A Soil Primer: Physical Characteristics

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Soil information has long been a mainstay for farmers, engineers, and land managers, but soil management in the urban landscape has received little attention from horticulturists, arborists, landscape professionals, or the average homeowner.

Soil information, when used by these groups, is usually limited to fertility considerations. But there is more to learn. Adverse urban soil conditions present serious environmental stresses for woodly landscape plants. Compaction, poor site drainage, man-made "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, both the landscape professional and the homeowner can enhance planting sites and eliminate some of the differences between nursery conditions and urban planting sites. Analysis of site soil conditions is not generally part of the landscape design phase, but it should be. Homeowners embarking on new landscaping projects should insist on obtaining a complete soil analysis. 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 may be necessary to increase the survival rate of woody plants on the site. Remedial action to improve the environment after completion of planting can be very costly and possibly unsuccessful.

Physical properties critical to the establishment of trees in urban landscapes include soil texture, structure, bulk density, permeability, drainage, and water table depth. The homeowner and landscaper should be familiar with these characteristics in order to plan a successful project. Because of the complex interrelationships among physical properties, no single factor in the following discussion is more important than another.

SOIL TEXTURE

Soil texture, the ratio of particle sizes (sand [largest], silt, and clay [smallest]), can be estimated quite easily. Textures can be estimated without the use of specialized equipment. Simply knead the soil between the thumb and forefinger. Gritty particles in the sample are sand; silt particles feel like flour; and clay particles are sticky. Often, this simple analysis is enough to give a basic idea of the soil texture. For large projects, more accurate textural analyses can be obtained from commercial laboratories.

Soil texture is important because it directly affects the permeability, moisture-holding capacity, nutrient bioavailability, and consistency (friability) of soils. These characteristics are described below.

SOIL STRUCTURE

Soil structure refers to the size and shape of soil aggregates — clumps of soil held together by a complex of organic compounds. Soil structure is described by the shape of the aggregate: granular, crumb, blocky (angular and subangular), prismatic, columnar and platy. The structure of the soil controls its permeability and gas exchange capacity and thus can affect drainage characteristics by "perching" or concentrating water in some layers of the soil.

Compaction resulting from the movement of heavy equipment causes soil structure to break down. Tilling compacted soil will help to 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 improved by tilling, the incorporation of organic matter such as peat moss, composted leaves, grass clippings, garden refuse, and other organic materials will lessen some of the permeability problems. However, this is not a long-term solution. There is no quick fix available. Gypsum is commonly used to "improve" aggregation, but it is only effective in saline soils. Its ability to improve soil structure in fine-textured alkaline soils has not been demonstrated. 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. It is controlled largely by soil texture. Silt loam and loam textures provide the greatest AWHC. Coarse textures (sand, sandy loam, etc.) have less microscopic surface area to hold the water for plants than do fine-textured soils (silty clay loam, clay loam, clay, etc.). Though these fine-textured soils contain large surface areas for holding water, the clay particles bind much of the water so tightly that little of it is available to plants.

BULK DENSITY

Bulk density is most commonly used as an indicator of soil compation. It is a measurement of the mass of soil per unit volume (usually grams per cubic centimeter). Bulk density usually ranges from 1.0 to 2.0 for mineral soils. Durng 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 in fine-textured soils (greater than 1.8) are indicative of compact, poorly aerated soil that cannot be penetrated by water or roots. Bulk densities between 1.0 and 1.4 are optimal for root growth. Root growth is reduced at densities between 1.5 and 1.8.

PERMEABILITY

Permeability is a measure of 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 water and gases more readily than do small pores. Transmission of water depends on the ability of water to move either laterally or vertically. Most of the root growth, gas exchange, and water movement through the soil occurs in the large pores along the faces of the soil aggregates.

SOIL DRAINAGE

Soil wetness is determined by a number of factors including rainfall, soil structure and texture, permeability, and infiltration characteristics. The degree of soil wetness can be broadly classified into seven categories, but only four of these are significant in our region: 1) somewhat excessively drained soils are rapidly permeable and have low levels of soil moisture, but they support plants well where there is no droughty season; 2) well-drained soils have an optimal amount of drainage to support plant growth without inhibiting root growth, yet they provide adequate moisture to the plants throughout most growing

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seasons; 3) somewhat poorly drained soils are wet for long periods of time. These soils restrict the rooting development of most plants; 4) poorly drained soils are wet throughout most of the year. They restrict root development in all plants other than wetland species.

Installation of drainage tiles is an effective management tool for somewhat poorly drained soils and poorly drained soils.

WATER TABLE DEPTH

The seasonal high water table and drainage characteristics are determined in undisturbed natural soils by marking the highest depth at which splotches of color occur. These splotches, termed ''mottles'', occur in many colors but are usually either dull dray or bright reddish orange. Gray colors dominating the soil indicate that the water table remains at that depth for the majority of the year, unless the area has recently been drained with tiles.

Mottling of the soil is a good indicator of water table depths only in undisturbed soils. On urban sites where fill materials are brought in, soil mottling is not a satisfactory indicator of water table depth.

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 plants have been killed by poor drainage or a high water table.

Except in areas with fine-textured soil materials that have been severely compacted, water table and drainage problems are easily overcome by installing tile drains. Severe compaction may call for the use of dry wells or the complete replacement of the soil environment in which the tree is to be planted.

CONCLUSION

Early detection and correction of soil problems are important for successful plant growth. The homeowner and/or landscaper who understands soil characteristics should analyze for soil texture, structure, water-holding capacity, bulk density, permeability, and drainage, as well as for water table depth. This is especially important in urban and suburban locations where the soils have been manipulated in the past. With the information gained, the enlightened homeowner or landscaper can make the suitable corrections which will help to ensure the success of the project.

Credit: The Morton Arboretum
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''June Bug Blues''

The Beetle's seem to have Their Day,
Laying Eggs without discretion,
As Larva eat and chew Their way,
With a munching perfection.
The June Bug starts the Summer Season,
And alerts a watchful Eye,
For many misfortunes can occur,
Beneath a Sunny Sky.

Kenneth R. Zanzig