.
11. Collect the sample in a clean cloth or polythene bag.
12. Label the bag with information like name of the farmer, location of the farm, survey number, previous crop grown, present crop, crop to be grown in the next season, date of collection, name of the sampler *etc.*

Collection of soil samples from a profile (for Fruit tree crops):

1. After the profile has been exposed, clean one face of the pit carefully with a spade and note the succession and depth of each horizon.
2. Prick the surface with a knife or edge of the spade to show up structure, color and compactness.
3. Collect samples starting from the bottom most horizon first by holding a large basin at the bottom limit of the horizon while the soil above is loosened by a khurpi.
4. Mix the sample and transfer to a polythene or cloth bag and label it.

Processing and storage:

1. Assign the sample number and enter it in the laboratory soil sample register.
2. Dry the sample collected from the field in shade by spreading on a clean sheet of paper after breaking the large lumps, if present.
3. Spread the soil on a paper or polythene sheet on a hard surface and powder the sample by breaking the clods to its ultimate soil particle using a wooden mallet.

4. Sieve the soil material through 2 mm sieve.
5. Repeat powdering and sieving until only materials of > 2 mm (no soil or clod) are left on the sieve.
6. Collect the material passing through the sieve and store in a clean glass or plastic container or polythene bag with proper labelling for laboratory analysis.

Precautions taken during Processing and Storage of Soil Sample:

1. For the determination of organic matter it is desirable to grind a representative sub sample and sieve it through 0.2 mm sieve.
2. If the samples are meant for the analysis of micronutrients at-most care is needed in handling the sample to avoid contamination of iron, zinc and copper. Brass sieves should be avoided and it is better to use stainless steel or polythene materials for collection, processing and storage of samples.
3. Air-drying of soils must be avoided if the samples are to be analyzed for $\text{NO}_3\text{-N}$ and $\text{NH}_4\text{-N}$ as well as for bacterial count.
4. Field moisture content must be estimated in un-dried sample or to be preserved in a sealed polythene bag immediately after collection.
5. Estimate the moisture content of sample before every analysis to express the results on dry weight basis.

Observation: Students must follow the requirement and procedure for collection of soil sample and kept inside the lab for soil analysis. The observed result writes below.

Remark:

Draw the neat labelled diagram of sampling tools used for soil sampling.

Signature of Faculty In-charge

Experiment No: 02

Identification of Rocks

Objective: To identify common rocks

Definition:

Rocks are aggregates of one or more minerals. They are the major components of the earth's crust. They might be solid and hard, loose or soft.

1) Igneous Rocks:

Igneous rocks are formed by the crystallization of hot molten magma. They are also known as primary rocks because they contain primary minerals such as quartz, feldspar and dark colored minerals such as Biotite, Augite, Hornblende.

The most important distinguishing character of igneous rock is the following evidences of their formation from liquid magma.

- a) **Presence of interlocking grains:** The mineral grains are in contact with one another so that there is no pore space between different grains (e.g. Granite).
- b) **The presence of cavities** formed by the escaping of gases as the magma cools down (e.g. Basalt).
- c) **The presence of flow structure** i.e. the arrangement of mineral grains in the direction of the flow of magma before cooling (e.g. Rhyolite).

Classification of igneous rock:

A) On the basis of chemical composition

- i) **Acid igneous rocks:** They are light in color and contain more than 65% SiO₂ as silicate or Silica (e.g. Granite and Rhyolite).
- ii) **Basic igneous rocks:** They are dark in color and contain less than 50% SiO₂ (e.g. Basalt and Gabbro).
- iii) **Neutral igneous rocks:** They have 50-65% SiO₂. (e.g. Andesite and Diorite).

B) On the basis of mode of occurrence

- i) **Intrusive igneous rock:** They are formed inside the earth's surface (e.g. Granite, Gabbro).
- ii) **Extrusive igneous rock:** They are formed at or near the earth's surface (e.g. Basalt, Obsidian)

Description of important igneous rocks:

- a. **Granite:** It is a light colored, medium to coarse grained igneous rock containing quartz and feldspar as the dominant minerals. Mica is almost always present in small grains.
- b. **Rhyolite:** It has similar mineralogical and chemical composition as granite. It is fine grained and extrusive in mode of origin
- c. **Gabbro:** It is dark colored and coarse grained basic igneous rock which has plagioclase feldspar as the dominant mineral. It also has small amounts of pyroxenes and amphiboles.
- d. **Basalt:** It has same chemical and mineralogical composition as Gabbro, however, it is fine grained. It is dark to greenish black in color.

2) Sedimentary Rocks:

It results from the deposition and re-cementation of weathering products of other rocks.

Most important distinguishing characters of sedimentary rocks are follows:

- a) **Fragmentary structure:** The presence of loose grains, broken materials from different rocks and minerals. A fairly large amount of pore space is present between grains, which are cemented together by iron oxide, silica, carbonate, or clays.
- b) **Stratification:** Depositional layers remain visible even after the compaction of sediments (e.g. Shale).
- c) **Presence of hard parts of organism:** Hard parts of dead marine organisms are often present (e.g. Shells in limestone).

Classification of sedimentary rocks:

Sedimentary rocks are classified as clastic or precipitates.

- i) **Clastic (or Fragmental):** Sedimentary rocks formed through physical and mechanical processes. Weathered rock fragments are consolidated by the exertion of pressure and by cementing materials (e.g. sandstone, siltstone, shale, conglomerate).
- ii) **Precipitates:** Sedimentary rocks formed by the chemical or biochemical precipitation of ions from solution.

Description of important sedimentary rocks:

- a) **Sandstone:** Contains dominantly sand sized particles (mostly quartz) bound together by various cementing agents.
- b) **Siltstone:** Contains dominantly silt sized particles
- c) **Shale:** Contains dominantly clay sized particles. The predominant mineral is clay.
- d) **Conglomerate:** Consists of gravels cemented together rounded by clay, stones, CaCO₃, pebbles silica or and iron.

- e) **Limestone:** Formed from chemical precipitation or from skeletal remains (sea shells). The principal minerals are calcite and dolomite. Dolomitic limestone is harder than calcitic limestone.
- f) **Coal:** It is the organic sedimentary rock formed from the remains of plants.

3) Metamorphic Rocks:

The natural agencies of temperature, pressure and chemical solution react with the original primary or secondary rock and change their character completely or partially. Such rocks are called metamorphic rocks.

Most important distinguishing characters:

- a. **Presence of foliation:** Horizontal layers parallel to one another.
- b. **Presence of dominant mica minerals:** Metamorphic rocks contain large amounts of biotite and muscovite micas (because of typical condition of temperature and pressure) which gives them silvery or shiny appearance.

Classification of metamorphic rocks:

Metamorphic rocks are classified according to their structure and parent rock.

- i) **Banded (foliated)** metamorphic rocks have more or less parallel layers of different minerals.
- ii) **Non-banded** metamorphic rocks have random pattern of mineral crystals.

Description of important metamorphic rocks:

- a) **Quartzite:** It is non-banded metamorphosed sandstone. Quartz is the dominant mineral. It is very hard and weathers extremely slowly.
- b) **Slate:** It is banded metamorphic rock derived from shale. The mineral grains derived are not visible. It forms sheets and is more compact and denser than shale.
- c) **Gneiss:** Banded metamorphic rock derived from acidic igneous rock such as granite. This rock has alternate light and dark colored bands. Quartz, feldspars and biotite micas are the dominant minerals.
- d) **Marble:** A recrystallized limestone. It is more coarse grained and weathers slower than limestone.
- e) **Schists:** Banded metamorphic rocks such as metamorphosed shale, gneiss or basic igneous rocks. Newly formed minerals such as mica, chlorite and hornblende tend to predominate.

Observation: Students must compare your results with above description and write proper remark in the given table.

Sl. No.	Description of Rocks	Name of Rocks
1		
2		
3		
4		
5		

Signature of Faculty In-charge

Experiment No: 03

Soil Texture Determination by Feel Method

- Objective:**
1. To familiarize with soil textural classes.
 2. To determine soil texture by feeling with hands.

Definition: Soil texture refers to the relative proportions of sand, silt and clay in a soil sample.

Classification of soil separates:

According to International Society of Soil Science (ISSS)

S. No	Soil Separate	Particle Diameter(mm)
1	Coarse Sand	2 - 0.02
2	Fine sand	0.2 - 0.02
3	Silt	0.02 - 0.002
4	Clay	< 0.002

According to United States Department of Agriculture (USDA)

S. No	Soil Separate	Particle Diameter(mm)
1	Very Coarse	2.0 - 1.0
2	Coarse	1.0 - 0.5
3	Medium	0.5 - 0.25
4	Fine	0.25 - 0.10
5	Very Fine	0.10 - 0.05
6	Silt	0.05 - 0.002
7	Clay	< 0.002

Characteristics of soil separates by feel methods:

- **Sand** particles are easily seen with the naked eye, feel coarse and gritty.
- **Silt** particles feel soft and flour like when dry and smooth when wet.
- **Clay** particles feel greasy and sticky when wet.

Soil textural classes:

According to the United States Department of Agriculture (USDA) system of classification, there are 12 textural classes (as shown on the textural triangle). Soil textural class can be determined in the field by the feel method.

The amount of clay can be estimated by feeling the stickiness; by making a ball and ribbon. Soils with higher amounts of clay form longer ribbons. Feeling of grittiness and smoothness of wet soil samples indicate amounts of sand and silt respectively.

Procedure:

1. Take about 25 g of soil in the palm, add water and moisten it. Knead the soil to break down all aggregates. The soil is at proper consistency when plastic and moldable.
2. Try to form a ball and squeeze it. If the soil does not remain in a ball when squeezed, the textural class of the sample is **SAND**.
3. Place the ball of soil between the thumb and the forefinger of your hand and gently push the soil with the thumb against the forefinger. Squeeze it upward and form a ribbon (1mm thick). If it does not form a ribbon, the textural class of the sample is **LOAMY SAND**.

4. If the soil forms a ribbon, then determine the size of the ribbon into either a short (< 2.5 cm long), medium (2.5 - 5 cm long) or a long (> 5 cm long).
5. Place a pinch of the soil ribbon on the palm of one hand. Add water to intake it wet. Gently rub it with the forefinger of another hand to feel the grittiness or smoothness.
6. Fill in the information in Data Sheet and use Table 1 below to determine the textural class of each sample.

Table 1 : Determination of Soil Texture by feel and Ribbon Size

Feel	Ribbon size		
	Short (<2.5cm)	Medium (2.5-5cm)	Long (>5 cm)
Gritty	Sandy Loam	Sandy Clay Loam	Sandy Clay
Neither gritty nor smooth	Loam	Clay Loam	Clay
Smooth	Silt Loam	Silty Clay Loam	Silty Clay

Observation: Students must compare your results with above description and write proper conclusion in the given table.

Sample No	Ribbon type	Predominant wet feel	Soil textural classes
1			
2			
3			
4			

Signature of Faculty In-charge

Experiment No: 04

Determination of Bulk Density

Objective: To determine of soil bulk density

Definition: Bulk Density =Weight of oven dry soil (g)/ Bulk volume of oven dry soil (cm³)

Equipment:

- a. Core sampler
- b. Core rings
- c. Digital Balance
- d. Oven

Procedure:

- a. Clean the stubble, grass, etc., from the soil surface and position the sampler.
- b. Drive or press the core sampler in a vertical soil surface far enough to fill the sampler, but not so far as to compress the soil in the confined space of the sampler.
- c. Remove the core sampler and the contents carefully without destroying the natural structure and without packing the soil. Shoveling along the side and under the sampler may be needed in some soils to remove the sample without disturbance.
- d. Takeout the core ring with the sample and trim the soil on both ends with a sharp-edged knife.
- e. Place the sample in an oven at 105 °C for 24hrs and weight will be given for bulk density determination.
- f. Take the weight of the oven dry soil. Calculate the volume of the core rings and calculate the bulk density of soils.

Calculation:

1. Soil volume (core sampler volume): To calculate the volume of the core sampler

- i) Measure the height (h) of the core sampler with the ruler in cm to the nearest mm
- ii) Measure the diameter of the core sampler and halve this value to get the radius (r)
- iii) core volume (cm³) = $\pi \times r^2 \times h$ ($\pi = 3.14$)

Sl. No.	Radius (r) cm	Height (h) cm	Core Volume cm³
1			
2			
3			
4			

2. Dry soil weight:

To calculate the dry weight of the soil:

- i) Weigh an ovenproof tray (W1 g).
- ii) Carefully take all soil into the tray. Dry the soil for 24 hours in a conventional oven at 105 °C.
- iii) When the soil is dry weigh the sample on the scales (W2 g)
- iv) Dry soil weight (W3 g) = W2 – W1

$$\text{Bulk Density (g/cm}^3\text{)} = \frac{\text{Dry soil wt. (W3)}}{\text{Soil Volume (V)}}$$

Bulk density is usually expressed in mega-grams per cubic meter (Mg/m³) but the numerically equivalent units of g/cm³ and t/m³ are also used (1 Mg/m³ = 1 g/cm³ = 1 t/m³) (Cresswell and Hamilton, 2002).

Observation: Students must complete your calculation with above formula and write proper value of bulk density.

Sample No.	Tray Wt W1 g	Dry Soil + Tray Wt W2 g	Dry soil Wt W3 g (W2-W1)	Core volume V cm ³	Bulk Density g/cm ³
1					
2					
3					
4					

Signature of Faculty In-charge

Reference:

D. Hillel, Ed. Applications of Soil Physics. Academic Press, New York, NY, pp. 319–344.

Experiment No: 05

Determination of Particle Density of Soil

Objective: To determine particle density of soils by using a pycnometer.

Definition: Particle density (PD) is the mass per unit volume of the soil solids.

$$PD = \text{Weight of oven dry soil (g)} / \text{Solid volume (cm}^3\text{)}$$

The PD value for most of the mineral soil 2.70 g/cm³ with an average of 2.65 g/cm³. The knowledge of PD is important to calculate volume weight relationships of soil, like porosity, and void ratio. The Particle density is also used in calculating settling velocity of particles of different sizes during mechanical analysis.

Equipment:

- a) Pycnometer.
- b) digital balance

Procedure:

1. Weigh a pycnometer flask with glass stopper and record mass (W₁ g).
2. Fill the flask about half full with air-dry soil. Weigh the flask, stopper and soil. Record the combined mass (W₂ g).
3. Add water to the soil slowly, mixing soil and water thoroughly by vigorous shaking until the flask is full. Allow the air bubbles to rise to the surface. Float foam out of the flask by adding a few more drops of water. Insert stopper, wipe the outside dry, weigh and record (W₃ g).
4. Pour out entire contents into waste bucket and rinse flask.
5. Then refill the flask with water only, stopper, wipe the outside dry, weigh and record (W₄ g).

Calculation:

$$\text{Particle Density (g/cm}^3\text{)} = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)} \times D_w$$

Where:

W₁ = Wt of the empty and dry pycnometer

W₂ = Wt. of pycnometer + dry soil sample

W₃ = Wt. of the pycnometer filled with soil and water

W₄ = Wt. of pycnometer filled with water

D_w = Density of water (g/cm³) at the observed temperature

Observations:

Sample No.	Pycnometer wt. W1 g	Pycnometer + Dry soil wt. W2 g	Pycnometer + Dry soil + water wt. W3 g	Pycnometer + water wt. W4 g	Particle Density g/cm ³
1					
2					
3					
4					

% Pore space:

Porosity. Porosity is pore volume expressed as a fraction of total soil volume. Porosity can be calculated if bulk and particle densities are known.

$$\text{Porosity (\%)} = \left(1 - \frac{\text{Bulk Density}}{\text{Particle density}} \right) \times 100$$

Observation: Students must complete your calculation with above formula and write proper conclusion.

Sample No.	Bulk density (g/cm ³)	Particle density (g/cm ³)	Porosity (%)
1			
2			
3			
4			

Conclusion:

Signature of Faculty In-charge

Reference:

D. Hillel, Ed. Applications of Soil Physics. Academic Press, New York, NY, pp. 319–344.

Flint, A.L., and L.E. Flint. 2002. Particle Density. pp. 229–240. Soil Sci.Soc. Am. Book Series No. 5. Soil Sci. Soc. Am. Madison, WI.

Experiment No: 06

Measurement of Soil Moisture Content by Gravimetric Method

Objective: To determine the soil moisture content in soil by gravimetric method

The soil moisture content may be expressed by weight as the ratio of the mass of water present to the dry to the dry weight of the soil sample, or by volume as ratio of volume of water to the total volume of the soil sample. To determine any of these ratios for a particular soil sample, the water mass must be determined by drying the soil to constant weight and measuring the soil sample mass after and before drying. The water mass (or weight) is the difference between the weights of the wet and oven dry samples. The criterion for a dry soil sample is the soil sample that has been dried to constant weight in oven at temperature between 100 - 110 °C (105 °C is typical). It seems that this temperature range has been based on water boiling temperature and does not consider the soil physical and chemical characteristics

Materials:

- Hot air oven
- Weighing balance
- Aluminum box (Moisture box)
- Auger or tool to collect soil samples

Procedure:

1. Weigh an aluminum box, and record the weight = W1 g
2. Place a soil sample of about 10 g in the box and record the weight (wet soil + box) = W2 g
3. Place the sample in the oven 105 °C and dry for 24 hours or overnight.
4. Weigh the sample, and record the weight (dry soil + box) = W3 g
5. Return the sample to the oven and dry for several hours, and determine the weight of (dry soil + box) until there is no difference between any two consecutive measurements of the weight.

Calculation:

The moisture content in dry weight basis may be calculated using the following formula:

$$\% \text{ Moisture content} = \frac{\text{wt. of wet soil} - \text{wt. of dry soil}}{\text{wt. of dry soil}} \times 100$$

Observation: Students must complete your calculation with above formula and write proper conclusion

Sample No.	Aluminum box wt W1 g	Aluminum box + Wet soil wt W2 g	Aluminum box + Dry soil wt W3 g	Wet Soil wt (W2-W1) W4 g	Dry Soil wt (W3-W1) W5 g	Moisture Content (%)
1						
2						
3						
4						
5						

Remark:

Signature of Faculty In-charge

Reference:

Black C.A. 1965. "Methods of Soil Analysis: Part I Physical and mineralogical properties". American Society of Agronomy, Madison, Wisconsin, USA

Experiment No: 07

Determination of soil pH

Principle:

The soil pH is the negative logarithm of the active hydrogen ion (H^+) conc. in the soil solution. It is the measure of soil sodicity, acidity or neutrality. It is a simple but very important estimation for soils, since soil pH influences to a great extent the availability of nutrients to crops. It also affects microbial population in soils. Most nutrient elements are available in the pH range of 6.5 to 7.5.

In various chemical estimations, pH regulation is critical. Specific colors as observed in the presence of various pH indicators and the color changes due to pH change are shown in the procedure for measurement of soil pH is given below.

Apparatus

- a) pH meter
- b) Balance
- c) Measuring cylinder
- d) Beaker
- e) Glass rod

Reagent

- a) Buffer solutions of pH 4, 7 and 9.2.

Procedure

1. Calibrate the pH meter, using 2 buffer solutions, one should be the buffer with neutral pH (7.0) and the other should be chosen based on the range of pH in the soil. Take the buffer solution in the beaker. Insert the electrode alternately in the beakers containing 2 buffer solutions and adjust the pH. The instrument indicating pH as per the buffers is ready to test the samples
2. Weigh 10 g of soil sample into 50 or 100 ml beaker, add 20 ml of $CaCl_2$ solution (use water instead of $CaCl_2$ solution throughout the procedure if water is used as a suspension medium).
3. Allow the soil to absorb $CaCl_2$ solution without stirring, then thoroughly stir for 10 second using a glass rod.
4. Stir the suspension for 30 minutes and record the pH on the calibrated pH meter.

Based on soil pH values, following types of soil reactions are distinguished:

pH Range	Soil Reaction
< 4.6	Extremely acid
4.6-5.0	Strongly acid
5.1-5.5	Moderately acid
5.6-6.5	Slightly acid
6.6-7.5	Neutral
7.6-8.5	Moderately alkaline
> 8.5	Strongly alkaline

The acidic soils need to be limed before they can be put to normal agricultural production. The alkali soils need to be treated with gypsum to remove the excessive content of sodium.

Observation: Students must compare your results with above pH value and write proper conclusion under remark area.

Sample No.	pH value	Remark
1.		
2.		
3.		
4.		

Signature of Faculty In-charge

References:

1. Jackson, M.L. 1973. Soil chemical analysis, Prentice Hall of India Private Limited, New Delhi.

Experiment No: 8

Determination of Soil Electrical Conductivity (EC)

Principle:

The electrical conductivity (EC) is a measure of the ionic transport in a solution between the anode and cathode. This means, the EC is normally considered to be a measurement of the dissolved salts in a solution. Like a metallic conductor, they obey Ohm's law.

Since the EC depends on the number of ions in the solution, it is important to know the soil/water ratio used. The EC of a soil is conventionally based on the measurement of the EC in the soil solution extract from a saturated soil paste, as it has been found that the ratio of the soil solution in saturated soil paste is approximately two-three times higher than that at field capacity. Generally, a 1:2 soil/water suspension is used.

Apparatus:

- a) EC meter
- b) Balance
- c) Measuring cylinder
- d) Beaker
- e) Glass rod

Reagent:

1. 0.01M Potassium chloride solution: Dry a small quantity of AR grade potassium chloride at 60 °C for two hours. Weigh 0.7456 g of it and dissolve in freshly prepared distilled water and make the volume to one litre. This solution gives an electrical conductivity of 1411.8×10^{-3} i.e. 1.412 deciSiemens per metre (dS/m) at 25 °C. For best result, select a conductivity standard (KCl solution) close to the sample value.

Procedure:

1. Take 10 g soil into 50 or 100 ml beaker, add 20 ml of distilled water, stopper the flask and shake on reciprocating shaker for one hour. Filter through Whatman No.1 filter paper. The filtrate is ready for measurement of conductivity.
2. Wash the conductivity electrode with distilled water and rinse with standard KCl solution.
3. Pour some KCl solution into a 25 ml beaker and dip the electrode in the solution. Adjust the conductivity meter to read 1.412 dS/m, corrected to 25 °C.
4. Wash the electrode and dip it in the soil extract.
5. Record the digital display corrected to 25 °C. The reading in dS/m of electrical conductivity is a measure of the soluble salt content in the extract, and an indication of salinity status of this soil. The conductivity can also be expressed as millimho per centimetre (mmhos/cm).

Soil	EC (dS/m)	Total salt content (%)	Crop reaction
1. Salt free	0-2 2-4	< 0.15	Salinity effect negligible, except for more sensitive crops
2. Slightly saline	4-8	0.15-0.35	Yield of many crops restricted
3. Moderately saline	8-15	0.35-0.65	Only tolerant crops yield satisfactorily
4. Highly saline	>15	> 0.65	Only very tolerant crops yield Satisfactorily

(N.B.: (1 mmhos/cm = 1 mS/cm = 1 dS/m).

Observation: Students must compare your results with above charts and write proper conclusion in remark area like EC value.

Sample No. Soil EC (dS/m)

Remark

- 1.
- 2.
- 3.
- 4.

Signature of Faculty In-charge

References:

1. Jackson, M.L. 1973. Soil chemical analysis, Prentice Hall of India Private Limited, New Delhi.

Experiment No: 9

Description of Soil Profile

Objectives:

- a) To familiarize with the profile description technique.
- b) To identify different horizons on morphological basis.
- c) To inter-relate the effect of vegetation and drainage on soil development.

Definition:

Soil profile: The soil profile is a vertical section of the soil through all its horizons and extends down to the parent material or to a depth of 2 meters or more in deep tropical soil.

Significance:

- a) The study of a soil profile and its characteristics help to determine the agricultural value of the land.
- b) It helps to diagnose such problems as salinity, alkalinity, water logging, and the presence of a hard pan in the soil and to explain their effects on use and management of soils.
- c) It is a pre-requisite of soil classification.

Materials:

1. Digging tool	2. Cutting knife
3. Measuring tape	4. Water bottle
5. Profile description sheets	6. Sampling bags

Description of soil horizons:

Each horizon is described for the following:

- i) Horizon symbol (refer to lecture notes).
- ii) Depth of enrich horizon.
- iii) Nature of horizon boundary: Horizon boundaries vary in distinctness and in surface topography.

Distinctness: The characteristic thickness of the boundary may be described as:

- **Abrupt (a)** - boundary less than 2.5 cm thick.
- **Clear (c)** - boundary 2.5 -5 cm thick.
- **Gradual (g)** - boundary 5 -1.2 cm thick.
- **Diffuse (d)** - boundary more than 12 cm thick.

Surface topography may be described as:

- **Smooth (s)** - The boundary is nearly a plane surface.
- **Wavy (w)** - Pockets are wider than their depth.
- **Irregular (i)** - Pockets are deeper than their width.
- **Broken (b)** - The horizon boundary is not continuous.

- iv) Soil color and mottling
- v) Soil texture
- vi) Soil structure
- vii) Soil consistence
- viii) Other-Such as cutans, root distribution, reaction to dilute HCl, presence of concretion, hard pan etc.

Master Horizons:

The capital letters are used to represent the master horizons. Earlier there were only six (6) master horizons (O, A, E, B, C and R), later on Soil Survey Staff added three more (L, M and W) horizons. A brief description of master horizons as under-

1) O- Horizon - A layer dominated by organic material. O horizon present in forest land and absent in arable lands.

2) A- Horizon -Mineral horizon that has formed at the surface or below an O -horizon. This horizon shows accumulation of organic matter closely mixed with the mineral fractions and due to this A- horizon is darker in nature.

A1 - Surface mineral horizon with an accumulation of well decomposed organic matter which coats the mineral particles and darkens the soil mass.

A2 - Sub-surface horizon which has lost organic matter, clay, iron or aluminum through eluviation.

A3 - Transitional to B but more like A than B.

3) E- Horizon - Main feature of E horizon is the loss of silicate clay, iron and aluminium. E- horizon most commonly differentiated from an underlying B- horizon by a colour of high value or lower chroma, or both. This horizon is lighter in colour and has less organic matter than the A- horizon. This horizon also called as a horizon of eluviation.

4) B- Horizon - Horizon that has formed below an A, E or O- horizon This horizon shows one more soil characteristic like: accumulation of clay, humus, iron, aluminium, carbonates, gypsum, strong gleying, low chroma mottles and alterations associated with formation of granular, blocky or w prismatic structure. This horizon can be generally considered as a layer of 2 accumulation or Illuviation.

B1-Transitional to A but more like B than A. Mineral horizon with Illuvial concentration of clay, iron,

B2- aluminum, organic matter, or alteration of parent material through physical and chemical means with formation of structure.

B3-Transition to C.

5) C- Horizon -Relatively unaltered parent material.

6) R- Horizon -Moderately consolidated bedrock.

Observation: Students must compare your results with above description and write proper conclusion in the given table.

Horizon depth cm	Texture & colour	Structure (Grade, size, type)	Horizon boundary	Consistency (moist)

Draw a neat labelled diagram of soil profile.

Signature of Faculty In-charge

Experiment No: 10

Determination of Soil Organic Matter

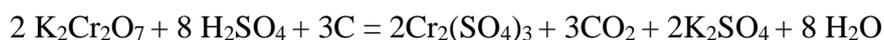
A fundamental understanding of different components of soil organic matter is required to improve soil health. Although organic fraction of soil typically accounts a continuum of materials ranging from highly decomposable to very recalcitrant, it is divided into two major fractions such as labile and stabilized ones. The labile fraction of soil organic carbon has a short turn over time. On the other hand, stabilized organic carbon is composed of organic materials that are highly resistant to microbial decompositions includes mainly humic substances having a longer turn over time. Soil organic carbon implies the readily oxidizable carbon (labile carbon) in the soil which we are interested to determine.

Oxidizable organic C can be determined by the partial oxidation of organic matter with chromic acid using the method proposed by Walkley and Black (1934). This procedure is also known as wet digestion method. Soil organic matter may be determined directly from the loss in weight by destroying organic matter or indirectly from the knowledge from the total organic carbon content – as carbon is the chief constituent of organic matter. Soil organic matter contains 58% carbon. Based on this assumption, the widely used conversion factor i.e., van Bemmelen factor (1.724) is used to convert soil organic carbon (OC) into soil organic matter (OM) content.

Principle:

In this method, a known amount of soil is treated with an excess amount of standard potassium dichromate solution in presence of concentrated sulphuric acid (conc. H₂SO₄). A part of organic matter present in soil is oxidized by chromic acid which is liberated from the reaction between potassium dichromate and concentrated sulphuric acid. This oxidation reaction is facilitated by the heat generated by conc. H₂SO₄. The excess of unconsumed potassium dichromate (i.e., potassium dichromate not reduced by organic carbon) is determined by titrating against standard ferrous ammonium sulphate solution (redox titration) in presence of ortho phosphoric acid, sodium fluoride and diphenylamine indicator. It is assumed that Cr₂O₇²⁻ reduced during the reaction with soil is equivalent to the organic carbon present in the sample.

The reaction can be represented as follows:



Before titration sodium fluoride or phosphoric acid is added. Orthophosphoric acid (H₃PO₄) is added to have a sharp colour change at the end of the titration. Because phosphate ions present in orthophosphoric acid combine with ferric ions forming a colourless complex, thus check the interference of ferric ion and make the end point sharp.

On addition of diphenylamine indicator normally deep violet or dull green colour appears due to presence of nascent 'O' which is evolved by the chromic acid. Because diphenylamine becomes violet under oxidized condition. The colour becomes turbid blue as titration proceeds. At the end point, the colour changes sharply to bottle green or brilliant green. This brilliant green colour is the colour of reduced form of chromium i.e. chromous ions which possess green color. Because during titration diphenylamine indicator undergoes oxidation and at the end point it is oxidized to colourless diphenylbenzidine compound.

Apparatus:

1. Balance
2. 500 ml conical flask
3. Burette
4. Pipette
5. Measuring cylinder

Reagents:

1. Standard 1N $K_2Cr_2O_7$ solution - Dissolve 49.04 gm $K_2Cr_2O_7$ in about 500 ml of distilled water and make the volume to 1 litre.
2. Ferrous ammonium sulphate solution (0.5N): Dissolve 196.1 g ferrous ammonium sulphate in 800 ml water containing 20 ml conc. H_2SO_4 and dilute to 1 litre.
3. Diphenylamine indicator: Dissolve 0.5 g of dye in a mixture of 20 ml of distilled water and 100 ml conc. H_2SO_4 .
4. Orthophosphoric acid (85%) or Sodium fluoride (NaF)

Procedure:

0.5-1.0 g of processed soil (sieved through 0.2mm sieve) is taken in a 500 ml conical flask, 10 ml of 1 N $K_2Cr_2O_7$ solution is added with a pipette and the flask is gently swirled to mix the reagent with the soil. Then 20 ml of conc. H_2SO_4 is poured slowly (If the chloride content of the soil is high sulphuric acid with silver sulphate solution is to be added). The flask is then swirled for about 30 seconds and keep it for 30 min. Then add about 200 ml of distilled water and 10 ml of orthophosphoric acid. The solution is allowed to cool. Then 1 ml of diphenylamine indicator is added to the solution (solution is deep violet) and the excess potassium dichromate is titrated against 0.5N ferrous ammonium sulphate till the color flashes from violet to a bottle green or brilliant green color. Also run a blank titration following all the above steps without taking soil.

Calculation:

$$\text{Organic Carbon (\%)} = \frac{\text{Blank value} - \text{sample value}}{\text{Blank value} \times \text{wt. of soil}} \times 10 \times 0.003 \times 100$$

(*N.B.*: 1 ml of 1N K₂Cr₂O₇ solution = 0.003 g of carbon)

The results can be converted to organic matter percentage by multiplying with 1.724 (assuming OM contains 58% C). The results are interpreted by using the following rating chart:

Rating	% OC
Low	< 0.5
Medium	0.5 - 0.75
High	> 0.75

Observation:

Sample No.	Initial reading (ml)	Final reading (ml)	Vol. used (ml)	% OC	% OM	Remark
1						
2						
3						
4						

Conclusion:

Signature of Faculty In-charge

References:

- Jackson, M.L. 1973. Soil chemical analysis, Prentice Hall of India Private Limited, NewDelhi.
- Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*, 37(1), 29-38.

