Interpreting Soil Test Reports and Fertilizer Source Options

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Your Questions

• How do I interpret a Soil Test Report?
• What are fertilizer options for forages/Western soil fertility issues?
• What info exists on ESN (Environmentally Sound Nitrogen) and is it worthwhile?
• How are urea applications managed differently than ammonium nitrate applications?
• What are small acreage fertilizer strategies/sustainable nutrient cycling for small acreages?
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 x ppm x depth/6 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).
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>10-200 lb/ac</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?
How about here?

<table>
<thead>
<tr>
<th>Lab Number</th>
<th>Field Description</th>
<th>SAMPLE DEPTH</th>
<th>pH</th>
<th>ORGANIC MATTER%</th>
<th>NITRATE NITROGEN PPM</th>
<th>NITRATE LBS/AC</th>
<th>PHOSPHORUS OLSEN PPM</th>
<th>POTASSIUM K PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>5948</td>
<td>GARDEN</td>
<td>0-6</td>
<td>7.8</td>
<td>2.0</td>
<td>8</td>
<td>16</td>
<td>27</td>
<td>237</td>
</tr>
<tr>
<td></td>
<td>M EAST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SULPHATE SULFUR PPM</td>
<td>SODIUM Na MEQ/100g</td>
<td>SALT HAZARD MMHOS/Cm</td>
<td>SOIL TEXTURE</td>
<td>LIME</td>
<td>MOISTURE INCHES</td>
<td>ZINC Zn PPM</td>
<td>MANGANESE Mn PPM</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>.20</td>
<td>1.12</td>
<td>CL</td>
<td>V</td>
<td></td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COPPER Cu PPM</td>
<td>IRON Fe PPM</td>
<td>CEC BASED ON TEXTURE</td>
<td>Apply three pounds of nitrogen, one pound of phosphorus, and one pound of potassium per 1000 sq. ft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What else do you see on soil test reports?
Fertilizer Recommendations

- Use EB 161. Point out ‘Guidelines’
- **Nitrogen**: Need yield potential.
  - Grass – 25 lb N/ton
  - Spring wheat – 3.3 lb N/bu
  - Winter wheat – 2.6 lb N/bu
  - Malt barley – 1.2 lb N/bu

- Fertilizer N =
  Available N (from table) - soil N (lb N/ac) (assumes Spring sampled); -25 lb N/ac more if Fall sampled
  - 10 lb N/ac if previous crop is an annual legume, 40 lb N/ac if previous crop is alfalfa
  - 20 lb N/ac if > 3% O.M.

- Orchardgrass N uptake ~ 1.3 x fescue, brome, timothy N uptake
Questions for you:

- Why might more N be needed this coming year in forage crops that received good rainfall in ’06?
- Why might less N than normal be needed this coming year in forage crops with average yields?
- What does this tell you??
What else should you and the grower consider in selecting N rate?

Assumes:
$4.00/bu, $0.35/lb N

http://www.montana.edu/extensionecon/software/FertilizerCostBenefit.xls
N rates on forages

• Don’t exceed 60 lb N/acre during seeding year, or within 9 months from fall seeding.
• Don’t exceed 15 lb N/acre if placed with seed.
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.


What might grower’s answer depend upon?
Table 18. Phosphorus fertilizer guidelines based on soil analysis.

<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>P Fertilizer Rate (lbs P₂O₅/a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfalfa-Grass</td>
<td>55</td>
<td>50</td>
<td>40</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Grass</td>
<td>45</td>
<td>35</td>
<td>30</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 21. Estimated nutrient uptake in harvested portions of crops.*

<table>
<thead>
<tr>
<th>Crop</th>
<th>Unit</th>
<th>Test Weight lbs/bu</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
<th>Fe</th>
<th>Zn</th>
<th>Mn</th>
<th>Cu</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>ton</td>
<td></td>
<td>48</td>
<td>11</td>
<td>53</td>
<td>28</td>
<td>5</td>
<td>5.50</td>
<td>0.38</td>
<td>0.11</td>
<td>0.11</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Grass</td>
<td>ton</td>
<td>13-45</td>
<td>25</td>
<td>10</td>
<td>38</td>
<td>7</td>
<td>2.50</td>
<td>2</td>
<td>0.08</td>
<td>0.13</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Costs to maintain P and K for 5 t/acre alfalfa hay

- 5 t/acre x 11 lb P₂O₅/t = 55 lb P₂O₅/acre
- 5 t/acre x 53 lb K₂O/t = 265 lb K₂O/acre

Cost = $0.28 x 55 = $15.40
+ $0.21 x 265 = $55.70

Total = $71/acre

How much is hay selling for this year?
What P and K fertilization strategy would you recommend for small acreages?
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 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 forages and small grains in Montana? Not enough research yet to say, but benefits are 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.
Fertilizer Application Timing

• Nitrogen:
  Avoid Fall N application on sandy soils.
  How favor warm season grasses in native pasture?
  Are split applications worth it?

• Phosphorus
  Apply in fall or late winter for better response.
### Organic fertilizer options for small landowners

<table>
<thead>
<tr>
<th>Common Organic Fertilizers</th>
<th>N (%)</th>
<th>P₂O₅ (%)</th>
<th>K₂O (%)</th>
<th>S (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Phosphate¹</td>
<td>0</td>
<td>3-16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Blood Meal²</td>
<td>12</td>
<td>1-2</td>
<td>0-1</td>
<td></td>
</tr>
<tr>
<td>Bone Meal²</td>
<td>1-6</td>
<td>11-30</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Gypsum³</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Greensand³</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Manures⁴: Dairy</td>
<td>0.6 - 2.1</td>
<td>0.7 - 1.1</td>
<td>2.4 - 3.6</td>
<td></td>
</tr>
<tr>
<td>Beef Cattle</td>
<td>1 - 2.5</td>
<td>0.9 - 1.6</td>
<td>2.4 - 3.6</td>
<td></td>
</tr>
<tr>
<td>Horse</td>
<td>1.7 - 3</td>
<td>0.7 - 1.2</td>
<td>1.2 - 2.4</td>
<td></td>
</tr>
<tr>
<td>Swine</td>
<td>3 - 4</td>
<td>0.4 - 0.6</td>
<td>0.5 - 1</td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td>2 - 4.5</td>
<td>4.5 - 5.5</td>
<td>1.2 - 2.4</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>3 - 4</td>
<td>1.2 - 1.6</td>
<td>3 - 4</td>
<td></td>
</tr>
</tbody>
</table>

³Gypsum and greensand data from Gardener's Supply Co. [http://www.gardeners.com](http://www.gardeners.com)
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.
• Fertilizing small acreages is similar to large acreages, but may be less constrained by economics.
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:

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