Nutrient Control BMPs:

- Soil Testing
- Plant Tissue Analysis
- Fertilizer Application
- Spill Prevention

Mabry McCray

Everglades Research and Education Center
Soil Testing

**Importance**

- Part of the “Nutrient Control Practices” listed under approved BMPs for water quality improvement in the EAA.

- Soil testing is an essential tool to formulate a sound amendment and nutrient management program.

- With increased emphasis on environmental quality and rising cost of fertilizer materials, soil testing has become an important tool to identify areas where inadequate or excess fertilization has occurred.
Relationship Between Soil Test P, Crop Yield, and Potential for Environmental Problems due to Excessive Soil P
Soil Testing: 3-Step Process

1. **Soil Sampling:**
   a) Collection of Soil Samples
   b) Handling and Submitting

2. **Laboratory Extraction and Analysis:**
   a) Sample Preparation
   b) Extraction and Measurement of Nutrients.

3. **Interpretation and Fertilizer Recommendation:**
   Making sense of the results to make reasonable nutrient (fertilizer) application recommendations for a specific crop.
1. Soil Sampling: Collection

- Critical to the soil testing process
- Remember that a very small area is sampled
- High field variability
- 20-25 cores samples collected per 40-acre field
Soil pH contour map
Torry muck (EAA)
Soil-test Pw contour map
Okeelanta muck (EAA)
1. Soil Sampling: Handling and Submitting

Proper handling is also important:

- Thoroughly mix the composite; break up cores.
- Soil samples should be delivered as soon as possible after collection.
- Clearly label and identify sample.
- Include contact information.
2. Laboratory Analysis: Sample Preparation
2. Laboratory Analysis: Sample Preparation
2. Laboratory Analysis: Measurement
3. Interpretation and Recommendation

Response of Crisphead Lettuce to Soil-Test P Levels

Interpretation and Recommendation:
- **95% Relative Yield**: The graph shows the relative yield (%) against soil-test P (lbs/acre) for Crisphead Lettuce. The 95% relative yield is indicated by the dotted line at approximately 90% yield. This is the point at which 95% of the maximum yield is achieved.
- **Critical Level**: The critical level is the soil-test P level at which the relative yield starts to drop significantly. In the graph, this is indicated by the vertical dotted line at a soil-test P level of 30 lbs/acre. This level is crucial for determining when nutrient management practices should be initiated to optimize yield.

Mathematical Model:
- The relationship between soil-test P and relative yield can be modeled by the equation:
  \[ y = 96.8 \left(1 - 1.6e^{-0.17x}\right) \]
- The coefficient of determination, \( r^2 \), is 0.66, indicating a moderate level of explained variance in the relative yield by soil-test P levels.
Proposed Revision of Sugarcane P Calibration

Mean Relative Sucrose

\[ y = 0.878(1-\exp^{-0.242x}) \]

\[ R^2 = 0.55, \ P < 0.0001 \]
# Revised Sugarcane P Calibration

<table>
<thead>
<tr>
<th>Mehlich 3 Soil P g P/m³</th>
<th>Phosphorus Fertilizer Rate lb P₂O₅/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant Cane</td>
</tr>
<tr>
<td>≤ 8</td>
<td>75</td>
</tr>
<tr>
<td>9-15</td>
<td>60</td>
</tr>
<tr>
<td>16-20</td>
<td>50</td>
</tr>
<tr>
<td>21-25</td>
<td>40</td>
</tr>
<tr>
<td>26-30</td>
<td>0</td>
</tr>
<tr>
<td>31-35</td>
<td>0</td>
</tr>
<tr>
<td>36-40</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>0</td>
</tr>
</tbody>
</table>
Fertilizer Application

3 Goals of Fertilizer Application BMPs

- Fertilize to cover all crop needs
- Reduce over- or misapplication
- Eliminate spills, cleanup spills
Apply minimum amount of P fertilizer that is needed to produce optimum yields

- Increase fertilizer use efficiency
- Timing of fertilizer application/split applications
- Placement of fertilizer close to root zone
- Fertilizer sources: soluble/slow release fertilizers
**Banding of P Fertilizers**

- Places fertilizer close to the root zone; more efficient uptake by plant.
- Reduces the soil-fertilizer surface contact area, resulting in less P fixation.
- Reduces likelihood of overlapping application to same rows.
- The most important advantage of banding is the significant reduction of the overall amount of P applied especially to vegetables.
Banding increases P availability to plants by:

a. providing concentration of P in narrow band in root zone (most important in short-lived shallow rooted crops)

b. decreasing pH in that narrow application zone, which temporarily allows > P availability by slowing P fixation
Fertilizer Misapplication Prevention

**Misapplication of fertilizer P:**

- Application of P fertilizer to soils with high P fertility levels.
- Application of P fertilizer to soils at higher than the recommended rates.
- Application of P fertilizer to non-target areas due to mechanical failures or lack of proper training.
Problems caused by increased P concentrations:

- Algal blooms
- Excessive aquatic weed growth
- Low dissolved oxygen levels
- Increased TP and TDP in drainage water
- Increased P loads off the farm
- Decreased drainage capacity of canals
Fertilizer Misapplication Prevention: Tune/Calibrate Equipment

- Before planting season starts
- Monitor actual application rates vs. calculated amounts
Fertilizer Misapplication Prevention: Reduce Turning Speed

Never broadcast fertilizer near canals. Use AIRMAX pneumatic controlled-edge applicator for those areas.
Fertilizer Misapplication Prevention: Proper Training
Recommendations to Reduce Fertilizer Spills

- Park fertilizer hoppers/trailers and field application rigs far away from ditch/canal banks.
- Park fertilizer hoppers/trailers on level ground (avoid slopes leading to open water).
- Limit the number of loading sites … easier to “police”.
- Properly train all personnel involved in handling fertilizer material.
- **Policy:** Park fertilizer hopper/trailers ONLY at sugarcane loading ramp sites.
Loading Site on Level Ground
Inspection of Fertilizer Loading Site
Recommendations to Reduce the Impact of Fertilizer Spills

- Contain spills on tarps placed under/between trailer and application rigs.
- Have buckets/shovels available for immediate clean-up.
- Sweep “mini-spills” off trailer/hopper onto tarp and apply soil/dirt/fertilizer clean-up mix in target field.
- **Policy:** All personnel involved in handling and spreading fertilizer should have a copy of the Standard Operating Procedures (SOP) on handling fertilizer spills.
Plant Tissue Analysis
## Sugarcane Leaf Nutrient Optimum Ranges

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Optimum Range</th>
<th>Est. 5-10% Loss</th>
<th>Est. 25% Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>2.0-2.6</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td>P</td>
<td>0.22-0.30</td>
<td>0.19</td>
<td>0.17</td>
</tr>
<tr>
<td>K</td>
<td>1.0-1.6</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Ca</td>
<td>0.22-0.45</td>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>Mg</td>
<td>0.15-0.32</td>
<td>0.13</td>
<td>0.11</td>
</tr>
<tr>
<td>Si</td>
<td>&gt;0.60</td>
<td>0.50</td>
<td>0.20</td>
</tr>
<tr>
<td>Fe</td>
<td>55-105</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Mn</td>
<td>20-100</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Zn</td>
<td>17-32</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Cu</td>
<td>4-8</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
http://edis.ifas.ufl.edu/AG435

http://edis.ifas.ufl.edu/SC075


Excel Spreadsheet to calculate DRIS indices for Sugarcane
http://erec.ifas.ufl.edu/DRIS/DRISCalculator.zip
Proposed Elemental Sulfur Recommendations for Sugarcane on Organic Soil
In high pH soils, micronutrients are less available to the crop. Elemental sulfur reduces pH as certain soil bacteria oxidize the sulfur to sulfate. By banding the sulfur under the row, it can have the maximum benefit, and limit the volume of soil you are treating. As soils get shallower with subsidence there are more situations with high pH and potential micronutrient deficiencies.
Sugarcane Yield and Soil pH

Relative sucrose yield

Site 5
Site 6

\[ y = -31.16 - (9.09x) - (0.64x^2) \]
If \( x < -7.06 \)

\[ r^2 = 0.60 \]
Leaf and Soil Manganese

\[ y = 19.4 \ln(x) - 9.7 \]
\[ r^2 = 0.81 \]
Preliminary Proposed Sulfur Recommendations for Sugarcane on Organic Soils

<table>
<thead>
<tr>
<th>Soil pH</th>
<th>Elemental S (lb/ac preplant in furrow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥7.5</td>
<td>250 – 500</td>
</tr>
<tr>
<td>7.2-7.4</td>
<td>100 – 250</td>
</tr>
</tbody>
</table>
| 6.6-7.1  | 100 (STM5) if Mehlich 3 extractable Mn < 5.0  
This could be combined with another source of Mn |

Elemental S application would likely work well as a variable rate application because of the variable nature of pH as soils become shallower.
Proposed Nitrogen Fertilizer Recommendations for Sandland Sugarcane
Plant Cane Yield Response to Nitrogen

\[ y = 1.038(1-e^{-0.009(x+54.54)}) \]

\[ r^2 = 0.84 \]
Stubble Cane Yield Response to Nitrogen

- Linear Plateau Model:
  \[ y = 0.332 + 0.004x \]
  if \( x < 154 \)
  \( r^2 = 0.92 \)

- Exponential Model:
  \[ y = 1.003(1 - e^{-0.011(x+31.63)}) \]
  \( r^2 = 0.91 \)
Proposed Nitrogen Recommendations

- **Plant Cane**: 220 lb N/acre in 5 split applications
- **Stubble cane**: 200 lb N/acre in 4 split applications
- Recommendations may also include an exception for excessive rainfall: Additional 30 lb N/ac if ≥ 4 inches rainfall in 2 days and within 20 days after a previous application
Nutrient BMPs very successful and economical
Requires proper annual training of personnel
Research on fertilizer use efficiency invaluable:
  - Fertilizer sources – slow release, micros, etc.
  - Soil fertility – pH effects, cycling, soil extractants, etc.
  - Crop nutrition – leaf analysis, supplementals, etc.