Understanding the Chemistry of Plant Nutrition:
Water Quality, Alkalinity and pH Management

Today’s Lecture
pH
Alkalinity
Injector Calibration
Substrate Monitoring

What is pH?
pH is the measure of H+ ions in a solution
• pH 0-7 = acidic
• pH 7-14 = basic (alkaline)
pH effects nutrient availability in the soil solution

Why we care…

What is Alkalinity
Alkalinity – the buffering capacity of water to resist change in pH
• Carbonate
  • CO$_3^{2-}$
• Bicarbonate
  • HCO$_3^{-}$

Alkalinity
Units of measure
• Milliequivalents/Liter
• PPM
Convert from meq/L to PPM
• Carbonate
  • 1 meq/L = 50 ppm
• Bicarbonate
  • 1 meq/L = 61 ppm
Alkalinity vs pH

Water Sample A
- pH 7.5
- Alkalinity = 1.5 meq/L
- Acceptable

Water Sample B
- pH 7.5
- Alkalinity = 7 meq/L
- Problematic

Alkalinity vs pH

Water Sample A
- pH 7.5
- Alkalinity = 1.5 meq/L
- pH = 5.8
- pH = 5.9
- pH = 6.0
- pH = 6.1
- pH = 6.2

Water Sample B
- pH 7.5
- Alkalinity = 7 meq/L
- pH = 5.8
- pH = 6.2
- pH = 6.6
- pH = 7.0
- pH = 7.4

Alkalinity

- Reverse Osmosis
- Acid injection
- None

Action Required

Correcting with lime
- request lower lime rate to be incorporated into substrate

Alkalinity

Correct with fertilizer selection
  - Potential basicity:
    Lbs or calcium carbonate that give an equal pH rise to that caused by 1 ton of fertilizer
  - Potential acidity:
    Lbs of calcium carbonate required to neutralized the acidity cause by using 1 ton of fertilizer

Potential Basicity:
- 445 lbs of calcium carbonate equivalent per ton

Potential Acidity:
- 445 lbs of calcium carbonate equivalent per ton

Warning: Fertilizer contains more than 50% Molybdenum. It should go in the bottom of the soil.
### Fertilizer Acidity Basicity

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Acidity</th>
<th>Basicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonium sulfate</td>
<td>2200</td>
<td>-</td>
</tr>
<tr>
<td>urea</td>
<td>1680</td>
<td>-</td>
</tr>
<tr>
<td>diammonium phosphate</td>
<td>1400</td>
<td>-</td>
</tr>
<tr>
<td>ammonium nitrate</td>
<td>1220</td>
<td>-</td>
</tr>
<tr>
<td>monoammonium phosphate</td>
<td>1120</td>
<td>-</td>
</tr>
<tr>
<td>superphosphate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>potassium chloride</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>potassium sulfate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>calcium nitrate</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
<td>potassium nitrate</td>
<td>-</td>
<td>520</td>
</tr>
<tr>
<td>sodium nitrate</td>
<td>-</td>
<td>580</td>
</tr>
</tbody>
</table>

### Alkalinity vs pH

- pH 7.5
- Alkalinity = 1.5 meq/L
Alkalinity vs pH

Water Sample A with 15-0-15 (344 CCE lbs Potentially Basic)

Time

pH 7.5
Alkalinity = 1.5 meq/L

pH = 5.8
pH = 6.2
pH = 6.6
pH = 7.0
pH = 7.4

Why Calibrate?

Nutrient toxicities
Over application
Nutrient deficiencies
Under application
$$$$$$$$$$$$$$
Cost of fertilizer
Cost of lost sales

How To Calibrate

Two methods

Flow Method

EC Method

PourThru

Irrigate the crop one hour prior to PourThru

PourThru

Place a plastic saucer under container

PourThru

Pour enough water over top of substrate to displace ~ 50mL of solution
Distilled Water Volumes

<table>
<thead>
<tr>
<th>Pot Size (inches &amp; cm)</th>
<th>ml</th>
<th>oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Pack</td>
<td>30</td>
<td>1.0</td>
</tr>
<tr>
<td>4&quot; (10 cm)</td>
<td>30</td>
<td>1.0</td>
</tr>
<tr>
<td>5&quot; to 6&quot; (12 to 15 cm)</td>
<td>75</td>
<td>2.5</td>
</tr>
<tr>
<td>6.5&quot;+ (16 cm+)</td>
<td>100</td>
<td>3.4</td>
</tr>
</tbody>
</table>

PourThru
Collect & analyze the leachate

6 or 8-inch saucers
PourThru

Measure
PourThru

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- Don’t over react
- Look for trends
- Don’t ignore it
- Consistency is the KEY