Student Outcome

Evaluate the effects of soil on water.

Learning Objectives

1. Explain the importance of available water to plant growth.
2. Identify the different types of soil waters.
3. Define available water capacity.
4. Explain the effect soil texture has on available water capacity.
5. Explain the effect that effective rooting depth has on available water capacity.
6. Explain the effect rock fragment content has on available water capacity.
7. Identify other factors which affect available water capacity.
8. Explain how available water capacity is determined.
9. Define permeability and identify the soil properties which affect permeability.
10. Identify the factors which affect the internal drainage of soil.
11. Explain how seasonal high water tables are determined.

Grade Level Expectations


Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
   - Ppt 1 – Water Removal by Plants
   - Ppt 2 – Kinds of Soil Water
2. Activity Sheet
   - AS 1 – Water Retention in Different Soils

Supplies & Equipment

- Three tomato plants
- Soil samples with different textures from earlier lessons
- See AS 1 for materials and equipment needed to complete the Activity Sheet.
Supplemental Information

1. Internet Sites

2. Print
**Interest Approach**

Select three tomato plants of the same size but grown in different soil textures. Water all the plants the same amount to start the observation. See how long it takes each plant to wilt. After wilt is observed, water the plants and see how quickly they respond to the water. Have students observe how the soil texture affects the water retention of the soil.

**Communicate the Learning Objectives**

1. Explain the importance of available water to plant growth.
2. Identify the different types of soil waters.
3. Define available water capacity.
4. Explain the effect soil texture has on available water capacity.
5. Explain the effect that effective rooting depth has on available water capacity.
6. Explain the effect rock fragment content has on available water capacity.
7. Identify other factors which affect available water capacity.
8. Explain how available water capacity is determined.
9. Define permeability and identify the soil properties which affect permeability.
10. Identify the factors which affect the internal drainage of soil.
11. Explain how seasonal high water tables are determined.

<table>
<thead>
<tr>
<th>Instructor Directions</th>
<th>Content Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective 1</strong></td>
<td></td>
</tr>
<tr>
<td>Discuss the importance of water retention and movement. Use PPt 1 to illustrate water use by plants.</td>
<td>Explain the importance of available water to plant growth.</td>
</tr>
<tr>
<td>■ P Pt 1 – Water Removal by Plants</td>
<td>1. All plants need water to survive. Too much or too little can be harmful.</td>
</tr>
<tr>
<td></td>
<td>2. Actively growing plants are 90% water.</td>
</tr>
<tr>
<td></td>
<td>3. Plants need water to take up nutrients and release moisture through transpiration.</td>
</tr>
<tr>
<td></td>
<td>4. Plants use 300-500 lbs of water for every pound of dry weight.</td>
</tr>
<tr>
<td></td>
<td>5. Soils with high available water have a greater productivity potential than soils with low available water.</td>
</tr>
</tbody>
</table>

| **Objective 2**       | Identify the different types of soil waters. |
|                       | 1. Gravitational water |
|                       | a. Fills large pores when soil is saturated |
|                       | b. Drains away quickly |
|                       | c. Plants cannot use |
|                       | 2. Capillary water |
|                       | a. This is held in smaller soil pores (capillaries) |
|                       | - Gravity |
|                       | - Cohesion |
|                       | b. Most is available to plants |
### Instructor Directions

<table>
<thead>
<tr>
<th>Objective 3</th>
<th>Content Outline</th>
</tr>
</thead>
</table>
| **3. Hygroscopic water** | 3. Hygroscopic water  
| a. This is held tightly in tiny soil pores. | a. This is held tightly in tiny soil pores.  
| - Adhesion | - Adhesion  
| - Roots cannot remove it | - Roots cannot remove it  
| b. Clayey soils contain large amounts | b. Clayey soils contain large amounts  
| c. Plants cannot use this unavailable water. | c. Plants cannot use this unavailable water. |

**Objective 3**

*Discuss field capacity of the soil. Also discuss the difference between available water capacity (AWC) and the wilting point. Refer to PPT 2.*

- PPT 2 – Kinds of Soil Water

**Objective 4**

*Use the soil samples with different soil textures from earlier lessons. Have the samples moist and let the students handle the samples. Ask the students to describe the water-holding capacity. Discuss Figure 10.3 in the student reference. Have students complete AS 1.*

- AS 1 – Water Retention in Different Soils

**Objective 5**

*Discuss the limiting factors in the soil that affect the rooting depth of plants. Have students give ideas on the effects of rooting depth on AWC.*

- AS 1 – Water Retention in Different Soils

**Objective 4**

*Explain the effect soil texture has on available water capacity.*

1. Soil texture has the greatest effect of the soil properties that influence AWC.
2. Water is held on the surfaces of soil particles.
3. Surface areas per volume of soil are dependent on the soil particle size.  
   a. Clay has a large surface area per volume.  
   b. Sand has a small surface area per volume.  
   c. Silt has a medium surface area per volume.  
4. Texture of different soil layers influences the downward movement of water.  
   a. Clay can delay downward movement if it is close to the surface.  
   b. Clay in a lower layer can pull water from layers above.

**Objective 5**

*Explain the effect that effective rooting depth has on available water capacity.*

1. Density of soil layers that limit rooting depth also limits AWC.  
   a. Fragipans  
   b. Gravelly or cobbly layers  
   c. Bedrock  
2. Soils allowing deep rooting are potentially very productive.  
   a. Greater volume of soil for water and nutrients
<table>
<thead>
<tr>
<th>Instructor Directions</th>
<th>Content Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective 6</strong></td>
<td>Explain the effect rock fragment content has on available water capacity.</td>
</tr>
</tbody>
</table>
| Discuss the soil in your area. Ask the students to estimate the water storage capacity of soils containing rock fragments. | 1. Horizons containing rock fragments contain less AWC.  
2. Rock fragments cannot store water. |

| Objective 7            | Identify other factors which affect available water capacity. |
| Discuss the influence of soil structure and organic matter content on AWC. Ask the students what other factors might affect the available water capacity. | 1. Structure and organic matter  
a. Influence the size of aggregates  
b. Affect the amount of pore spaces between particles  
2. Structure and density  
a. Dense layers with poor structure inhibit rooting depth  
b. Fragipans  
3. Abrupt changes in soil texture from one horizon to another |

| Objective 8            | Explain how available water capacity is determined. |
| Discuss what soil properties provide clues for determining available water capacity. Ask students how they would calculate the AWC of a particular soil. Refer to Figure 10.6 of the student reference. | 1. Multiply AWC rate by horizon thickness by percent fine earth.  
a. Determine AWC rate for a particular soil texture.  
b. Measure the thickness of the horizon.  
c. To find the percentage of fine earth, subtract the percentage of rock fragment from 100%.  
2. Repeat calculation for each horizon within the effective rooting depth.  
3. Add together the AWCs for all horizons within the effective rooting depth. |

<p>| Objective 9            | Define permeability and identify the soil properties which affect permeability. |
| Discuss texture of the soil as it relates to permeability. Discuss Table 10.3 and Table 10.4 of the student reference. | 1. Permeability is affected by the rate at which water moves through a saturated soil. Least permeability layer is used. |</p>
<table>
<thead>
<tr>
<th>Instructor Directions</th>
<th>Content Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Porosity, size of pores, and interconnection of pores influence permeability.</td>
<td>2. Porosity, size of pores, and interconnection of pores influence permeability.</td>
</tr>
<tr>
<td>a. Texture</td>
<td>a. Texture</td>
</tr>
<tr>
<td>b. Structure</td>
<td>b. Structure</td>
</tr>
<tr>
<td>c. Density</td>
<td>c. Density</td>
</tr>
<tr>
<td>d. Organic matter content</td>
<td>d. Organic matter content</td>
</tr>
<tr>
<td>e. Mineralogy</td>
<td>e. Mineralogy</td>
</tr>
</tbody>
</table>

**Objective 10**

Refer to Figure 10.7 of the student reference to discuss classes of internal drainage. Discuss what factors might indicate or affect the internal drainage of soil.

Identify the factors which affect the internal drainage of soil.

1. Height of the water table
2. Length of time that soil remains saturated

**Objective 11**

Explain that a seasonal high water table is the highest average depth of a saturated zone during the wettest season. Analyze the water resources in your area. When do you expect seasonal high water in your area?

Explain how seasonal high water tables are determined.

1. By evidence of reduction
   a. Grayed colors
   b. Gray mottles
2. By using boreholes to measure depth and duration of water table
   a. Apparent water table stands in a freshly dug borehole
   b. Perched water table levels fall when bore is extended

**Application**

- AS 1 – Water Retention in Different Soils

Answers to AS 1:
1. The crumbly soil will have more air spaces between the particles. Soils high in humus have high water-holding capacity and act like a sponge.
2. Lack of organic matter
3. Organic matter increases water-holding capacity of the soil and helps prevent soil erosion.

Other activities:
1. Grow several pepper plants in pots until each has several leaves. The divide the plants into three groups, watering each differently. Water one group so often that the soil stays wet. Water a second group when the soil surface dries. Water the third group only when the plants wilt. Have the students observe
<table>
<thead>
<tr>
<th>Instructor Directions</th>
<th>Content Outline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the difference in plant growth and discuss the importance of water. Have the students explain field capacity and available water.</td>
</tr>
<tr>
<td>2.</td>
<td>Have ready for class soil samples of texture ranging from sandy to clay. Take three one-gallon cans and cut out both ends and set them on the ground. Fill each can with a different soil sample. Pour a half-gallon of water through each sample and discuss the results.</td>
</tr>
</tbody>
</table>

**Closure/Summary**

Plants need water to survive, although the amount of water needed varies widely. There are three kinds of soil water: gravitational water, available water, and unavailable water. Available water capacity (AWC), the capacity of soil to hold water in a form available to plants, is largely determined by soil texture. Soil permeability, internal soil drainage, and effective rooting depth (based largely on soil texture and structure) all work together to influence the available water capacity of a particular soil.

**Evaluation: Quiz**

Answers:
1. b
2. d
3. g
4. i
5. h
6. j
7. c
8. f
9. e
10. a