How Soil Factors Affect Plant Establishment and Growth

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Soil information has long been used by farmers, engineers and land managers, but little attention has been paid to soil management in the urban landscape by horticulturalists, arborists and landscape professionals.

Soil information used by the landscape industry is usually limited to fertility considerations only. But there is more to learn. Harsh urban soil conditions present one of the most severe environmental stresses encountered by woody landscape plants. Compaction, poor site drainage, manmade soil (mortar, building rubble, etc.) alkalinity and clayey materials are just a few of the physical limitations in urban planting sites.

By understanding basic soil properties, the landscape professional can modify planting sites and eliminate some of the differences between nursery conditions and the urban planting site. Analysis of site soil conditions is not generally a part of the design phase, but it should be. If soil information is not provided during design, it should be gathered and utilized during plan implementation. Site modification is more difficult at this stage, but in many instances may be the only way to increase the survival rate of woody plants on the site. Often, remedial action to improve the trees' environment after planting is unsuccessful, and very costly.

Physical soil properties critical to the establishment of trees in urban landscapes include texture, soil structure, available water holding capacity, bulk density, permeability and water table depth. Because of the complex interrelationships between physical properties, no single factor in this list is more important than another.

Soil texture Soil texture, the ratio of particle sizes (sand, silt and clay), can be estimated easily. Textures can be obtained in the field by kneading the soil between the thumb and forefinger. Gritty particles in the sample are sand; silt particles feel floury; and clay particles are sticky.

Textural analyses of soils can also be performed by commercial laboratories. Often, if a soil is the least bit sticky, people are quick to say that it is clay. In actuality, few soils in northern Illinois are clay.

Soil texture controls the permeability, moisture holding capacity and consistence, or friability, of soils.

Soil structure Soil structure refers to the size and shape of soil aggregates. These aggregates, or peds, are held together by a complex of organic compounds. Soil structure is described by the shape of the aggregate: granular, crumb, blocky, subangular blocky, prismatic and columnar. Soil structure controls the permeability and gas exchange, and affects the drainage characteristics by "perching" water in some layers of the soil.

Compaction from equipment causes the soil structure to break down. Tilling compacted soil will help increase its permeability and aeration. However, if the compaction is severe and the structure is destroyed, reaggregation may not occur. This is true of many urban situations, particularly where organic matter levels are low.

If poorly aggregated soil cannot be overcome, tilling and working in organic matter will ease some of the permeability problems. However, this is not a long-term solution. There s no quick fix to soil reaggregation available. Gypsum is com-

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monly used to "improve" aggregation, but it is only effective in saline soils. Its ability to improve soil structure in alkaline materials that are fine textured has not been shown. Recent research on organic polymers to improve aggregation is promising, but few commercial products are available.

Water holding capacity Available water holding capacity (AWHC) refers to the capacity of the soil to hold water that plants can use. This is essentially the moisture levels from field capacity (saturation point) to the wilting point percentage. AWHC is controlled largely by soil texture. Silt loam and loam textures provide the largest AWHC of any soil texture. Coarser textures (sandy, sandy loam, etc.) have less surface area to hold the water for plants than do finer textured soils. Finer textured soils (silty clay loam, clay loam, clay, etc.) contain large surface area for holding water, but the clay particles bind much of it tightly so less is available to the plants.

Bulk density Bulk density is most commonly used as an indicator of soil compaction. It is a measurement of the mass of soil per unit volume. During the compaction process, soil structure is destroyed and large soil pores collapse. Density is an indirect indicator of the adequacy of soil pore space. High densities (greater than 1.8) indicate soil conditions which prevent root growth and survival due to reduced soil aeration, poor water movement and impenetrability. Bulk densities between 1.0 and 1.4 are optimum for root growth. Root growth is reduced at densities between 1.5 and 1.8

Permeability Permeability indicates the ability of water, gases and plant roots to move through the soil over a period of time. Pore space, texture and soil structure control the permeability of soil. Soils with coarse textures are more permeable than fine textured soils. Large pores transmit soil water and gases more readily than small. Transmission of water depends on the ability of water to move either laterally or downward. Most of the root growth, gas exchange and water movement through soils occurs in the large pores along the faces of the soil aggregates.

Water table depth The seasonal high water table and drainage characteristics are determined in intact soil profiles by marking the highest depth at which splotches of gray colors occur. These splotches are termed "mottles". Mottles occur in many colors, but are usually either dull gray or bright reddish-orange. If the gray color (gley) dominates the soil, the water table is at that depth for the majority of the year, unless the area has been recently (10-20 years) tiles drained.

Mottling and gleying of the soil are not good indicators of water table depths in disturbed urban soils, because the color of the soil applies to the soil before disturbance. Often, fill materials for urban sites do not originate at the site, but are brought in from other areas. This makes historic characteristics of little value in site evaluation.

In disturbed soils, monitoring of near-surface water tables is usually the only reliable measure of potential water logging. Unfortunately, site investigations are rarely undertaken until the plant has been killed by poor drainage or a high water table.

Water table and drainage problems are easily overcome by tile drainage, except in areas with fine textures soil materials that have been severely compacted. In these situations, site improvement usually involves the use of dry wells and the complete replacement of the soil environment in which the tree is to be planted.