

<b>Course</b>	Agricultural Science II
<b>Unit</b>	Soil Science
<b>Lesson</b>	Soil Fertility
<b>Estimated Time</b>	Two 50-minute blocks

### Student Outcome

Identify what plants get from the soil to be healthy and what gives them maximum yields.

### Learning Objectives

1. Identify a plant's essential macronutrients.
2. Explain the macronutrients' primary functions for plant growth.
3. Explain the hunger signs which can be observed in crops that lack the major elements.
4. Identify a plant's essential micronutrients.
5. Explain the importance of organic matter.
6. Identify the major nutrients supplied by organic matter.

### Grade Level Expectations

SC/ES/1/B/09-11/a

### Resources, Supplies & Equipment, and Supplemental Information

#### Resources

1. PowerPoint Slides
  - PPt 1 - Nitrogen Cycle
  - PPt 2 - Contents of a Bag of Fertilizer
2. Activity Sheet
  - AS 1 - How Organic Matter Builds Soil Structure
3. Minor, Paul E. *Soil Science* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1995.
4. *Soil Science Curriculum Enhancement*. University of Missouri-Columbia: Instructional Materials Laboratory, 2003.

#### Supplies & Equipment

- See AS 1 for materials and equipment needed to complete the Activity Sheet.

#### Supplemental Information

1. Internet Sites
  - Hodges, Steven C. Soil Fertility Basics: NC Certified Crop Advisor Training. Soil Science Extension, North Carolina State University. Accessed May 19, 2008, from <http://www.soil.ncsu.edu/nmp/Nutrient%20Management%20for%20CCA.pdf>.
  - Nutrient Deficiency Symptoms. Back-to-Basics Soil Fertility Information, The Mosaic Co., Plymouth, MN. Accessed May 19, 2008, from <http://www.back-to-basics.net/>.
  - Nutrient Deficiency Symptoms. K-MAG, The Mosaic Co., Plymouth, MN. Accessed May 19, 2008, from <http://www.kmag.com/general/nds.htm>.

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- ❑ Soil Fertility. Agronomy Extension, Iowa State University. Accessed May 19, 2008, from <http://www.agronext.iastate.edu/soilfertility/>.

2. Print

- ❑ Ashman, Mark R., and Geeta Puri. *Essential Soil Science: A Clear and Concise Introduction to Soil Science*. Malden, MA: Blackwell Publishing, 2002.
  - ❑ Brady, Nyle C., and Ray R. Weil. *The Nature and Properties of Soils*. 14th ed. Upper Saddle River, NJ: Prentice Hall, Inc., 2007.
  - ❑ Coyne, Mark S., and James A. Thompson. *Fundamental Soil Science*. Clifton Park, NY: Delmar CENGAGE Learning, 2005.
  - ❑ Donahue, Roy L., and Roy Hunter Follett. *Our Soils and Their Management*. Danville, IL: Interstate Publishers, Inc. 1990.
  - ❑ Plaster, J. Edward. *Soil Science and Management*. 2nd ed. Albany, NY: Delmar Publishers, Inc., 1992.
  - ❑ White, Robert E. *Principles and Practice of Soil Science: The Soil as a Natural Resource*. 4th ed. Malden, MA: Blackwell Publishing, 2005.
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### Interest Approach


Show examples of fertilizer grades, rations, and formulations. Take students to visit a fertilizer manufacturer if possible or invite a sales person to speak to the class.

### Communicate the Learning Objectives

1. Identify a plant's essential macronutrients.
2. Explain the macronutrients' primary functions for plant growth.
3. Explain the hunger signs which can be observed in crops that lack the major elements.
4. Identify a plant's essential micronutrients.
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Instructor Directions	Content Outline
<p><b>Objective 1</b></p> <p><i>What is a fertile soil? Discuss the 17 elements necessary for plant growth.</i></p>	<p><b>Identify a plant's essential macronutrients.</b></p> <p>There are 9 essential macronutrients (out of 17 elements necessary for plant growth).</p> <ol style="list-style-type: none"><li>1. Three are supplied by water and air.<ol style="list-style-type: none"><li>a. Carbon (C)</li><li>b. Hydrogen (H)</li><li>c. Oxygen (O)</li></ol></li><li>2. Six are available in the soil.<ol style="list-style-type: none"><li>a. Available mainly in mineral solids<ul style="list-style-type: none"><li>- Calcium (Ca)</li><li>- Magnesium (Mg)</li><li>- Potassium (K)</li></ul></li><li>b. Available in mineral solids and organic matter<ul style="list-style-type: none"><li>- Phosphorus (P)</li><li>- Sulfur (S)</li></ul></li><li>c. Available primarily in organic matter<ul style="list-style-type: none"><li>- Nitrogen (N)</li></ul></li></ol></li></ol>
<p><b>Objective 2</b></p> <p><i>Discuss the primary functions of each macronutrient for adequate plant growth. Refer to PPT 1 when discussing nitrogen.</i></p> <p><input type="checkbox"/> PPT 1 – Nitrogen Cycle</p>	<p><b>Explain the macronutrients' primary functions for plant growth.</b></p> <ol style="list-style-type: none"><li>1. Nitrogen (N)<ol style="list-style-type: none"><li>a. Nitrogen provides critical elements for plant growth.<ul style="list-style-type: none"><li>- Needed for photosynthesis</li><li>- Needed for plant and root cells</li><li>- Needed for dark green, lush growth</li></ul></li><li>b. Many compounds in plants contain nitrogen.<ul style="list-style-type: none"><li>- Amino acids</li><li>- Enzymes</li></ul></li></ol></li></ol>

Instructor Directions	Content Outline
	<ul style="list-style-type: none"> <li>- Chlorophyll</li> <li>a. Soils need nitrogen to produce crops. <ul style="list-style-type: none"> <li>- Helps the breakdown of organic material</li> <li>- Needed by microbes to decompose matter</li> </ul> </li> <li>2. Phosphorus (P) <ul style="list-style-type: none"> <li>a. A component of every living cell</li> <li>b. Concentrated in seeds and growing parts of plants</li> <li>c. Needed for root development</li> <li>d. Aids in the maturing of crops</li> </ul> </li> <li>3. Potassium (K) <ul style="list-style-type: none"> <li>a. Helps in the uptake of other nutrients</li> <li>b. Assists in enzyme systems affecting metabolism and photosynthesis</li> <li>c. Helps regulate the opening and closing of stomata in the leaves</li> <li>d. Important in the formation of carbohydrates</li> <li>e. Helps regulate the uptake of water in the root cells</li> <li>f. Important for strong brace roots</li> </ul> </li> <li>4. Calcium (Ca) <ul style="list-style-type: none"> <li>a. Exchangeable calcium aids in the availability of other elements</li> <li>b. Essential for building cell walls, new roots, and leaves</li> </ul> </li> <li>5. Magnesium (Mg) <ul style="list-style-type: none"> <li>a. Chlorophyll contains magnesium, which is vital in the photosynthesis process.</li> <li>b. Magnesium is contained in the seed.</li> </ul> </li> <li>6. Sulfur (S) <ul style="list-style-type: none"> <li>a. Sulfur is a vital part of all plant proteins and some hormones.</li> </ul> </li> </ul>
<p><b>Objective 3</b></p> <p><i>Discuss why more soils are likely to be deficient in nitrogen, phosphorus, and potassium. Discuss the fertilizer 12-12-12 and explain its meaning using PPt 2.</i></p> <p><input type="checkbox"/> PPt 2 – Contents of a Bag of Fertilizer</p>	<p><b>Explain the hunger signs which can be observed in crops that lack the major elements.</b></p> <ul style="list-style-type: none"> <li>1. Nitrogen deficiency symptoms <ul style="list-style-type: none"> <li>a. Pale green color and poor growth and shortage of chlorophyll are evident.</li> <li>b. Leaves may turn yellow and die during extended dry periods.</li> <li>c. Crop residue will not decompose within a year.</li> <li>d. Soil will not produce.</li> </ul> </li> <li>2. Phosphorus deficiency symptoms</li> </ul>

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	<ul style="list-style-type: none"> <li>a. Stunted growth</li> <li>b. Late maturity</li> <li>c. Purple spots and streaks in leaf tissues indicate excess sugar caused by slow conversion to starch and cellulose.</li> </ul> <p>3. Potassium deficiency symptoms</p> <ul style="list-style-type: none"> <li>a. Edges and areas between veins on older leaves turn yellow, then brown.</li> <li>b. Small brown spots develop while the veins remain green.</li> <li>c. Brace roots may not fully develop.</li> </ul>
<p><b>Objective 4</b></p> <p><i>Discuss how micronutrients or trace elements may affect the process of chlorophyll development.</i></p>	<p><b>Identify a plant's essential micronutrients.</b></p> <ul style="list-style-type: none"> <li>1. The eight micronutrients are trace elements found in the soil that are essential to plant health. <ul style="list-style-type: none"> <li>a. Boron (B)</li> <li>b. Chlorine (Cl)</li> <li>c. Copper (Cu)</li> <li>d. Iron (Fe)</li> <li>e. Manganese (Mn)</li> <li>f. Molybdenum (Mo)</li> <li>g. Cobalt (Co)</li> <li>h. Zinc (Zn)</li> </ul> </li> <li>2. Other elements such as sodium (Na) are absorbed but are not essential micronutrients.</li> </ul>
<p><b>Objective 5</b></p> <p><i>Compare two soil samples, one high in organic matter and the other low in organic matter. Discuss the importance of organic matter in the soil. After this discussion, have students complete AS 1.</i></p> <p> AS 1 – How Organic Matter Builds Soil Structure</p>	<p><b>Explain the importance of organic matter.</b></p> <ul style="list-style-type: none"> <li>1. Improves soil structure <ul style="list-style-type: none"> <li>a. Enhances aeration</li> <li>b. Enhances healthy root development</li> </ul> </li> <li>2. Adds to the total CEC of the soil</li> <li>3. Supplies essential nutrients</li> </ul>
<p><b>Objective 6</b></p> <p><i>Discuss the decomposition of organic matter. Discuss ways to maintain organic matter in the soil.</i></p>	<p><b>Identify the major nutrients supplied by organic matter.</b></p> <ul style="list-style-type: none"> <li>1. Supplies most of the naturally occurring nitrogen in soil</li> <li>2. Accounts for about half of the phosphorus found in soil</li> </ul>

Instructor Directions	Content Outline
<p><b>Application</b></p> <p>AS 1 – How Organic Matter Builds Soil Structure</p>	<p>Answers to AS 1:</p> <ol style="list-style-type: none"> <li>The cultivated field has a higher percent of organic matter and improved the soil tilth. This helps soil hold water and therefore decreases the amount of water runoff.</li> <li>The undisturbed fence row is low in organic matter.</li> </ol> <p>Other activities:</p> <ol style="list-style-type: none"> <li>Grow nutrient-deficient plants as a class project. Make note of the deficiency symptoms observed. Use construction sand as the growing media as it contains fewer nutrients. Plant several inch-tall seedlings of corn, beans, and tomatoes into moist sand in individual pots. Fertilize them with water-soluble fertilizer. Each pot should receive all the elements except the nutrient you choose to be deficient.</li> <li>Show a slide series of plant deficiency problems.</li> <li>Have students research newspaper articles citing nutrient deficiencies in crops planted on land damaged by recent flooding or a hurricane.</li> </ol>
<p><b>Closure/Summary</b></p>	<p>A fertile soil produces high-yielding, healthy crops. Although a fertile soil has nutrient balance and quantity, nutrients alone are not sufficient to make a soil fertile. Fertile soil depends on soil texture, structure, root depth, organic matter content, available water capacity, aeration, length of growing season, and physical support.</p>
<p><b>Evaluation: Quiz</b></p>	<p>Answers:</p> <ol style="list-style-type: none"> <li>b</li> <li>a</li> <li>e</li> <li>c</li> <li>d</li> <li>i</li> <li>j</li> <li>h</li> <li>g</li> <li>f</li> </ol>