Fertilizer Grade and Calculations

John Peters

UW Soil Science Department
University of Wisconsin Soil Test Report
### Nutrient Recommendations

#### Soil Test Report

**LAB NO. 5230**
- County: Wood
- Number: 5230
- Date Received: 1/26/2004
- Date Processed: 3/8/2004

**Samples Analyzed By:**
- Soil & Forage Analysis Lab
- 8396 Yellowstone Drive
- Marshfield, WI 54449

**SOIL TEST REPORT**

Results also available on-line at [http://uwlab.soils.wisc.edu/reports](http://uwlab.soils.wisc.edu/reports)

**lab number: 5230 access code: wxaf**

**This Report is for:**
- Semi Annual Check Sample Exchange
- February 2004

#### Nutrient Recommendations

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Yield Goal</th>
<th>Crop Nutrient Need</th>
<th>Fertilizer Credit</th>
<th>Nutrients to Apply</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>per acre</td>
<td>N</td>
<td>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;O</td>
</tr>
<tr>
<td>Corn, grain</td>
<td>151-170 bu</td>
<td>120</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>Soybean</td>
<td>46-55 bu</td>
<td>0</td>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>Corn, grain</td>
<td>151-170 bu</td>
<td>120</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>Pea (chick, fiel)</td>
<td>1-2 tons</td>
<td>30</td>
<td>15</td>
<td>130</td>
</tr>
</tbody>
</table>

The lime required for this rotation to reach pH 6.3 is 4 T/a of 60-69 lime or 3 T/a of 80-89 lime.

#### ADDITIONAL INFORMATION

- **Fertilizer credit based on 1 year(s) of 4 tons/acre of surface dairy manure.**
- **If lime has been applied in the last two years, more lime may not be needed due to incomplete reaction.**
- **Year 1, 3:** If corn harvested for silage instead of grain add extra 30 lbs P2O5 per acre and 90 lbs K2O per acre to next crop.

**A lime recommendation is calculated only when soil pH is more than 0.2 units below the optimum pH.**

**Starter fertilizer (e.g. 10-20-20 lbs N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O) is advisable for row crops on soils slow to warm in the spring.**

**A soil nitrate test may better estimate actual corn N needs.**

**If conservation tillage leaves more than 50% residue cover when corn follows after corn, add an additional 30 N lbs/a.**

**If alfalfa will be maintained for more than three years, increase recommended K<sub>2</sub>O by 20% each year.**
### Graphic Interpretation and Lab Results

#### Test Interpretation

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Very Low</th>
<th>Low</th>
<th>Optimum</th>
<th>High</th>
<th>Very High</th>
<th>Excessive</th>
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<tbody>
<tr>
<td>Corn, grain</td>
<td>PPPPPP</td>
<td>PPPPPPPPPP</td>
<td>PPPPPPPPPP</td>
<td>PPPPPPPPPPPP</td>
<td>PPPPPPPPPP</td>
<td>PPPPPPPPPP</td>
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<tr>
<td></td>
<td>XXXXXXXX</td>
<td>XXXXXXX</td>
<td>XXXXXXXX</td>
<td>XXXXXXX</td>
<td>XXXXXXXX</td>
<td>XXXXXXXX</td>
</tr>
<tr>
<td>Soybean</td>
<td>PPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
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<tr>
<td></td>
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<td>XXXXXXX</td>
<td>XXXXXXXX</td>
<td>XXXXXXXX</td>
</tr>
<tr>
<td>Corn, grain</td>
<td>PPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
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<td>XXXXXXX</td>
<td>XXXXXXXX</td>
<td>XXXXXXX</td>
<td>XXXXXXXX</td>
<td>XXXXXXXX</td>
</tr>
<tr>
<td>Pea (chick, field)</td>
<td>PPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
<td>PPPPPPPP</td>
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<tr>
<td>Rotation pH</td>
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</table>

#### Laboratory Analysis

<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>Soil pH</th>
<th>O.M. %</th>
<th>Phosphorus ppm</th>
<th>Potassium ppm</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
<th>Estimated CEC</th>
<th>Boron ppm</th>
<th>Manganese ppm</th>
<th>Zinc ppm</th>
<th>Sulfate-Sulfur ppm</th>
<th>Sulfur Avail. Index</th>
<th>Texture Code</th>
<th>Sample Density</th>
<th>Buffer Code</th>
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<tbody>
<tr>
<td>4</td>
<td>5.6</td>
<td>2.2</td>
<td>25</td>
<td>78</td>
<td>750</td>
<td>140</td>
<td>5</td>
<td>0.5</td>
<td>35</td>
<td>2.3</td>
<td>8.8</td>
<td>57</td>
<td>2</td>
<td>1.49</td>
<td>6.6</td>
</tr>
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</table>

**Adjusted Avg.**

5.6 2.2 25 78 750 140 5 0.5 35 2.3 8.8 57
# Secondary and Micronutrient Recommendations

<table>
<thead>
<tr>
<th>Interpretations</th>
<th>Ca-OPT</th>
<th>Mg-OPT</th>
<th>B-L</th>
<th>Mn-H</th>
<th>Zn-L</th>
<th>SAI-H</th>
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<tbody>
<tr>
<td>Response to added Ca is unlikely.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Soil Mg is optimum. Maintain level with dolomitic lime.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Year 1,2,3,4: Confirm the need for B by plant analysis.</td>
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<td></td>
<td></td>
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<tr>
<td>Year 1,2,3: Confirm the need for Zn by plant analysis.</td>
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<tr>
<td>Year 4: Response to Zn is unlikely.</td>
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<tr>
<td>Response to sulfur unlikely.</td>
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<tr>
<td>Year 1,2,3,4: Response to Mn is unlikely.</td>
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</table>

Recommendations based on A2809 Soil Test Recommendations for Field, Vegetable, and Fruit Crops page 1 for field '4'
Key steps to obtaining a proper fertilizer recommendation

- Take a good soil sample, (publicationA2100)
Key steps to obtaining a proper fertilizer recommendation

• Take a good soil sample, (publicationA2100)
• Use a Wisconsin Certified Laboratory

A & L Great Lakes Laboratories, Inc.
3505 Conestoga Drive
Fort Wayne, IN 46808
260-483-4759

AgSource Cooperative Services
106 N. Cecil Street
Bonduel, WI 54107
715-758-2178

Dairyland Laboratories
217 E. Main Street
Arcadia, WI 54612
608-323-2123

Mowers Soil Testing Plus, Inc.
117 East Main Street
Toulan, IL 61483
309-286-2761

Rock River Laboratory
P. O. Box 169
Watertown, WI 53094
920-261-0446

UW Soil & Plant Analysis Lab
5711 Mineral Point Road
Madison, WI 53705
608-262-4364

UW Soil & Forage Analysis Lab
8396 Yellowstone Drive
Marshfield, WI 54449
715-387-2523
Key steps to obtaining a proper fertilizer recommendation

- Take a good soil sample, *(publicationA2100)*
- Use a Wisconsin Certified Laboratory
- Take the appropriate nutrient credits for manure or previous legume crops
Key steps to obtaining a proper fertilizer recommendation

- Take a good soil sample, (publicationA2100)
- Use a Wisconsin Certified Laboratory
- Take the appropriate nutrient credits for manure or previous legume crops
- Follow the guidelines listed on the report
What is Needed?

<table>
<thead>
<tr>
<th>Nutrients to Apply</th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>P₂O₅</td>
<td>K₂O</td>
</tr>
<tr>
<td>lbs/a</td>
<td>0</td>
<td>18</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>78</td>
<td>29</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>15</td>
<td>130</td>
</tr>
</tbody>
</table>
$P_2O_5 \ & \ K_2O \ or \ P \ & \ K$

- Grades for P and K are expressed as oxides, rather than on elemental basis
- Fertilizer recommendations are also given on oxide basis
  - lbs $P_2O_5$ / acre
  - lbs $K_2O$ / acre
- P and K in fertilizer not actual present as $P_2O_5$ or $K_2O$
  - Plants do not actually use $P_2O_5$ or $K_2O$
  - Oxide forms are used only to indicate amounts of P and K in fertilizer
<table>
<thead>
<tr>
<th>Elemental Name</th>
<th>Elemental Symbol</th>
<th>Oxide Name</th>
<th>Oxide Symbol</th>
<th>Plants Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>Phosphate</td>
<td>P₂O₅</td>
<td>H₂PO₄⁻</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>Potash</td>
<td>K₂O</td>
<td>K⁺</td>
</tr>
</tbody>
</table>
Can I just apply 150 – 10 – 55?

- NO
- Certain decisions and calculations must be done first
- Crop, soil, source and price considerations
- Make the best choice after considering the whole picture
Fertilizer Types

- Mixed Fertilizer – contains more than one of the three major nutrients (ie 18-46-0)
- Complete Fertilizer – contains all three of the major nutrients (ie 6-24-24)
- Straight Fertilizer – contains only one of the three major nutrients (ie 46-0-0)
Fertilizer Grades

• Useful in determining application rates
• Minimum guaranteed amounts of available N, P$_2$O$_5$ and K$_2$O in fertilizer

5 – 10 – 30
N – P$_2$O$_5$ – K$_2$O

Calculated on a % of total weight basis
What is Needed?

<table>
<thead>
<tr>
<th>Nutrients to Apply</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td>lbs/a</td>
<td>0</td>
<td>18</td>
<td>47</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>78</td>
<td>29</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>15</td>
<td>130</td>
<td></td>
</tr>
</tbody>
</table>
Example 150 – 10 – 55

N – P$_2$O$_5$ – K$_2$O

• 150 lbs N/a
• 150 lbs N x 100 lbs urea/45 lbs N = 333 lbs urea (45-0-0)
• Or
• 150 lbs N x 100 lbs ammonium sulfate/21 lbs N = 714 lbs ammonium sulfate (21-0-0-24)
Material considerations

• Cost per pound of nutrients for urea
  – Example urea at $200/ton,
  – Contains .45 lbs N/lb urea x 2000 = 900 lbs N
  – $200/900 lbs N = $0.22/lb N

• Cost per pound of nutrients for AMS
  – Example ammonium sulfate at $200/ton
  – Contains .21 lbs N/lb AMS x 2000 = 420 lbs N
  – $200/420 lbs N = $0.48/lb N
Other considerations

- Availability – $\text{NH}_4$ vs. $\text{NO}_3$
- Additional nutrients – Sulfur in AMS
Example 150 – 10 – 55

N – P$_2$O$_5$ – K$_2$O

- 10 lbs P$_2$O$_5$/a
- 10 lbs P$_2$O$_5$ x 100 lbs TSP/46 lbs P$_2$O$_5$ = 22 lbs triple super phosphate (0-46-0)
- Or
- 10 lbs P$_2$O$_5$ x 100 lbs (9-23-30)/23 lbs P$_2$O$_5$ = 43 lbs fertilizer
Example 150 – 10 – 55

N – P\textsubscript{2}O\textsubscript{5} – K\textsubscript{2}O

- 55 lbs K\textsubscript{2}O/a
- 55 lbs K\textsubscript{2}O \times 100 lbs potash (KCl)/60 lbs 55 lbs K\textsubscript{2}O = 92 lbs potash (0-0-60)
- Or
- 55 lbs K\textsubscript{2}O \times 100 lbs potassium sulfate /50 lbs 55 lbs K\textsubscript{2}O = 110 lbs fertilizer (0-0-50)
Fertilizer Ratio

- Relative proportion of $N$, $P_2O_5$ and $K_2O$ in a fertilizer

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-24-24</td>
<td>1:4:4</td>
</tr>
<tr>
<td>5-10-30</td>
<td>1:2:6</td>
</tr>
<tr>
<td>9-9-9</td>
<td>1:1:1</td>
</tr>
</tbody>
</table>
Conversions between elemental and oxide forms

1 lb of $P_2O_5$ = 0.44 lbs P

1 lb of P = 2.29 lbs $P_2O_5$

1 lb of $K_2O$ = 0.83 lbs K

1 lb of K = 1.20 lbs of $K_2O$
Nutrient amounts in liquid fertilizers

- Calculation of nutrient content of liquid fertilizers requires information on weight per gallon of the liquid fertilizer

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight (lbs/gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-34-0</td>
<td>11.7</td>
</tr>
<tr>
<td>9-18-9</td>
<td>11.7</td>
</tr>
<tr>
<td>28-0-0</td>
<td>10.7</td>
</tr>
</tbody>
</table>
Nutrient amounts in liquid fertilizers

• 10.7 lbs x 28lbs N/100 lbs. Material = 3.0 lbs N per gallon of 28-0-0

• Therefore, if you need to apply 50 lbs of N per acre, how many gallons should you apply

• 50lbs N x one gallon/3.0 lbs = 16.7 gallons per acre
Summary

- Know what nutrients are needed and in what amount of N, $\text{P}_2\text{O}_5$ and $\text{K}_2\text{O}$
- Consider soil type, additional crop nutrient needs, price and availability
- Make the best choice of ready mixed product or order custom blended material
1. Calculate the pounds of N, P\textsubscript{2}O\textsubscript{5} and K\textsubscript{2}O in 1 ton (2000 lbs) of 9-18-30.

9-18-30 means there is 9 lbs of N, 18 lbs of P\textsubscript{2}O\textsubscript{5} and 30 lbs of K\textsubscript{2}O in every 100 lbs of material.

Since there is 20 x 100 lbs in a ton

Multiply \[ 9 \times 20 = 180 \text{ lbs of N} \]
\[ 18 \times 20 = 360 \text{ lbs of P}_2\text{O}_5 \]
\[ 30 \times 20 = 600 \text{ lbs of K}_2\text{O} \]
2. Which is a cheaper source of N?

82-0-0 @ $245/ton or
46-0-0 @ $160/ton

82-0-0 contains:

\[
82 \times 20 = 1640 \text{ units of N for } \$245/\text{ton} \\
\frac{\$245}{164 \text{ units}} = 14.9\text{¢ / unit of N}
\]

46-0-0 contains:

\[
46 \times 20 = 920 \text{ units of N for } \$160/\text{ton} \\
\frac{\$245}{164 \text{ units}} = 17.4\text{¢ / unit of N}
\]
3. Sven of Sven and Ole’s super nifty fertilizer company, says that 3 gal/a of his liquid fish emulsion (3-2-3) is equivalent to 6 gal/a of a 7-21-7 liquid fertilizer from the local coop. The fish emulsion weight 8.7 lb/gal and the 7-21-7 weighs 10.8 lb/gal

How much N, P$_2$O$_5$ and K$_2$O would be applied per acre with each material?
3. How much N, P$_2$O$_5$ and K$_2$O would be applied per acre with each material?

Fish emulsion: 3 gal x \( \frac{8.7 \text{ lb}}{\text{gal}} \) = 26.1 lbs

\[
\begin{align*}
N & \quad \frac{3 \text{ lbs N}}{100 \text{ lbs}} \times 26.1 \text{ lbs} = 0.783 \text{ lbs N} \\
P_2O_5 & \quad \frac{2 \text{ lbs } P_2O_5}{100 \text{ lbs}} \times 26.1 \text{ lbs} = 0.522 \text{ lbs } P_2O_5 \\
K_2O & \quad \frac{3 \text{ lbs } K_2O}{100 \text{ lbs}} \times 26.1 \text{ lbs} = 0.783 \text{ lbs } K_2O \\
\end{align*}
\]

Liquid fertilizer: 6 gal x \( \frac{10.8 \text{ lb}}{\text{gal}} \) = 64.8 lbs

\[
\begin{align*}
N & \quad \frac{7 \text{ lbs N}}{100 \text{ lbs}} \times 64.8 \text{ lbs} = 4.53 \text{ lbs N} \\
P_2O_5 & \quad \frac{21 \text{ lbs } P_2O_5}{100 \text{ lbs}} \times 64.8 \text{ lbs} = 13.61 \text{ lbs } P_2O_5 \\
K_2O & \quad \frac{7 \text{ lbs } K_2O}{100 \text{ lbs}} \times 64.8 \text{ lbs} = 4.53 \text{ lbs } K_2O \\
\end{align*}
\]
4. If a fertilizer recommendation for corn calls for 160 lb N/a, 50 lb P$_2$O$_5$/a, and 50 lb K$_2$O/a, how many pounds of the following fertilizer materials will be needed to supply the recommended amounts of nutrients on a per acre basis?

46-0-0  0-46-0  0-0-50
4. Recommendation - 160 lb N/a, 50 lb P$_2$O$_5$/a, and 50 lb K$_2$O/a

\[
\begin{align*}
\frac{160 \text{ lbs N}}{0.46 \text{ N}} &= 348 \text{ lbs of 46-0-0} \\
\frac{50 \text{ lbs P}_2\text{O}_5}{0.46 \text{ P}_2\text{O}_5} &= 109 \text{ lbs of 0-46-0} \\
\frac{50 \text{ lbs K}_2\text{O}}{0.50 \text{ K}_2\text{O}} &= 100 \text{ lbs of 0-0-50}
\end{align*}
\]
5. If 600 lb of 34-0-0, 800 lb of 18-46-0, and 600 lb of 0-0-60 are mixed, what is the grade of the resulting fertilizer blend?

\[
\begin{align*}
600 \times 0.34 &= 204 \text{ units of N} \\
800 \times 0.18 &= 144 \text{ units of N} \\
800 \times 0.46 &= 368 \text{ units of } \text{P}_2\text{O}_5 \\
600 \times 0.60 &= 360 \text{ units of } \text{K}_2\text{O}
\end{align*}
\]
5. If 600 lb of 34-0-0, 800 lb of 18-46-0, and 600 lb of 0-0-60 are mixed, what is the grade of the resulting fertilizer blend?

348 units N, 368 units P$_2$O$_5$, 360 units K$_2$O

2000 lbs

20 = 17.4 – 18.4 – 18.0