PRACTICAL MANUAL

Geology and Soils

FNR-117 3(2+1)

Dr. Susheel Kumar Singh

Dr. Bharat Lal

2020

College of Horticulture & Forestry

Rani Lakshmi Bai Central Agricultural University

Jhansi-284003, Uttar Pradesh

Syllabus: Soil, Water and Plant Analysis 2(1+1)

Identification of rocks and minerals; Collection and preparation of soil samples; Soil analyses for moisture, colour, bulk density, organic matter, pH, EC; Textural analysis by hydrometer method; Study of soil profile; Study tour for identification of rocks and minerals and profile studies; Practicals on introduction to Tensiometer, pressure plate and neutron probe etc.

Name of Students .....

Roll No. .....

Batch .....

Session .....

Semester .....

Course Name : .....

Course No. : .....

Credit .....

Published:

No. of copies: ……..

Price: Rs.

CERTIFICATE

This is to certify that Shri./Km. .....ID No.....has completed the practical of course.....course No. ..... as per the syllabus of B.Sc. (Hons.) Agriculture/ Horticulture/ Forestry ..... semester in the year.....in the respective lab/field of College.

Date: Course Teacher

CONTENTS

Experiment No. 1

Objective: Identification of different rocks

Rock: In geology, naturally occurring and coherent aggregate of one or more minerals. Rocks are commonly divided into three major classes according to the processes that resulted in their formation. These classes are igneous rocks, which have solidified from molten material called magma. Sedimentary rocks: those consisting of fragments derived from preexisting rocks or of materials precipitated from solutions; and metamorphic rocks, which have been derived from either igneous or sedimentary rocks under conditions that caused changes in mineralogical composition, texture and internal structure.

1. Basalt

Rock type:

……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..…..…

……..…

……..

……

……

……

2. Conglomerate

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..…..…

……..…

……..

……

……

……..

……..

3. Dolostone

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..……

……..…

……..

……

……

4. Gabbro

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..……

……..…

……..

……

……

5. Gneiss

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..……

……..…

……..

6. Granite

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..……

……..…

……..

……

……

7. Limestone

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..……

……..…

……..

……

8. Marble

Rock type: ……

Composition:……

……..…

Environment:……

……..……

Characteristics:……...

……..……

……..…

……..

……

Experiment No. 2

Objective: Identification of different rocks

1. Quartzite

Rock type: ……

Composition:……

……

Environment:……

……

Characteristics:……

……

……

……

……

2. Rhyolite

Rock type: ……

Composition:……

……

Environment:……

……

Characteristics:……

……

……

……

……

3. Sandstone

Rock type:

……

Composition:……

……

Environment:……

……

Characteristics:……..

……..…

……..…

4. Shale

Rock type: ……

Composition:……

……..…

Environment:……

……..…

Characteristics:……..

……..…

……..…

……..

……

……

……

……

5. Slate

Rock type: ……

Composition:……

……..…

Environment:……

……..…

Characteristics:……..

……..…

……..…

……..

……..

……

……

……

Experiment No. 3

Objective: To study about the identification criteria of different minerals.

Some physical properties which is used for mineral identification are

1. **Color:** ……..……

……..

……..

……..

S. No.	Mineral	Color
1.	Quartz	
2.	Feldspars, calcite, dolomite, gypsum, kaolinite, muscovite	
3.	Iron pyrite (called “Fools Gold”)	
4.	Olivine , serpentine, hornblende	
5.	Garnet	
6	Biotite, augite, haematite, magnetite, graphite	
7.	Orthoclase	

2. **Streak:** ……

……..

……..

……..

……..

3. **Striations:** ……..……

……..

……..

……..

4. **Hardness:** ……..……

……..

Hardness (Mho's scale)	Mineral Substance	Test
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

5. **Lustre:** ……

……..

……..

6. Transparency: ……...

……..

- Transparent - ……
- Translucent - ……
- Opaque - ……

7. Specific gravity: ……

……..

……..

……...

……...

……...

……...

8. Tenacity: ……

……..

……..

9. Cleavage and Fracture: ……..

……..

……..

……...

……...

……...

……...

10. State of aggregation and crystal form: ……..

……..

……..

……...

……...

……...

……...

……...

……...

Experiment No. 4

Objective: Collection and preparation of soil samples for analysis

Soil sampling is perhaps the most important step for analysis of soil. It includes collection of soil material by considering the variability of soils; handling and processing of soils and finally storing the processed soil in bag for its actual testing.

1. **Objectives of soil testing:** ……..

……..

……..

……..

……..

2. **Materials required for soil sampling:** ……

……..

……..

……..

3. **Write the sampling procedure of soil:** ……..

……..

……..

……..

……..

……..

……..

……..

……..

……...

……...

……...

4. **Depth of soil sampling for different conditions**

Field crops	
Deep rooted crops	
Forage or pasture crops	
For immobile nutrients (P, K, Ca and Mg)	
Nitrate, Sulfate	
Saline alkali soils	

Draw the procedure of soil sampling

5. Processing and storage of soil sample: ……

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

6. What are the precautions should be kept in mind during soil sampling: ……

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

Experiment No. 5

Objective: Estimation of moisture content of given soil sample A by gravimetric method

Weighted soil sample is the placed in oven at 105° C and it is a dried to constant weight. The weight difference is considered to be water present in soil sample

Materials required: ……..

……..

1. **Write its procedure.**

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. Observation:

I	Weight of empty moisture box (g)	X g	
II	Weight of moisture box + fresh soil	Y g	
III	Weight of moisture box + oven dry soil	Z g	
a	Weight of moisture present in the soil	(Y-Z) g	
b	Weight of oven dry soil	(Z-X) g	

3. Calculation:

$$\textbf{Moisture (\%)} = \frac{\text{Weight of moisture present in the soil}}{\text{Weight of oven dry soil}} \times 100$$

Result:

……..

……..

……..

……..

……..

Experiment No. 6

Objective: Estimation of moisture content of given soil sample B by gravimetric method

Weighted soil sample is the placed in oven at 105° C and it is a dried to constant weight. The weight difference is considered to be water present in soil sample

Materials required: ……..

……..

4. **Write its procedure.**

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

5. Observation:

I	Weight of empty moisture box (g)	X g	
II	Weight of moisture box + fresh soil	Y g	
III	Weight of moisture box + oven dry soil	Z g	
a	Weight of moisture present in the soil	(Y-Z) g	
b	Weight of oven dry soil	(Z-X) g	

6. Calculation:

$$\textbf{Moisture (\%)} = \frac{\text{Weight of moisture present in the soil}}{\text{Weight of oven dry soil}} \times 100$$

Result:

……..

……..

……..

……..

……..

Experiment No. 7

Objective: Determination of soil color by using Munsell color chart.

The color of soil is due to organic matter, mineral matter and mixture of these two. Munsell color chart is used for identifying color of the soil. This chart is a note book having cards of different color. Each card has chips of different color along with a hole below each chip. The three variable of a color i.e. Hue, value and chroma are indicated on each card. Hue indicates main color of spectrum and main wavelength of light. Value indicates relative blackness or whiteness of color. Chroma indicates relative purity of color.

Materials required: ……..

……..

1. Write the procedure for determination of soil color

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. Observations

Sample No.	Dry soil					Moist soil				
	Munsell notation					Munsell notation				
	Hue	Value	Chroma	Combination	Color name	Hue	Value	Chroma	Combination	Color name
1.										
2.										

3. Result

1. Sample number = ……
2. Color of dry soil = ……
3. Name of the dry soil color = ……..
4. Color of moist soil = ……

5. Name of the moist soil color = ...

Experiment No. 8

Objective: Estimation of bulk density of soil by core method

Density is an expression of mass of the oven-dry soil to its per unit volume. The core method involves pressing uniformly a metal core sampler of 0.05 to 0.10 m diameter into the soil to a desired depth and removing carefully. The sample is dried to constant weight at 105°C and weighed.

Materials required: ……..

……..

1. **Write the procedure:** ……

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. Observations

A. Volume of the core sampler …….

S. No.	Sampling depth (m)	Weight of moisture Box (g)	Weight of moisture Box + fresh sample (g)	Weight of moisture box + dry sample (g)	Oven dry wt of soil (g)	Water content in the sample (g/g)
1.						

Calculations

Bulk density (g cm^{-3} or Mg m^{-3}) = $\frac{\text{oven dry weight of soil sample}}{\text{volume of sample}}$

Result: ……

……..……

Experiment No. 9

Objective: Estimation of bulk density of soil by pycnometer method

The bulk density of a soil is the mass of a unit of volume of soil and its represents as

$$\text{Bulk density of soil (g cm}^{-3}\text{ or Mg m}^{-3}) = \frac{\text{Mass}}{\text{Volume}}$$

or

$$\text{Bulk density of soil } (D_b)\text{ (g cm}^{-3}\text{ or Mg m}^{-3}) = \frac{\text{Wight of oven dry soil}}{\text{Volume of Bulk soil (Solid+Pores)}}$$

Materials required: ……..

……..

1. Write the procedure: ……

……..

……..

……..

……..

……..

……..

2. Observation:

I	Weight of empty pycnometer	W_1 g	
II	Weight of Pycnometer + soil	W_2 g	
III	Volume of the soil or Volume of water needed to fill the bottle	V ml	

3. Calculation:

a. Weight of soil= $(W_2 - W_1)$g

b. Volume of the soil= V ml

$$\text{Bulk density of soil (Db) (g cm}^{-3}\text{ or Mg m}^{-3}) = \frac{(W_2 - W_1)\text{g}}{\text{V ml}}$$

……..

……..

……..

……..

……..

……..

4. Results ……

……..

Experiment No. 10

Objective: Determination of soil organic carbon by Walkley and Black Methods

The titration method (Walkley and Black 1934), organic matter is oxidized with chromic acid (potassium dichromate + H_2SO_4). In the titration method, the unconsumed potassium dichromate is back-titrated against ferrous sulphate or ferrous ammonium sulphate (redox titration).

Materials required: ……..

……..

……..

1. Reagents required for the analysis of organic carbon with their preparations.

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. Write the procedure: ……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

3. Calculation

Organic carbon (%) in soil = $\frac{10(B-S)}{B} \times 0.003 \times \frac{100}{\text{Wt of sample (g)}}$

where,

B and S stand for the titre values (mL) of blank and sample, respectively.
Actual organic carbon (%) = OC (%) × 1.3 * (* based on 77 % recovery)
Organic Matter (%) in soil = OC (%) × 1.724 * * (** based on 58 % carbon in organic matter)
Organic carbon (g/kg) in soil = OC (%) × 10
Organic carbon (g/ha) in 0-15 cm soil = OC (g/kg) × 2.24 $\times 10^6$

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

4. Results and Interpretations

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

Experiment No. 11

Objective: Determination of pH from given soil sample

Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases the soil pH decreases thus becoming more acidic. Soil pH affect the different nutrient availability and their proportion.

Materials required: ……..

……..

1. Preparation of standard buffer solution for pH calibration: ……

……..

……..

……..

……..

……..

……..

……..

2. Procedure for the measurement of soil pH: ……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

3. Results:……

……..

……..

……..

……..

4. Interpretation: ……

……..

……..

……..

……..

……..

5. What should be precaution during sample analysis

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

Experiment No. 12

Objective: Estimation of electrical conductivity of given soil sample

Electrical conductivity (EC) is measurement of soluble salts in the soil- water system. Ions, like metals, allow the electric current to pass through them. Hence, electrical conductivity of soil – water system increases with increasing content of soluble salts in the soil.

Materials required: ……..

……..

1. Preparation of reagents required for the calibration of EC meter.

……..

……..

……..

2. Write the procedure for determination of EC from soil sample.

……..

……..

……..

……..

……..

3. Results:……

……..

……..

4. Interpretation: ……

……..

……..

……..

……..

……..

5. Precaution during sample analysis: ……..

……..

……..

……..

……..

……..

……..

Experiment No. 13

Objective: Textural analysis of soil by hydrometer method

The particle-size distribution expresses the proportion of various sizes of particles in a soil, especially sand, silt and clay that determine soil texture. Soil texture can be related to soil physical properties such as water retention characteristics, surface area, swelling and shrinking, soil strength, and tillage properties. The hydrometer method measures the density of suspension or concentration of suspension in the sedimentation cylinder in g/liter at specified times. The time and depth of sampling is decided from the settling velocity of particles in the sedimentation cylinder under the influence of gravity.

Materials required: ……..

……..

……..

……..

1. Write the procedure of texture analysis.

1.1. Calibration of hydrometer: ……..

……..

……..

……..

……..

……..

……..

……..

1.2. Particle size analysis: ……

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. Observations

S. No.	Time, t (min.)	Hydrometer reading, R	Suspension concentration C, (g/litre)	Summation percentage, P	Particle size, X (Microns)
1.	0.5				
2.	3.0				
3.	10.0				
4.	30.0				
5.	90.0				
6.	120.0				
7.	270.0				
8.	720.0				

3. Calculations:

$C = R - R_t$, $P = 100\,(C/C_0)$ and $X = \theta / t^{1/2}$

Where C_0 = oven-dry weight of soil in g liter of suspension,

C = Suspension concentration (g /litre),
R= Hydrometer reading at time t,
R_t = hydrometer reading in calgon solution,
P = Summation percentage,
X = Particle diameter in microns and
θ = Sedimentation parameter to be obtained from the standard table

Plot a relationship between summation percentage and particle size on a semi- logarithmic graph paper with particle size on log-scale. Find out percentage of fine sand, silt and clay from the curve.

4. Results

Coarse sand %= ----------

Fine Sand %= ----------

Silt % = ----------

Clay % = ----------

Texture of soil (use texture triangle) ----------

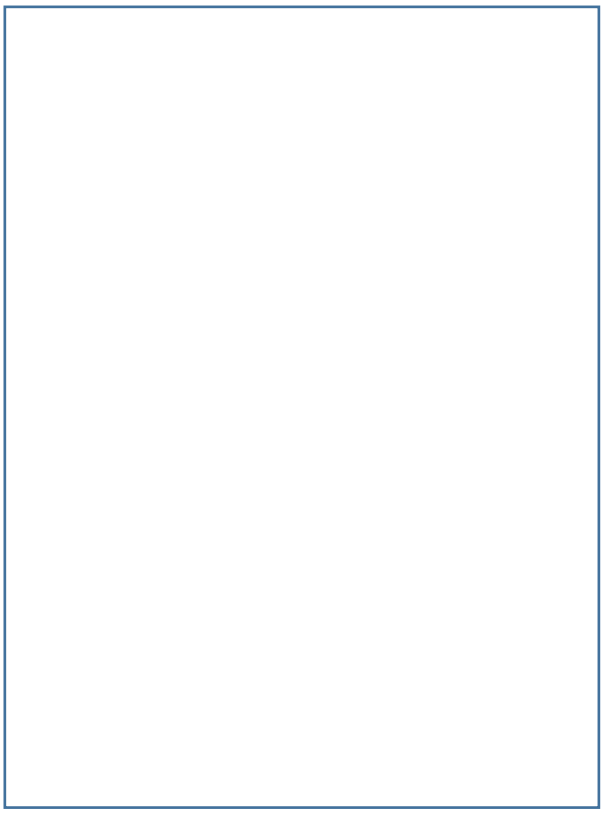
Experiment No. 14

Objective: Description of soil profile in the field.

The vertical section of the soil from the surface extending in to the parent material is called soil profile. The various layers, composing the soil, are called horizons. A soil horizon may be defined as a layer (of varying thickness) approximately parallel to the soil surface. The study of soil profile and its characteristics determines the agricultural value (orchard, forest & crop) of land and explain its behavior towards use and management. It is pre-requisite for classifying of soils. The horizons in profile can be designated as follows:

Exercise for the student

1. What are the Materials required to study soil profile. Draw horizons in profile.



……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

2. Write the soil profile study procedure.

A. Write down the selection procedure of site for soil profile study:

……

……

……

……

……

.....

.....

B. Write down the procedure of digging of a soil profile: ……

……..

……..

.....

C. Write down the examination and description of soil profile: ……

……

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

……

……

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

D. Write down the general description of profile site in given Performa:

The general description of soil profile should include

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3. **What are the precautions one should take while study of soil profile?**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Experiment No. 15

Objective: Determination of soil moisture by Neutron Probe Method (Indirect Method)

Neutrons emitted from a radioactive source (usually Radium-Berrylium or Americium-Beryllium) upon collision with a particle having mass nearly equal to its own, like hydrogen atom in the soil and release their energy and gets thermalized. The thermalized neutrons are detected by a detector and recorded on a scalar.

Materials required: ……..

……..

……..

.....

1. Write the procedure for installation and moisture detection by neutron probe.

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. Calculations

Standard count = SC
Actual count = AC
Count ratio CR = $\frac{AC}{SC}$
Constants of calibration curve = a and b
Volumetric water content ($\theta v = a + bCR$) m^3m^{-3}

……..
……..
……..
……..
……..
……..
……..
……..
……..
……..
……..
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

3. Write the precautions:

……...
……..
……..
……..
……..
……..

.....

Experiment No. 16

Objective: To study about the pressure plate apparatus.

A pressure membrane apparatus is used to subjected to soils matric potentials as low as 10,000 kPa. It is used, along with the tension plate to obtain data to construct soil water characteristic curves.

1. **Write the working principle of pressure plate apparatus.**

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

2. **Applications of pressure plate apparatus.**

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

Experiment No. 17

Objective: Measurement of soil moisture by using tensiometer

Tensiometer is a device to measure soil moisture tension or equivalent negative pressure of water the soil. The effective range of tensiometer is 0 to 0.85 bar depending on quality of the porous cup.

Materials required: ……..

……..

……..

……..

……..

1. Procedure for the determination of moisture by tensiometer.

1.1 Installation of tensiometer

……..

……

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

1.2 Measurement of soil moisture

……..

……..

……..

……..

……..

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Experiment No. 18

Objective: Report on Study tour made for soil testing Laboratory

Report: ……..

……..

……..

……..

……..

……..

……

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

APPENDICES

IDENTIFICATION OF DIFFERENT ROCKS

S.No	Name of Rock	Specifications
1.	**Basalt**	**Rock type:** Igneous (extrusive/volcanic) **Composition:** It constituents of feldspar, olivine, pyroxene and amphibole. **Environment:** Basalt is solidified lava, like rhyolite which flows much quicker because it is less viscous. **Characteristics:** Red-brown to black color, frothy with small visible holes where gas escaped while the lava cooled.
2.	**Conglomerate**	**Rock type:** Sedimentary **Composition:** It is fragments of other rocks and minerals which cemented by silica, calcite or iron oxide. **Environment:** The rock fragments can be rounded from being rolled along a stream bed or a beach during transportation. While the matrix are angular instead of rounded, the rock is called a breccia. **Characteristics:** Dark grey color with imbedded fragments.
3.	**Dolostone**	**Rock type:** Sedimentary **Composition:** It mainly composed with dolomite and fossils Metamorphoses. **Environment:** It formed under magnesium rich conditions. In limestone calcium replaced by magnesium ions which form limestone to dolostone. The hard parts (skeleton, teeth and shell) and sometimes tissue (Leaves, flowers, muscle and cartilage) may be deposited/sediments to become rock. **Characteristics:** Grey color with fossils that are visible.
4.	**Gabbro**	**Rock type:** Igneous (intrusive/plutonic) **Composition:** feldspar, olivine, pyroxene and amphibole etc **Environment:** Gabbro is formed by magma that cools very slowly into hard rock below or within the Earth's crust. **Characteristics:** Dark grey-black and shiny surfaces of feldspar are visible.
5.	**Gneiss**	**Rock type:** Metamorphic **Composition:** quartz, feldspar and mica. **Environment:** Gneiss forms at high temperatures and pressures. The temperature needed is about 700°C and the pressure needs to be about 12-15 kilo bars at a depth of about 40 km. **Characteristics:** It banded with alternating layers of dark and light minerals.
6.	**Granite**	**Rock type:** Igneous (intrusive/plutonic) **Composition:** It composed with having feldspar, quartz, mica and hornblend. **Environment:** Granite is formed by magma that cools very slowly into hard rock below or within the Earth's crust. **Characteristics:** Pink color appear in crystal feldspar, white or grey quartz and black mica. There is no horizontal banding in granite.
7.	**Limestone**	**Rock type:** sedimentary **Composition:** Mostly calcite **Environment:** The calcite comes out of solution and is deposited on the sea floor as a chemical precipitate. The precipitates can build up along with other sediments or on their own and eventually form limestone. Another way for limestone to form is by the buildup of the shells and skeletons of marine animals **Characteristics:** Whitish-grey with a chalky texture. There are no visible fossils in these samples.
8.	**Marble**	**Rock type:** Metamorphic **Composition:** Very pure re-crystallized form of calcite. **Environment:** Marble forms at many temperatures and pressures **Characteristics:** Medium to coarser grained, light colored and calcite crystals may be visible in the rock.
9.	**Quartzite**	**Rock type:** Metamorphic **Composition:** recrystallized quartz grains Original Rock: sandstone **Environment:** Quartzite forms at many temperatures and pressures **Characteristics:** Light grey or white in color, medium grained and very hard in nature
10.	**Rhyolite**	**Rock type:** Igneous (extrusive/volcanic) **Composition:** It consist of feldspar, quartz, mica and hornblend **Environment:** It formed by magma that has reached on the Earth's surface (lava) and therefore

		cools very quickly. **Characteristics:** Very fine grained, pinkish-grey, sometimes with dark streaks. If dipped in water and rubbed on a piece of paper, rhyolite will likely tear the paper rather than leave a muddy streak.
11.	**Sandstone**	**Rock type:** Sedimentary **Composition:** It contains feldspar, quartz and other minerals such as mica are also found but it depend on how much weathering has occurred. **Environment:** **Characteristics:** Coarse to very fine grains, grey colour which feels like sandpaper.
12.	**Shale**	**Rock type:** Sedimentary **Composition:** It mainly composed in grains of clay **Environment:** Shale sediments are deposited in a lake or a deep, slow flowing river **Characteristics:** It appears dull, reddish- brown, very fine grains (smooth to the touch), breaks easily. If an edge is dipped in water and drawn along a surface, shale will leave a muddy streak
13.	**Slate**	**Rock type:** Sedimentary **Composition:** clay minerals **Environment:** Slate forms from the heat and pressure when shale is buried deep in the crust. The depth of burial is about 10 km and temperature at depth is about 200°C. **Characteristics:** Dark grey to black color, very fine grains (smooth to the touch), harder than shale and distinct layers are visible.

IDENTIFICATION CRITERIA OF DIFFERENT MINERALS

Color: In nature, the color of minerals is variable; a mineral may have more than one color depending upon its chemical composition. The colors of a few important rock-forming minerals are:

SN	Mineral	Color
1.	Quartz	Color less
2.	Feldspars, calcite, dolomite, gypsum, kaolinite, muscovite	White to pale
3.	Iron pyrite (called "Fools Gold")	Yellow / golden
4.	Olivine , serpentine, hornblende	Greenish
5.	Garnet	Reddish - brown
6	Biotite, augite, haematite, magnetite, graphite	Black
7.	Orthoclase	Pink or flesh colored

Streak: Streak is fine powder of the mineral which representing its true color and greater reliability. Streak is produced and determined by rubbing the specimen on a piece of unglazed porcelain plate i.e. called streak plate.

Striation: The parallel thread-like lines or narrow bands running across the surfaces of mineral are called striations. These are reflections of the internal arrangement of atoms in to the crystals. These are clearly observed on crystals of quartz, feldspars and pyrite

Hardness: The resistance of a mineral to scratching is known as hardness. The hardness is expressed in Mho's scale and indicated by numerals (1 to 10).

Hardness (Mho's scale)	Mineral Substance	Test
1	Talc	Scratches by a finger nail
2	Gypsum	Just scratches by a finger nail
3	Calcite	Scratches not easily by a copper coin piece
4	Fluorite	Scratches not easily by a steel knife
5	Apatite	Just scratches by a knife
6	Feldspars (orthoclase)	Scratches soft glass
7	Quartz	Scratches glass easily
8	Topaz	Scratches glass but not hard enough to be used as grinding material
9	Corundum	Very hard and used as grinding material for all minerals
10	Diamond	The hardest mineral known

Lusture: Lustre is the general appearance of a mineral in reflected light. For example, iron minerals have metallic lustre, clay minerals have dull lustre, micas have a shining lustre and quartz have a vitreous lustre.

Transparency: It is the degree of penetration of light through a mineral. Transparent - mica, Translucent - quartz
Opaque- pyrite and magnetite.

Specific gravity: It is the ratio between the weight of a mineral or a substance to the weight of an equal volume of water.

- Heavy minerals: Mineral have specific gravity > 2.85, eg- pyroxene, amphiboles, garnet, zircon etc
- Light minerals have specific granny < 2.85, eg quartz, micas, muscovite, feldspars etc.

Tenacity: The mineral resistance to breaking, crushing or binding is called tenacity. Minerals may be brittle, malleable and flexible or elastic.

Cleavage and fracture: The tendency of a mineral to split in certain preferred directions along smooth plane surfaces is called cleavage. The cleavage planes are governed by the internal arrangement of atoms and the direction in which the atomic bonds are relatively weak such as mica and feldspars.

Fracture, on the other hand is the property of a mineral to break along an irregular surface which is not connected with the crystalline form such as in glass and quartz

State of aggregation and crystal form: Almost all the rock-forming minerals have got crystalline structure. The specific atomic arrangement of the minerals (as in a crystal) is called its crystal form. A crystal may be defined as a substance with regular geometric faces and definite structure. The angle between the faces is always constant for a particular crystal.

COLLECTION AND PREPARATION OF SOIL SAMPLES

1. **Objectives of soil testing.**
   Evaluation of fertility status of soil
   Estimation of the available nutrients status of soil
   Determination of problems soil and their remediations.
2. **Materials required for soil sampling.**
   Khurpi , Spade , Augers , Bucket , Scale , Wooden roller , Mortar and pestle, Sieve, Polythene/paper/cloth bags , Labels , Card-board cartons , Rack , Aluminium boxes.
3. **Write the sampling procedure of soil.**
   - The sampling should be done in a zig-zag pattern across the field to get homogeneity.
   - Scrap away the surface litter and insert the sampling auger to plough depth (15 cm)
   - Take at least 15 samples randomly distributed over each area and put them in a clean bucket
   - If a sampling auger is not available make a 'V' or 'U' shaped cut to a depth of 15 cm or to a required depth using a spade and remove 1.0 to 1.5 cm thick slice of soil from top to bottom of the exposed face of the 'V' or 'U' shaped cut and put in a clean bucket or basin and in similar manner collect the soil sample from all the spots.
   - Thoroughly mix the soil samples taken from 15 or more spots of each area. Remove foreign bodies such as plant roots, stubbles, leaves, glass pieces, pebbles, stones or gravels.
   - Quartering technique is done by dividing the thoroughly mixed soil into four equal parts and discarding two opposite quarters.
   - Remix the remaining two quarters and again divide into four equal parts and reject the opposite two.
   - Repeat this procedure until about ½ kg of soil is left
4. **Depth of soil sampling for different conditions**

Field crops	0-15 or 0-20 cm
Deep rooted crops	0-15, 15-30 and 30-60 cm (Sampling at different depths or layers is ideal)
Forage or pasture crops	0-10 cm
For immobile nutrients (P, K, Ca and Mg)	Sampling at tillage depth
Nitrate, Sulfate	60 cm (when the biological activity is low)
Saline alkali soils	Salt crust should be sampled separately and the depth of sampling should be recorded

5. **Processing and storage of soil sample.**
   - The soil sample received at the laboratory is air-dried in shade and spread on a sheet of paper after breaking large lumps, if present, with a wooden mallet.
   - The soil thus prepared is sieved through a sieve with round holes, 2 mm in diameter.
   - The material on the sieve is again ground and sieved till all aggregate particles are fine enough to pass through and only stones and organic residues remain on the sieve.
   - For micronutrients analysis nylon sieve should be used
   - Transfer the sieved material in a airtight plastic container and leveled the soil sample
6. **Precautions to be kept in mind during soil sampling**
   - Avoid sampling near bunds, irrigation channels, compost / fertilizer heaps, under trees (shade), damp areas.
   - Any contamination with fertilizer, manure, salts, lime or any chemicals must be avoided.
   - Rusted iron sampling tools, pestles and mortars or sieve must not be used for collection and processing of soil samples specially if micro nutrients need to be determined.

ESTIMATION OF MOISTURE CONTENT OF GIVEN SOIL SAMPLE BY GRAVIMETRIC METHOD

Materials required: Sample Auger/ Spad/ Khurpi, Moisture box, Hot air oven, Desiccator

Procedure

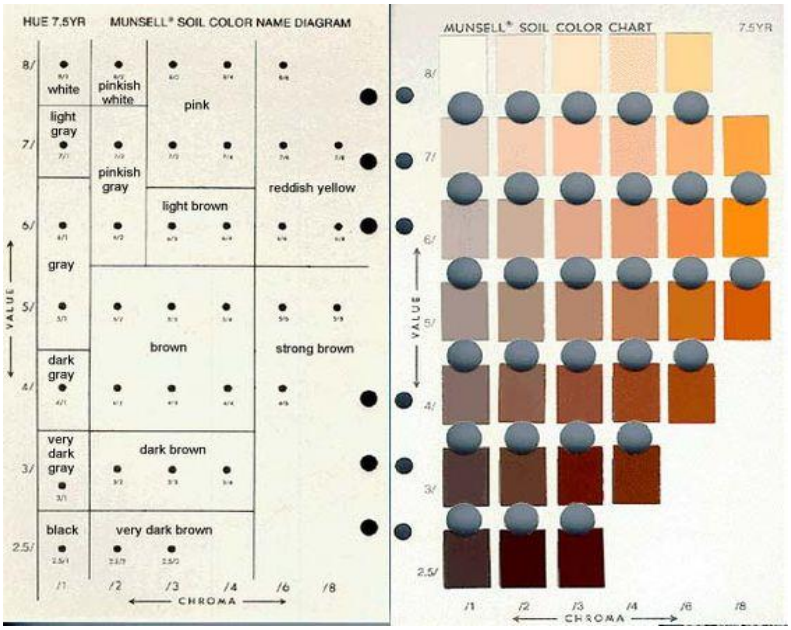
- Take weight of moisture box.
- Take soil sample of about 100g from required depth with help of Auger/ Spad/ Khurpi.
- Put the moist soil sample in the moisture box and close the box to prevent loss of water moisture by evaporation.
- Bring the moisture box containing the moist soil to the lab and weigh immediately.
- Place the moisture box in hot air oven till a constant weight at 105° C temperature. This take about 48 hours.
- Allow the sample to cool for some time in hot air oven. Than close the moisture box and put into the desiccator for further cooling now weigh the sample closed moisture box with the oven dry soil.

DETERMINATION OF SOIL COLOR BY USING MUNSELL COLOR CHART

Materials required: Munsell soil color chart , Water bottle, Tube or post hole auger, Small clods of soil

Write the procedure for determination of soil color

- Take a small clod of soil and note its moisture condition, weather it is dry or moist.
- Match the color of the clods with the cards showing 'Hue' values.
- Note the 'Hue'.
- Place the clod below the hole of chip and match the nearest 'Value' and 'Chroma'.
- Note the Munsell notation.
- Write the color of the soil according to Munsell notation.
- Find out the color of soil at both dry and moist condition. If soil is dry first note the color of dry soil. Then moist the clod with few drops of water and note the color



ESTIMATION OF BULK DENSITY OF SOIL BY CORE METHOD

Materials required: A core sampler with removable sample cylinder fitted inside, hydraulic or simple jack assembly , a shovel, straight edged knife, moisture box, cellophane tape, balance, and oven.

Write the procedure

- Locate two grass-free and crack-free representative spots for duplicate sampling. .
- Apply a heavy lubricant on the inside wall of the core sample cylinder.
- Place the core sampler over the ungrassed, smooth soil surface in the middle of the jack assembly.
- Attach the jack with the beam of the assembly and position the jack head with the center of the base plate over the handle of the core sampler and align the sampler stem with the jack head
- Drive the jack slowly until the sampler is pushed to the desired depth.
- Reverse the jack and remove the plate over the handle.
- Tilt the sampler a little forward and backward to partly detach from the soil mass below and carefully lift the sample without any jerk and disturbance of natural structure.
- Unscrew the lid over the outer core cylinder and carefully remove the sample holder (inner cylinder).
- Trim the excess soil from each end of the sample holder with a straight-edged sample volume is the same as the volume of the sample holder.

- Transfer the sample to a moisture box and seal with cellophane tape for transportation to the laboratory and oven dry at 105 °C for drying until constant weight.
- Report bulk density along with moisture content in the sample.

ESTIMATION OF BULK DENSITY OF SOIL BY PYCNOMETER METHOD

Materials required: Pycnometer (RD bottle), 50cc capacity, Electronic balance, Burette and Hot air oven

Write the procedure

- Weigh the dry empty pycnometer of 50cc capacity.
- Fill it with soil flush upto bring tapping the bottle about 20 times and find it weight.
- Remove the soil and now fill the bottle with water by burette and note the exact volume of water needed to fill the bottle.

DETERMINATION OF SOIL ORGANIC CARBON BY WALKLEY AND BLACK METHODS

Reagents required for the analysis of organic carbon with their preparations.

- 1 N Potassium dichromate: Dissolve 49.04 g of AR grade $K_2Cr_2O_7$ in about 500 mL of distilled water and make the volume to one litre.
- Conc. Sulphuric acid
- 0.5N Ferrous ammonium sulphate: Dissolve 196 g of ferrous ammonium sulphate in distilled water, add 20 mL of conc. H_2SO_4 and make volume to one litre. The ferrous ammonium sulphate should be from a fresh lot and light green in colour. Yellowing of the salt indicates its oxidation.
- Diphenylamine indicator: Dissolve 0.5 g of the dye in a mixture of 20 mL of distilled water and 100 mL of conc. H_2SO_4.
- Orthophosphoric acid (85%) or sodium fluoride

Procedure: Weigh 1 g of 0.2 mm soil sample into 500 mL dry conical flask of borosilicate glass e.g. Corning, Borosil etc.

- Add 10 mL of 1N $K_2Cr_2O_7$ and 20 mL of conc. H_2SO_4
- Swirl a little and keep on an asbestos sheet for 30 minutes.
- Add slowly 200 mL of distilled water and 10 mL of orthophosphoric acid.
- Add 1 mL of diphenylamine indicator.
- Take 0.5 N ferrous ammonium sulphate solution in 50 mL burette.
- Titrate the contents until green colour starts appearing.
- If the titre value is <6, repeat taking 0.2 to 0.5 g of soil sample.

Interpretations

SN	Organic Carbon (%)	Category
1.	< 0.3	Low
2.	0.5 – 0.75	Medium
3.	> 0.75	High

DETERMINATION OF pH

Materials required: pH meter, Beakers (100 ml), Glass rods, Electrical balance, Measuring cylinder, Washing bottle with distilled water

Preparation of standard buffer solution for pH calibration.

- pH 4.0: Transfer one pH 4.0 buffer tablet into 100 ml volumetric flask. Add distilled water to dissolve the tablet and dilute in to 100 ml.
- pH 7.0: Transfer one pH 7.0 buffer tablet into 100 ml volumetric flask and add distilled water to dissolve the tablet and dilute the solution to 100 ml mark with distilled water.
- pH 9.2: Transfer one pH 9.2 buffer tablet into 100 ml volumetric flask. Add distilled water to dissolve the tablet and dilute in to 100 ml

Procedure for the measurement of soil pH.

- Take 10 g soil in 50 ml beaker.
- Add 20 ml distilled water.
- The suspension is stirred at a regular interval for 30 minutes. This time is required for the soil and water to attain equilibrium.
- After half an hour again stir the soil suspension and measure the pH on a pH-meter and reading taken.

Interpretation

Soil pH Value	>4.5	4.5-5.0	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.5	7.5-8.0	8.0-8.5	8.5-9.5	>9.5
Interpretation	Extremely Acidic	Very Strongly Acidic	Strongly Acidic	Moderately Acidic	Slightly Acidic	Normal	Slightly Alkali	Moderately Alkali	Strongly Alkali	Very Strongly Alkali

What should be precaution during sample analysis

- Proper calibration of pH meter before testing of sample with the help of, 7.0 and 4.0 or 9.2 pH value buffer solution.
- Never touch the glass electrode with bottom of the beaker.
- The electrode must be washed with distilled water and dried with the tissue paper before each measurement.

ESTIMATION OF ELECTRICAL CONDUCTIVITY

Materials required: EC meter, Beakers (100 ml), Electrical balance, Measuring cylinder, Washing bottle with distilled water

Name the reagents required the calibration of EC meter.

- 0.01NPotassium chloride (KCl): Dissolve 0.7456 g dry potassium chloride (AR) in distilled water and make up the volume to 1000 ml. The electrical conductivity of this solution is 1.41 dSm^{-1} at 25^0C.

Write the procedure for determination of EC from soil sample.

- Take 10 g of soil in 100 ml beaker.
- Add 20 ml of distilled water and shake intermittently for 30 minutes and allow standing until clear supernatant liquid is obtained.
- Adjust the instrument for temperature and cell constant accordingly.
- Determine the conductivity of the supernatant liquid with the help of conductivity meter.

Interpretation

S. No.	**Soil**	**EC (dS/m)**	**Total salt content (%)**	**Crop reaction**
1	Salt free	0-4	<0.15	Salinity effect negligible except for more sensitive crop
2	Slightly alkaline	4-8	0.15-0.35	Yield of many crop 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

What should be precaution during sample analysis

- Allow the instrument to warm up for 30 minutes.
- Set the temperature knob to room temperature.
- Ensure that the conductivity cell should be completely dipped into soil: water suspension or extract.
- Wash the conductivity cell with gentle stream of distilled water and wipe with tissue paper.
- Keep the conductivity cell dip in to distilled water when not in use.

TEXTURAL ANALYSIS OF SOIL BY HYDROMETER METHOD

Materials required: 500 ml beaker, filtration apparatus, 1000 ml sedimentation cylinder, 0.2 mm sieve, plunger, shaker, constant temperature room, water bath, Whatman No. 42 filter paper, stop watch, policeman, 105 °C oven, 50 ml china dish, physical balance, standard hydrometer, N/ 10 HCL, 1% $AgNO_3$ solution, phenolphthalein indicator, 5% calgon solution ($NaP0_3$), and 30 % hydrogen peroxide

Write the procedure of texture analysis.

Calibration of hydrometer:

1. Add 100 ml of calgon solution to the sedimentation cylinder.
2. Fill the remaining volume of the sedimentation cylinder with distilled water to make exactly 1 liter and mix the suspension thoroughly with the plunger.
3. Bring the sedimentation cylinder to the constant temperature room and record the temperature after equilibration.
4. Lower the hydrometer into the solution carefully and record the scale reading RL at the upper edge of meniscus surrounding the hydrometer stem.

Particle size analysis:

- Weigh 40 g air-dry soil and equal quantity for determination of the oven-dry weight.
- Transfer the sample in a 600 ml beaker; add 100 ml calgon solution and 400 ml distilled water. Allow the sample to soak for 10 minutes.
- Transfer the suspension to dispersion cup and stir the suspension for 5 minutes with the motor mixer.
- Transfer the suspension to the sedimentation cylinder and make up the volume to 1000 ml mark with distilled water. Place the cylinder in a constant temperature laboratory.
- Mix the suspension thoroughly with plunger and record the time immediately. Record the temperature of the suspension.
- Add a drop of amyl alcohol if the surface is covered with foam and re-stir the suspension with plunger if the time was not recorded immediately.
- Lower the hydrometer into the suspension slowly and read the scale at the top of the meniscus after 30 seconds. Remove the hydrometer carefully, rinse the surface and wipe it dry with a tissue paper.
- Without mixing the suspension between measurements, lower the hydrometer slowly into the suspension about 10 seconds before each measurements and take hydrometer reading R at 3, 10, 30 90. 120 and 720 minutes. (Remove the hydrometer, rinse it and wipe dry with tissue paper after each reading).
- Pour the suspension from the sedimentation cylinder into a 0.2 mm sieve. Discard the effluent.
- Wash the residue on the sieve with clean tap water.
- Transfer the residue from sieve to a china dish, dry it in oven at 105 °C, and report it as coarse sand.

Table: Standard table of sedimentation parameter

R	θ	R	θ	R	θ	R	θ	R	θ	R	θ
-1	49.4	6	47.7	13	45.9	20	43.9	27	41.9	34	39.8
0	49.2	7	47.4	14	45.6	21	43.7	28	41.6	35	39.5
1	48.9	8	47.2	15	45.3	22	43.4	29	41.3	36	39.2
2	48.7	9	47.0	16	45.0	23	43.1	30	41.0	37	38.9
3	48.4	10	46.7	17	44.8	24	42.8	31	40.7	38	38.6
4	48.2	11	46.4	18	44.5	25	42.5	32	40.4	39	38.3
5	47.9	12	46.2	19	44.2	26	42.2	33	40.1	40	38.0

DESCRIPTION OF SOIL PROFILE

Materials required: Digging tools - Spade, pickaxe, khurpi , Cutting knife with a strong wooden handle, Abney's level or inclinometer, Altimeter, Measuring scale / tape, Munsell's colour chart, Dilute hydrochloric acid (10%), Wash bottle (with distilled water), Magnifying lens, Indicator papers, Tray with shoulder, Profile description papers, Soil sample bags with polythene lining, Copying pencil/ ball pen

Write the identification procedure of soil profile.

1.1 Selection of area for profile study

- It is representative of the normal conditions prevailing in the area.
- It is away from tree an irrigation channel/ditch/rivers, roads, human inhabitation etc.
- It shows minimum of human interference, if, possible virgin area should be selected

1.2 **Digging of the profile:** Dig out a pit of size 2m x 2m to a depth of 2 m or upto the parent material. Provide steps, if necessary, on one side for getting into the pit.

1.3 Examine and description of soil profile

- Identify the horizons of the profile on that side of the pit which receives maximum daylight.
- Demarcate the horizons on the basis of characteristics that can be seen or measured in the field such as color, texture, structure, consistence, presence of carbonates etc.
- If the horizons are not properly differentiated as in case of alluvial and black soils, examination of soil should be done at a depth intervals of 15 cm down to 1 m depth and thereafter, at intervals of 15 cm up to 2m or up to the parent material, whichever occurs earlier.
- Location of the profile: Give longitude and latitude with distance and direction from a nearby bench-mark reference site.
- Parent material e.g. alluvium, mica schist, granite etc.
- Physiographic position of the site e.g. terrace, flood plain, depression, plateau, valley bottom etc.
- Land form of surrounding area and elevation (in meters above the mean sea level)
- Hydrology, drainage condition, depth of ground water, moisture condition in the profile and artificial drainage.
- Biological activity, root development etc

- Evidence of erosion and its intensity, presence of salts or alkali
- Human influence like tillage, levelling, use of amendments, heavy manuring etc.
- Presence of surface stones or rock out crop

2. Observations to be recorded during profile study

Horizon symbol, Depth of from the top to bottom of a particular horizon in centimeters, Nature of boundary with the horizon below, Color : Moist and dry –Munsell colour chart, Colour of mottling (if any), Texture: Feel method which will be explained in the field, Structure: Three feature of structure viz. grade, class and type, Consistence : wet, moist and dry, Cutans(ped coatings), pressure faces, slickensides , Roots traces : The quantity, size and location of roots in each horizon, Nodule concretions and cementation (if any), Pores Lithorelics: The content of rock and mineral fragments in each horizon, note down their percentage, Hard pans, Content of carbonates, soluble salts etc, Artefacts : The activity of man's activity, Soil reaction

3. Precaution taken during profile study

- Expose the profile at such a place that it is representative of the whole area.
- Do not expose it at elevated or depressed locations in field or in a direction directly facing the sun.
- Dig the profile at such a place that maximum visibility is obtained.
- Remove the plant cover if any before digging the pit in a manner so that the soil surface is not disturbed.
- Mark the soil sample bags properly indicating location, depth, horizon details, etc.
- Dig the profile pit in such a way that one side of it has steps for movement of the personnel.

DETERMINATION OF SOIL MOISTURE BY NEUTRON PROBE METHOD (INDIRECT METHOD)

Materials required

- Neutron probe assembly consisting of probe, detector, scalar (counting device) and cable.
- Access tube of aluminium or steel of 20 gauze with 1.9 inch and 2.0 inch internal and outer diameter, respectively.
- Soil auger slightly smaller than the tube for drilling the access holes

Write the procedure for installation and moisture detection by neutron probe

- Prepare a plot measuring 1 m × 1 m in the field.
- Drill a hole with the help of auger and insert the access tube in the soil with little disturbance such that no bulge is created in the access tube. Keep the access tube 10-20 cm above the soil and cover with inverted can or close its opening with a rubber cork to prevent entry of trash. In order to prevent water entry into the tube, close the lower end of the access tube with rubber stopper.
- Turn on the scalar and allow it to warm up for few minutes.
- Place the probe on the top of the access tube and measure the counts, called standard counts. The normal counting time is one minute. The 'background' count thus obtained should not be much more than 100 counts per minute. Approximately a 15 cm soil layer is characterized by a single measurement.
- Take readings at successive depth intervals starting at least 18-25 cm from the soil surface.
- Lower the probe in the access tube to a depth at which water content is to be determined and note the counts.
- Calculate the count ratio by dividing the observed counts at a depth by the standard counts.
- Determine the water content of that layer of soil gravimetrically and convert to volumetric water content by multiplying it with bulk density of the soil.
- Construct a calibration curve by filling a linear relation ($\theta v = a + bCR$) between volume water content (θv) and the count ratio (CR).

Write the precautions

- Use dent-free access tubes
- Always plug the lower end of the access tube
- Protect the neutron source from free water, otherwise it will get spoiled
- Do not touch open probe with hands
- Check the batteries of the probe and scalar before taking the instrument to the field.

PRESSURE PLATE APPARATUS

Working principle: Water relationships are among the most important physical phenomena that affect the use of soils for agricultural or engineering purposes. In the laboratory study of these many physical relationships, as well as the extraction of soil solution for chemical analysis, the Pressure Plate Extractors have become eminently successful research tools. Many

methods, such as compaction, centrifugation, displacement, molecular absorption, and suction have been used to investigate the physical properties of soils as well as to remove soil solution for chemical analysis. In each of these methods the range of application is quite limited. In many instances the methods are cumbersome. In some cases the soil structure is destroyed in the process of making an extraction. By contrast the Pressure Plate apparatus provide a convenient, reliable means of removing soil moisture, under controlled conditions, from soil samples throughout the whole plant growth range, without disturbing the soil structure. The method may be used on disturbed samples or undisturbed soil cores. Through the application of the Pressure Plate Apparatus moisture retention curve may be developed for each soil type. The curves relate the soil suction, at which moisture is held by the soil to its moisture content. This relationship is important in studies of soil moisture movement and of quantity and availability of soil moisture for plant growth.

Applications

- Irrigation and Drainage
- Geological & Environmental samples
- Agricultural engineering

MEASUREMENT OF SOIL MOISTURE BY USING TENSIOMETER

Materials required: Tensiometer with porous ceramic cup, connecting tube, flexible thin nylon (surgical) tube with mercury or vacuum gauge, cap and rubber stopper. Scale and supporting stake, air-free (boiled and cooled) water with wash bottle, screw auger and a bucket with mug, moisture boxes, oven, balance, T-joint and pinch cock.

Procedure for the determination of moisture by tensiometer.

Installation of tensiometer

- Fill the tensiometer with air-free water.
- Place the cap firmly and stand the tensiometer in bucket containing air-free, clean water
- Select a representative location in the field.
- Bore a hole slightly smaller in diameter than the cup to the depth of the measuring point.
- Dip the cup in the slurry made from the soil removed from the depth at which the tensiometer is be installed.
- Slowly insert the ceramic cup and its connected tube into the hole and fill gaps around the outside wall prevent the surface water seepage. The gauge or manometer connections should be about 10 cm above the ground level.
- If necessary, twist the tensiometer clock-wise with slight pressure, before packing, to an intimate contact between the wall of the cup and soil.
- Fill air-free water in the tube connected to the ceramic cup and the fine surgical tube (manometer) connected to mercury reservoir with the help of wash bottle. Force water through the tube until air-bubbles remain.

Measurement of soil moisture

- Measure the depth of insertion from the middle of the ceramic cup to the ground surface (Z_1), and height above the ground to the level of mercury in the cup (Z_2). If the reference plane is set at the centre of the cup, (Z_1+Z_2) is the distance from the reference plane to the surface of the mercury in the pot. This will tend to draw the water from the cup and therefore, mercury will rise in the manometer to counterbalance this pulling force {equivalent to (z_1+z_2)}, even if the soil moisture tension is zero. Accordingly, the zero point on the manometer should be set at a height, say Z_3, above the mercury level in the pot.

  Z_3 is given by

  $$Z_3 = [(Z_1+Z_2)/\rho_m-\rho_w]\ \rho_w\ ,\quad \text{cm of Hg}$$

  Where ρ_m and ρ_w are the densities of mercury and water respectively.
- Record rise of mercury in the surgical nylon tube (scale) above the zero point as per schedule and checking for air-bubbles in the connecting tubes. To remove air, open the cap and force air free water into the tube through wash bottle. Replace the cap firmly and record soil moisture tension after the equilibrium is established.
- The tensiometer can also be calibrated in terms of water content in the soil at the level gravimetrically, for the full working range of the tensiometer. To do this proceed as below.
- Select an area of 2.5 m x 2.5 m and make a 0.2 m high bund all around
- Add enough water to saturate the soil well below the measuring depth.
- Two days after wetting, install two tensiometers, 0.25 m away from the centre of the plot long axis, at the depth of the measurement.
- Place bricks for easy access to the tensiometer site when the plot is wet.
- Irrigate the plot again and record the soil suction and moisture content at a convenient interval from near saturation to the highest suction value (take at least 5 observations).
- To determine soil moisture gravimetrically, take 3 samples around the centre of the cup.
- Plot soil water content versus tension on a graph paper.