

BOTANY, PLANT PHYSIOLOGY AND PLANT GROWTH

Lesson 10: SOILS

I. LESSON DESCRIPTION

Students in class complete a reading assignment on soils, and then evaluate soil samples to identify physical properties. *Estimated time requirement for this lesson is 35 minutes.*

Curriculum Standards: Minnesota Academic Standards in Science, Minnesota Department of Education, 5-24-10, Grades 9-12:

- 9.4.1.2.4 “Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.”
- 9.4.1.1.1 “Explain how cell processes are influenced by internal and external factors, such as pH and temperature, and how cells and organisms respond to changes in their environment to maintain homeostasis.”

National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards, National Council for Agricultural Education, 2009:

- Natural Resource Systems (NRS):
 - NRS.01.02.05.a. Demonstrate techniques used to identify rock, mineral and soil types.
- Plant Systems (PS):
 - PS.02.02.01.a. Identify the major components of growing media and describe how growing media support plant growth.

The root-soil interface and the physical makeup of the soil relate heavily to the normal physiological processes of plants.

Student Preparation: (1) 10_Soils_: The Jar Test; Determining Soil Exercise. (2) Assign each student to collect a handful of soil in a Ziploc sandwich bag. Ask half of the students to sample soil from a lawn area and the other half to sample soil from a flower bed; if the bed is mulched, ask them to dig through the mulch to obtain soil only. Ask students to take notes on the state of health of nearby plants. (3) Complete a reading assignment, 10_Soils_Reading.pdf.

Student Learning Objectives: After completing this class, students will be able:

- (1) to name and describe 5 soil layers,
- (2) to summarize five physical properties of soil and how they relate to plant health,
- (3) to quantify the percentages of the 4 components of soil, and
- (4) to point out the ideal soil pH for most plants.

Instructional Methods: Reading Assignment, Learning Activity.

II. LESSON PLAN

Introduction

Legend:

Text in normal face - Represents teacher's words.

Text in italic face - Represents suggestions for the teacher.

Interest Approach:

- QUESTION: Visualize a plant at various phases during all three basic plant processes – photosynthesis, respiration, and transpiration. Focus on the various items entering the roots; what kind of substances are you seeing?
- ANTICIPATED RESPONSES: *(Students provide opinions for a minute or two.)* Water and minerals.
- ANSWER: The most obvious things you will visualize entering the roots will be water and the mineral nutrients from the soil. But another important ingredient in the soil is something you won't see: the air. As we'll see later, about one-fourth of an ideal soil should be air, so that sufficient oxygen is supplied for biological activities such as root growth.
- As we used our knowledge of the 17 essential plant nutrients to understand and improve plant growth, similarly we need to know more about the medium that delivers those nutrients – the soil. We can improve plant health with the correct physical properties of soil, and the correct ratio of soil components.

Relevancy:

- In this lesson we'll learn about those physical properties and components.

Learning Objectives:

- After attending this class, you will be able:
 - (1) to name and describe 5 soil layers,
 - (2) to summarize five physical properties of soil and how they relate to plant health,
 - (3) to quantify the percentages of the 4 components of soil, and
 - (4) to point out the ideal soil pH for most plants.
- Now let's move into a study session on soil science.

Instructional Methods

Reading Assignment: 10 minutes estimated

- Distribute to each student a copy of the reading assignment, 10_Soils_Reading.pdf, if you haven't pre-assigned it.*
- Please take 10 minutes to review the reading assignment that you studied before class.

Learning Activity: 20 minutes estimated

- Studying soils requires visual skills and tactile skills. Let's divide the class into two teams, one group for the students who collected soil samples from the lawn, another for the students who collected soil samples from the garden. As I point out particular traits to observe, have someone on your team write a brief summary of your findings on the board.
- A. VISUAL TEST: Bring out the soil samples you collected, and without opening the bag, you can examine three of the five physical properties of soil: color, texture, and structure.
- First identify the color, and refer to the reading material to relate the color's significance. Is the color light, or is it dark with organic material? Is the hue closer to a reddish brown that implies good drainage, or a yellowish or gray color implying poor drainage?
- Second, determine the texture. Can you see any materials that look like sand, silt, and clay?
- Third, describe the structure. Do the materials have specific shapes like individual sand grains, or is there no definite structure, like a lump of clay?
- B. TACTILE TEST: Now open the bags so you can determine soil texture by rubbing the material between your thumb and fingers. Refer to your reading material and find the list of five items under "Principal Surface Soil Classes Found in Minnesota", where you find loam, sandy loam, silt loam, silty clay loam, clay loam. Which class suits your sample?
- COMPARE LAWN SAMPLES WITH GARDEN SAMPLES: Let's look at the summary results on the board. Have we found any overall differences between the lawn samples and the garden samples? *(The hope here is that the lawn samples will lack the high organic content and good texture found in the garden samples, based on the assumption that most garden beds have undergone much more improvement over the years than a lawn.)*
- In what state of health did you find the plants where you collected the samples? Or, if you didn't take note of present conditions, then project a theory: Based on the physical properties that you observed in your samples today, what state of plant health would you expect to find if you planted something in this type of soil?

Conclusion

- You've taken a very close look at soils and their importance in plant health.
- As you observe plants and trees that thrive, consider the unseen conditions in the soil, such as the physical properties of the soil and the proper ratio of soil solids, air, and water. If you are planning to add some plants to your garden, consider these factors before planting so you can improve the soil if necessary. Dave Barry said, "Your first job is to prepare the soil. The best tool for this is your neighbor's motorized garden tiller. If your neighbor does not own a garden tiller, suggest that he buy one."
- We've concluded all seven lessons on plant anatomy and physiology. Next, we'll move into the wide variety of trees, shrubs, and other plants that we enjoy in the labors of gardening as well as in the pleasures of visiting public gardens.

OPTIONAL ACTIVITIES

- Assign the students a research project to search for an interesting image portraying the various combinations of sand, silt, and clay in a diagram called the "Soil texture triangle". Using your favorite web search engine, you can instantly invoke the diagram. For example, with Google (www.Google.com), click the link named "Images", then the link "Advanced Image Search", and then type "Soil texture triangle" (without the quotation marks) in the field labeled "related to the exact phrase". Observe the various loam classifications.
- Assign the students a research project to locate a chart portraying the importance of soil pH in the availability of certain minerals. For example, with Google (www.Google.com), click the link named "Images", then the link "Advanced Image Search", and then type "availability soil pH" (without the quotation marks) in the field labeled "related to all the words".
- Consider doing a soil test. The Soil Testing Laboratory at the University of Minnesota offers soil testing. As a group, follow the instructions on the website to collect samples of soil, mail them in, and then evaluate the results as a group when you receive the report. You can use the exercise just to experience the process of a test, or you can add interest by testing the soil in an area where vegetation is particularly luxuriant or problematic. For more information, visit their website at <http://soiltest.cfans.umn.edu/index.htm>.
- Purchase a pH test kit for soil, and determine the pH of several of the soil samples that students brought to the class activity. Relate the results to the health of the existing plants where the soil was found, or else relate the results that students would expect from that soil.
- Assign a research project for students to explore various issues regarding organic techniques. One source would be <http://www.newfarm.org/>. Look for the Search feature on the home page and enter the term soil and it will retrieve numerous articles related to soils.
- Assign a research project for students to explore contemporary issues regarding soil conservation. This is an important issue for both agricultural areas and developed

areas. Helpful measures include the creation of buffer strips of vegetation to absorb runoff, rather than admit excess fertilizers and pesticides into the waterways. Potential resources might be found at the website for the Natural Resources Conservation Service, www.nrcs.usda.gov; the Soil and Water Conservation Index, https://efotg.sc.egov.usda.gov/efotg_locator.aspx; www.swcs.org; and the Conservation Technology Information Center, www.ctic.purdue.edu/CTIC/CTIC.html.

RESOURCES

Books:

- *Biology of Plants, Seventh Edition*, by Peter H. Raven, Ray F. Evert, Susan E. Eichhorn. Publisher: W. H. Freeman; 7th edition (December 17, 2004). Hardcover: 944 pages. ISBN: 0716710072. Very comprehensive book on botany.

Websites:

- <http://soiltest.cfans.umn.edu/index.htm>. - University of Minnesota Soil Testing Laboratory
- <http://www.newfarm.org/> - *New Farm* magazine from Rodale Institute. Look for the Search feature on the home page and enter the term soil and it will retrieve numerous articles related to soils.
- <http://soils.usda.gov/> - USDA Natural Resources Conservation Service
- <http://www.greenbeltconsulting.com/ctp/treeandsoil.html> - Features an article "The Tree and the Soil", adaptation of a 1970 USDA publication, FS-32 "How a Tree Grows"