

Unit C: Traits of Soil

Lesson 4: Water and Air of Soil

Terms

- ▶ Gravitational Water
- ▶ Capillary Water
- ▶ Hygroscopic Water
- ▶ Saturation
- ▶ Field Capacity
- ▶ Wilting Point
- ▶ Air Dry

- I. There are three stages of water found in soil
 - A. Gravitational water– free water that flows freely through soil due to the force of gravity.
 - 1. Gravitational water is found in the macropores. It moves rapidly out of well drained soil and is not considered to be available to plants.
 - 2. It can cause upland plants to wilt and die because gravitational water occupies air space, which is necessary to supply oxygen to the roots.
 - 3. Drains out of the soil in 2–3 days.

B. Capillary water–water found in the small holes of soil.

1. Most, but not all, of this water is available for plant growth
2. Capillary water is held in the soil against the pull of gravity. Forces acting on Capillary Water micropores exert more force on water than do macropores. Capillary water is held by cohesion (attraction of water molecules to each other) and adhesion (attraction of water molecule to the soil particle). The amount of water held is a function of the pore size (cross–sectional diameter) and pore space (total volume of all pores). This means that the tension (measured in bars) is increasing as the soil dries out.

- C. Hygroscopic water– water that forms very thin films around soil particles forming a tight bond. This water is unavailable to plant use.
1. Not held in the pores, but on the particle surface. This means clay will contain much more of this type of water than sands because of surface area differences.
 2. Hygroscopic water is held very tightly, by forces of adhesion. This water is not available to the plant.
 3. Gravity is always acting to pull water down through the soil profile. However, the force of gravity is counteracted by forces of attraction between water molecules and soil particles and by the attraction of water molecules to each other.

II. Water is used in many different formats when found within soil.

A. Water is used for plant growth.

1. Plants absorb water available to them for growth throughout their lifespan.
2. Too much water could “drown” the plant causing it to die.
3. Roots of a plant **MUST** be able to exchange gases within the soil in order to survive.

B. Water is used to form tight bonds between clay particles.

1. Water not available to plants causes tight bonds to clay particles. These clay particles then form a tight bond with one another.
2. This is hygroscopic water that forms these bonds.

C. Water is used for animal life.

1. Animals living in the soil need some water to stay alive.
2. Too much water could wash the insects and animals away.

D. Water is used for human use and consumption.

1. Wells are dug through the soil to where water is located deep in the soil. This water can be used to drink, cook, clean, water plants, etc.

III. There are different measures of water found in the soil.

A. Saturation

1. All soil pores are filled with water.
2. This condition occurs right after a rain.

B. Field capacity

1. Moisture content of the soil after gravity has removed all the water it can.
2. Usually occurs 1–3 days after a rain.

C. Wilting point

1. Soil moisture percentage at which plants cannot obtain enough moisture to continue growing.

D. Hygroscopic water

1. Water absorbed from the atmosphere and held very tightly by the soil particles, so that it is unavailable to plants in amounts sufficient for them to survive.

E. Oven dried

1. Soil that has been dried in an oven at 105 degrees C for 12 hours. All soil moisture has been removed.
2. This point is not important for plant growth but is important for calculations since soil moisture percentage is always based on oven dry weight.

F. Plant available water

1. Water that is held in the soil.
2. Plants are able to uptake this water found in the soil.

IV. Water can cause different forces that can be found in the soil.

A. Adhesion

1. The attraction of soil water to soil particles and other particles.

B. Cohesion

1. The attraction of water molecules to other water molecules.

C. Capillarity

1. A capillary is a very thin tube in which a liquid can move against the force of gravity. The narrower the tube the higher the liquid rises due to the forces of adhesion and cohesion.

V. The air found in soil is very different from the air found in the atmosphere. The air in soils is not exposed to moving air currents, and is much more moist or humid than atmospheric air. It also tends to be very rich in carbon dioxide, and poor in oxygen. Oxygen is removed by living organisms, and carbon dioxide is left behind. This carbon dioxide leaks out of the soil, slowly replenishing the atmosphere's carbon dioxide supplies.

Review/Summary

1. What are the differences between types of water in the soil?
2. What are the uses of water in the soil?
3. Name the seven different measures of water found in the soil.
4. What are examples of different forces of water found in the soil?
5. Explain how the air in soil is different from the air found in the atmosphere.