Magic from the Manual: Soil Texture Versus Soil Structure

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Many decisions a nursery or landscape manager makes are dependent upon knowing characteristics of the soil in which the plants are grown. Soil is a diverse and dynamic system consisting of air, water, mineral particles, organic matter, and living organisms. It supports plants and their roots, and it supplies nutrients and water for plant growth. Healthy soil also supplies oxygen to plant roots. Various parent materials from glacial deposits, wind blown particles, river deposits, volcanos, etc., are the basis from which soils are formed. The ongoing process of soil formation takes hundreds or thousands of years and is influenced by rainfall, temperature, and plant and animal life. The physical and chemical properties of soil are determined by these soil-forming processes. Critical soil characteristics for plant growth include texture, structure, drainage, aeration, water holding capacity, nutrient holding capacity, compaction, pH, and salinity. Thus, the type of soil will dictate the type of crops that can be grown, and the management practices required to grow them successfully.

A good growing soil is composed of approximately 50% solids, 25% moisture, and 25% air. Approximately 95 to 99% of the solid component consists of sand, silt, and clay particles and one to five percent consists of organic matter. The water component or soil solution, includes a soluble salt concentration of 100 to 1000 parts per million, which contains many of the nutrients necessary for plant growth. The air component contains the high concentrations of 0.3 to 0.6% carbon dioxide which is approximately ten to 20 times more than the air people breathe. It also contains oxygen, which is essential for root respiration and growth. If the normal 15 to 20% soil oxygen level is reduced to ten percent by excessive moisture or compaction, root injury can occur. Root growth stops at three percent soil oxygen, and roots are killed if soil oxygen further decreases or remains at this level for a short period of time. For optimum plant growth, all soil must maintain adequate moisture, but at the same time, provide adequate aeration.

Soil Texture

One of the most important physical properties of a soil is texture. Soil texture is the proportion of sand, silt, and clay particles that make up a soil. By definition, these particles are distinguished solely by size. Clay particles are less than 0.002 millimeters, silt is 0.002 to 0.05 millimeters, and sand is 0.05 to 2.0 millimeters in size. The relative size of these particles is depicted in Figure 1. The 12 different textural classes of soil are based on their different proportions of sand, silt, and clay, and are identified as follows: clay, sandy clay, silty clay, sandy clay loam, clay loam, silty clay loam, sand, loamy sand, sandy loam, loam, silt loam and silt. Soil scientists use a textural triangle to delineate these soil textural classes as shown in Figure 2. The percent of sand, silt, and clay is measured in the laboratory and then the respective percentage lines are followed to their intersections on the triangle. For example, a soil with 20% clay, 60% silt, and 20% sand is classified as a silt loam. Note that a soil classified as a "loam" has roughly equal proportions of silt and sand and less than 25% clay. Soil is often called "loam", when it may, in fact, have quite a different texture.

Even though the exact percentages of sand, silt, and clay for a particular soil may not be known, a good idea of the textural class can be determined by a "feel" test. First, moisten a small handful of soil and knead it until the soil has the consistency of putty. Then squeeze the ball of soil between thumb and forefinger to push out a ribbon. A soil that sticks together for a ribbon one to three inches long indicates a high clay content and is fine textured. A soil that feels gritty with low cohesion indicates a high sand content and is coarse textured. A soil that feels silky and forms a ball, but does not feel sticky, is medium textured and indicates a high silt content.

Soil texture is important because it influences water and nutrient holding capacity, drainage, aeration, susceptibility to compaction, irrigation and planting practices, and erodability. For example, coarse-textured soils such as sand, loamy sand or sandy loam, have a low water holding capacity, drain quickly, and are low in nutrients, especially nitrogen and potassium. These soils usually require irrigation to be productive. Medium-textured soils such as loam and silt loam usually have good drainage and adequate water and nutrient holding capacity. Fine-textured soils such as clay loam and clay, have a high water and nutrient holding capacity, but are usually poorly drained and are difficult to manage when wet. These soils must often be tiled to improve crop productivity. The water holding capacity of a soil as influenced by texture is illustrated in Table 1.

Table 1. Soil texture and soil water-holding capacity.

Texture	Inches of Water/Foot of Soil
Loamy Sand	0.6 to 1.0
Sandy Loam	1.0 to 1.3
Loam	1.7 to 2.3
Silt Loam	2.0 to 2.8
Clay	2.0 to 3.5

When a soil has an organic matter content of greater than 20 to 30%, the soil is referred to as "organic soil". Soils with an organic matter content greater than 60 to 80% are referred to as peat and muck. These soils are usually low in phosphorus and potassium, and may or may not provide significant amounts of nitrogen. They are usually found in low-lying areas, they are slow to warm up in the spring, and unless special measures are taken, they are poorly drained.

Soil texture is extremely difficult, if not impossible, to change. To add enough sand or loam to a field or even to a landscape to provide a meaningful change across the entire area and to a significant depth would require exorbitant quantities and would most likely be cost prohibitive.

Soil Structure

The manner in which sand, silt, and clay particles are held together is referred to as soil structure. Decayed organic matter and humic acids interact with mineral particles to form structural aggregates of various shapes and sizes. Soil structure may affect pore size distribution and therefore, affect the ability of a soil to drain and provide adequate aeration. A soil with 60% stable aggregates, which are aggregates that do not break down easily, is considered to have good structure. A good soil structure, often referred to as good tilth, will allow cultural operations to be performed with minimal problems and enable plants to establish extensive root systems.

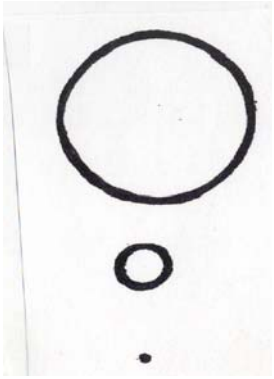
SOIL TEXTURE PARTICLE	RELATIVE SIZE	DIAMETER OF PARTICLE (Millimeters)
SAND		0.05 – 2.0
SILT		0.002 – 0.05
CLAY		LESS THAN 0.002

Figure 1. Relative sizes of sand, silt, and clay particles enlarged 500 times.

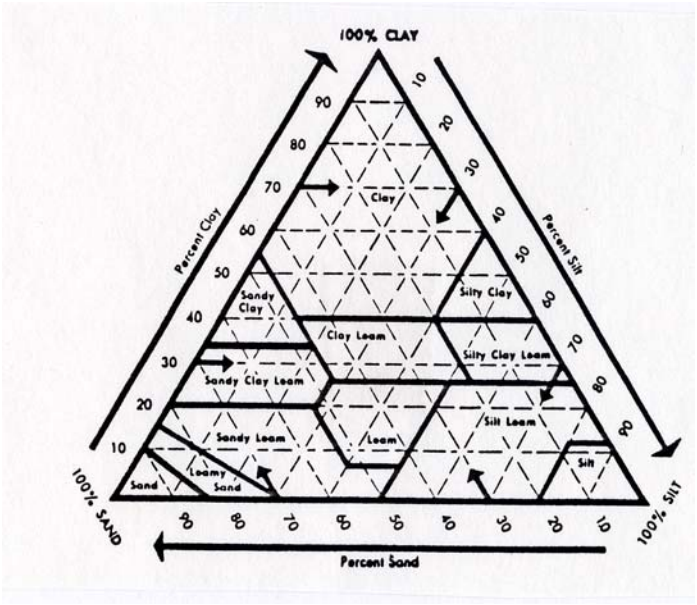


Figure 2. Soil Texture Triangle. After measuring the percent sand, silt, and clay in a soil sample, the texture is determined from the Soil Texture Triangle.

While soil texture is generally considered a fixed property that cannot be changed, soil structure can be modified, for better or worse, in a relatively short period of time. Working or traveling over a wet soil can cause compaction and it will destroy good soil structure. Compaction crunches soil aggregates, therefore, compacted soils have much less pore space and a greater amount of solid particles per unit. This decreases soil oxygen and therefore, restricts root growth. To prevent compaction from occurring, allow soils to drain after a rain or irrigation before working the soil or driving on the soil. The amount of time to wait after a heavy rain will depend upon how the soil texture allows the soil to drain. For example, a sandy soil may require one day

to reach a proper moisture content, whereas, a clay soil may require a week or more. Soils can range from being very poorly drained, where a soil is saturated with water much of the time, to excessively well drained, which is a droughty soil. Poor drainage is a leading cause of transplant failure. Poor drainage is most likely to be a problem on heavy clay soils, and in low areas. The poorest drainage occurs when there is a water table near the surface. Certain plants, like yews and rhododendrons, are particularly sensitive to poor drainage. Deep tillage of two to three feet, berms, tilling, large planting holes, and turf aeration will facilitate drainage and aeration of compacted soils.

Certification Examination Questions

1. T F Soil is a diverse and dynamic system consisting of air, water, mineral particles, organic matter and living organisms.

2. A good growing soil is composed of approximately:
   A. 25% Solids, 50% Moisture and 25% Air.
   B. 60% Solids, 25% Moisture and 15% Air.
   C. 50% Solids, 25% Moisture and 25% Air.
   D. 40% Solids, 30% Moisture and 30% Air.
   E. 25% Solids, 25% Moisture and 50% Air.

3. T F Soil Structure refers to the size of the soil particles.

4. T F Root injury can occur if the soil oxygen level drops to 10% or less.

5. T F Poor drainage is most likely to be a problem in sandy soils and in low areas.

Certification Examination Question Answers

1. True
2. C
3. False
4. True
5. False

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