

Soils: The Key to Successful Establishment of Urban Vegetation

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1. Introduction

It has been estimated that 80% of urban-vegetation problems are attributable to the soil environment (Patterson *et al.*, 1980). Foresters and horticulturists are facing the question of how to improve woody plant growth under these circumstances. In many cases, the solution is to modify rooting environments. This requires gaining a basic understanding of soil properties, acknowledging the difficulties associated with urban soils, and conducting proper site assessments prior to planting.

2. Tree Roots

An appropriate first consideration is of the part of the tree that interacts most intimately with soil—the roots. Tree roots obtain water, minerals, and oxygen from the soil. These nutrients, in turn, are used by the plant to synthesize carbohydrates and energy through the processes of photosynthesis and respiration. They also synthesize hormones that trigger growth in the entire tree. The soil also provides support and anchorage to root systems.

Tree roots exist predominantly in the top 30 cm (12 inches) of soil and usually do not extend deeper than 1 or 2 m (40 to 79 inches) (Perry, 1982). Roots grow in the top layers primarily because of their requirement for oxygen and a permeable soil; oxygen concentrations are greatest near the soil surface where the soil is less dense. These top layers are also favorable for growth because of the organic matter and nutrients that are usually present.

In the absence of restriction, roots will often extend horizontally to occupy an area four to seven times greater than the tree's projected crown area. Roots are opportunistic and will extend into zones where resources are most plentiful and conditions are most favorable for growth (Perry, 1982). Regard for a tree's "natural" root distribution helps to underscore how susceptible roots are to disturbances made at the soil surface, even at points far beyond the projected crown area.

3. Soil Properties

It is necessary to gain a basic knowledge of soil properties in order to fully understand the problems encountered with urban soils. Many of these difficulties, including compaction and impeded drainage, are a function of soil's physical properties. Soil's chemical and biological properties also are significantly impacted in urban forests and warrant consideration.

3.1. Physical Properties

Soil's physical properties include texture and structure. These properties, in turn, influence soil pore space, aeration, infiltration of water and drainage capacity, susceptibility to compaction, nutrient-holding capacity, temperature, and color.

3.1.1. Soil Texture

Soil is a mixture of particles of different sizes. These sizes are summarized in Table 1. The primary particle-size classes are sand, silt, and clay.

Sand particles are between 0.05 and 2 mm in diameter and are relatively rounded or cubelike in shape. This shape allows large pores to exist between particles. Soils that contain a high proportion of large sand particles often exhibit favorable aeration and drainage because air and water can readily move through the large pore spaces.

Silt particles are between 0.002 and 0.05 mm in diameter and diverse in shape. Silt is intermediate between sand and clay in terms of its properties.

Table 1. Particle-Size Classes

Particle-size class	USDA diameter range (mm)
Gravel	6.7–2.0
Very coarse sand	2–1
Coarse sand	1–0.5
Medium sand	0.5–0.25
Fine sand	0
Very fine sand	0
Silt	0
Clay	<0.002

USDA—United States Department of Agriculture.