SULFUR
SULFUR (S)

- Role of S in plants
  - Component of amino acids
  - Essential for nitrate reductase enzyme
    - Nitrate $\rightarrow$ organic-N
- Deficiency symptoms not localized
Figure 1. The sulfur cycle.
POTENTIAL SULFUR DEFICIENCIES

- Low organic matter soils
- No recent manure history
- Low sulfur in precipitation
- Low subsoil sulfur
## Sulfur Removed by Crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Portion harvested</th>
<th>Yield/acre</th>
<th>Sulfur removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>hay</td>
<td>4 tons</td>
<td>23</td>
</tr>
<tr>
<td>Corn</td>
<td>grain</td>
<td>150 bu</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>silage</td>
<td>15 tons</td>
<td>25</td>
</tr>
<tr>
<td>Oat</td>
<td>Grain</td>
<td>80 bu</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>straw</td>
<td>2 tons</td>
<td>9</td>
</tr>
<tr>
<td>Potato</td>
<td>tubers</td>
<td>400 cwt.</td>
<td>10</td>
</tr>
</tbody>
</table>
SULFUR AVAILABILITY INDEX (SAI)

= Sum of available S inputs:

• Organic matter – 2.8 lb S/a for 1% OM
• S in rain & snow – 10 or 20 lb S/a
• S in subsoil 5, 10, or 20 lb S/a
• S in manure – depends on rate, kind
• Soil sulfate-S test
SAI Interpretation:

- $< 30 = \text{Apply S to S-demanding crops}$
- $30-40 = \text{Confirm S need by plant analysis}$
- $> 40 = \text{No additional S needed}$
## Suggested treatments for sulfur deficiencies

<table>
<thead>
<tr>
<th>Crop</th>
<th>Sulfur needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forage legumes:</td>
<td>-- lb S/acre --</td>
</tr>
<tr>
<td>Incorporated at seeding</td>
<td>25 - 50</td>
</tr>
<tr>
<td>Topdressed on established stand</td>
<td>15 - 25</td>
</tr>
<tr>
<td>Corn, small grains, vegetables &amp; fruits</td>
<td>10 - 25</td>
</tr>
</tbody>
</table>
# Sources of sulfur fertilizer

<table>
<thead>
<tr>
<th>Name of fertilizer</th>
<th>Chemical formula</th>
<th>Fertilizer analysis (%)</th>
<th>Sulfur Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very soluble:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonium sulfate</td>
<td>(NH$_4$)$_2$SO$_4$</td>
<td>21-0-0</td>
<td>24</td>
</tr>
<tr>
<td>Potassium sulfate</td>
<td>K$_2$SO$_4$</td>
<td>0-0-50</td>
<td>18</td>
</tr>
<tr>
<td>Potassium-magnesium sulfate</td>
<td>K$_2$SO$_4$ • 2MgSO$_4$</td>
<td>0-0-22</td>
<td>23</td>
</tr>
<tr>
<td>Ammonium thiosulfate</td>
<td>(NH$_4$)$_2$S$_2$O$_3$</td>
<td>12-0-0</td>
<td>26</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>MgSO$_4$ • 7 H$_2$O</td>
<td>0-0-0</td>
<td>14</td>
</tr>
</tbody>
</table>
## Sources of sulfur fertilizer

<table>
<thead>
<tr>
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<th>Sulfur Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slightly soluble:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium sulfate (gypsum)</td>
<td>CaSO$_4$ 2H$_2$O</td>
<td>0-0-0</td>
<td>17</td>
</tr>
<tr>
<td><strong>Insoluble:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elemental sulfur</td>
<td>S</td>
<td>0-0-0</td>
<td>88-98</td>
</tr>
</tbody>
</table>
MICRONUTRIENTS
Essential Plant Nutrients

• Micronutrients:
  – Zinc (Zn) $\text{Zn}^{++}$
  – Manganese (Mn) $\text{Mn}^{++}$
  – Iron (Fe) $\text{Fe}^{++}$ or $\text{Fe}^{+3}$
  – Copper (Cu) $\text{Cu}^{++}$
Essential Plant Nutrients

• Micronutrients:
  – Boron (B) $\text{H}_2\text{BO}_3^-$
  – Molybdenum (Mo) $\text{MoO}_4^{--}$
  – Chlorine (Cl) $\text{Cl}^-$
  – Nickel (Ni) $\text{Ni}^{++}$
<table>
<thead>
<tr>
<th>Crop</th>
<th>Boron</th>
<th>Manganese</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Corn</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Soybean</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Cabbage</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Beets</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Potato</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>
MICRONUTRIENT FERTILIZERS

• Apply only when:
  ✓ Soil test is low
  ✓ Deficiency symptoms on plant
  ✓ Plant analysis indicates deficiency
  ✓ High crop requirement
MICRONUTRIENT FERTILIZERS

- Fertilizer addition recommended only when:
  - Soil test is low
  - Crop requirement is high or medium

✓ Soil test is low

AND

✓ Crop requirement is high or medium
POTENTIAL MICRONUTRIENT DEFICIENCIES

- Zinc
  - High pH soils
  - Eroded or scalped soils
  - Lower organic matter soils
  - Corn
ZINC DEFICIENCY
MICRONUTRIENT FERTILIZER RECOMMENDATIONS

• **Zinc**
  - ✓ Apply 2-4 lb Zn/acre (banded) if crop has high requirement
  - ✓ Apply 4-8 lb Zn/acre (broadcast)
  - ✓ Foliar applications = 1 lb Zn/acre, repeat treatments may be needed
POTENTIAL MICRONUTRIENT DEFICIENCIES

- Manganese
  - High pH soils
  - Dark colored soils in Southern & Southeastern Wisconsin
  - Red soils in Eastern Wisconsin
  - Soybean & small grains
MANGANESE DEFICIENCY
MICRONUTRIENT FERTILIZER RECOMMENDATIONS

- Manganese
  ✓ Apply 5 lb Mn/acre (banded) if crop has high requirement
  ✓ Foliar applications = 1lb Mn/acre, repeat treatments may be needed
  ✓ Broadcast applications not recommended
POTENTIAL MICRONUTRIENT DEFICIENCIES

• Boron
  ▪ Low pH soils
  ▪ Periods of dry weather
  ▪ Alfalfa
• **Boron**

- ✓ **Apply 2-3 lb B/acre (broadcast) if crop has high requirement**
- ✓ **Apply 1-2 lb B/acre (broadcast) if crop has medium requirement**