Interpreting Soil Test Reports and Fertilizer Source Options

**Eastern** Extension Agent Training, September 25, 2006

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Your Questions

• How do I interpret a Soil Test Report?
• What are fertilizer options for small grains?
• What info exists on ESN (Environmentally Sound Nitrogen) and is it worthwhile?
• How are urea applications managed differently than ammonium nitrate applications?
What should you first look for on a soil test report?

• Depth – should have at least a 0-6 in. section
• Nitrate-N – Is it in lb/ac or ppm? If in ppm, you need to convert to lb/ac: $2 \times \text{ppm} \times \text{depth}/6 \text{ in.}$ and add up separate depths.
• Is phosphorus measured as Olsen P or Bray P? (MSU guidelines are for Olsen P and there are not good conversions between the 2).
# Soil Test Report

## Nutrient in the Soil

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>0-6&quot;</th>
<th>6-24&quot;</th>
<th>0-24&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate</td>
<td>37 lb/ac</td>
<td>36 lb/ac</td>
<td>74 lb/ac</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>1.4 ppm</td>
<td>1.4 ppm</td>
<td>1.4 ppm</td>
</tr>
<tr>
<td>Potassium</td>
<td>259 ppm</td>
<td>259 ppm</td>
<td>259 ppm</td>
</tr>
<tr>
<td>Chloride</td>
<td>8 lb/ac</td>
<td>8 lb/ac</td>
<td>8 lb/ac</td>
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<tr>
<td>Sulfur</td>
<td>360 lb/ac</td>
<td>360 lb/ac</td>
<td>360 lb/ac</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.57 ppm</td>
<td>0.57 ppm</td>
<td>0.57 ppm</td>
</tr>
<tr>
<td>Iron</td>
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<tr>
<td>Manganese</td>
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<tr>
<td>Copper</td>
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<td></td>
</tr>
<tr>
<td>Magnesium</td>
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<tr>
<td>Calcium</td>
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<td></td>
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<tr>
<td>Sodium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic Matter</td>
<td>2.5%</td>
<td>2.5%</td>
<td>2.5%</td>
</tr>
<tr>
<td>Carbonate (CCE)</td>
<td>0.44 mmho/cm</td>
<td>0.44 mmho/cm</td>
<td>0.44 mmho/cm</td>
</tr>
<tr>
<td>Sol. Salts</td>
<td>0.67 mmho/cm</td>
<td>0.67 mmho/cm</td>
<td>0.67 mmho/cm</td>
</tr>
</tbody>
</table>

## Interpretation

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Low</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
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<tbody>
<tr>
<td>Nitrate</td>
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<tr>
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<tr>
<td>Sol. Salts</td>
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</tr>
</tbody>
</table>

## 1st Crop Choice

- **Nutrient:** Barley-Malt
- **Yield Goal:** 50 BU
- **Suggested Guidelines:** Band
- **Application:** N
- **P₂O₅:** 15 Band (Starter)*
- **K₂O:** 10 Band (Starter)*
- **Cl:** 5 Band (Trial)
- **S:** 5 Band (Trial)
- **B:**
- **Zn:** 2 Band
- **Fe:**
- **Mn:**
- **Cu:**
- **Mg:**
- **Lime:**

## 2nd Crop Choice

- **Nutrient:**
- **Yield Goal:**
- **Suggested Guidelines:**
- **Application:** N
- **P₂O₅:**
- **K₂O:**
- **Cl:**
- **S:**
- **B:**
- **Zn:**
- **Fe:**
- **Mn:**
- **Cu:**
- **Mg:**
- **Lime:**

## 3rd Crop Choice

- **Nutrient:**
- **Yield Goal:**
- **Suggested Guidelines:**
- **Application:** N
- **P₂O₅:**
- **K₂O:**
- **Cl:**
- **S:**
- **B:**
- **Zn:**
- **Fe:**
- **Mn:**
- **Cu:**
- **Mg:**
- **Lime:**

## Soil pH

- **pH:** 7.5
- **Buffer pH:**

## Cation Exchange Capacity

<table>
<thead>
<tr>
<th>% Ca</th>
<th>% Mg</th>
<th>% K</th>
<th>% Na</th>
<th>% H</th>
</tr>
</thead>
</table>

**Crop 1:** Caution: Seed Placed Fertilizer Can Cause Injury. **Crop Removal:** P₂O₅ = 24 K₂O = 25. **AGVISE Band guidelines will build P & K test levels to the medium range over many years.**
### What else should I look for?

<table>
<thead>
<tr>
<th>Test</th>
<th>“Good” range</th>
<th>Possible problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
<td>6-8</td>
<td>Low-poor nodulation; High-can indicate high Na. Either high or low-can tie up P</td>
</tr>
<tr>
<td>Organic Matter (O.M.)</td>
<td>2-8%</td>
<td>Low-poor water holding capacity, low nutrient release; High-Cu deficiency, salts if from manure</td>
</tr>
<tr>
<td>“EC” or salts</td>
<td>&lt; 4 mmho/cm</td>
<td>Poor water uptake, decreased yields</td>
</tr>
<tr>
<td>Nitrate-N</td>
<td>10-100 ppm</td>
<td>Low-chlorosis; High-’burn’ if hot, dry</td>
</tr>
<tr>
<td>Olsen Phosphorus (P)</td>
<td>16-60 ppm</td>
<td>Low-poor energy storage, root growth High-possible Zn deficiency or P losses</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>250-700 ppm</td>
<td>Low-chlorosis, short internodes High-possible Ca deficiency</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>&gt; 0.5 ppm</td>
<td>Low-stunted growth, interveinal chlorosis</td>
</tr>
</tbody>
</table>
Any red flags here?
What else do you see on soil test reports?
Fertilizer Recommendations

- Use EB 161. Point out ‘Guidelines’

- **Nitrogen**: Need yield potential.
  - Spring wheat – 3.3 lb N/bu
  - Winter wheat – 2.6 lb N/bu
  - Malt barley – 1.2 lb N/bu
  - Grass – 25 lb N/ton

- Fertilizer N =
  - Available N (from table)
  - - spring soil N (lb N/ac) (-25 lb N/ac if fall soil N)
  - - 10 lb N/ac if previous crop was an annual legume, 40 lb N/ac if previous crop was alfalfa
  - - 20 lb N/ac if > 3% O.M.
  - + 10 lb N/ac per 1000 lb of residue/ac if N will be topdressed on stubble (up to 40 lb N/ac)

<table>
<thead>
<tr>
<th>Yield Potential (bu/a)*</th>
<th>Available N (lbs/a) **</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>78</td>
</tr>
<tr>
<td>40</td>
<td>104</td>
</tr>
<tr>
<td>50</td>
<td>130</td>
</tr>
<tr>
<td>60</td>
<td>156</td>
</tr>
<tr>
<td>70</td>
<td>182</td>
</tr>
<tr>
<td>80</td>
<td>208</td>
</tr>
<tr>
<td>90</td>
<td>234</td>
</tr>
</tbody>
</table>
How estimate straw residue?

• Need previous yield (bu/ac) and test weight (lb/bu)
• Grain yield (lb/ac) = Yield x test weight
• Straw yield (lb/ac) = Grain yield x 1.67 (ww)
  Grain yield x 1.33 (sw)
• Residue = straw yield – straw baled

Need help? Call or email me.
Questions for you:

• Why might more N be needed this coming year in recrop areas that received good moisture in ’06?
• Why might less N be needed this coming year for crops being seeded into fallow that received good moisture?
QUESTIONS?
What else should you and the grower consider in selecting N rate?

- Cost of fertilizer
- Expected price/bu
- Expected size of discounts

http://www.montana.edu/extensionecon/software/FertilizerCostBenefit.xls
Phosphorus and Potassium Fertilization Strategies

1. **Sufficiency Approach** – Do you want to apply minimum necessary to maximize yield in most years? *If so*, use Table 18 (P) and Table 19 (K).

2. **Maintenance Approach** – Do you want to replace the nutrients removed at harvest? *If so*, use Table 21.

3. **Build Approach** – Do you want to build your soil P and K, to minimize yield losses and save on fertilizer in future years? *If so*, add amounts from 1 and 2.

What might grower’s answer depend upon?
From Table 18

<table>
<thead>
<tr>
<th>Crop</th>
<th>Olsen P Soil Test Level (ppm)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16*</td>
</tr>
<tr>
<td></td>
<td>P Fertilizer Rate (lbs P$_2$O$_5$/a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat-Spring</td>
<td>50</td>
<td>45</td>
<td>35</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Wheat-Winter</td>
<td>55</td>
<td>50</td>
<td>45</td>
<td>40</td>
<td>35</td>
</tr>
</tbody>
</table>

If want to see specific example, go to [http://landresources.montana.edu/soilfertility](http://landresources.montana.edu/soilfertility)

Go to ‘Soil Fertility 101-Wheat Focus’ under ‘Presentations’
QUESTIONS?
N Source Options

- Urea (46-0-0)
- UAN liquid (28-0-0)
- Anhydrous ammonia (82-0-0)
- Ammonium nitrate (limited supplies)
- Ammonium sulfate (21-0-0-24). Expensive per lb of N, but S can increase protein, esp. in dry years.
- CRNs - Controlled release nitrogen, such as ESN.
- Urease inhibitors – Applied to urea to decrease volatilization, such as Agrotain.
Controlled Release N

• Made with polymer coatings to:
  – Decrease leaching
  – Decrease volatilization
Ex: In 124 studies, ESN increased corn yield an average of 7 bu/ac over urea (Blaylock and Tindall, 2006). Increase likely due to decreased volatilization.

ESN Cost? $50 -$70 more per ton. Net economic gain on corn (mainly Midwest)

Worth of CRNs and Agrotain on small grains and forages in Montana? Not enough research yet to say, but benefits likely less due to smaller revenues here and less potential for volatilization.
Differences between urea and ammonium nitrate

• Urea is more damaging to seed germination

  Implications:
  1. MSU recommends < 30 lb N/ac of AN with seed, but < 15 lb N/ac of UR (crop dependent).
  2. Recommend a spreader (or wider spreader) so that more UR can be placed near seed.

• Urea has higher potential to volatilize

  Implications:
  1. Urea application should be done during period with cool temperatures, especially when on moist, sandy soils with residue.
  2. Urea should be irrigated (>0.5 inches) or tilled in if possible.

• Urea is not immediately available for plant uptake

  Implication: For same effect, urea needs to be applied earlier in season, especially if Fall soil test N levels are low (<20-30 lb N/ac).
P Source options

• Monoammonium P (MAP)
• Diammonium P (DAP)
• Liquids (generally more expensive than MAP and DAP)

Generally no yield differences between sources. Exception: Liquids produce higher yields on highly calcareous soils (> 20% CaCO₃)

Placement: Need roughly 3 times more P if broadcast than if placed near the seed at Olsen P levels < 8 ppm, and 2 times more P when Olsen P = 8-12 ppm. MSU guidelines assume P will be banded with the seed.
Conclusions

• Given some criteria, soil test reports can be quickly evaluated for potential problems.

• N, P, and K recommendations can be made by knowing how to use EB 161 AND giving the grower some options (e.g. sufficiency vs. build)

• Different N and P sources generally don’t produce large yield differences. However, good management of volatile N sources can reduce yield losses in some situations.
QUESTIONS?

For more information on N cycling, fertilizer sources, placement and timing see: http://landresources.montana.edu/nm

For more information on urea volatilization and management, see: http://www.oznet.ksu.edu/library/crpsl2/NCR326.pdf

MSU Soil Fertility webpage: http://landresources.montana.edu/soilfertility