

Agronomy 354 - Soils and Plant Growth

PHYSICAL PROPERTIES OF SOILS

Mass or Weight of Soil: weight of soil. Soil mass is derived from: (a) minerals, (b) organic matter, (c) water, and (d) gases. Minerals and organic matter are often lumped together and called "soil solids." The mass of an air-dried soil sample comes almost entirely from minerals.

Volume of Soil: amount of "space" it takes up. Volume of soil is derived from its solid components (minerals and organic matter) and its pores. Both solids and pores are important. The solids determine soil strength and many chemical properties. The pores are where water, gases, roots, and other organisms reside.

$$\text{Volume}_{\text{total}} = \text{Volume}_{\text{solids}} + \text{Volume}_{\text{pores}}$$

Pores: the volume not filled by solids in soils. Important pore characteristics include: (a) total volume (i.e., % pore volume); (b) shape; (c) orientation; (d) continuity; and (e) tortuosity.

Bulk Density: $\text{BD} = (\text{mass of soil sample}) / (\text{total volume of soil sample})$. BD ranges from 0.8 to 1.9 g/cm³. The ideal BD for plant growth is 1.35 g/cm³. The volume of a soil with a BD of 1.35 g/cm³ (84 lb/ft³) is generally about one-half pores and one-half solids. Higher BD indicates fewer pores and more solids. Consequently, high BD usually represents dense or compacted conditions. Low BD indicates high amounts of porosity and/or high amounts of organic matter.

Surface Area: SA = the area of the surfaces on minerals and organic matter per unit weight or volume of soil. It is on the surfaces of soil solids that many of the important chemical reactions occur. Consequently, increased surface area results in more potential for chemical reactions and water adsorption.

Texture: = % sand + % silt + % clay = 100%. Sand-sized particles have diameters between 2.0 and 0.05 mm. Silt-sized particles have diameters between 0.05 and 0.002 mm. Clay-sized primary particles are smaller than

0.002 mm. Sand-sized particles influence soil strength, drainage, and aeration. Silt-sized particles influence the soil's ability to maintain plant-available water. Clay sized particles have low soil strength when wet and tend to inhibit drainage and aeration. However, clays are extremely chemically reactive.

Textural Class: expressive names used to group like textures. These names are based upon the influence each of the particle sizes has on the soil. If sand, silt, and clay each influence a soil equally, the textural class is loam. If sand and clay predominate, the texture might be sandy loam. The most common textures in Iowa are silt loam, loam, silty clay loam, and clay loam.

Soil Organic Matter: = OM = decomposing and decomposed plant and microbial biomass; more-or-less synonymous with humus. As the content of OM increases in soil the soil color becomes progressively more black. OM tends to have low strength, drain excess water freely, readily hold plant-available water, and be very chemically reactive. OM is a source of plant nutrients and its decomposition increases soil acidity (decreases soil pH). Typical OM contents in Mollisol A horizons range from 3 to 8 percent. Typically soil parent materials contain no OM.

Structure = soil aggregates: Soil structure is the architecture of soil. Common types of structure include granular, blocky, prismatic, and platy. Structure exists because of bond between clays and OM and trapping of the sand and silt particles. The difference between texture and structure is analogous to a brick wall. The bricks and mortar are texture but structure arises when mortar glues to itself and bricks. The type of structure controls the major pore characteristics of a soil. For example, a clay-textured soil with strong granular structure will have excellent porosity and excellent drainage and aeration.

Adapted from a document prepared by Dr. Lee Burras