Certification Training Magic from the Manual:
Soils for Nursery and Landscape Management

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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. 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.

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 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. 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. 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.

Soil Texture

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. 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 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. Soils can range from being very poorly drained, where the 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 problem on heavy clay soils, and in low areas. The poorest drainage occurs when there is a water table near the surface. Deep tillage of two to three feet, berms, tilling, large planting holes, and turf aeration will facilitate drainage and aeration of compacted soils.

Organic Matter and Soil Amendments

Amendments to a soil may include organic matter or the addition of a different soil texture. Whenever any amendment is added to an existing soil, the possibility of developing an "interface" exists. An interface is the connecting surfaces of existing soil and the amendments. If these two meeting surfaces are quite different, aeration and drainage may be negatively influenced. This may have a significant effect on root growth and may prevent roots from growing through or into the interface. To prevent interface formation, insure that the two components are thoroughly mixed. Some organic matter such as manure **may** serve as a source of slow release nutrients, however most organic matter sources consume more nutrients than they provide.

The addition of organic matter such as compost, peat, wood chips, or bark can help improve soil water holding capacity, drainage, and pH. The rate of incorporation will depend on the situation and soil. For example, where trees or shrubs are to be planted, a "transition zone" can be developed by using a large planting hole and adding amendments directly to the backfill such as 1/3 amendment, 2/3 existing soil. This will prevent the roots from encountering a severe interface.

Cation Exchange Capacity (CEC)

Clay particles and organic matter in the soil have negative charges that attract and hold on to positively charged ions called cations. The cation exchange capacity of a soil is a measure of the amount of positively charged ions that a soil can hold. In general, the higher the clay and organic matter content of a soil, the greater the nutrient holding capacity. However, a high nutrient holding capacity does not always imply high nutrient levels.

Soil pH

Another important soil chemical property affecting nutrient availability and plant growth is soil pH, which is a measure of acidity or alkalinity. Very simply, pH is a relative measure of the hydrogen ion (H^+) concentration. The pH scale ranges from 1 to 14, with 7 being neutral. In extremely acidic soils wherein the pH is less than 4.5, aluminum or manganese toxicity may result. In highly basic or alkaline soils with a pH greater than 7.0, iron becomes unavailable and iron chlorosis may develop. For most plants, a pH of 5.5 to 7.0 provides the greatest nutrient availability. For some plant species such as azalea, blueberry, and rhododendron, the optimal pH is 4.5 to 5.5.

Various materials can be used to either raise or lower soil pH. Before any pH adjustment is attempted, the soil should be tested to determine the initial pH. Agricultural limestone is the most common material used to raise soil pH from a pH of 4 to a pH of 5. Liming or increasing the pH is seldom required or necessary for nursery crops or container media in most of Minnesota. Test the soil **before** adding lime. Elemental sulfur or iron sulfate can be used to lower soil pH, for example from a pH of 7 to pH of 6. However, it is more difficult to lower the pH than to increase it. Elemental sulfur is slow acting and may take several months before a pH change can be detected. Iron sulfate is faster acting and can lower pH within two to three weeks.

Irrigation water often has a high pH and, therefore, can raise the pH of the soil or medium over time. To avoid an increase in pH, use acidic fertilizers like ammonium sulfate and iron sulfate. Acidification treatments like sulfur may need to be repeated. High levels of soluble salts in the soil will damage roots and foliage. This is a greater problem in heavy soils than in well-drained soils where the soluble salts can be leached through the soil profile.

Soil Surveys and Soil Sampling Techniques

Most Minnesota counties offer detailed soil surveys that can be obtained from local Extension or soil Conservation District Offices. However, the soil maps may not be fully accurate in sites heavily modified by home construction or other developments.

The manner in which a soil sample is taken has a profound effect on the final analysis. It is critical to have consistency in sample collection over time, but randomization across the area is necessary each time a sample is taken. Take samples at least six hours after irrigation and at least one month after an application of fertilizer, except where a constant fertilization program is used. In that case, sample one to two days after the last irrigation. Take 15-20 core samples from an X or zigzag pattern across the field. For field soils, request the **Regular Series plus the Nitrates and Soluble Salts Test.** For container medium samples, scrape aside ½ to one inch of the surface of the medium. Take a core of the medium just off-center of the container and through the entire container depth. Sample at least ten containers per species, or groups of species. Samples should be taken at least monthly throughout the growing season. Check with local Extension office for Soils Testing Lab.

Study Questions:

1. T F Soil structure and texture are extremely difficult, if not impossible, to modify or change.

2. T F In general, the higher the clay and organic matter content of a soil, the greater the nutrient holding.

3. The addition of organic matter may help improve soil water holding capacity, drainage and pH. Which of the following is **not** appropriate organic matter?
A. Wood Chips
B. Peat
C. Compost
D. Sand
E. Bark

Answers: 1-F, 2-T, 3-D

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