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Soil Moisture Determination Methods

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Water, an excellent solvent for most of the plant nutrients, is a primary requisite for plant growth. Water serves four functions in plants: it is the major constituent of plant protoplasm (85-95%); it is essential for photosynthesis and conversion of starches to sugars; it is the solvent in which nutrients move into and through plant parts; and it provides plant turgidity, which maintains the proper form and position of plant parts to capture sunlight. In fact, the soil water is a great regulator of physical, chemical and biological activities in the soil. Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. As a result, soil moisture plays an important role in the development of weather patterns and the production of precipitation. Therefore, the measurement of soil moisture is needed to determine when to irrigate and the amount of water needed for irrigation, to evaluate evapotranspiration and to monitor soil matric potential.

Direct Methods

Gravimetric Method

- The gravimetric method is a direct measurement of soil water content and is therefore the standard method by which all indirect methods are calibrated.
- The gravimetric water content, also called mass water content, is the ratio of the weight loss in drying to the dry weight of the soil sample. The mass water content can be expressed as mass water percentage by multiplying it with 100.
- This method involves collecting soil sample from the field using soil auger from representative depths in the root zone and then determining its fresh and dry weights.
- The moist weight is determined by weighing the soil sample as it is at the time of sampling, and the dry weight is obtained after drying the soil sample in an oven at 105°C for 24 hours or more to get a constant dry weight.
- The weight loss represents the soil water.

Volumetric Method

- The volumetric water content is defined as the volume of water present in a given volume (usually 1 m3) of dry soil.
- When multiplied by 100 it gives volume water percentage. This method involves collecting soil sample from the field using core sampler of known volume from representative depths in the root zone and then determining its moist and dry weights.
- To calculate the volume water content from gravimetric water content, we need to know the bulk density.
- In the field we think of plant root systems as exploring a certain depth of soil, and because we express precipitation and irrigation components, as depth of water (for

example mm of rain or irrigation), it is often convenient to express the volumetric water content as a depth ratio (depth of water per unit depth of soil).

- Conveniently, the numerical values for these two expressions are the same. For example, for a soil containing 0.1 m3 of water per m3 of soil (10% by volume) the depth ratio of water is 0.1 m of water per metre depth of soil.

Spirit Burning Method

- Soil moisture from the sample is evaporated by adding alcohol and iginiting. Provided the sample is not too large, the result can be obtained in less than 10 minutes.
- About 1.0 ml of spirit or alcohol per g of soil sample at field capacity and 0.5 ml at permanent wilting point is adequate for evaporating the soil moisture.
- This method is not recommended for soils with high organic matter content.

Infrared Moisture Balance

It consists of a 250 watt infrared lamp, sensitive balance and autotransformer. All housed in an aluminium cabinet. The radiation emitted by infrared lamp quickly vaporizes the soil moisture. The instrument is directly calibrated in per cent moisture. It gives fairly reliable moisture estimates in about 5 minutes.

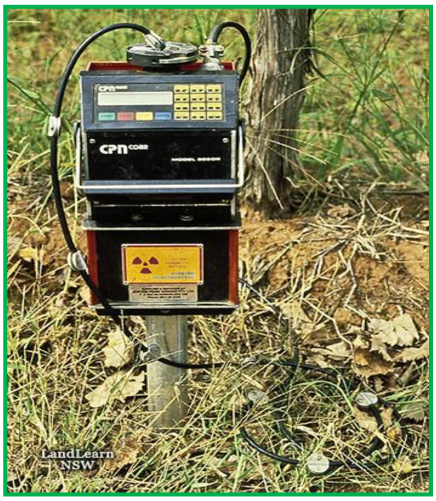
Indirect Methods

Electrical Resistance Blocks

Gypsum blocks or electrical resistance blocks, with two electrodes, is placed at a desired soil depth and allowed to come to equilibrium with soil moisture.

- Electrical resistance of the block is measured by a meter based on the principal of **Whetstone Bridge**.
- Electrical resistance of the soil decreases with increase in water content. Soil water content is obtained with calibration curve, for the same block, of electrical resistance against known soil water content.
- Resistance blocks read low resistance (400 – 600 ohms) at field capacity and high resistance (50,000 to 75,000 ohms) at wilting point.

Neutron Scattering Technique

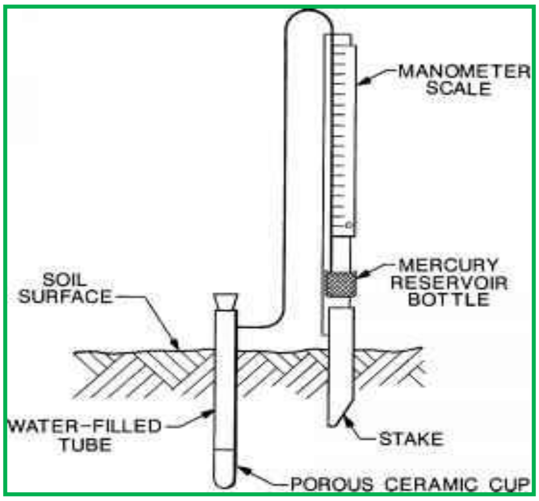


- The neutron moisture meter consists of two main components viz., a probe containing a source of fast neutrons (**americium and beryllium**) and **boron trifluoride** (BF_3) gas as a detector of slow neutrons, which is lowered into a hollow access tube pre-inserted into the soil;
- A scaler or rate meter usually battery powered and portable to monitor the flux of the slow neutrons that are scattered and attenuated in the soil.
- The fast neutrons (having an energy range of 2 – 4 MeV (million electron volt) and an average speed of about 1600 km/sec) are emitted radially into the soil, where they encounter and collide with hydrogen nuclei (namely protons).

- Through repeated collusions, the neutrons are deflected and "scattered", and they gradually loose some of their kinetic energy.
- As the speed of the initially fast neutrons diminishes, it approaches a speed of 2.7 km/sec, equivalent to a energy of about 0.03 eV (electron volt).
- Neutrons slowed down to such a speed are said slow neutrons. The slow neutrons thus produced scatter randomly in the soil, quickly forming a cloud of constant density around the probe.
- The density of sow neutrons formed around the probe is nearly proportional to the concentration of hydrogen in the medium surrounding the probe, and therefore approximately proportional to the volume fraction of water present in the soil.
- The slowed neutrons are detected by slow neutron detector containing BF3 gas, which is then transmitted through electric pulses to the scaler and is displayed as moisture content.

Tensiometer

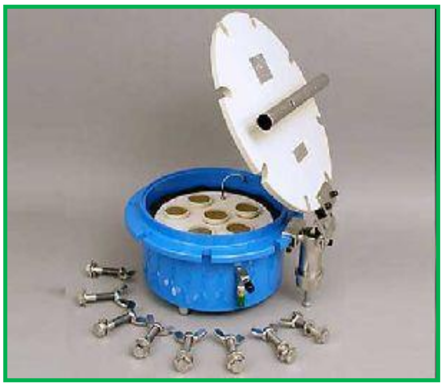
- The tensiometer is an instrument designed to provide a continuous indication of the soil's matric suction (also called soil-moisture tension) in situ.
- The tensiometer consists of a porous ceramic cup, connected through a tube to a vacuum gauge (or manometer),
- All parts filled with water.
- Cup is placed in the soil where the suction measurement is to be made,
- The water inside the cup comes into hydraulic contact and tends to equilibrate with soil water through the pores in the ceramic walls. When initially placed in the soil,
- The water contained in the tensiometer is generally at atmospheric pressure (essentially, 0 bars tension).
- Soil water, being generally at higher tension, exercises a suction, which draws out a certain amount of water from the rigid and air tight tensiometer.



- Consequently, the pressure inside the tensiometer falls below atmospheric pressure.
- The subpressure is indicated by a vacuum gauge or manometer.
- A Tensiometer left in the soil for a period of time tends to track the changes in the soil's matric suction.
- As soil moisture is depleted by drainage or plant uptake, or as it is replenished by rainfall or irrigation, corresponding readings on the Tensiometer gauge occur.
- Suction measurements by tensiometry are generally limited to matric suction values below 1 bar or 100 kPa.
- However in practice, under field conditions the sensitivity of most tensiometers is a maximal tension of about 0.85 bars or 85 kPa.

Pressure Plate and Pressure Membrane Apparatus

- Laboratory measurements of soil water potential are usually made with pressure membrane and pressure plate apparatus.
- It consists of ceramic pressure plates or membranes of high air entry values contained in airtight metallic chambers strong enough to withstand high pressure of 15 bars or more.



- The apparatus enables development of soil moisture characteristic curves over a wide range of matric potential.
- The porous plates are first saturated and then soil samples are placed on these plates.
- Soil samples are saturated with water and transferred to the metallic chambers.
- The chamber is closed with special wrenches to tighten the nuts and bolts with required torque for sealing it. Pressure is applied from a compressor and maintained at a desired level.
- It should be ensured that there is no leakage from the chamber. Water starts to flow out from saturated soil samples through outlet and continues to trickle till equilibrium against the applied pressure is achieved.
- Soil samples are taken out and oven dried to constant weight for determining moisture content on weight basis. Moisture content is determined against pressure values varying from −0.1 to −15 bars.
- The values of moisture content so obtained at a given applied pressure are used to construct soil moisture characteristic curves.

Conclusion

The soil moisture content of soil is the quantity of water it contains. Water content is used in a wide range of scientific and technical areas. The soil moisture content of soil is the quantity of water it contains. In soil science, hydrology and agricultural sciences, water content has an important role for groundwater recharge, agriculture and soil chemistry. If the moisture content of a soil is optimum for plant growth, plants can readily absorb soil water.