College of Agriculture Engineering Sciences

Soil and Water Dept. (Principle of Irrigation)

3rd stage Lecture (3)

Soil Water Content

2022-2023

Soil Water Content

Water content or moisture content is the quantity of water contained in a material, such as soil (called soil moisture). which can range from 0 (completely dry) to the value of the materials' porosity at saturation. It can be given on a volumetric or mass (gravimetric) basis.

a) Gravimetric water content $(\boldsymbol{\theta_m})$

Gravimetric water content (θm) is the mass of water per mass of dry soil. It is measured by weighting a soil sample, drying the sample to remove the water, then weighting the dried soil.

$$\boldsymbol{\theta_m = \frac{M_w}{M_s}}$$

Where: θ_m= Gravimetric water content, M_w = Mass weight of water and M_s= Mass weight of solid.

b) Volumetric water content $(\boldsymbol{\theta_v})$

Volumetric water content is a numerical measure of soil moisture. It is simply the ratio of water volume to soil volume.

Another equally valid measurement is GWC, gravimetric water content, which measures weight rather than volume.

$$\boldsymbol{\theta_v = \frac{V_w}{V_s}} \quad \textbf{or} \quad \boldsymbol{\theta_v = \rho_b * \theta_m}$$

Where: θ_v= Volumetric water content, V_w= Volume of water, V_s= Volume of solid, ρ_b= bulk density and θ_m= Gravimetric water content.

Example: A soil is sampled by a core measuring 7.8 cm in diameter and 8.4 cm height. Calculate gravimetric and volumetric water contents and dry bulk densities using the following data:

1. Weight of empty core = 300 g
2. Weight of core + wet soil = 1000 g
3. Weight of core + oven dry (105^0C) soil = 860 g

Answer:

Why soil moisture is important?

Applying water too soon or in excess of crop needs, or applying it too late and less than the crop needs, results in inefficient irrigation application;

so, we need to measure water content or soil moisture to know the best time for irrigation.

Soil moisture measurements

The soil moisture status requires measurements in the field, from which one can:

- Known times of the next irrigation.
- What depth of water should be applied.
- How much water has been applied and its uniformity over the field.

Bulk density, field capacity, and the permanent wilting point are also needed.

Methods of Soil moisture measurements

Direct method	Indirect method
Feel method	Tensiometer
Volumetric method	Gypsum block
Gravimetric method	Neutron probe
	Time domain reflectometer
	Remote sensing

Feel Method

- The feel method involves estimating soil–water by feeling the soil.

Gravimetric method

The soil sample is collected in a moisture can and the wet weight of the sample is recorded. The soil sample is dried in the oven at 105 ℃ for 24-48 hours until constant weight is obtained and the dry weight of the sample is recorded.

$$\textbf{moisture content} = \frac{\textbf{Wet weight} - \textbf{Dry weight}}{\textbf{Dry weight}} \times 100$$

Tensiometer

Tensiometers are (PVC) tubes filled with degassed water, connected at one end to a porous ceramic cup and attached to a pressure gauge or sensor at the other end.

They are normally buried permanently in the soil at a specific depth. A tensiometer measures soil water suction (negative pressure), which is usually expressed as tension. This suction is equivalent to the force or energy that a plant must exert to extract water from the soil.

Soil-water tension is commonly expressed in units of bars or centibars. One bar is equal to 100 centibars (cb).

How tensiometer work

A tensiometer is a water-filled tube with a vacuum gauge and filling port at the upper end and a ceramic cup at the lower end.

When it is placed in the soil, the water in the instrument comes to equilibrium with the water in the soil by flowing through the ceramic cup. At equilibrium, the water tension in the instrument is equal to the water tension in the soil. Then the vacuum gauge measures the soil water tension.

Gypsum blocks

Gypsum blocks use two electrodes placed into a small block of gypsum to measure soil water tension. Wires connected to the electrodes are connected to either a portable hand-held reader or a data logger.

The amount of water in the soil is determined by the electrical resistance between the two electrodes within the gypsum block. More water present in the soil will reduce the resistance, while less water will increase it.