Unit E: Basic Principles of Soil Science

Lesson 4: Understanding Soil Texture and Structure

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

1. Describe the concept of soil texture and its importance.
2. Determine the texture of a soil sample.
3. Describe soil structure, its formation, and importance.
4. Identify various soil structures.

Recommended Teaching Time: 3 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has been developed for use with this lesson plan

List of Equipment, Tools, Supplies, and Facilities:

Writing surface
PowerPoint Projector
PowerPoint Slides
Transparency Masters
Sample of soil
Copies of Student Lab Sheets
Soil pit

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide 2):

- Clods
- Loam
- Peds
- Permeability
- Soil structure
- Soil texture
- Soil workability
- Textural triangle
- Water-holding capacity

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.

Provide students with various samples of soil. One sample should be nearly all sand, one nearly all clay, and one nearly all silt. Ask students to determine how the samples differ. Would each sample be equally productive? Indicate that the samples vary according to the size of soil particles. Ask students how particle

size might affect various soil properties. Allow comments to lead to a discussion of soil texture.

Summary of Content and Teaching Strategies

Objective 1: Describe the concept of soil texture and its importance.

(PowerPoint Slide 3)

I. Importance of Soil Texture

A. ***Soil texture*** is the fineness or coarseness of a soil. It describes the proportion of three sizes of soil particles. These are:

1. Sand—large particle
2. Silt—medium-sized particle
3. Clay—small particle

(PowerPoint Slide 4)

B. Texture is important because it affects:

1. ***Water-holding capacity***—the ability of a soil to retain water for use by plants
2. ***Permeability***—the ease with which air and water may pass through the soil

(PowerPoint Slide 5)

3. ***Soil workability***—the ease with which soil may be tilled and the timing of working the soil after a rain
4. Ability of plants to grow—some root crops like potatoes and onions will have difficulty growing in a fine-textured soil

****Use TM: E4-1 or PowerPoint 6 to show students the relative size of soil particles. Have the students relate these to items they see every day. Explain to them that if they enlarged these particles at proportional sizes: the clay would represent the size of a grape, silt would represent the size of an orange, and sand would represent the size of a head of cabbage. This will give students a better visual image when comparing the relative size of soil products.**

Objective 2: Determine the texture of a soil sample.

(PowerPoint Slide 7)

II. Determining Soil Texture

A. Soil texture may be determined in one of two ways:

1. The percentages of sand, silt, and clay may be tested in the lab. Once tested, you may determine the textural class of the soil by referring to the ***textural triangle***. There are 12 basic textural classes:

(PowerPoint Slide 8)

a. Silt

b. Silt loam
c. Silty clay loam
d. ***Loam***—contains some of all 3 soil particle sizes
e. Sandy clay loam
f. Loamy sand
g. Sand
h. Sandy loam
i. Sandy clay
j. Clay loam
k. Silty clay
l. Clay

(PowerPoint Slide 9)

2. The relative amounts of sand, silt, and clay may also be determined in the field using the ribbon method. Five textural classes may be determined using the ribbon method:
    a. Fine-textured—a ribbon forms easily and remains long and flexible.
    b. Moderately fine-textured—a ribbon forms but breaks into pieces ¾ to 1 inch long.
    c. Medium-textured—no ribbon forms. The sample breaks into pieces less than ¾ inch long. The soil feels smooth and talc-like.

(PowerPoint Slide 10)

    d. Moderately coarse-textured—no ribbon forms. The sample feels gritty and lacks smoothness.
    e. Coarse-textured—no ribbon forms. The sample is composed almost entirely of gritty material and leaves little or no stain.

****Use TM: E4-2 or PowerPoint Slide 11 to explain the textural triangle. Give students various percentages of sand, silt, and clay (making sure percentages add up to 100), and ask them to determine the soil texture using the textural triangle. When students have mastered this, divide them into groups and have them complete LS: E4-1, Sedimentation Test of Soil Texture. Finally, discuss the various textural classes listed above for the ribbon method. Give each student several different samples to determine soil texture using the ribbon method.**

Objective 3: Describe soil structure, its formation, and importance.

(PowerPoint Slide 12)

III. Importance of Soil Structure

A. ***Soil structure*** is the arrangement of the soil particles into clusters or aggregates of various sizes and shapes. Aggregates that occur naturally in the soil are referred to as ***peds***, while clumps of soil caused by tillage are called ***clods***.

(PowerPoint Slide 13)

B. Structure is formed in two steps.
    1. A clump of soil particles sticks loosely together. These are created through:
        a. Plant roots surrounding the soil and separating clumps
        b. Freezing and thawing of soil
        c. Soil becomes wet and then dries
        d. The soil is tilled
        e. Fungal activity

(PowerPoint Slide 14)

    2. Weak aggregates are cemented to make them distinct and strong. Clay, iron oxides, and organic matter may act as cements. When soil microorganisms break down plant residues, they produce gums that also glue peds together.

(PowerPoint Slide 15)

C. Soil structure is important for several reasons:
    1. It improves soil tilth.
    2. It improves permeability.
    3. It resists the beating action of raindrops, minimizing the formation of crusts that reduce crop stands.

****Take a sample of soil with good structure and place it on a tabletop or desktop. Students should be able to see that the soil does not all fall apart. These naturally occurring clusters demonstrate soil structure. Using the notes above, discuss how soil structure is formed and why it is important for good plant growth.**

Objective 4: Identify various soil structures.

(PowerPoint Slide 16)

IV. There are eight primary types of structure. They are:
A. Granular—aggregates are small, non-porous, and strongly held together.
B. Crumb—aggregates are small, porous, and weakly held together.
C. Platy—aggregates are flat or plate-like. Plates overlap, usually causing slow permeability.
D. Prismatic or Columnar—aggregates are prism-like with the vertical axis greater than the horizontal. Prismatic has flat caps while columnar has rounded caps.
E. Blocky—aggregates are block-like, with six or more sides. All three dimensions are about the same.
F. Structureless—there is no apparent structure. It may be found in one of two forms:
    1. Single grain—soil particles exist as individuals and do not form aggregates.
    2. Massive—soil particles cling together in large uniform masses.

****Use TM: E4-3 or PowerPoint Slide 17 to demonstrate the various types of soil structure. If possible, dig a soil pit to show students the different types of soil structure and where they can be found. Remind students that granular, crumb, and platy are usually found in the top soil or A horizon; prismatic, columnar, and blocky are usually found in the subsoil or B horizon; and that structureless is usually found in the substratum or C horizon. (A soil profile lesson will follow this lesson, and will give more detail.)**

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 in determining which objectives need to be reviewed or taught from a different angle. Questions on PowerPoint Slide 18 can also be used.

Application: Application can involve one or more of the following student activities using attached lab sheet: Sedimentation Test of Soil Texture - LS: E4-1

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

Answers to Sample Test:

Part One: Matching
1=e, 2=d, 3=a, 4=b, 5=f, 6=c

Part Two: Completion
1. soil workability
2. loam
3. fine-textured
4. clods
5. massive and single grain

Part Three: Short Answer
1. a. large
   b. small
   c. medium

2. Plants which have large structures that grow underground have difficulty growing in fine-textured soils.

3. Students can list any two of the following: improves soil tilth, improves permeability, and reduces formation of crusts which reduces crop stand.

Sample Test Name_____

Test

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Part One: Matching

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

a. water-holding capacity	c. peds	e. soil texture
b. soil structure	d. permeability	f. textural triangle

_____ 1. The fineness or coarseness of soil particles.

_____ 2. The ease with which air and water may pass through the soil.

_____ 3. The ability of soil to retain moisture for plants.\

_____ 4. The arrangement of soil particles into clusters or aggregates.

_____ 5. A chart used to classify soil according to its coarseness or fineness.

_____ 6. Aggregates that occur naturally in the soil.

Part Two: Completion

Instructions. Complete the following statements.

1. The ease with which soil may be tilled is referred to as _____.

2. A sample that contains some of each of the sizes of soil particles is referred to as a _____.

3. When conducting the ribbon method for determining texture, the soil forms a long, pliable ribbon. This soil's texture could be classified as _____.

4. Clumps of soil that are caused by tillage are referred to as _____.

5. A soil that has no structure may appear in one of two forms. They are _____ and _____.

.

Part Three: Short Answer

Instructions. Use the space provided to answer the following questions.

1. Classify the following soil particles as small, medium, or large in comparison to each other:

a. sand—

b. clay—

c. silt—

2. How does texture affect the ability of plants like potatoes and onions to grow?

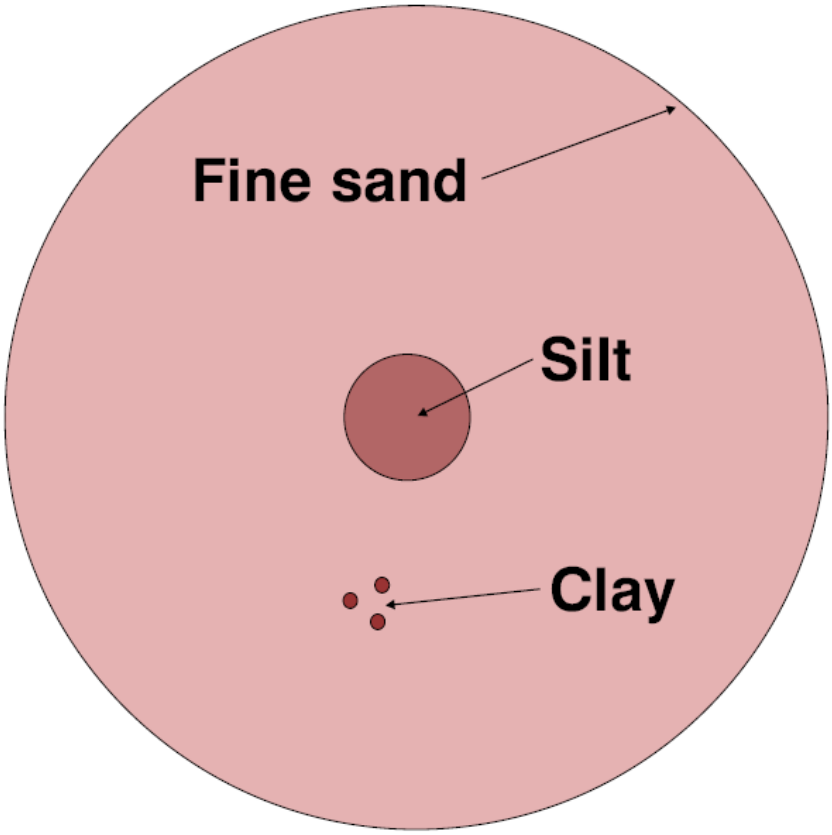
3. Briefly explain two of the three ways that soil structure is beneficial to plant growth.

a.

b.

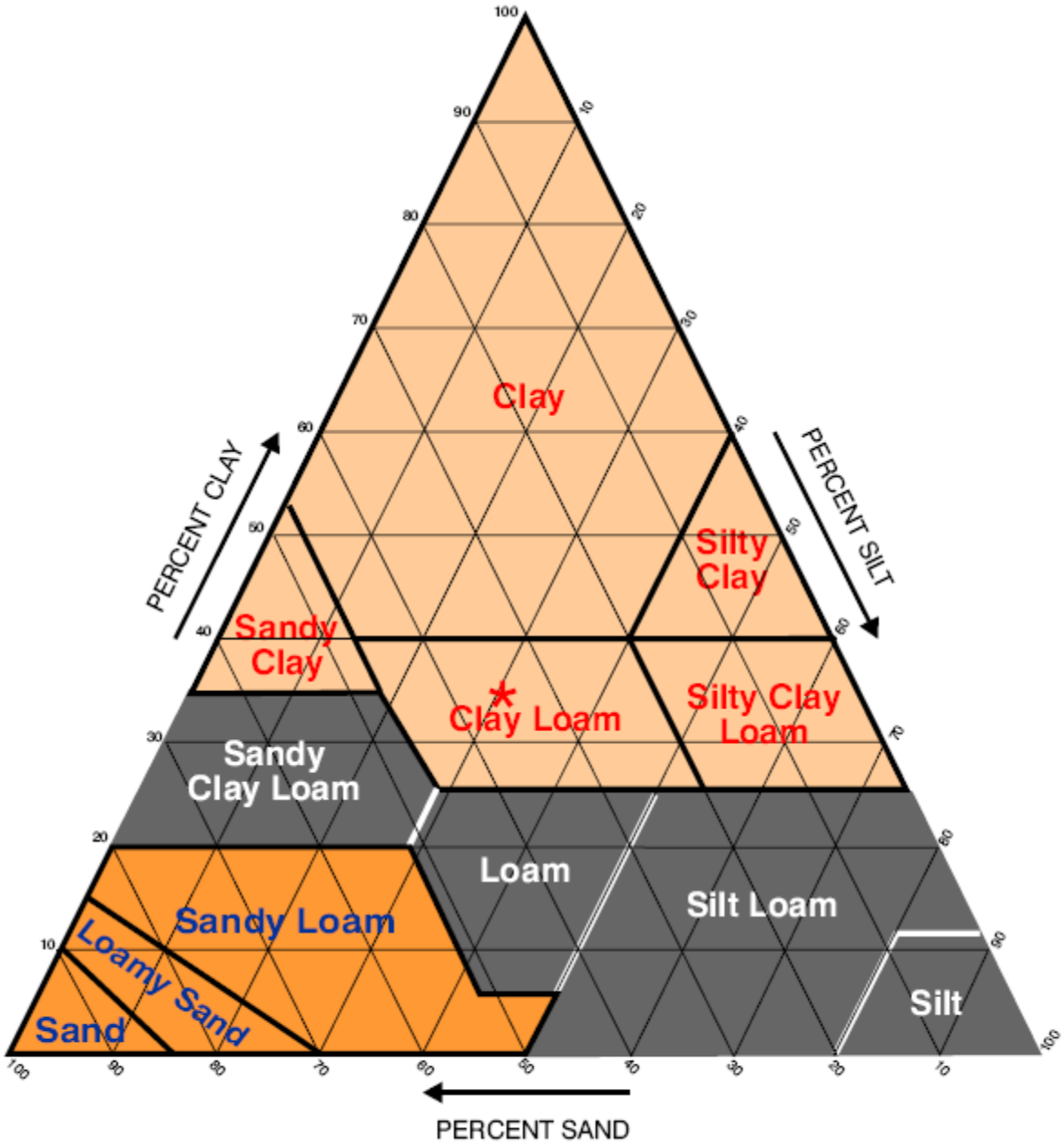
TM: E4-1

RELATIVE SIZE OF SOIL PARTICLES



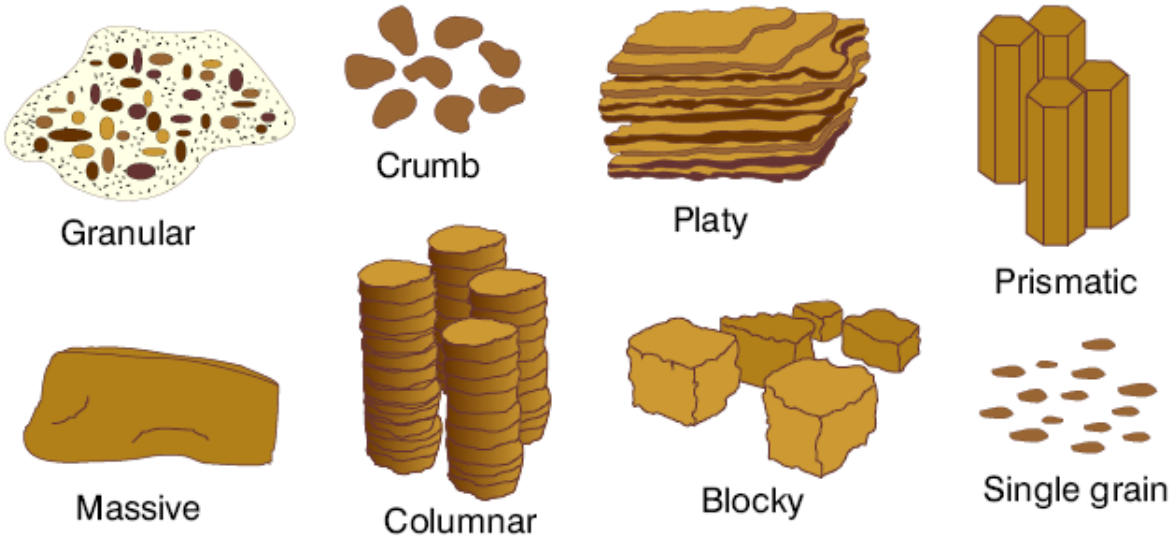
TM: E4-2

SOIL TRIANGLE



TM: E4-3

VARIOUS TYPES OF SOIL STRUCTURE



LS: E4-1 Name_____

Lab Sheet

Sedimentation Test of Soil Texture

Purpose:

Measure relative amounts of sand, silt, and clay in a sample of soil. This activity is based on the fact that large, heavy particles will settle most rapidly in water, while, small, light particles will settle most slowly. The dishwashing soap is used to "dissolve" the soil aggregates and keep the individual particles separated.

Materials:

Soil sample
1.7 liter plastic bottle with lid
Dishwashing soap
Measuring cup
Metric Ruler
Tablespoon

Procedure:

Day 1—

1. Collect two soil samples. One should come from a garden, flower bed, or field. The other one should come from a yard, roadside, or housing development. Remove any trash or rocks from the samples.
2. Using the masking tape and marker, create a label for each bottle that lists where the soil sample came from and the date.
3. Fill the bottle about ¾ full of the soil sample.
4. Add water to each bottle until the bottle is almost full.
5. Add 2 tablespoons of dishwashing liquid to each bottle
6. Tighten the lids securely so that the bottles do not leak.
7. Shake the bottle vigorously until the particles separate from each other (about three to five minutes).
8. Place the bottles in a safe location and allow the samples to settle.
9. After about 10 minutes, observe the bottles and record your findings in the Data Table.

Day 2—

1. Observe your bottle and record your findings.

Day 3—

1. Observe your bottle and record your findings. By now, even the smallest particles should be completely settled. You should be able to see the different layers of sand, silt, and clay. Any material left floating in the water is considered organic matter.
2. Use the bottle outlines provided to draw the layers that you see. You can use a ruler to measure the depths of the different layers. Use different colored pencils, markers, or crayons for each layer. Label the layers.

DATA TABLE			
	Day 1	Day 2	Day 3
Sample 1			
Sample 2			