HORT325: Soils & Fertilizers

Soil Composition
Soil Texture/Structure & Water Capacity
Soil pH & Nutrient Availability
Fertilizers
Soil Testing

Definitions in Handbook

- Soil Structure
- Soil Porosity
- Pore Space
- Soil Air
- Soil Air Movement
- Soil Water
- Drainage
- Soil Organic Matter
- Soil Temperature
- Soil Crusts

What is Soil?

- Sand
  – 0.05 mm to 2.00 mm
- Silt
  – 0.002 mm to 0.05 mm
- Clay
  – Less than 0.002 mm
- Organic Matter
  – Dynamic; the “glue” that cements soil particles into aggregates
<table>
<thead>
<tr>
<th>Soil Fraction</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Coarse Sand</td>
<td>2.0 to 1.0 mm</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>1.0 to 0.5 mm</td>
</tr>
<tr>
<td>Medium Sand</td>
<td>0.5 to 0.25 mm</td>
</tr>
<tr>
<td>Fine Sand</td>
<td>0.25 to 0.10 mm</td>
</tr>
<tr>
<td>Very Fine Sand</td>
<td>0.10 to 0.05 mm</td>
</tr>
<tr>
<td>Silt</td>
<td>0.05 to 0.002 mm</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt;0.002 mm</td>
</tr>
</tbody>
</table>

See you in Lab!
Why is Soil Texture Important?

- Water (& Nutrient) holding capacity
- Soil Texture & Organic Matter determine Soil Structure

Exam Question

- What is the percent sand, silt & clay of your bare soil vegetable plot?
- Describe the texture of this soil using the Soil Texture Triangle.

Soil pH

- Measure of hydrogen ion activity of soil solution (acidity)
- Logarithmic scale
- Most plants do best in slightly acidic soils (~6.5 covers most vegetables)
- pH determines nutrient availability
Adjusting Soil pH

• Too low
  – Ground agricultural limestone
  – The finer the grind, the more rapid response
• Too high
  – Elemental sulfur; Sulfuric acid; Aluminum sulfate
  – Chelated iron (for iron deficiency)

Fertilizers

• Commercial Fertilizers are Labeled with the Percentage of Nitrogen (N), Available Phosphate (as P₂O₅) and Soluble Potash (as K₂O)
• These numbers are often referred to as N-P-K
• So, a 100 bag of 10-10-10 fertilizer contains 10 pounds of N, P and K right?
• Wrong! It’s 10 pounds of N, 10 pounds of P₂O₅ and 10 pounds of K₂O
• Multiply P₂O₅ by 0.44 = 4.4 lbs
• Multiply K₂O by 0.83 = 8.3 lbs
Complete vs. Incomplete Fertilizers

- **Complete fertilizer**
  - Contains N, P & K
- **Incomplete fertilizer**
  - Missing one or more of the major elements
- Complete fertilizer can be made by adding multiple incomplete fertilizers

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>%N</th>
<th>%P₂O₅</th>
<th>%K₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium nitrate</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>21</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Monopotassium phosphate</td>
<td>11</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>Muriate of potash (potassium chloride)</td>
<td>0</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Super phosphate</td>
<td>0</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Triple super phosphate</td>
<td>0</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Urea</td>
<td>46</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urea-ammonium nitrate (tanks)</td>
<td>32</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Specialty Fertilizers

- **Slow release fertilizers**
  - Coated with resin or sulfur to control the rate of release
  - Can be applied less frequently and at higher rates without risk of "burning"
- **Water soluble fertilizers**
  - Highly available since already in solution
  - Uniform application
  - Very efficient especially when combined with drip system

Organic Fertilizers

- Nutrients derived solely from the remains or a byproduct of a once-living organism
- Most are slow release (rely on microbes to mineralize the nutrients) and often contain micronutrients
- Act as soil conditioners, increase organic matter, improve physical structure
- Cottonseed meal, Blood meal, Fish emulsion, Sewage sludge and manures (should be composted)
- Usually very low in major nutrients, so require high levels:

<table>
<thead>
<tr>
<th>Type of manure</th>
<th>%N</th>
<th>%P₂O₅</th>
<th>%K₂O</th>
<th>Suggested amounts of material (lbs. per 1000 sq ft/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken manure</td>
<td>2.0-4.5</td>
<td>4.6-6.0</td>
<td>1.2-2.4</td>
<td>125/3,445</td>
</tr>
<tr>
<td>Steer manure</td>
<td>0.6-2.5</td>
<td>0.9-1.6</td>
<td>2.4-3.6</td>
<td>450/19,602</td>
</tr>
<tr>
<td>Dairy manure</td>
<td>0.6-2.1</td>
<td>0.7-1.1</td>
<td>2.4-3.6</td>
<td>600/26,136</td>
</tr>
</tbody>
</table>
Fertilizer Burn

- Fertilizers are salts and salts pull moisture away from the plant and even from plant roots
- Two rules when applying fertilizer during hot weather when soil moisture is limited:
  - Do not over apply nitrogen fertilizers
  - Make sure adequate moisture is present after applying fertilizers high in salts

A list of commonly used fertilizers and salt index or burn potential

<table>
<thead>
<tr>
<th>Material</th>
<th>Analysis</th>
<th>Per equal weights of materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium nitrate</td>
<td>33% Nitrogen</td>
<td>104.7</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>21% Nitrogen</td>
<td>69.0</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>46% Nitrogen</td>
<td>73.6</td>
</tr>
<tr>
<td>Lime</td>
<td>4% Nitrogen</td>
<td>71.4</td>
</tr>
<tr>
<td>Cone Super Phosphate</td>
<td>45% P₂O₅</td>
<td>10.1</td>
</tr>
<tr>
<td>Superphosphate</td>
<td>20% Phosphorus (P₂O₅)</td>
<td>7.8</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>60% Potash (K₂O)</td>
<td>110.3</td>
</tr>
<tr>
<td>Potassium sulfate</td>
<td>56% Potash (K₂O)</td>
<td>48.1</td>
</tr>
<tr>
<td>Gypsum</td>
<td>33% Calcium oxide</td>
<td>6.1</td>
</tr>
<tr>
<td>Epsom salts</td>
<td>10% Magnesium oxide</td>
<td>44.0</td>
</tr>
</tbody>
</table>

Salt Index Basis: Sodium nitrate = 100

Fertilizer Application

- Frequency determined by soil type, crop, irrigation frequency (runoff), type of fertilizer
- General rule of thumb:
  - Nitrogen is for leafy top growth
  - Phosphorus is for root and fruit production
  - Potassium is for cold hardiness, disease resistance and general durability
Application Methods

• Broadcast
  – Spread over the growing area and mechanically incorporated into the soil
• Band
  – Narrow bands applied in furrows to the side and below the seeds or plants
• Sidedress
  – Banding applied to the side of growing plants
• Fertigation
  – Water soluble fertilizers applied with irrigation water
• Starter Solutions
  – Water soluble fertilizers applied with water used to set transplants
• Foliar Feed
  – Used for a quick response or micronutrients are unavailable or soil is too cold for plants to extract

Soil Testing

• Measures nutrient availability of the soil, prior to any amendments that are made
• You should always amend soil based on a soil test:
  – Nutrients can only come from the soil + amendments
  – The soil test will show you how much is available in the soil, so you can estimate how much is needed
  – Estimates are based on how much the crop will remove
  – Applying too much fertilizer = waste money & pollute the environment
  – Applying not enough fertilizer = crop will suffer