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 $P_2O_5$) and Soluble Potash (as $K_2O$)
- 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 $P_2O_5$, and 10 pounds of $K_2O$
- Multiply $P_2O_5$ by 0.44 = 4.4 lbs
- Multiply $K_2O$ 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>
<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>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>21</td>
<td>0</td>
<td>0</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>
<td>11</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>Monoammonium phosphate</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Super phosphate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Triple super phosphate</td>
<td>0</td>
<td>45</td>
<td>0</td>
<td>0</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>Urea</td>
<td>46</td>
<td>0</td>
<td>0</td>
<td>46</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urea-ammonium nitrate (fluid)</td>
<td>32</td>
<td>0</td>
<td>0</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 (dry)</th>
<th>%N</th>
<th>%P₂O₅</th>
<th>%K₂O</th>
<th>%N</th>
<th>%P₂O₅</th>
<th>%K₂O</th>
<th>Suggested amount 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>125/5,445</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steer manure</td>
<td>0.8-2.5</td>
<td>0.9-1.6</td>
<td>2.4-3.6</td>
<td>450/19,602</td>
<td></td>
<td></td>
<td></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>
<td></td>
<td></td>
<td></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>13% Nitrogen</td>
<td>104.7</td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>27% 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>46% Nitrogen</td>
<td>73.4</td>
</tr>
<tr>
<td>Conc 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>40.1</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

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**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:
  - The nutrients required for optimal plant growth will come from the soil + amendments that are made
  - The soil test will show you how much is available in the soil, so you can estimate how much is needed to add

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**Soil Test Results Handout**

- Already applied:
  - 200 lbs/A of 13-13-13 banded
  - 25 lbs/A water-soluble Plant Starter (8-45-14)
- Fertigation Plans:
  - 75 lbs/A Miracid (21-7-7)
  - 50 lbs/A General Purpose (20-10-20)
  - 25 lbs/A Cal-Mag (15-5-15)