Soil Sampling and Nutrient Recommendations

Kent Martin
SW Agronomy Agent Update
12/1/2009
Outline

- How to take a soil sample
  - What is the appropriate depth for soil tests
  - How many should you take
  - How often should we sample
  - Preparing samples for lab analysis
  - Good or not-so-good soil tests

- Nutrient Recommendations
  - N recommendation Model
  - P and K ( Sufficiency and Build-Maintain)
Why Should We Soil Test?

- Determine plant available nutrients in soil
- Estimate crop responses to nutrient additions
- Record long-term soil fertility trends
- Problem solving
- Generate nutrient recommendations
- Make financial decisions
Appropriate Soil Sample Depth

- Consistently take samples from the same depth
- 6 inch sample – P, K, pH, Organic Matter
- Approximate depth of historical tillage
- 24 inches – Nitrate, Chloride, Sulfate

Mobile nutrients can be taken up from deeper in the soil
# Number of Soil Samples

## Number of soil samples for specific accuracy

<table>
<thead>
<tr>
<th>pH</th>
<th>P</th>
<th>K</th>
<th>OM</th>
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<td>0.1</td>
<td>337</td>
<td>10</td>
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<td>0.2</td>
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<td>0.3</td>
<td>38</td>
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<tr>
<td>0.4</td>
<td>21</td>
<td>100</td>
<td>0.4</td>
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</table>

Kansas State University
Number of Soil Samples

- Number of composite samples submitted to the lab depends on management areas
- 15-20 subsamples for each composite sample
Number of Soil Samples

- Number of composite samples may depend on field variability
- Identify management zones
Number of Soil Samples

- Number of composite samples may depend on field variability
- Identify management zones
**Number of Soil Samples**

Number of composite samples may depend on field variability

- Identify management zones

Diagram:
- Sandy Loam
- Slope
- Silt Loam
- Low land
- Creek
- Sandy Loam
Number of Soil Samples

- Grid soil sampling
  - Requires more samples and ultimately more cost
  - 60 ac field divided into ~2 ac grids
Grid Soil Sampling

- May be beneficial in highly variable fields
- GPS and precision application equipment make this possible
How Often Should We Sample

- Every year until a history is established
- Historical trends is a strong point of soil testing
- Generally recommended every 3-4 years
Preparing Samples for Lab

Know your objectives

- Laboratory data is only as good as the sample submitted – regardless of the lab

Combine subsamples into composite samples

- Keep uniform depth and mix thoroughly
- Avoid contamination – buckets used for mixing
- Know how much sample to submit – a sandwich bag is usually enough
Lubricants for Soil Sampling?

Table 2. Effects of soil probe lubricants on soil chemical Analysis (Blaylock et al., 1995. Wyoming).

<table>
<thead>
<tr>
<th>Lubricant</th>
<th>Organic Matter</th>
<th>NO3-N</th>
<th>P</th>
<th>K ppm</th>
<th>Fe</th>
<th>Mn</th>
<th>Zn</th>
<th>Cu</th>
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<td>No lubricant</td>
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<td>16</td>
<td>263</td>
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<td>3.8</td>
<td>1.1</td>
<td>2.3</td>
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<td>Dove Soap</td>
<td>1.67</td>
<td>2.6</td>
<td>14</td>
<td>280</td>
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<td>Motoroil</td>
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<td>9.9</td>
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<td>0.6</td>
<td>1.0</td>
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<td>LSD_{0.05}</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.7</td>
<td>0.8</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Preparing Samples for Lab

Drying samples

- Not necessary except nitrate samples that are not submitted immediately
- Nitrate – lay out on paper, turn on fan
  - Don’t – put it in the oven or microwave it
- Freezing is an option for nitrate samples

Fill out paperwork including relevant historical information
# Soil Sample Information Sheet

## Grower Information
- Grower: ____________
- Address: ____________
- Phone: ____________  County: ____________
- Email: ____________

## Sample Information
- **For Lab Use**
- **Sample ID**
- **Sample Depth**
  - Top
  - Sub
- **First Crop Choice**
  - Intended Crop: ____________
  - Yield Goal: ____________
- **Second Crop Choice**
  - Intended Crop: ____________
  - Yield Goal: ____________
- **Tillage**
  - Conv.
  - No-Till
- **Irrigated**
  - Yes
  - No
- **Previous Crop**
  - ____________
  - ____________
  - ____________
- **Soil Test Requested**

## Analysis Included
<table>
<thead>
<tr>
<th>Package No./Name</th>
<th>Analysis Included</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>pH. Buffer pH, P, K</td>
<td>$0</td>
</tr>
<tr>
<td>#2</td>
<td>Package #1 + O.M. + NO₃</td>
<td>$10.50</td>
</tr>
<tr>
<td>#3</td>
<td>Package #1 + Zn</td>
<td>$8</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Package #1 + O.M., Zn, S, NO₃, CEC</td>
<td>$15.50</td>
</tr>
<tr>
<td>Environmental</td>
<td>Package #1 + Zn, Cu, NO₃, Cl</td>
<td>$14</td>
</tr>
<tr>
<td>Profile</td>
<td>NO₃, S, Cl (0-24)</td>
<td>$7</td>
</tr>
</tbody>
</table>

*Individual tests can be selected. For full listing of analyses offered please refer to the back of this sheet.*

## Type of Fertilizer Recommendation for P and K
- [ ] Sufficiency – Sufficiency recommendations are based upon meeting the intended crops nutrient requirements.
- [ ] Build – Build-maintenance recommendations can be used to build soil test P and K within a certain number of years.

**Number of years to build P and K: ____**

**Comments:** ____________

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K-State Research and Extension
Soil Testing Laboratory
2308 Hubbert North Plant Sciences Center
Manhattan, KS 66506-5503
Tel: 785-532-7897 Fax: 785-532-7412
www.agronomy.ksu.edu/soiltesting/
Where To Send Your Samples

- Your objectives! What is important?
  - Tests appropriate for your area
  - Accurate results
  - Turn around time
  - Cost
  - Service

- Part of a government program?
  - Ask your local extension agent what tests are required – Don’t assume all labs provide the same required tests!
Choosing Soil Tests

- **pH (1:1 soil:water)**
  - Very accurate and reliable
  - Substantial research conducted on pH
  - Determines if lime is needed
  - pH > 7.3 – calcium carbonate present (free lime)
  - pH < 5.8 – crop response to lime

- **Buffer pH (Buffer Index)**
  - Very accurate and reliable
  - Tells how much lime to add
  - SMP is most common
Choosing Soil Tests

Phosphorus

- Variety of tests
- Bray P-1
  - Most correlation/calibration data
  - Inaccurate on calcareous soil (reads low)
- Olsen P
  - Specific to high pH soil (abundant data on high pH)
- Mehlich 3
  - Works on a wide range of soil pH (acid → calcareous)
  - Limited correlation/calibration data
  - Most common
Choosing Soil Tests

- **Potassium**
  - Exchangeable ammonium acetate
  - Fairly good test
  - Most useful for watching trends over time

- **Nitrate**
  - KCl extractable
  - Abundant data
  - Based on expected yield
  - Adjusted based on organic matter, previous crop, fallow
Choosing Soil Tests

- **Organic Matter (%)**
  - Modified Walkley-Black or loss on ignition
  - Reliable, consistent data
  - May be inflated if crop residue is in sample
  - Warm season crop N adjustment = %OM×20
  - Cool season crop N adjustment = %OM×10

- **Zinc**
  - DTPA extract – diethylenetriaminepentacetic acid
  - Good predictor of crop response
  - Reliable on high pH soil, less on acid soils
Choosing Soil Tests

- Sulfate
  - Calcium phosphate extract
  - Little calibration data
  - Variable crop response
  - Credit from organic matter ($2.5 \times \% \text{ OM}$)

- CEC (Cation Exchange Capacity)
  - Measured by summation ($K^+, Ca^{++}, Na^+, H^+$)
  - Soil’s potential to ‘hold’ nutrients
  - Overestimates on calcareous soils
Choosing Soil Tests

- Iron
  - DTPA extractable
  - Poor calibration data
  - Inadequate for acid soils
  - Limited use for calcareous soil

- Calcium, Magnesium, Manganese, Molybdenum
  - Poorly calibrated
  - Deficiency is rare
Choosing Soil Tests

**Boron**
- Poor calibration
- Poor soil test
- Used for alfalfa grown on sandy soil

**Copper**
- Poor Calibration
- Deficiency is rare
- Occasional deficiency in wheat on organic soil
Choosing Soil Tests

- **Exchangeable Sodium Percentage**
  - Fairly reliable
  - Diagnoses alkali/sodic soils

- **Soluble Salts (Electrical Conductivity)**
  - 1:1 soil to water paste
  - Diagnoses saline soil
## Soil Tests Summary

<table>
<thead>
<tr>
<th>Good</th>
<th>Questionable</th>
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</thead>
<tbody>
<tr>
<td>pH</td>
<td>Calcium</td>
</tr>
<tr>
<td>Buffer pH</td>
<td>Magnesium</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Copper</td>
</tr>
<tr>
<td>Potassium</td>
<td>Manganese</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Molybdenum</td>
</tr>
<tr>
<td>Organic Matter</td>
<td></td>
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<tr>
<td>Zinc</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td></td>
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<td>ESP</td>
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<tr>
<td>Soluble Salts</td>
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</table>

Questionable: Calcium, Magnesium, Copper, Manganese, Molybdenum
## Soil Test Results

**K-State Research and Extension**  
**Soil Testing Laboratory**  
2308 Throckmorton Plant Sciences  
Center Manhattan, KS 66506-5503  
Tel: (785) 532-7457 Fax: (785) 532-7412  
www.oznet.ksu.edu/agronomy/SoilTesting/

### Soil Test Results

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Sample ID</th>
<th>Soil pH</th>
<th>Buffer pH</th>
<th>Organic Matter</th>
<th>Nitrate Nitrogen ppm</th>
<th>Sulfate ppm</th>
<th>Phosphorus ppm</th>
<th>Potassium ppm K</th>
<th>Calcium ppm Ca</th>
<th>Magnesium ppm Mg</th>
<th>Sodium ppm Na</th>
<th>Zinc ppm Zn</th>
<th>Iron ppm Fe</th>
<th>Manganese ppm Mn</th>
<th>Copper ppm Cu</th>
<th>Sulfate ppm S</th>
<th>Chloride ppm Cl</th>
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</table>

### Fertilizer Recommendations

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Previous Crop</th>
<th>Intended Crop</th>
<th>Yield Goal</th>
<th>Lime, EEC</th>
<th>Phosphorus</th>
<th>Potassium</th>
<th>Zinc</th>
<th>Sulfur</th>
<th>Chloride</th>
<th>Boron</th>
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</tbody>
</table>

### Pounds Actual Nutrient Per Acre

| Special Tests

<table>
<thead>
<tr>
<th></th>
<th>Cation Exchange Capacity meq/100g</th>
<th>Aluminum ppm Al</th>
<th>DTPA Bone ppm</th>
<th>Texture % Sand % Silt % Clay</th>
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</table>

Approved by:

Comments:

Submitted By:
Nutrient Recommendations

Soil Test Interpretations and Fertilizer Recommendations

Available at: http://www.agronomy.ksu.edu/SoilTesting
# Nutrient Recommendations

## SOIL TEST REPORT

**General Information:**
- **Producer:**
- **Address:**
- **City, State:**
- **County:**
- **Region:**
- **Date:** 2/23/09
- **Tillage:**
- **Lime Incorporation Depth (in):**
  - Conventional: 8-9
  - No: 4
- **Irrigation:**
- **Years to build soil test:**

## Crop Information:

<table>
<thead>
<tr>
<th>Field ID</th>
<th>Total Sample Depth (in)</th>
<th>Intended Crop</th>
<th>Yield Goal (Bushel or Ton)</th>
<th>Second Crop</th>
<th>Yield Goal (Bushel or Ton)</th>
<th>Third Crop</th>
<th>Yield Goal (Bushel or Ton)</th>
<th>Previous Crop</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
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## Soil Test Results:

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Field ID</th>
<th>pH</th>
<th>SMP Buffer pH</th>
<th>Organic Matter %</th>
<th>Nitrate-N (ppm</th>
<th>Multilish 3 P (ppm)</th>
<th>NiOAc Ext. K (ppm)</th>
<th>DTPA Zn (ppm)</th>
<th>Sulfur ppm</th>
<th>Chloride ppm</th>
<th>Boron ppm</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

*Enter profile NO₃ N value if 0-24” sample was submitted, otherwise enter the NO₃ N value for the surface sample.*
# Nutrient Recommendations

## Fertilizer Recommendations

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Field ID</th>
<th>Previous Crop</th>
<th>Intended Crop</th>
<th>Yield Goal</th>
<th>Lime ECC</th>
<th>Nitrogen</th>
<th>Phosphate P2O5</th>
<th>Potassium K2O</th>
<th>Zinc</th>
<th>Sulfur</th>
<th>Chloride</th>
<th>Boron</th>
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Comments:
- #NAME?
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- #NAME?
- #NAME?
## Nutrient Removal

<table>
<thead>
<tr>
<th>Crop</th>
<th>Unit</th>
<th>P2O5</th>
<th>K2O</th>
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<tbody>
<tr>
<td>Alfalfa</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>60.00</td>
</tr>
<tr>
<td>Red clover</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Bermudagrass</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Fescue, tall</td>
<td>lbs/ton</td>
<td>12.00</td>
<td>40.00</td>
</tr>
<tr>
<td>Corn</td>
<td>lbs/bu</td>
<td>0.33</td>
<td>0.26</td>
</tr>
<tr>
<td>Corn silage</td>
<td>lbs/ton</td>
<td>3.20</td>
<td>8.70</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>lbs/bu</td>
<td>0.40</td>
<td>0.26</td>
</tr>
<tr>
<td>Sorghum silage</td>
<td>lbs/ton</td>
<td>3.20</td>
<td>8.70</td>
</tr>
<tr>
<td>Wheat</td>
<td>lbs/bu</td>
<td>0.50</td>
<td>0.30</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>lbs/cwt</td>
<td>1.50</td>
<td>0.60</td>
</tr>
<tr>
<td>Oats</td>
<td>lbs/bu</td>
<td>0.25</td>
<td>0.20</td>
</tr>
<tr>
<td>Soybeans</td>
<td>lbs/bu</td>
<td>0.80</td>
<td>1.40</td>
</tr>
<tr>
<td>Native grass</td>
<td>lbs/ton</td>
<td>5.40</td>
<td>30.00</td>
</tr>
</tbody>
</table>
Nutrient Removal

Example

Assume 50 bu/ac wheat

\[ 50 \times 0.5 = 25 \text{ lb } P_2O_5/\text{ac removed} \]

\[ 50 \times 0.3 = 15 \text{ lb } K_2O/\text{ac removed} \]

5 years of production without fertilization

\[ 125 \text{ lb } P_2O_5/\text{ac removed} \]

\[ 75 \text{ lb } K_2O/\text{ac removed} \]
Questions?