Animal, Plant & Soil Science

Lesson D1-5

Soil Texture and Structure

Interest Approach

- 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.

Objectives

- 1 **Describe the concept of soil texture and its importance.**
- 2 **Determine the texture of a soil sample.**
- 3 **Explain soil structure, its formation, and importance.**
- 4 **Identify various soil structures.**
- 5 **Define bulk density and particle density, describe their importance, and calculate the bulk density and particle density of soil samples.**

Terms

- aggregates
- bulk density
- clay
- clods
- loam
- particle density
- peds
- permeability
- sand
- silt
- soil structure
- soil texture
- soil workability
- textural triangle
- water-holding capacity

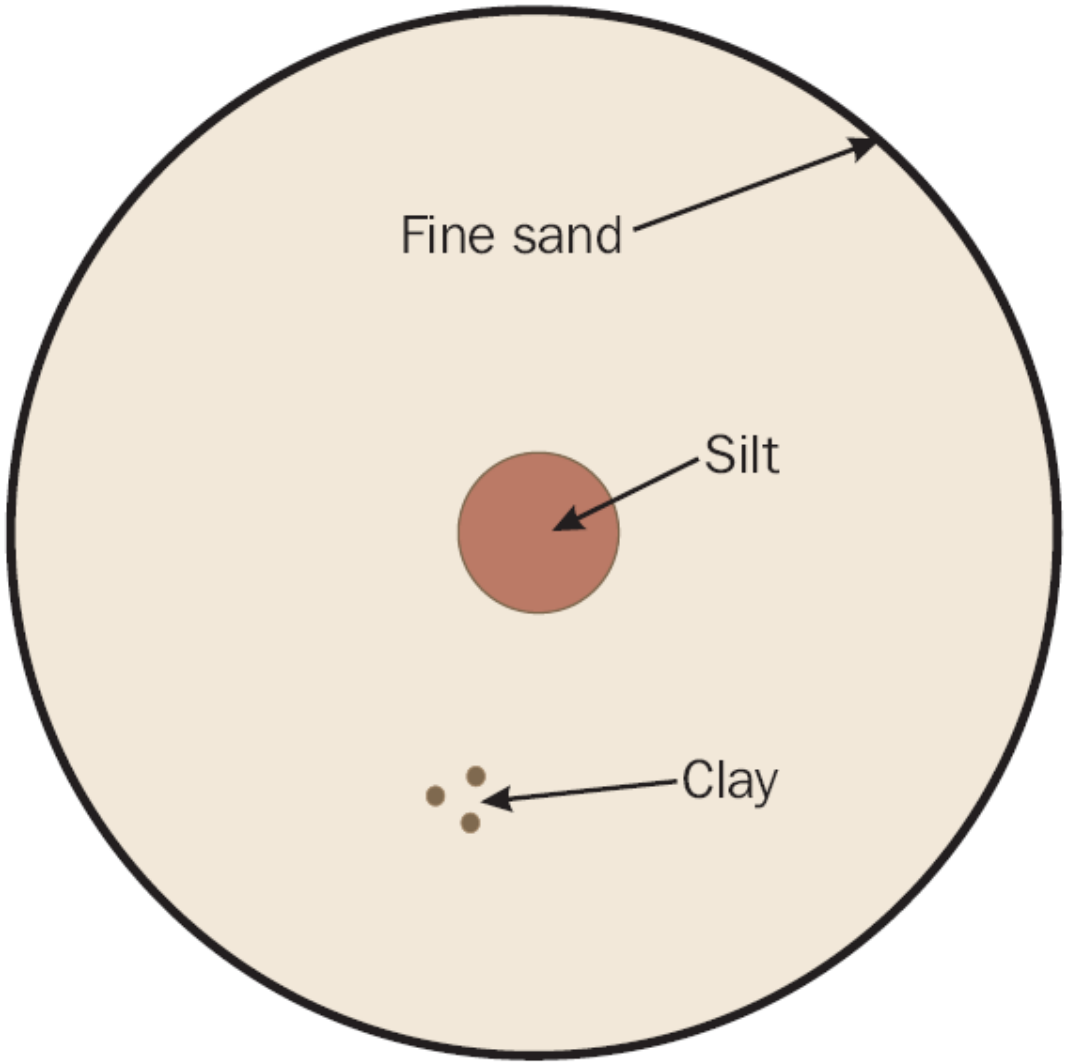
What is soil texture, and why is it important?

- I. ***Soil texture*** is the fineness or coarseness of a soil.

- A. Texture describes the proportion of three sizes of soil particles. These are sand, silt, and clay.

- 1. ***Sand*** is the largest mineral particle.
- 2. ***Silt*** is a medium-sized mineral particle.
- 3. ***Clay*** is the smallest mineral particle.

THE RELATIVE SIZES OF SAND, SILT, AND CLAY PARTICLES

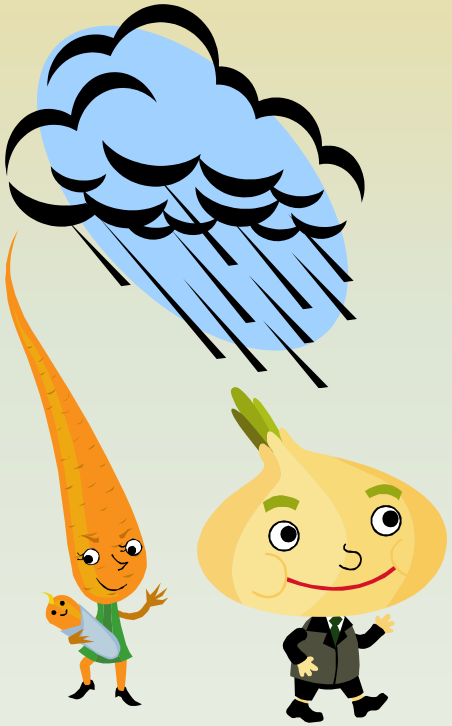


What is soil texture, and why is it important?

- B. Soil texture is important because it affects water-holding capacity, permeability, soil workability, and plant growth.

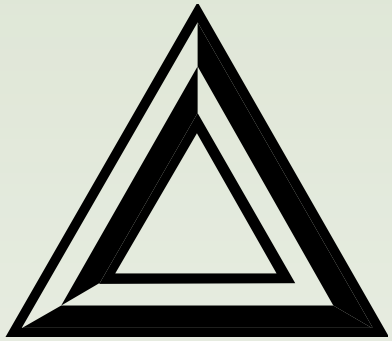
- 1. ***Water-holding capacity*** is the ability of a soil to retain water for use by plants.
- 2. ***Permeability*** is the ease with which air and water may pass through the soil.

What is soil texture, and why is it important?



- 3. ***Soil workability*** is the ease with which soil may be tilled and the timing of working the soil after a rain.
- 4. Most plants grow best in soils that have good aeration and water-holding capacity. Some root crops, like carrots and onions, have stunted growth in a fine-textured soil.

How is the texture of soil determined?



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

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

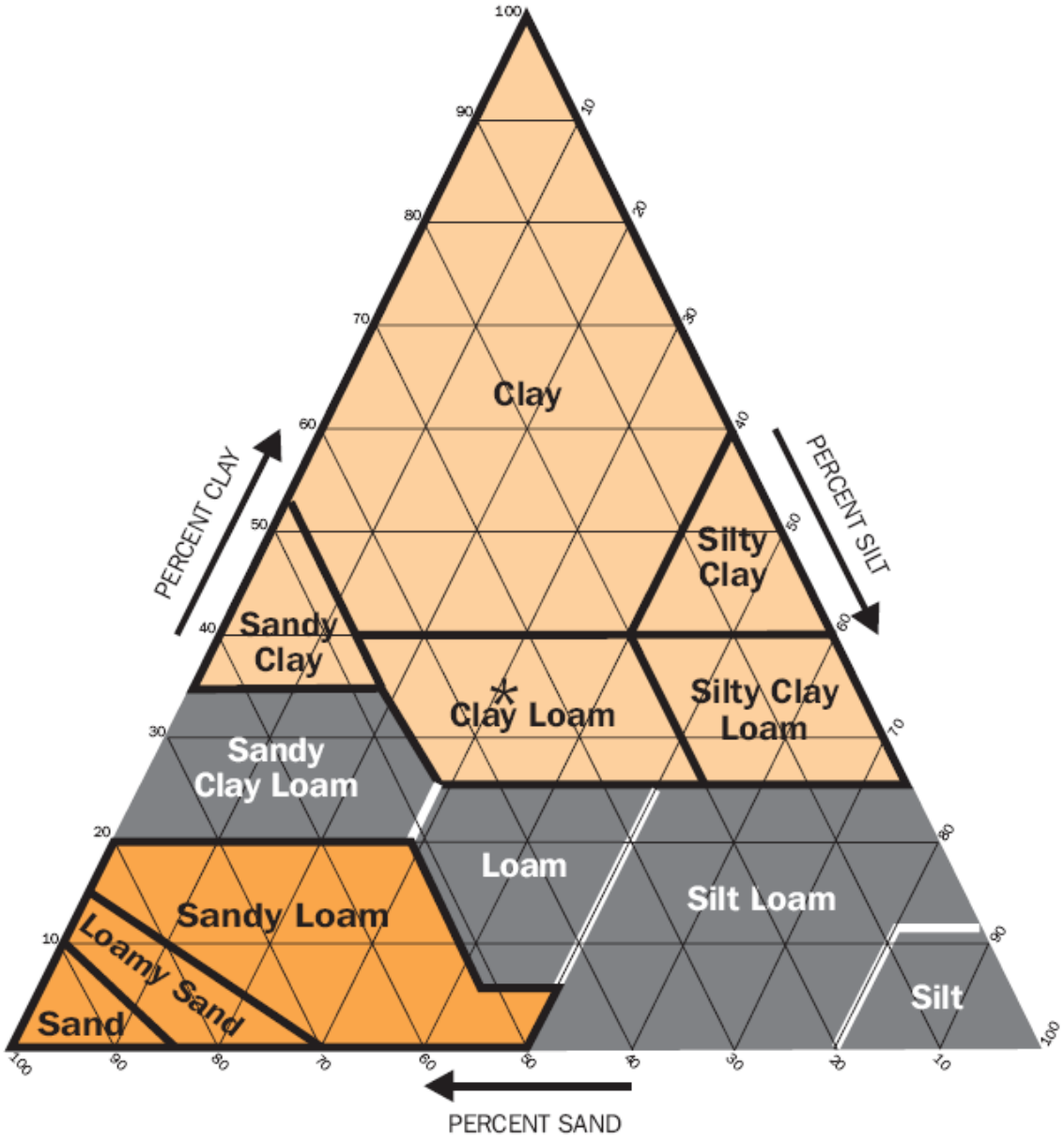
How is the texture of soil determined?

- 1. Silt
- 2. Silt loam
- 3. Silty clay loam
- 4. ***Loam***—contains some of all three soil particle sizes
- 5. Sandy clay loam
- 6. Loamy sand

How is the texture of soil determined?

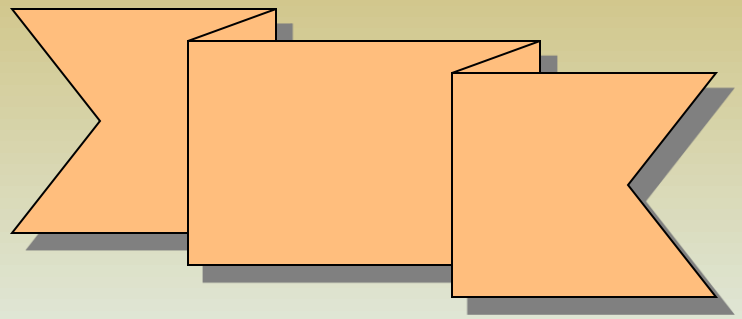
- 7. Sand
- 8. Sandy loam
- 9. Sandy clay
- 10. Clay loam
- 11. Silty clay
- 12. Clay

SOIL TRIANGLE



How is the texture of soil determined?

- B. 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:



- 1. Fine textured—A ribbon forms easily and remains long and flexible.
- 2. Moderately fine textured—A ribbon forms but breaks into pieces ¾ to 1 inch long.

How is the texture of soil determined?

- 3. Medium textured—No ribbon forms. The sample breaks into pieces less than ¾ inch long. The soil feels smooth and talc-like.
- 4. Moderately coarse textured—No ribbon forms. The sample feels gritty and lacks smoothness.
- 5. Coarse textured—No ribbon forms. The sample is composed almost entirely of gritty material and leaves little or no stain.

What is soil structure, how does it form, and why is it important?

- III. Different soils have different soil structures.

- 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.

What is soil structure, how does it form, and why is it important?

- B. Structure is formed in two steps.

- 1. A clump of soil particles sticks loosely together because of:
  - a. Plant roots surrounding the soil
  - b. Freezing and thawing of the soil
  - c. Soil becoming wet and then drying
  - d. Soil being tilled
  - e. Fungal activity

What is soil structure, how does it form, and why is it important?

- 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.

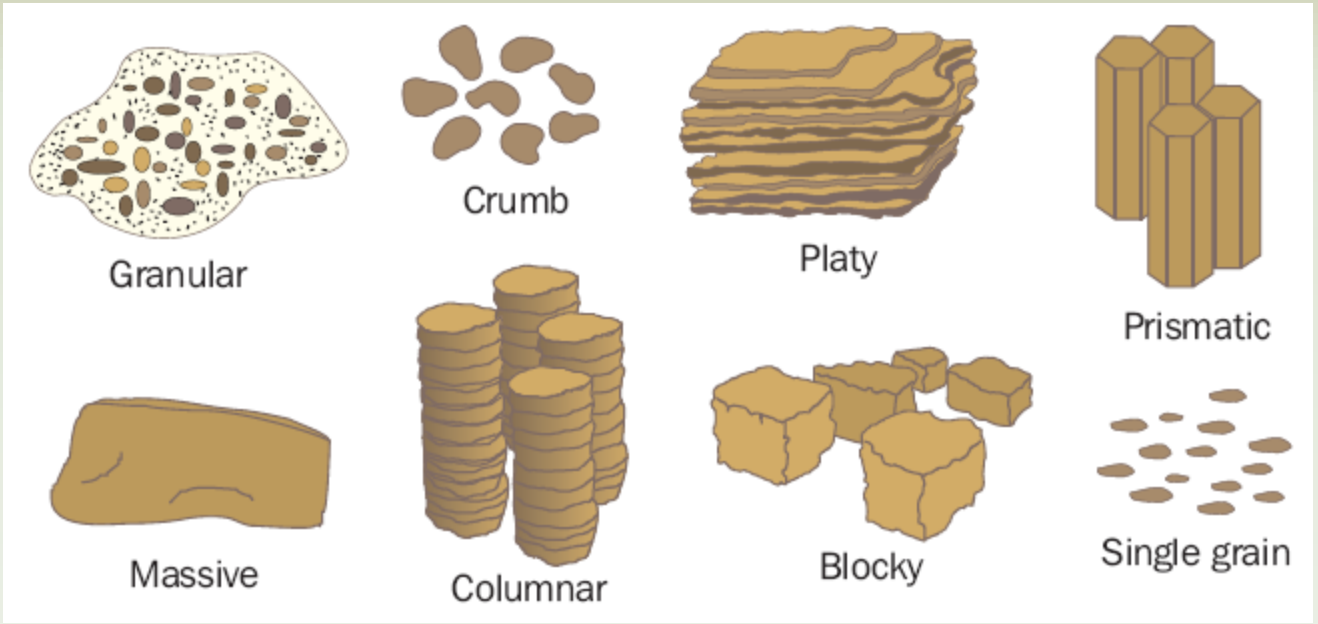
What is soil structure, how does it form, and why is it important?

- 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.

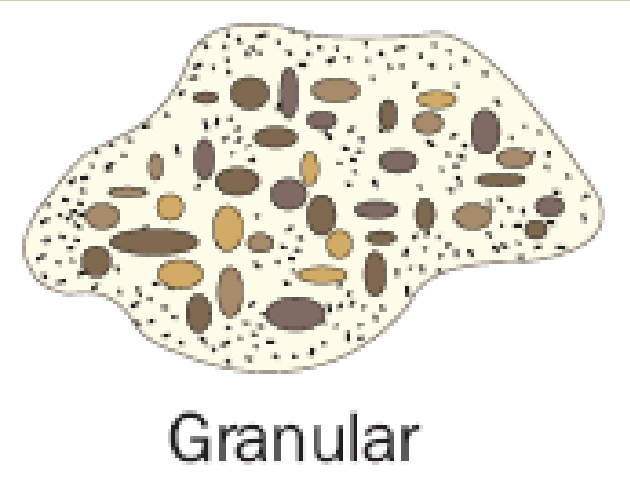
What are the various soil structures, and what do they look like?

- IV. There are eight primary types of structures.



What are the various soil structures, and what do they look like?

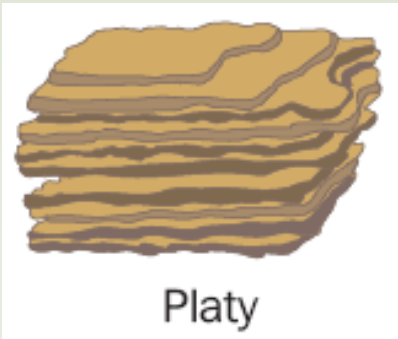
- A. Granular aggregates are small, nonporous, and strongly held together.



What are the various soil structures, and what do they look like?

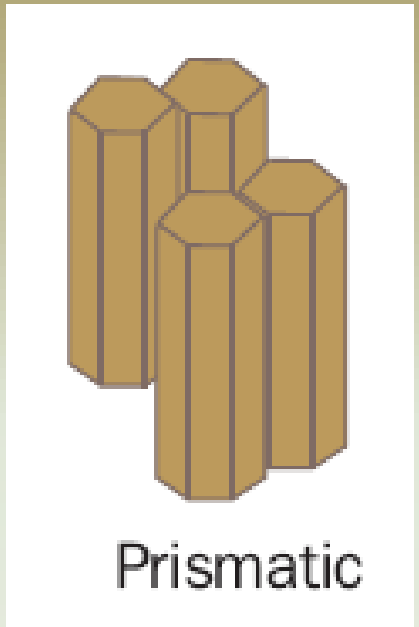
- B. Crumb aggregates are small, porous, and weakly held together.

- C. Platy aggregates are flat, or plate-like. Plates overlap, usually causing slow permeability.



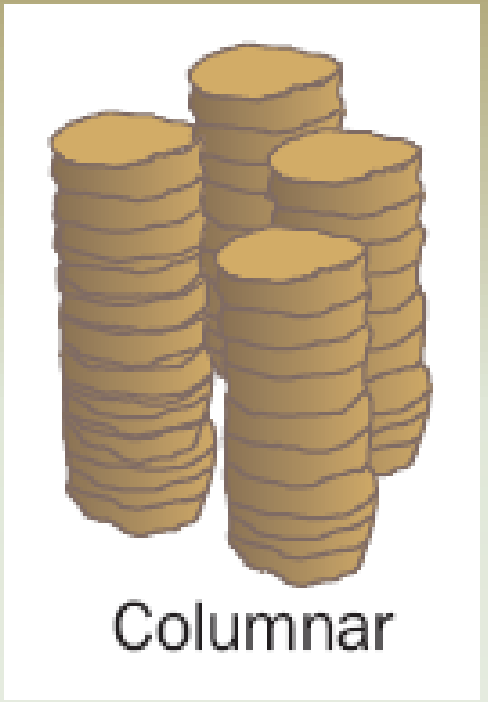
What are the various soil structures, and what do they look like?

- D. Prismatic aggregates are prism-like, with the vertical axis greater than the horizontal. Prismatic aggregates have flat caps, while columnar aggregates have rounded caps.



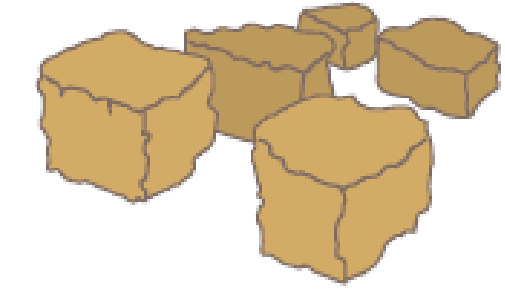
What are the various soil structures, and what do they look like?

- E. Columnar aggregates are similar to prismatic aggregates and are bounded by flat or slightly rounded vertical faces. The tops of columns, in contrast to those of prisms, are very distinct and normally rounded.



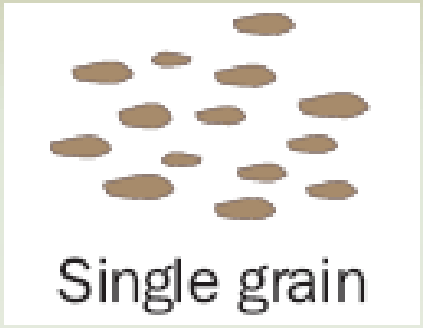
What are the various soil structures, and what do they look like?

- F. Blocky aggregates are block-like, with six or more sides. All three dimensions are about the same.

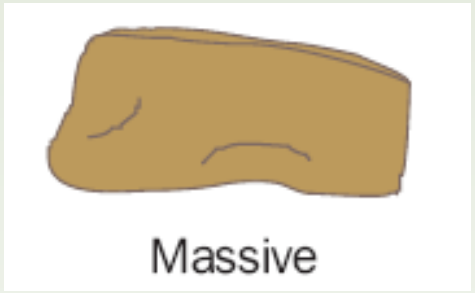


What are the various soil structures, and what do they look like?

- G. Structureless soil, as the name suggests, involves 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.



What are bulk density and particle density, why are they important, and how are they calculated?

- V. ***Bulk density*** is the ratio of the mass of dry solids in a medium to the volume of the medium. It involves the measure of the mass of the entire volume of a soil sample. The density is a major factor in dealing with root movement and stability of the soil. ***Particle density*** is the ratio of the mass of solids to the volume of the soil solids. It is determined largely by the texture. Particle density involves the measure of the mass of only the solid particles in a soil sample.

What are bulk density and particle density, why are they important, and how are they calculated?

- A. Soil texture affects bulk density. Different separates have different masses and have corresponding pore space. Soil structure also determines density because various soil arrangements compact more easily than others.

What are bulk density and particle density, why are they important, and how are they calculated?

- B. Bulk density and particle density are important in the production of crops.

- 1. Pore space decreases with higher soil density. As a result, soil aeration and water-holding capacity decrease. The decrease in water-holding capacity is especially significant in the larger pore spaces that are readily available to hold water that plants can utilize.
- 2. Erosion can also be affected by density. Water that is slow to infiltrate the soil stays in contact with the topsoil for a longer period, increasing the rate of erosion.

What are bulk density and particle density, why are they important, and how are they calculated?

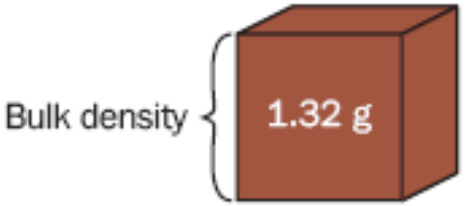
- 3. Flooding will result from excessive runoff and decreased infiltration in wet years. Puddling can result from localized compaction, as is the case in tractor tire ruts.
- 4. The production of containerized crops is influenced by bulk density. Light bulk density eases handling and shipping of the potted plants. Heavy bulk density is needed to provide support for the plants. For potted plants, the growing medium's bulk density should be light enough to ease handling and heavy enough to support the plants.

What are bulk density and particle density, why are they important, and how are they calculated?

- C. Bulk density is calculated by dividing the mass of dry soil by the volume of the soil.
- D. Particle density is calculated by dividing the mass of the soils in a soil sample by the volume of solids in the soil sample.

CALCULATING BULK DENSITY AND PARTICLE DENSITY

BULK DENSITY



1 cubic centimeter
(1.0 cm^3)

To calculate:

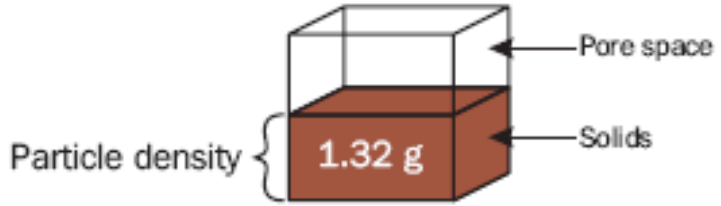
Volume = 1.0 cm^3 (solids and pores)

Mass = 1.32 g (sieved solids only)

$$\text{Bulk density} = \frac{\text{Mass of dry soil}}{\text{Volume of soil (solids and pores)}}$$

$$\text{Bulk density} = \frac{1.32}{1.0} = 1.32\ g/cm^3$$

PARTICLE DENSITY



1 cubic centimeter
(1.0 cm^3)

To calculate:

Volume = 0.5 cm^3 (solids only)

Mass = 1.32 g (sieved solids only)

$$\text{Particle density} = \frac{\text{Mass of solids}}{\text{Volume of solids}}$$

$$\text{Particle density} = \frac{1.32}{0.5} = 2.64\ g/cm^3$$

REVIEW

- 1. What is soil texture, and why is it important?
- 2. How is the texture of soil determined?
- 3. What is soil structure, how does it form, and why is it important?
- 4. What are the various soil structures, and what do they look like?
- 5. What are bulk density and particle density, why are they important, and how are they calculated?