Lesson C8–4

Identifying Nutrient Deficiencies in Crops

Unit C. Plant and Soil Science

Problem Area 8. Soil Fertility and Moisture Management

Lesson 4. Identifying Nutrient Deficiencies in Crops

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: I: Apply principles of anatomy and physiology to produce and manage plants in both a domesticated and natural environment.

Benchmark: I-A. Analyze and evaluate nutritional requirements and environmental conditions to develop and implement a fertilization plan.

Performance Standard: 2. Determine plant nutrient requirements for optimum growth.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Identify primary macronutrients and their deficiencies.
2. Identify secondary macronutrient and their deficiencies.
3. Identify micronutrients and their deficiencies.
4. Describe environmental conditions that influence nutrient deficiencies.
List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:


Other Resources. The following resources will be useful to students and teachers:


List of Equipment, Tools, Supplies, and Facilities

- Writing surface
- Overhead projector
- Transparencies from attached masters
- Copies of student lab sheet
- Plant tissue testing kit

Terms. The following terms are presented in this lesson (shown in bold italics):

- Macronutrients
- Micronutrients
- Nutrients
- Primary nutrients
- Secondary macronutrients
- Trace elements
Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Display to the students a healthy plant and one that has a nutrient deficiency. Ask students to identify differences between the two. Lead a discussion that introduces the lesson.

Summary of Content and Teaching Strategies

Objective 1: Identify primary macronutrients and their deficiencies.

Anticipated Problem: What are the primary macronutrients and their deficiencies?

I. The elements used by plants for growth and development are often referred to as nutrients. Nutrients that are required in great amounts are called macronutrients.

A. There are nine macronutrients.

1. Carbon, hydrogen, and oxygen are not considered in a fertility program because they are part of the air around the plant. Nitrogen (N), phosphorus (P), and potassium (K) are considered to be primary nutrients because they are used by plants in large amounts.

B. Nitrogen deficiency symptoms—Plants are light green, older leaves yellow (chlorosis); yellowing begins at leaf tip and extends along midribs in corn and sorghum, and slow or dwarfed growth.

C. Phosphorus deficiency symptoms—Plants dark green with purple cast to leaves and stems, and stunted leaves and plants.

D. Potassium deficiency symptoms—Yellow/brown discoloration and scorching along outer margin of older leaves that begins at leaf tip in corn and sorghum.

Use TM: C8–4A and C8–4B as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 5 in Introduction to Plant and Soil Science Technology and Chapter 8 in Soil Fertility Manual are recommended.

Objective 2: Identify secondary macronutrients and their deficiencies.

Anticipated Problem: What are the secondary macronutrients and their deficiencies.

II. Secondary macronutrients are needed in moderate amounts.

A. Calcium (Ca), magnesium (Mg) and sulfur (S) are the secondary macronutrients.
B. Calcium deficiency symptoms. Emergence of the primary leaves delayed, terminal buds deteriorate, young leaves at growing points die back, short branched roots, leaf tips may be stuck together in corn.

C. Magnesium deficiency symptoms. Loss of green leaf color starting with bottom leaves; older leaves have yellow discoloration between veins, reddish-purple from edge inward.

D. Sulfur deficiency symptoms. Young leaves light green with veins being lighter.

Use TM: C8–4C as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency master to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 5 in Introduction to Plant and Soil Science Technology and Chapter 8 in Soil Fertility Manual are recommended.

Objective 3: Identify micronutrients and their deficiencies.

Anticipated Problem: What are the micronutrients and their deficiencies?

III. Micronutrients or trace elements are required in small amounts. Boron (B), copper (Cu), chlorine (Cl), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

A. Boron deficiency symptoms—Young leaves yellow and thick, growth buds appear as white or light brown dead tissue.

B. Copper deficiency symptoms—Young leaves uniformly pale yellow, may wilt and wither without chlorosis, heads to not form or may be grain-less on small grains.

C. Chlorine deficiency symptoms—Wilting of upper leaves, then chlorosis.

D. Iron deficiency symptoms—Leaves yellow to almost white, veins remain green, interveinal chlorosis to leaf tip.

E. Manganese deficiency symptoms—Leaves yellowish-gray or reddish-gray with green veins.

F. Molybdenum deficiency symptoms—Older leaves yellow, stunted growth, young leaves wilt and die along margins.

G. Zinc deficiency symptoms—Older leaves yellow, stunted growth, broad white to yellow bands appear on the leave so each side of the midrib, shortened internodes.

Use text material to strengthen student understanding of concepts. Chapter 5 in Introduction to Plant and Soil Science Technology and Chapter 8 in Soil Fertility Manual are recommended.

Objective 4: Describe environmental conditions that influence nutrient deficiencies.

Anticipated Problem: What environmental conditions influence nutrient deficiencies?

IV. Understanding environmental conditions and their effects on the crop can help pinpoint a problem that is developing.
A. All factors that influence crop growth, response to fertilization and yield should be evaluated.
   1. The soil must be of good tilth and permeable enough for roots to expand and feed extensively. A crop will develop a root system 6 feet or more in depth in some soils to get water and nutrients. A shallow or compacted soil does not offer this root feeding zone. Wet or poorly drained soils result in shallow root systems.
   2. Cool soil temperature slows organic matter decomposition. This lessens the release of nitrogen, sulfur, and other nutrients. Nutrients are less soluble in cool soils, and that increases deficiency potential. Phosphorus and potassium diffuse more slowly in cool soils. Root activity is decreased.
   3. Acid soil conditions reduce the availability of calcium, magnesium, sulfur, potassium, phosphorus, and molybdenum, and increase the availability of iron, manganese, boron, copper, and zinc.
   4. Insect damage is often mistaken for deficiency symptoms. Examine roots, leaves, and stems for insect damage that may look like or may induce a nutrient deficiency.
   5. Close study will show the difference between plant disease and nutrient deficiency.
   6. Dry soil conditions may create deficiencies such as boron, copper and potassium. Drought slows movement of nutrients to the roots.
   7. Soluble salts and alkali are problems in some areas. They may cover only part of the field. They are usually present where a high water table exists, where salt water contamination has occurred, or where poor quality water has been used for irrigation.
   8. Herbicides and mechanical controls are more important today than ever before. Weeds rob crop plants of water, air, light, and nutrients. Some weeds may even release substances that inhibit crop growth.
   9. Some soils develop hardpans (compaction) and require deep tillage. This requires more phosphorus and potassium to build up fertility.
  10. Row width, spacing of plants in the row, and number of plants per acre have important effects on yields.
  11. Irrigation water can contain nitrate, sulfate, boron, potassium, bicarbonate, chlorine and other salts. A water analysis should be used to modify production practices for utilization of various water sources.

Use TM: C8–4D as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 8 in Soil Fertility Manual and Chapter 5 in Introduction to Plant and Soil Science Technology are recommended.

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used to determine which objectives need to be reviewed or taught over using a different approach. Questions provided in the recommended textbooks may also be used to help review.
**Application.** Application can involve student activity with the provided lab.

**Evaluation.** Evaluation should focus on student achievement of the objectives for each lesson. Various techniques can be used, such as performance on the application activities. A sample written test is attached.

**Answers to Sample Test:**

**Part One: Matching**

1 = b, 2 = c, 3 = d, 4 = a

**Part Two: Completion**

1. Nitrogen (N), phosphorus (P) and potassium (K)
2. environmental
3. Calcium (Ca), magnesium (Mg) and sulfur (S)

**Part Three: Short Answer**

1. Because they are part of the air around the plant.
2. See the lesson outline for examples.
Test

Lesson C8–4: Identifying Nutrient Deficiencies in Crops

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Macronutrients  
b. Micronutrients  
c. Nutrients  
d. Secondary macronutrients

1. Trace elements are required in small amounts.
2. Elements used by plants for growth and development.
3. Elements needed in moderate amounts.
4. Nutrients that are required in great amounts.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. ____________, ____________, and ____________ are considered to be primary nutrients because they are used by plants in large amounts.
2. Understanding _______________ conditions and their effects on the crop can help pinpoint a problem that is developing.
3. ____________, ____________, and ____________ are the secondary macronutrients.

Part Three: Short Answer

Instructions. Provide information to answer the following questions.

1. Carbon, hydrogen, and oxygen are considered macronutrients but yet are not considered in a fertility program. Why?

2. Name three general nutrient deficiency symptoms.
CROP PLANTS WITH NUTRITIONAL DISEASES

Top left—corn ear with boron deficiency. Top right—wheat with manganese deficiency. Bottom left—potato leaf with potassium deficiency. Bottom right—soybean with zinc deficiency. (Courtesy, Potash and Phosphate Institute)
NITROGEN INCREASES UPTAKE OF OTHER NUTRIENTS BY THE PLANT

Differences in Content of Other Nutrients

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>None</th>
<th>160 lb/A</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, %</td>
<td>2.36</td>
<td>3.02</td>
<td>+0.08</td>
</tr>
<tr>
<td>P, %</td>
<td>0.18</td>
<td>0.26</td>
<td>+0.08</td>
</tr>
<tr>
<td>K, %</td>
<td>2.22</td>
<td>2.44</td>
<td>+0.22</td>
</tr>
<tr>
<td>Ca, %</td>
<td>0.66</td>
<td>0.68</td>
<td>+0.02</td>
</tr>
<tr>
<td>Mg, %</td>
<td>0.24</td>
<td>0.26</td>
<td>+0.02</td>
</tr>
<tr>
<td>Mn, ppm</td>
<td>40</td>
<td>47</td>
<td>+7</td>
</tr>
<tr>
<td>Fe, ppm</td>
<td>163</td>
<td>162</td>
<td>-1</td>
</tr>
<tr>
<td>Zn, ppm</td>
<td>22</td>
<td>36</td>
<td>+14</td>
</tr>
<tr>
<td>B, ppm</td>
<td>12</td>
<td>18</td>
<td>+6</td>
</tr>
<tr>
<td>Cu, ppm</td>
<td>10</td>
<td>14</td>
<td>+4</td>
</tr>
</tbody>
</table>

Yield/Acre

- None: 118 bu
- 160 lb/A: 139 bu

WHY?

Because N becomes building blocks called amino acids inside the plant.
Because these building blocks produce protoplasm leading to strong plant cells.
Because these cells create a vigorous plant with a root system that searches for other nutrients to help it meet the big-yield appetite N gives it.
EXAMPLES OF NUTRIENT DEFICIENCIES

Top left—potassium deficiency in alfalfa. Top right—nitrogen deficiency in corn. Bottom left—iron deficiency in a tomato plant. Bottom right—magnesium deficiency in a grape plant. (Courtesy, Potash and Phosphate Institute, Norcross, Georgia)
# Diagnostic Calendar—Fall to Fall

## Start to Plan Ahead

<table>
<thead>
<tr>
<th>But look back to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
</tr>
<tr>
<td>Yields</td>
</tr>
<tr>
<td>Poor areas</td>
</tr>
<tr>
<td>Drainage problems</td>
</tr>
<tr>
<td>Crop lodging</td>
</tr>
<tr>
<td>Compaction</td>
</tr>
</tbody>
</table>

### FALL

- Sample soils under growing crops for next year. What is deficient?
- Enough plants? Ears filled? Right size? Was yield goal high enough?
- Fall is best time to install drainage systems. Enough drains?
- Root lodging: Root worms? Low K? Saturated soil?
- Stalk breakage: Stalk borers? Diseases? Low K? Low Cl?

## Set Yield Goals:

<table>
<thead>
<tr>
<th>Visit neighbors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit dealers and advisors</td>
</tr>
<tr>
<td>Attend meetings</td>
</tr>
<tr>
<td>Read and study</td>
</tr>
<tr>
<td>Check yield trials</td>
</tr>
</tbody>
</table>

## Get Ready Early:

<table>
<thead>
<tr>
<th>Machinery ready?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction potential?</td>
</tr>
<tr>
<td>Less tillage?</td>
</tr>
<tr>
<td>Fertility level?</td>
</tr>
<tr>
<td>Drainage?</td>
</tr>
</tbody>
</table>

### WINTER

- What is a reasonable yield goal for the farm? For specific fields?
- Compare notes with other leading growers.
- Secure supply of fertilizers, lime, seed and pesticides.
- Study new information carefully: from research, Extension, agribusiness.
- Read farm papers, technical journals, commercial releases.
- Compare various hybrid sources, yield tests and long-time trends. Will hybrids respond to high populations and high fertility?
- Planter or drill ready? Calibrated to plant enough seed per/A?
- Right seeding depth? Correct starter placement?
- Avoid heavy equipment on wet soils.
- Plan for conservation tillage, if possible.
- Sample soils early.
- Spot drainage problem areas during early rains. Ponding? Why? Cure?
<table>
<thead>
<tr>
<th>Get Set! Go! Check:</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
<td>• Plant early to take advantage of light, heat units.</td>
</tr>
<tr>
<td>Seedling damage</td>
<td>• Crusting? Planting depth? Germination? Temperature? Moisture?</td>
</tr>
<tr>
<td>Cultivation damage</td>
<td>• Insects? Disease? Chemical damage from herbicides or fertilizers?</td>
</tr>
<tr>
<td>N needs: Re-check!</td>
<td>• Birds? Shallow rooting? Saturated soil? Starvation?</td>
</tr>
<tr>
<td>Weather patterns</td>
<td>• Root pruning?</td>
</tr>
<tr>
<td></td>
<td>• Adequacy may depend on amount N applied, rainfall, and yield potential. How much supplemental N is needed?</td>
</tr>
<tr>
<td></td>
<td>• Chart stress periods throughout growth cycle. Record unusual weather during early growth, pollination period and grain-filling stages.</td>
</tr>
<tr>
<td>Walk Fields!</td>
<td>SUMMER</td>
</tr>
<tr>
<td>Insects? Diseases? Weeds?</td>
<td>• Inspect fields several times during growth. Take soil map along.</td>
</tr>
<tr>
<td>Nutrient hunger?</td>
<td>• Watch for diseases, insects, or obvious damage on leaves, stalks, ears, heads, pods, or roots. Are weeds robbing nutrients and water from crop?</td>
</tr>
<tr>
<td>Tissue quick tests</td>
<td>• Any known or unknown deficiency symptoms?</td>
</tr>
<tr>
<td>Plant analyses</td>
<td>• Use tissue tests, especially to detect hidden hunger…or help explain growth differences between areas.</td>
</tr>
<tr>
<td>Too dry?</td>
<td>• Too dry? Irrigation scheduling adequate?</td>
</tr>
<tr>
<td>Compaction?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Look again!</td>
<td>FALL</td>
</tr>
<tr>
<td>Estimate yields</td>
<td>• A ripe ear on a green corn stalk indicates adequate fertility and good hybrid. Before and during harvest, ask: “Was stand adequate?”</td>
</tr>
<tr>
<td>Check Harvest Equipment</td>
<td>• Always check yields accurately in some manner.</td>
</tr>
<tr>
<td>List Management</td>
<td>• Do not leave yield in the field. Set combine properly.</td>
</tr>
<tr>
<td>Changes Needed</td>
<td>• Study check list thororoughly, then summarize on back page.</td>
</tr>
<tr>
<td></td>
<td>Test soils before seeing advisors.</td>
</tr>
</tbody>
</table>
Lab Sheet

N–P–K Tissue Test on Field Crops

Purpose:
To determine the levels of nitrogen, phosphorus, and potassium contained in the tissues of selected field crop plants.

Materials:
Plant tissue samples from selected field crops, tissue testing kit, paper towels, pliers.

Procedure:
1. Collect plant tissues to be tested. The latest mature leaf should be used for tissue testing.
2. Plant sap should be extracted from the petiole or midrib of these leaves.
3. Follow the procedures outlined in the plant tissue test kit instructions.
4. Develop a data summary table for recording the results of each test.