

Practical Manual
On
Fundamentals of Agronomy
(AG 101)

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FUNDAMENTALS OF AGRONOMY

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EXPERIMENT NO.1

Title: -

Objective: - To Study about various crops of different Botanical name, family & season.

A. Cereals Crop

S.No	Common Name	Botanical Name	Family	Season
1	Rice	Oryza Sativa	Gramineae	Kharif
2	Wheat	Triticum aestivum	“	Rabi
3	Sorghum	Sorghum bicolor	“	Kharif
4	Maize	Zea mays L.	“	“
5	Pearl millet	Pennisetum glaucum	“	Kharif
6	Barley	Hordeum vulgare	“	Rabi

B. Pulses Crop

S.No	Common Name	Botanical Name	Family	Season
1	Chickpea	Cicer arietinum	Fabaceae	Rabi
2	Pea	Pisum sativum	“	“
3	Cowpea	Vigna unguiculata	“	Kharif
4	Soyabean	Glycine max	“	“
5	Mung	Vigna radiata	“	“
6	Lentil	<i>Lens esculenta</i>	“	Rabi
7	Pigeon pea	Cajanus cajan	“	Kharif
8	Urd	Vigna mungo	“	“

C. Oilseed Crop

S.No	Common Name	Botanical Name	Family	Season
1	Groundnut	Arachis hypogaea	Fabaceae	Kharif
2	Seasame	Sesamum indicum	<u>Pedaliaceae</u>	“
3	Mustard	Brassica spp.	Brassicaceae	Rabi
4	Linseed	Linum usitatissimum	<u>Flax family</u>	“
5	Sunflower	Helianthus	<u>Daisy family</u>	All season

D. Fibre Crop

S.No	Common Name	Botanical Name	Family	Season
1	Cotton	Gossypium	<u>Malvaceae</u>	Kharif
2	Jute	Corchorus olitorius	<u>Malvaceae</u>	“
3	Sunn hemp	Crotalaria juncea	Fabaceae	“

E. Forage Crop

S.No	Common Name	Botanical Name	Family	Season
1	Oat	Avena sativa	Poaceae	Rabi
2	Napier grass	Pennisetum purpureum	<i>Poaceae</i>	
3	Berseem	Trifolium alexandrinum	<u>Fabaceae</u>	Rabi
4	Lucerne	Medicago sativa	Fabaceae	“
5	Guar	Cyamopsis tetragonoloba	<u>Fabaceae</u>	Kharif

F. Sugar Crop

S.No	Common Name	Botanical Name	Family	Season
1	Sugarcane	Saccharum officinarum	Poaceae	Kharif
2	Sugar beet	Beta vulgaris L	Chenopodiaceae	Rabi

G. Drug

S.No	Common Name	Botanical Name	Family	Season
1	Tabacco	Nicotiana tabacum	Solanaceae	Rabi

EXPERIMENT No.2

Title: -

Objective: To study about identification of crops, seeds, fertilizers and pesticides.

MATERIALS REQUIRED:

1. Crops (Cereals, pulses and millets)
2. Seeds (Rice, wheat and Maize)
3. Fertilizers(Urea, DAP (Diammonium Phosphate),MOP (Muriate of Potash)
4. Pesticides(Weedicides: Atrazine and Glyphosate)

THEORY:

Identification of crops:

Cereals: Cereals are identified in the fields based on the characteristics possessed by them:

- a. Cereals are herbaceous plants belonging to Grass family (Gramineae or Poaceae)
- b. They have round, hollow stem.
- c. Cereals have narrow leaves and flowers as inflorescence (spikes, earhead and panicles)
- d. They are generally monocots.
- e. Cereals are used in making flours that has been used since ancient time to feed human.

Pulses: Pulses are identified in the fields based on the characteristics possessed by them:

- a. Pulses are the crops that belong to family Leguminaceae or Fabaceae.
- b. Pulses are generally dicots with broad leaves bearing pods.
- c. It adds protein to our diet and fixes atmospheric nitrogen into the soil
- d. Pulses are rich in amino acids like lysine and methionine.

Millets: Millets are identified in the fields based on the characteristics possessed by them:

- a. Millets belong to Grass family (Gramineae or Poaceae)
- b. They produce small edible seeds
- c. Millets have narrow leaves and flowers as inflorescence (spikes, earhead and panicles)
- d. Millets are used as forage crops and as food cereals.

2. Identification of seeds:

Seeds are identified as under:

a. Rice:

1. Rice seeds are oval or round in shape
2. These are straw yellow in color.
3. Rice seeds has following features: Water: 68.44 g
Protein: 2.69 g Energy: 130 kcal

b. Wheat:

1. Wheat seeds are generally oval in shape
2. These are straw yellow in color.
3. It is of 5-7 mm in size

c. Maize:

1. Seeds of maize are bold in appearance.
2. It is pale yellow/bright yellow in color.
3. Seeds are narrow at the end and wider at the top.

4. Identification of fertilizers:

a. Urea:

1. It is extensively used as nitrogenous fertilizer which supplies 46% nitrogen to the soil.
2. Granules of urea are crystalline white.
3. It is an organic fertilizer.

b. DAP (Diammonium Phosphate)

1. It is extensively used as fertilizer which supplies 46% phosphorus and 18% nitrogen to the soil.
2. It is greyish in color.

C. MOP (Muriate of Potash): It is extensively used as fertilizer which supplies 60% potassium to the soil.

2. It is reddish in color.

4. Identification of Weedicides:

a. Atrazine

1. It is a selective weedicide.
2. It kills weeds soon after emergence.
3. It is used in weed management of crops like maize and sugarcane.

b. Glyphosate:

1. Glyphosate (N-(phosphonomethyl) glycine) is a broad-spectrum systemic herbicide and crop desiccant.
2. It is an organ phosphorus compound, specifically a phosphatase.
3. It is used to kill weeds, especially annual broadleaf weeds and grasses that compete with crops.

EXPERIMENT NO. 3

Title: -

Objective: To study identification of tillage implements.

MATERIALS REQUIRED:

1. Primary tillage implements:

- a. Wooden plough
- b. Mouldboard plough
- c. Disc plough
- d. Chisel plough
- e. Rotary hoe

2. Secondary tillage implements

- a. Cultivator
- b. Harrow
- c. Gun taka

3. Implements for sowing

- a. Seed drill
- b. Ferti-cum-seed drill

THEORY:

Tillage: The physical manipulation of soil with tools and implements to result in good tilth for better germination and growth of crops is called tillage.

Primary Tillage: The opening of compacted soil with the help of different plough is called primary tillage.

Secondary Tillage: The finer operation performed on the soil after primary tillage are known as secondary tillage.

A. Primary tillage implements:

Ploughs are used for primary tillage. Implements used for opening and loosening of the soil are known as ploughs. Ploughs are of three types: wooden ploughs, iron or inversion ploughs and special purpose ploughs.

1. **Wooden Plough or Indigenous Plough:** Indigenous plough is an implement which is made of wood with an iron share point. It consists of body, shaft, pole, share and handle. It is drawn with bullocks. It cuts a "V" shaped furrow and opens the soil but there is no inversion. Ploughing operation is also not perfect because some unploughed strip is always left between furrows. This is reduced by cross ploughing, but even then small squares remain unploughed.

Soil Turning Ploughs: Soil turning ploughs are made of iron and drawn by a pair of bullocks or two depending on the type of soil. These are also drawn by tractors.

2. **Mouldboard Plough:** The parts of mouldboard plough are frog or body, mould board or

wing, share, landside, connecting, rod, bracket and handle. This type of plough leaves no unploughed land as the furrow slices are cut clean and inverted to one side resulting in better pulverization. The animal drawn mouldboard plough is small, ploughs to a depth of 15 cm, while two mouldboard ploughs which are bigger in size are attached to the tractor and ploughed to a depth of 25 to 30 cm. Mouldboard ploughs are used where soil inversion is necessary. Victory plough is an animal drawn mouldboard plough with a short shaft.

3. **Disc Plough:** The disc plough bears little resemblance to the common mouldboard plough. A large revolving concave steel disc replaces the share and the mouldboard. The disc turns the furrow slice to one side with a scooping action. The usual size of the disc is 60 cm in diameter and this turns a 35 to 30 cm furrow slice. The disc plough is more suitable for land in which there is much fibrous growth of weeds as the disc cuts and incorporate the weeds. The disc plough works well in soil free from stones. No harrowing is necessary to break the clods of the upturned soil as in a mouldboard plough.

4. **Chisel plough:** It is mainly used for breaking hard pans and for deep ploughing (60- 70 cm) with less disturbance to the top layers. Its body is thin with replaceable cutting edge so as to have minimum disturbance to the top layers it contains a replaceable share to shatter the lower layers.

5. **Rotary hoe:** It cuts the soil and pulverizes it. The cutting of soil is done by either blades or tynes. The blade types are widely used. The depth of cut is up to 12 to 15 cm. It is suitable for light soils.

B. Secondary tillage implements: Different types of implements like cultivators, harrows, plank and rollers are used for secondary tillage.

1. **Tractor Drawn cultivator:** Cultivator is an implement used for finer operation like breaking clods and working the soil to a fine tilth in the preparation of seed bed. Cultivator is also known as tiller or tooth harrow. It is used to further loosen the previously ploughed land before sowing. It is also used to destroy weeds that germinate after ploughing. Cultivator has two rows of tynes attached to its frame in staggered form. The main object of providing two rows and staggering the position of tynes is to provide clearance between tynes so that clods and plant residues can freely pass through without blocking. Provision is also made in the frame so that tynes can be set close or apart as desired. The number of tynes ranges from 7 to 13. The shares of the tynes can be replaced when they are worn out.

2. **Harrow:** Harrows are used for shallow cultivation in operations such as preparation of seedbed, covering seeds and destroying weed seedlings. Harrows are of two types' disc harrow and blade harrow.

1. **Disc Harrow:** The disc harrow consists of a number of concave discs of 45 to 55 cm in diameter. These discs are smaller in size than disc plough, but more number of discs are arranged on a frame. These discs are fitted 15 cm apart on axles. Two sets of discs are mounted on two axles. All the discs revolve together with axles. The discs cut through the soil and effectively pulverize the clods.

2. **Blade Harrow:** Blade harrows are used for different purposes like removal of weeds and stubbles, crushing of clods, working of soil to shallow depth, covering the seeds, inter cultivation and harvesting of groundnut etc.

3. **Indigenous Blade Harrows:** The general design of an indigenous blade harrow which is known as guntaka consists of a beam to which two pegs are attached at the ends. A blade is attached to these two Pegs. Two shaft poles and a handle are the other parts of guntaka.

3. **Guntaka:** Guntaka or blade harrow is smaller than peddaguntaka. Though the length of the beam is almost same, weight of the beam is lighter than peddaguntaka. It is used for removal of weeds and stubbles and for covering crop seeds. It is worked by a pair of cattle.

C. Implements for sowing:

1. **Seed Drill:** Seed drill consists of a wooden beam to which 3 to 6 tynes are fixed. These tynes open the furrows into which the seeds are dropped. Holes are made into these tynes and into these holes, the bottom ends of bamboo or metal seed tubes are fitted. These seed tubes are connected at the top to a wooden seed receptacle called hopper. The seeds are fed at a uniform rate into this hopper by skilled labour walking behind the seed drill.

2. **Ferti-cum-Seed Drill:** Fertilizers are placed at a depth of 5 cm and 5 cm away from seed rows for effective utilization of fertilizers. Both operations viz. drilling seeds and fertilizers are done simultaneously by Ferti-cum-seed drill. It is similar to seed drill, but with extra tynes and hopper for drilling fertilizers.

EXPERIMENT NO.4

Title: -

Objective: To study effect of sowing depth on germination and seedling vigour.

MATERIALS REQUIRED:

1. Seeds of wheat
2. Experimental pots (20 cm diameter)
3. Rose can for watering
4. FYM (Farm Yard Manure)
5. Carbendazim for seed treatment

THEORY:

1. The depth of sowing seed is important as it contributes in achieving a good crop stand and establishment resulting in higher yield.
2. To shallow sowing results in poor germination due to inadequate soil moisture at top soil layer.
3. On the other hand deep sowing can also result significantly reduced crop yield and emergence.
4. If the depth of coleoptile is less than the depth of planting, emergence of seeds become difficult.

Procedure:

1. Experimental pots were filled with soil and FYM upto different depth marked on the pots.
2. Healthy wheat seeds were treated with carbendazim @ 2.5g/kg of seeds.
3. Five seeds of wheat seeds were sown at the depth of 5 cm and 10 cm deep.
4. Irrigation was given immediately after sowing.
5. Seedling emergence were observed in each experimental pots.

Result:

1. The seeds which were sown at 5 cm germinated after 8 days of sowing.
2. The seeds which were sown at 10cm germinated 14 days after sowing.
3. Shorter primordial leaves observed in seeds sown at 10 cm depth.
4. Poor seedling vigour observed in seeds sown at 10 cm depth.

CONCLUSION:

On the basis of seed germination and seedling vigour, the optimum depth of sowing for the seed can be considered 5-6 cm.

EXPERIMENT NO.5

Title: -

Objective: To study the yield contributing characters and yield estimation.

Post- harvest studies

A. Yield attributing characters

1. Number of Panicles m⁻² Procedure:

Two randomly selected spots, previously used for counting the number of total tillers were also used for counting panicles/m² by running 1 m row length in randomly selected two spots of transplanted and drum seeded rice while 50 cm² quadrat in case of broadcasted crop. Then the values were converted to per m².

2. Panicle length (cm) Procedure:

The length of ten randomly selected panicles from each plot at maturity were measured in cm by using meter scale from neck-node to the tip of the apical grains and were averaged for recording mean panicle length.

3. Number of total grains/panicle Procedure:

Ten panicles selected for measuring the panicle length were used for knowing the total number of grains per panicle. Total number of filled grains were also counted.

4. Number of filled grains /panicle Procedure:

The grains from ten randomly selected panicles were separated and cleaned. Sound and bold grains were counted and averaged for recording mean filled grains/ panicle.

5. 1000 grain weight Procedure:

One thousand cleaned dried seeds were counted randomly from the yield of each plot and weighed by using a digital electronic balance to determine the test weight.

B. Yield Estimation

1. Grain yield Procedure:

Each plot was marked for net plot size to remove the border effect, the net plot was harvested, threshed and cleaned. After complete sun drying the grain weight of each net plot was measured on physical top balance and converted to quintals per hectare. The results were expressed on **14 % moisture basis.**

2. Straw yield Procedure:

After threshing, the cleaned grain yield was deducted from the bundle weight for obtaining straw yield of each net plot area and converted to quintals per hectare.

3. Harvest index (HI)

Procedure:

Harvest index for each plot was calculated from the economic yield and biological yield by using expression as suggested by Singh and Stoskopf (1971). The economic yield indicates grain yield whereas, the biological yield represents the total yield (grain + straw) of the plot. Harvest index (HI) was calculated by the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (grain + straw) (kg/ha)}} \times 100$$

For Examples

Q. Calculate the Harvest Index of Rice crop based following data.

- a. Grain Yield = 10 tones/h
- b. Straw Yield = 6 tones/h

EXPERIMENT NO. 6

Title:-

Objective: To study Seed germination and viability test.

MATERIALS REQUIRED:

1. Petri dishes
2. Alcohol (70-90%) as sterilizer
3. Absorbent paper
4. Filter paper- Whatmann Grade 181
5. Distilled water
6. Funnel
7. Seeds of cereal
8. Thin plastic bag

THEORY:

Seed viability is the measure of how many seeds in a lot are alive and could develop into plants that will reproduce under appropriate field conditions.

Top-of-paper method: This method is most suitable for species with seeds smaller than 2 mm in diameter such as small-seeded vegetables and forage grasses. The seeds are germinated on top of moist absorbent paper in containers with close-fitting lids to prevent moisture loss. Commonly used containers include 9 cm glass or plastic Petri dishes.

Procedure:

1. Sterilize container surfaces by wiping with 70–95% alcohol or soaking in 20% bleach or hot water at 55°C for 10–15 minutes.
2. Cut the absorbent paper to the size and shape of the container. For Petri dishes, round filter paper such as Whatmann Grade 181 of appropriate diameter can be used.
3. Place the paper substrate at the bottom of the container or Petri dish.
4. Label containers with accession number, number of replicate and testing date; use a pencil or permanent marker for labelling.
5. Add the required volume of distilled water. If distilled water is not available, boiled and cooled tap water can be used. The volume of distilled water depends on the thickness of the paper substrate and the size of container. For Whatman Grade 181 filter paper in 9 cm Petri dishes, 4 ml of water is required. The filter paper should not be so wet that a film of water forms around the finger when it is pressed.
6. Firm down the paper substrate in the container using an upside down funnel or tweezers.

7. Spread the seeds uniformly on the surface of the paper so that they are not touching. It is recommended that the distance between seeds should be at least three to five times the seed diameter.
8. Cover the containers and ensure that there is no air lock resulting from excess moisture on the covers.
9. Place the containers in a germinator or incubator maintained at the recommended temperature for germination of the species.
10. Check the moisture level of the substrate regularly, especially when humidity inside the cabinets is not controlled or when the temperature is set at 25°–30°C. Blotters usually need to be watered several times during the test. Alternatively, keep the containers in a thin plastic bag (loosely folded at the open end, but not sealed to allow diffusion of oxygen) to prevent the substrate from drying.
11. Run the test for the recommended period and count the number of seeds that have germinated.
12. If some seeds have not germinated and appear to be dormant, treat with appropriate techniques to stimulate germination and continue the test until all seeds have germinated or until no further germination has occurred after two consecutive counts.
13. Make a note of the seeds that did not germinate but are firm and sound at the end of the first count, and those that failed to germinate and are presumed dead at the end of the germination test.

EXPERIMENT NO-07

Title:-

Objective: - To study the calculation of fertilizer requirement.

THEORY: -

Question

What will be the recommended dose of fertilizer for rice crop sown in the area of 1 ha (10000 sq.) if N, P₂O₅, K₂O is supplied as 120:60:40 kg/ha through Urea, DAP (Diammonium phosphate) and MOP (Muriate of potash).

[Urea: 46% N, DAP: 46% P; 18% N; MOP: 60% K₂O]

SOLUTION: -

Formula-

Amount of fertilizers required in kg/ha = Recommended dose X Area *ha m*² X Conversion factor (c.f) 10000 m²

First we calculate the dose of DAP, because DAP contains both nitrogen and phosphorus.

CALCULATION: -

Calculation of P₂O₅ and N from DAP:-

46 kg of phosphorus is supplied by = 100 kg DAP

60 kg of phosphorus is supplied by = $100 \times 60 = 130.43$ kg of DAP 46

Now,

18 kg of nitrogen is supplied by = 100 kg of DAP i.e.

100 kg of DAP gives = 18 kg N

130.43 kg DAP gives = 18×130.43 kg N = 23.47 kg of N.100

Calculation of Nitrogen from urea: - Nitrogen is supplied by both urea and DAP

Hence, required nitrogen supplied through urea is = $(120 - 23.47)$ kg N = 96.5 kg N

Calculation of potash from MOP:-

60 kg of potash is supplied by 100 kg MOP

40 kg of potash is supplied by = 100×40 kg MOP = 66.66 kg MOP 46

RESULT: -

The recommended dose of fertilizers for supplying 120:60:40 kg of N: P₂O₅: K₂O per hectare for rice crop is

Urea = 209.83 kg/ha

MOP = 66.66 kg/ha DAP = 130.43 kg/ha

EXPERIMENT No. 08

Title:-

Objective: - To study the calculation on plant population and water requirement.

THEORY: -

Plant population: - Plant population refers to the plant density which depends on number of viable seeds, germination percentage and survival rates.

FORMULAE: -

$$\text{Plant population} = \frac{\text{Area m}^2}{\text{Spacing of crop R.R X P.P m}^2}$$

Where,

R.R is row to row spacing between the plants,
is plant to plant spacing

Question-

Calculate the plant population for following plants

- a) Rice (20 X 10) cm
- b) Wheat (22.5 X 10) cm
- c) Maize (60 X 20) cm
- d) Sorghum (45 X 15) cm

Solution-

$$\begin{aligned} \text{a) Plant population of rice} &= \frac{10000 \text{ m}^2 \times 100}{20 \times 10 \text{ m}^2} \\ &= \frac{10000}{200} = 5000 \text{ plants/hecture} \end{aligned}$$

Water requirement of a crop: -

$$\text{Irrigation Requirement IR} = \text{WR} - (\text{ER} + \text{S})$$

Where,

IR = Irrigation requirement

WR = Water requirement of a crop

ER = Effective rainfall

S = Depth of shallow water table

Irrigation Requirement: Irrigation Requirement (IR) refers to the quantity of water, exclusive of effective rainfall (ER) and soil profile contribution from that of shallow water table also (S), required for crop production. This amounts to net irrigation requirement plus other economically unavoidable losses.

Farm irrigation requirement depends on water needs of individual crops, their area and losses

application mainly by way of seepage and refers to the quantity of water delivered at the point of entry into the individual field to be irrigated. The irrigation requirement of an outlet command area includes the irrigation requirements of individual farm holdings and the losses (seepage, percolation, evaporation and weed consumption) during conveyance in the distribution system from the outlet of command area to the individual farm holdings. Irrigation interval is the time between the starting of one irrigation and starting of the next on the same field. Irrigation period is the time taken for giving one irrigation for a specified area of land for a specified area of crop.

EXPERIMENT No. 09

Title:-

Objective: -To study use of tillage implements (reversible plough, harrow, leveller, seed drill).

MATERIALS REQUIRED:

1. Reversible plough
2. Harrow
3. Leveller
4. Seed Drill.

THEORY:

Uses:

1. Reversible plough: It is a one way plough that facilitates inversion of furrow slice to one side only.
2. Harrow: Harrows are used for shallow cultivation in operations such as preparation of seedbed, covering seeds and destroying weed seedlings. Harrows are of two types' disc harrow and blade harrow.
3. Leveller: It is an important equipment that is used for farming and agriculture with a purpose to level the land in order to achieve a uniform slope, good drainage good seed bed.
4. Seed Drill:
 - a. Seed drill is a secondary tillage implement that consists of a wooden beam to which 3 to 6 tynes are fixed. These tynes open the furrows into which the seeds are dropped.
 - b. The seeds are fed at a uniform rate into this hopper by skilled labour walking behind the seed drill.

EXPERIMENT No. 10

Title:-

Objective: -To study soil moisture measuring devices.

MATERIALS REQUIRED:

1. Tensiometer
2. Neutron moisture meter
3. Pressure membrane and pressure plate apparatus

THEORY:

Tensiometer:

1. Tensiometer are also called irrometers since they are used in irrigation scheduling. A Tensiometer consists of a long tube with a pores ceramic cup at one end .The other end of the tube is closed with rubber cork and a vacuum gauge is fitted to the side of the tube. The length of the tube varies from 30 cm to 100 cm depending on the depth at which moisture is to be estimated.
2. With the help of a crow bar a hole is made in the soil to the desired depth. Tensiometer is placed in the hole and firmly pressed on all sides for the soil to be in close contact with the ceramic cup.
3. The tube is filled with water slowly so as to mold formation of air bubbles. As soil dries, water from the porous cup enters the soil.
4. Due to depletion of water in the tube, vacuum is measured with vacuum gauge.
5. Refilling of the tube is necessary after each irrigation or rainfall.
6. Tensiometer is sensitive up to 0.9 bars of soil moisture.
7. Hence, Tensiometer are suitable for sandy soils as most of the available water are upto 1 bar potential.

Neutron Moisture Meter.

1. Soil moisture can be estimated quickly and continuously with neutron moisture meter without disturbing the soil. Another advantage is that soil moisture can be estimated from large volume of soil. This meter scans the soil to about 15 cm diameter around the neutron probe in wet soil and 50 cm in dry soil.
2. Neutron moisture meter consists of a probe and a scalar or rate meter. The probe contains fast neutron source which may be a mixture of radium and beryllium or americium and beryllium.
3. Access tubes are aluminum tubes of 50 to 100 cm length and are placed in the field where

moisture has to be estimated. Neutron probe is lowered into access tubes to the desired depth.

4. Fast neutrons are released from the probe which scatter into the soil. When the neutrons encounter nuclei of hydrogen atoms of water, their speed is reduced. The Scalar or rate meter counts the number of slow neutrons which are directly proportional to water molecules.

5. Moisture content of the soil can be known from the calibration curve with counts of slow neutrons. The two drawbacks of the instrument are that it is expensive and moisture content from shallow top layers cannot be estimated. The fast neutrons are also slowed down by other sources of hydrogen (present in the organic matter). Other atoms such as chlorine, boron and iron also slow down the fast neutrons thus overestimating the soil moisture content.

Pressure Membrane and Pressure Plate Apparatus.

1. Pressure membrane and pressure plate apparatus is generally used to estimate field capacity, permanent wilting point and moisture content at different pressures.

2. The apparatus consists of air-tight metallic chamber in which porous ceramic pressure plate is placed. The pressure plate and soil samples are saturated and are placed in the metallic chamber.

3. The required pressure, say 0.33 bar or 15 bars is applied through a compressor. The water from the soil sample which is held at less than the pressure applied trickles out of the outlet till equilibrium against applied pressure is achieved.

4. After that, the soil samples are taken out and oven-dried for determining the moisture content.

EXPERIMENT No. 11

Title:-

Objective: -To study Measurement of field capacity, bulk density and infiltration rate.

Field Capacity: When the supply of water is stopped, water continues to drain from large pores for a day or two and become negligible thereafter. The macropores are again filled with air. The micropores are still filled with water and it moves because of capillary force. This water is called capillary water (**Fig 4.11**). The soil is then said to be at its field capacity (FC). Soil moisture tension, which varies from soil to soil, generally, ranges from 1/10 to 1/3 atmospheres. Soil water potential at FC ranges from - 0.1 to - 0.3 bars or - 0.01 to - 0.03 MPa (Mega Pascal). Field capacity is considered as the upper limit of water availability to plants. Soil water content at FC can move in any direction, but always in the direction of increasing tension.

Dry bulk density: A given bulk of soil is not all solids. On volume basis, it may be about 50 per cent pore space occupied by water and air. The dry bulk density or simple density (P_b) is the ratio of mass of oven dry soil solid particles (M_s) to the total volume of the soil (V_b). This volume includes the volume of soil solids (V_s), soil water (V_w) and air (V_a). The volume of water and volume of air constitute the total volume of pores.

Therefore, bulk density is expressed as: $P_b = M_s / V$ $V = V_s + V_w + V_a$

Soil texture, structure, organic matter content and soil management practices influence bulk density of soil. For a soil in which the pores constitute half of the volume, bulk density is half of particle density, namely 1.3 to 1.35 g cm⁻³. In sandy soils, bulk density can be as 1.6 g cm⁻³. In extremely compacted soils, bulk density might approach, but never reach, particle density. Ideal bulk density for optimum crop growth varies from 1.2 g cm⁻³ for a soil to about 1.4 g cm⁻³ for a sandy soil.

Infiltration: It refers to the entry and downward movement of water into the soil surface. Infiltration is a surface characteristic of a soil.

Infiltration rate is the rate at which the water is passing through the surface to the soil. Initially, the infiltration rate is more but it decreases because the soil gets wet

. According to the rate of entry of water from surface to the soil, infiltration rate is grouped in to four categories.

1. Very slow: Soils with less than 0.25 cm h⁻¹ - very clay soils
2. Slow: Infiltration rate of 0.25 cm to 1.25 cm h⁻¹ - soils with high clay
3. Moderate: Infiltration rate of 1.25 to 2.5 cm h⁻¹ - sandy loam/silt loam soils
4. Rapid: Infiltration rate is more than 2.5 cm h⁻¹ - deep/sandy silt loam soils.

EXPERIMENT No. 12

Title:-

Objective: -To study measurement of irrigation water.

THEORY:

1. Measurement of water is needed in several aspects of irrigation water management. An essential condition of efficient use of irrigation water is that the water delivered and used be measured to ensure maintenance of proper delivery schedule to:

- ❖ Determine the amount of water delivered to the land
- ❖ Test the wells for their yield in meeting the crop water requirements
- ❖ Estimate conveyance and other losses
- ❖ Detect the origin of these losses for remedial action.

Most flow rate measurements are based on the fundamental equation:

$$Q=A \times V$$

Where,

Q = Volume flow rate (discharge) in liters per second (1 s⁻¹) A = Cross-sectional area of flow (cm²) V = Velocity of flow through the cross-section (cm³).

2. **Volumetric method:** It is the simplest method of water measurement to calculate discharges from pumps or other water lifts commonly used in the small farms. Water is allowed to flow from irrigation channel through a siphon tube into a bucket. Time required to fill the bucket is noted. Discharge rate of flow of water in the channel is calculated as indicated below:

$$\text{Discharge rate} = \frac{\text{Volume of water collected in the bucket}}{\text{Time required to fill the bucket}}$$