Nutrient Deficiencies: What to look for and when to sample

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Macro and Micronutrients

- C, H, O – Water and Air supplied
- N, P, K, Ca, Mg, S – Fertilizer and soil
- B, Cu, Fe, Mn, Zn, Mo, Cl, Ni – mainly soil supplied
Am I Mobile?

- Mobile nutrients – symptoms appear first on lower leaves
- Immobile nutrients – symptoms appear first on upper leaves
Phosphorus (P)
Phosphorus

• Sufficient ear leaf concentration
  – 0.2-0.4%

• Primary Macronutrient

• Role in Plant
  – Constituent of proteins, coenzymes, nucleic acids
  – Energy transfer

• Deficiencies in soils
  – Can be deficient under many circumstances
  – Favored by very high and very low pH
    • High availability of Ca, Fe, Al….etc.
  – Favored by cool soil temperature
Nitrogen (N)
Nitrogen

• Sufficient ear leaf concentration
  – 2.7-3.5%
• Primary Macronutrient
• Role in Plant
  – Constituent of proteins, chlorophyll, and nucleic acids
• Deficiencies in soils
  – Can be deficient under many circumstances
    • Mobile nutrient
  – Soils natively low have low organic matter and are well drained
  – Will denitrify under water logged conditions
Potassium (K)
Potassium

- Sufficient ear leaf concentration
  - 1.7-2.5%
- Primary Macronutrient
- Role in Plant
  - Involved with photosynthesis, carbohydrate translocation, and protein synthesis
- Deficiencies in soils
  - Can be deficient under many circumstances
  - Low native K levels in the soil
  - Sandy soils or soils with low CEC
Magnesium (Mg)
Magnesium

• Sufficient ear leaf concentration
  – 0.2-0.4%
• Secondary Macronutrient
• Role in Plant
  – Enzyme activator
  – Component of chlorophyll
• Deficiencies in soils
  – Very acid, sandy soils
  – Favored by very high rainfall
  – High levels of K in the soil or fertilizer rates
Calcium (Ca)
Calcium

- Sufficient ear leaf concentration
  - 0.4-1.0%
- Secondary Macronutrient
- Role in Plant
  - Component of cell walls
  - Role in cell structure and permeability of membranes
- Deficiencies in soils
  - Rarely if ever seen in Midwest
  - Favored by very low pH (<5.0)
  - Highly weathered acid soils
  - High levels of Mg or K on the CEC
Zinc (Zn)
Zinc

- Sufficient ear leaf concentration
  - 50-150 ppm
- Micronutrient
- Role in Plant
  - Involved with enzyme systems that regulate plant metabolic activities
- Deficiencies in soils
  - High soil pH
  - Low soil organic matter with high pH
  - Cool, wet soils
  - High phosphorus fertilizer rates on marginal Zn soils
Sulfur (S)
Sulfur

• Sufficient ear leaf concentration
  – 0.1-0.3%
• Secondary Macronutrient
• Role in Plant
  – Plant proteins
    • Somewhat involved with photosynthesis proteins
• Deficiencies in soils
  – Sandy, low organic matter soils
  – Large amounts of plant residues
  – Fine textured soils with low organic matter
Iron (Fe)
Iron

- Sufficient ear leaf concentration
  - 50-200 ppm
- Micronutrient
- Role in Plant
  - Chlorophyll synthesis
  - Enzymes for electron transfer
- Deficiencies in soils
  - High soil pH and free lime
    - Calcareous soils
  - High soil moisture
Manganese (Mn)
Manganese

- Sufficient ear leaf concentration
  - 20-250 ppm
- Micronutrient
- Role in Plant
  - Photosynthesis
  - Oxidation-reduction system control
- Deficiencies in soils
  - High soil pH
  - Sandy soils high in organic matter
  - Peat or muck soils
Copper (Cu)
Copper

• Sufficient ear leaf concentration
  – 3-15 ppm

• Primary Macronutrient

• Role in Plant
  – Catalyst for respiration
  – Component of enzymes

• Deficiencies in soils
  – Organic soils
  – High soil pH (<7.5)
  – Not a known problem in MN soils
Boron (B)
Boron

• Sufficient ear leaf concentration
  – 4-15 ppm
• Micronutrient
• Role in Plant
  – Sugar translocation?
  – Carbohydrate metabolism?
  – Reproductive structure development
• Deficiencies in soils
  – Drought
  – Sandy soils low in organic matter
  – High soil pH
Other Micros

• Molybdenum
  – Nitrogen fixation
  – Transforming nitrate to ammonium

• Chlorine
  – Oxygen production in photosynthesis
  – Plant water relations

• Nickel
  – Seed germination
  – Urease activity
# What Crops are Sensitive to Deficiency

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Sensitive crops</th>
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</thead>
<tbody>
<tr>
<td>Boron</td>
<td>Alfalfa, Clover, Sugar Beet</td>
</tr>
<tr>
<td>Copper</td>
<td>Small Grains, Corn</td>
</tr>
<tr>
<td>Iron</td>
<td>Soybeans</td>
</tr>
<tr>
<td>Manganese</td>
<td>Alfalfa, Small Grains, Soybean, Sugar Beet</td>
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<tr>
<td>Zinc</td>
<td>Corn, Edibles</td>
</tr>
<tr>
<td>Nutrient</td>
<td>Sensitive crops</td>
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<td>--------------</td>
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</tr>
<tr>
<td>Boron</td>
<td>Corn, Edible Beans</td>
</tr>
<tr>
<td>Copper</td>
<td>Cereals, Legumes</td>
</tr>
<tr>
<td>Iron</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>Cereals</td>
</tr>
<tr>
<td>Zinc</td>
<td>Cereals</td>
</tr>
<tr>
<td>Nutrient</td>
<td>Toxicity Symptoms</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Boron</td>
<td>Burning on leaf margins, leaves look scotched and fall off</td>
</tr>
<tr>
<td>Copper</td>
<td>Suppressed root growth, may induce Fe deficiency</td>
</tr>
<tr>
<td>Iron</td>
<td>Not known</td>
</tr>
<tr>
<td>Manganese</td>
<td>Brown spots on older leaves surrounded by chlorotic circles</td>
</tr>
<tr>
<td>Zinc</td>
<td>Chlorosis in plants sensitive to Fe, most crops are tolerant to high Zinc</td>
</tr>
</tbody>
</table>
Toxicities

- Other elements may be taken into the plant
  - Some of these may be toxic
  - For example, aluminum is toxic to many plants but is taken up
  - Serious problem in highly weathered soils
- Heavy metals also may accumulate in soils and plants
How to Differentiate

• It can be hard to tell a deficiency from a toxicity
  – Some mimic or may induce symptoms
  – Dig up plants and look at the roots
    • Some toxicities will severely impact the roots
• Take plant and soil samples
  – Need to know what you are looking for
When To Sample

• Sampling should be done before reproductive development—Why?
  – Plant tissue concentrations tend to decrease late in the season

• What is the best plant part to sample
  – Small Plants <12” – whole above ground mass
  – Prior to tasseling - Upper mature leaf below whorl
  – After tasseling – ear leaf
Figure 1. For plants less than 12 inches tall, submit all of the above-ground portion cut 1 inch above the soil surface.

Figure 2. For plants taller than 12 inches but prior to tasseling, submit the entire first mature leaf below the whorl. A mature leaf is completely unrolled from the stalk and has a formed sheath (collar).

Figure 3. For plants with 50% of ears showing silks, submit the entire ear leaf. Break off at the base of the leaf, but do not include portions of the leaf sheath (collar). Sample before silks turn brown.
<table>
<thead>
<tr>
<th></th>
<th>Low YLD</th>
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<th>High YLD</th>
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<tbody>
<tr>
<td>N</td>
<td>1.2</td>
<td>1.3</td>
<td></td>
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</tr>
<tr>
<td>P</td>
<td>0.3</td>
<td>0.3</td>
<td></td>
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<tr>
<td>K</td>
<td>0.4</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>&lt; 0.01</td>
<td></td>
<td>&lt; 0.01</td>
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<tr>
<td>Mg</td>
<td>0.10</td>
<td>0.10</td>
<td></td>
<td></td>
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<tr>
<td>S</td>
<td>0.06</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2.5</td>
<td>2.2</td>
<td></td>
<td></td>
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<tr>
<td>Fe</td>
<td>16.1</td>
<td>20.8</td>
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</tr>
<tr>
<td>Mn</td>
<td>4.3</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>1.7</td>
<td>1.2</td>
<td></td>
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<tr>
<td>Zn</td>
<td>17.3</td>
<td>17.5</td>
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</tbody>
</table>
What to Avoid

- Plant sampling is only as good as the sample taken
  - Avoid damaged plants
  - Avoid dead or dying plants
  - Avoid severely stressed plant
    - Moisture
    - Temperature
  - Avoid sampling during the hottest part of the day
Don’t confuse damage symptoms with deficiencies
Anhydrous Bands
Boron Damage – applied In-furrow
UAN Injury
Thank You

Questions?

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