Soil, Plant & Water Relationships

Understanding Soil Water Holding Capacity

- Soil textural classification:
  - Sand, silt, clay content

Porosity
- Porosity is a measure of how much pore space exists in the soil
- Volume of pores/volume of the soil x 100
- Porosity is given as % and may be 30% to 40% in soil and higher in artificial media
- Porosity of a clay and a silt loam can be the same

Permeability
- How fast can water move into/through the soil (inches/hour)?
- Higher in dry soil/lower in wet soil
- Higher in soils with larger pore spaces (sands, loams, amended soils, potting mix)
- Lower in soils with smaller pore spaces (silts, clays, compacted soil or soil layer)
Soil Intake Rate

- Saturated permeability for clay soils may be <0.06"/hour
- Saturated permeability for silt loam soils may be 0.2"/hour
- Permeability generally declines with compaction, rainfall, irrigation, increased moisture content, decreased organic matter or amendments, and increased density

Compaction

- Compaction reduces porosity, infiltration, and water holding capacity
- Compaction can be increased by traffic, tillage, impact (mechanical or hydraulic), and chemical changes (sodium, calcium)

Salts

- Due to the dissolved ions in salty water it takes more pressure for water taken up into plants
- As salt concentrations increase it reduces the availability of water to plants

Soil is a Reservoir

- Capacity
  - Soil type
  - Root depth
- Moisture Level
  - Evaporation
  - Rain
  - Irrigation
Irrigation Basics for Landscape Irrigation Contractors – LSU AgCenter

The Soil Reservoir

- Saturation
- Saturation Allowance
- Field Capacity
- Irrigation Amount (Typically 50% of AW)
- Rapidly Available Water
- Available Water (AW)
- Permanently Wilt Point
- Hygroscopic Water

Gravitational Water (Rapid Drainage)

Why do we want to irrigate?

To replace rain water that has evaporated.

Evapotranspiration (ET)

- Evaporation of water from the soil or plants surfaces and transpired from leaves.
  - It is typically measured in inches

- Weather conditions affect ET:
  - Solar radiation
  - Temperature
  - Wind
  - Humidity

Effective Rain Fall

- Measurement of rain is as important as the measurement of ET
- Rainfall replenishes soil moisture
- Rainfall that runs off is NOT effective rain
  - Soil percolation rate and slope limit effective rain.
- Rain that soaks below the roots is NOT effective rain
  - A soil moisture balance calculation determines when the root zone is saturated.

Irrigation Requirement

- ET – Effective Rain = Irrigation Requirement
- The Irrigation Requirement is met when sprinklers run long enough to return the soil moisture level back to desired levels – no more / no less.

Effective Rain Fall

- Measurement of rain is as important as the measurement of ET
- Rainfall replenishes soil moisture
- Rainfall that runs off is NOT effective rain
  - Soil percolation rate and slope limit effective rain.
- Rain that soaks below the roots is NOT effective rain
  - A soil moisture balance calculation determines when the root zone is saturated.

Typical Irrigation System Adjustments

- Inches Daily Evaporation
- Inches of Irrigation Used with Weekly Adjustments
- Inches of Irrigation Used with Monthly Adjustments

Days

ET

Inches

0.00
0.05
0.10
0.15
0.20
0.25

0 5 10 15 20 25 30
Benefits of ET-Based Water Management

- Efficient Water Use
  - Save Money
  - Preserve Natural Resources
- Healthy Landscapes
  - Watered when needed
  - Watered right

The Soil Reservoir

Benefits of ET-Based Water Management

- Efficient Water Use
  - Save Money
  - Preserve Natural Resources
- Healthy Landscapes
  - Watered when needed
  - Watered right

Soil, Plant & Water Relationships

Average inches depth of water per foot depth of soil in plant root zone

Field capacity

Fig. 3.12. Simplified comparison of the water-holding characteristics of different textured soils. (Courtesy U. S. Department of Agriculture, 1985.)

Soil, Plant & Water Relationships

Table 3.1. Range in available water-holding capacity of soils of different texture

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>Range</th>
<th>Average per ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Very coarse sands</td>
<td>35 to 45</td>
<td>40</td>
</tr>
<tr>
<td>2. Coarse sands</td>
<td>65 to 99</td>
<td>83</td>
</tr>
<tr>
<td>3. Loams</td>
<td>105 to 120</td>
<td>115</td>
</tr>
<tr>
<td>4. Loams</td>
<td>125 to 135</td>
<td>130</td>
</tr>
<tr>
<td>5. Sandy loams</td>
<td>145 to 150</td>
<td>150</td>
</tr>
<tr>
<td>6. Fine sands</td>
<td>165 to 200</td>
<td>185</td>
</tr>
<tr>
<td>7. Peak soil types</td>
<td>185 to 220</td>
<td>200</td>
</tr>
</tbody>
</table>

Moisture Extraction

Where do plants get their water?

- Soil root zone – available water
- Typical sandy soils:
  - 1.5 inches of water can be held in the soil (per foot of soil) ~ 0.75 in. of that is available
  - Typical root zone: 1 to 1.5 ft.

Soil, Plant & Water Relationships
Water Management

Soil, Plant & Water Relationships

Concept:
- **MAD** – Management-allowed deficit/depletion
  - Percentage of available water within the soil that you will allow to be removed before you irrigate

- **MAD %**
  - 25-40, Shallow-rooted, high value fruit and vegetable crops
  - 40-50, Orchards, vineyards, berries, ornamentals, and medium rooted row crops
  - 50, mature trees, forage crops, grain crops, and deep-rooted row crops

Formula:

\[ d_x = \frac{MAD}{100} \times W_a \times Z \]

- \( d_x \) = maximum net depth of water to be applied per irrigation (mm/inches)
- \( MAD \) = management-allowed depletion (%)
- \( W_a \) = available water-holding capacity of the soil (mm/m or in./ft)
- \( Z \) = effective root depth, (m or ft)

Slope effects

- Sloping terrain will increase the chance of runoff and will decrease water infiltration

- The greater the slope, the greater the problems will be

- Consider splitting irrigation in multiple cycles