WORKING WITH URBAN SOILS

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INTRODUCTION

The soil is an important part of the terrestrial ecosystem and is often ignored in our planning and design either because it is out of sight or because it is not considered as having significant influence on plant growth. Another misnomer is that if the soil presents a problem it can be easily overcome or modified adequately for the purposes at hand, usually by the addition of some amendment. Unfortunately, these oversights occur too commonly in urban landscape activities.

Roots are just as important to the photosynthetic activity and well-being of the tree as are its leaves (Perry, 1982). The water and nutrients required by the tree in the photosynthetic process are absorbed through the root system from the soil. In fact, nearly 80 percent of the carbon assimilated by the tree is allocated to the root system. The root system also serves as an important storage location for plant energy substances such as carbohydrates and as mechanical support for the tree - a fascinating physical structure (Zimmermann and Brown, 1971). A healthy tree will have a well-developed and vigorous root system; a sickly tree will have a limited root system showing little root extension.

Many planting failures may be attributed to our ignorance of the normal course of root growth and of the influence of environmental conditions upon it (Partyka, 1982), and especially the lack of consideration and understanding for the conditions that exist within the urban soil. Too many times the urban soil conditions are simply unfit for trees (Foster, 1977). Sinclair and Hudler (1988) describe four concepts of tree decline caused by:

1. Primarily by perennial or continual irritation by one factor.
2. Drastic injury plus secondary stress.
3. Interchangeable predisposing, inciting, and contributing factors.
4. Synchronous cohort senescence.

An example of the first is iron chlorosis of pin oaks; the second is street tree decline by various causes subsequent to construction damage to the tree roots; the third is illustrated by girdling roots, restricted rooting space of urban trees, soil compaction leading to water shortage and rootlet mortality, deicing salt effects, chronic effects of *Verticillium dahliae*, etc.; and the fourth by the decline and mortality of groups of trees of similar age and species becoming predisposed to damage. Under urban conditions we probably most often witness the second and third causes. The two-stage causation of massive removal of urban tree roots greatly reduces water absorption, leading to water stress and to the invasion of root fungi, such as *Ganodema lucidum* through the wounds. The limbs and trunks then become susceptible to secondary insects and diseases. By the time symptoms appear, the original causal factor has been forgotten.

Our purpose here is to contrast natural soil with urban soil and discuss the conditions presented by the latter that create problems for the urban tree and its root system. We will also examine the special problems of the standard tree pit and suggest ways to assess urban soils.

DEFINITION OF URBAN SOIL

Natural Soil

The soil is a major component of the natural terrestrial ecosystem. It has formed at the earth's surface as the result of the interactions between the climatic parameters of rainfall and temperature, vegetation and its associated fauna, the underlying weathered geologic material, and topography, over intervals of time ranging from very recent to long geologic time. It attains a stratified form with layers, called horizons, and has the appearance of a baker's layer cake (the soil profile). Thus, the soil exhibits attributes of the locality in which it is found and exists as a continuum over the surface of the earth's crust. It is a porous medium made up of mineral material, organic residues in various degrees of decay, and contains air and water in varying proportions. It is a dynamic system composed of physical and chemical processes together with biological processes undergoing daily and seasonal changes and fluctuations, that give the soil its ability to retain nutrients and water in plant-available form and provides mechanical support for plants (Brady, 1990).

Agricultural Soil

An agricultural soil is one that has been physically and/or chemically manipulated by human activities for domesticated plant production. It usually exhibits a distinct surface horizon, the plow layer, created by cultivation and tillage, incorporation of organic residues, and having nutrient content and soil reaction (pH) adjusted to support intensive plant production. The effects of chemical adjustments may extend downward into the lower portion of the soil profile called the subsoil. The agricultural soil is generally well managed because the farmer's welfare directly depends upon the level of land husbandry practiced. The farmer needs to maintain the organic matter content, tilth and fertility of the soil and protect it from erosion for sustainable productivity.

Potting Soil

At this point it is helpful to describe what is meant or what is usually found to be "potting soil." This is a compounded mixture of sand, peat or composted organic residue including animal manure, some specified soil, and one or several manufactured conditioners such as vermiculite or perlite, all mixed in varying proportions depending upon the experience of the user. The rationale for a coarse mix is to aid drainage of the container, since drainage of the greenhouse pot or any container with a limited depth, is very restricted as compared to a natural well-drained soil profile. The potting soil is then used in pots, planting flats, window boxes, or as an additive to natural soil.

Urban Soil

Urban soil is one that has been disturbed or manipulated by human activity connected with construction and urbanization. It has one or more horizons, at least 50 cm thick, composed of material that has undergone one or more of the following actions associated with urban activities: mixing, compaction, pulverization, filling, scraping (topsoil removed), addition of anthropeic contaminants or toxic substances at levels above those of natural soil. Though soil removed for mining operations as overburden then later replaced has characteristics similar to the above, it is not included here since we are concerned primarily with urbanization. The degree of departure from natural soil is directly related to the proportion of the profile that exhibits disturbed characteristics and the severity of the disturbance (Mullins, 1988). Characteristics that differentiate urban soils from their natural counterparts are: a high degree of vertical and spatial variability, a loss of structure leading to a tendency towards compaction, poor aeration status and generally impeded drainage, presence of a hydrophobic crust on the bare surface, elevated soil reaction (pH), increased temperatures, interrupted cycling of nutrients and organic matter, and the presence of anthropeic contaminants and toxic substances (Craul, 1985a,b). Generally, these soil materials have been in place for only a short time, and the climatic and vegetative factors of soil formation so dominant in natural soils are not yet expressed. Further, the material has been placed by human activity rather than by natural agents.

CHARACTERISTICS OF URBAN SOIL

To gain an appropriate appreciation of urban soil conditions and the problems they present to root system growth and development, a brief discussion of each urban soil characteristic follows.

Vertical and Spatial Variability

Soil properties gradually grade from one horizon to the next lower one in a natural soil; however, these same properties may exhibit abrupt changes in an urban soil as the result of construction activities associated with urbanization and development (Craul and Klein, 1980). Cutting, filling, scraping away of topsoil exposing the subsoil then subsequent respreading, all create these abrupt changes or discontinuities. If the changes are drastic, water drainage, gaseous diffusion (aeration), and root penetration may be impeded.

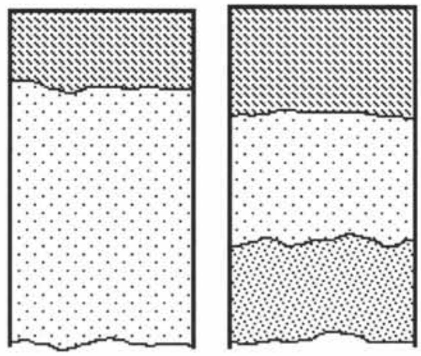


Figure 1. Two degrees of profile variability.

If the soil profile consists entirely of fill material, then there may be a series of abrupt changes, each presenting a different root environment that may or may not be favorable (Short, 1983). Spatial variability is just as complex as vertical variability. The spatial distribution of construction activities is superimposed over the natural variability that exists in soils, thus compounding the variation in urban areas. In fact, it is impossible to predict soil conditions without a knowledge of the constructional history of the site and detailed on-site investigation. It is not unusual to find drastic soil property differences between adjacent tree pits within a city block (Berrang, et.al., 1985; Robert Skiera, personal communication). Thus, one tree pit may have optimum conditions of drainage for one or several tree species whereas the next one may be totally unfavorable for any tree.

Loss of Aggregation and Susceptibility to Compaction

The aggregation of soil particles into structural elements in the process of soil formation creates pore space between the mineral particles. Soil structure is a significant property that influences water infiltration, movement and retention, gaseous diffusion and ease of root penetration by the amount, arrangement or pattern, and size of the pore spaces. A well-aggregated soil will have a range of pore sizes (macropores and micropores) with some large enough to permit water movement and drainage, and root penetration. The roots will follow the path of least resistance and where the environmental conditions are most favorable (Gilman, et. al. 1987). The bulk density, a measure of the degree of soil compaction, would be about 1.33 megagrams per cubic meter or somewhat less and has about 50 percent pore space (Figure 2).

Figure 2. A comparison of three pore space percentages.

The aggregation is essentially lost when the soil is scraped away, stockpiled, then later backfilled. The pore space is reduced, mainly at the expense of the larger pores, and the soil becomes more dense or compacted. Mechanical compaction by equipment, foot traffic and vibration may have the same effect

(Patterson, 1976). Unfortunately, many urban soil materials are inherently self-compacting due to high silt or fine sand content and lack of organic matter. A compacted soil has mostly small pore spaces (micropores) which may be smaller than the minimum diameter required for extension of the root cap (Taylor, 1974). Further, the soil may be resistant to compression by root circumnutational movement, thus mechanically inhibiting root growth (Fisher, 1964). Bulk density values in excess of about 1.75 megagrams per cubic meter for sandy soils and 1.55 megagrams per cubic meter for clays will inhibit root penetration (Veihmeyer and Hendrickson, 1948). In a study on mine soil restoration, Thompson, et.al. (1987), found a significant relationship between root length density expressed as root length per unit soil volume and its bulk density. The bulk density ranged from 1.40 to 1.93 megagrams per cubic meter and the root length density linearly ranged from 0.748 to 0.047 cm per cubic cm. Patterson (1976), Short (1983), and Craul and Klein (1980) all report urban soil bulk density values in excess of these limits. This condition forces the roots to be near the surface, thus more susceptible to mechanical injury, drought and elevated temperatures. Pomerleau and Lortie (1962) found that birch dieback was most severe when roots were shallowest. Open winters with abnormal freezing temperatures accompanied by drying are thought to be the cause. The bronze birch borer attacked the weakened trees. And it appears that once a soil is compacted, it takes a long time for recovery (Throud and Frissell, 1976) or the soil must be mechanically loosened.

Poor Aeration Status and Water Drainage

The diffusion of oxygen into the soil and carbon dioxide and other gases out of the soil through the air-filled macropores under unsaturated soil conditions is essential to favorable soil organism growth. Soil microorganisms, including tree roots, require a minimum amount of oxygen, moisture and nutrients for survival, and can tolerate to varying degrees carbon dioxide and other gas concentrations above a critical level, as well as lack of moisture and minimum rooting space down to critical levels. But the tree will exhibit vigorous growth when these below ground conditions are favorable in most respects. A so-called ideal topsoil has 50 percent pore space, 25 percent moisture content and 25 percent air-filled pore space. However, research results show that most urban soils have porosities less than this ideal (Patterson, 1976; Short, 1983). Conversely, these are soils with bulk densities greater than 1.33 megagrams per cubic meter. The pore space consists dominantly of small micropores that slows water movement, and because they contain water most of the time, gaseous diffusion is inhibited (Craul, 1972). As a result, oxygen is not able to diffuse into that portion of the soil and carbon dioxide and gases formed by anaerobic (reduction) conditions cannot be removed (Bakker and Hidding, 1970). Existing roots die and growing roots will not extend into these areas of the soil.

Hydrophobic Crusts

A bare urban soil exhibits a pronounced tendency to form a crust on or within several centimeters of its surface (Ruark, et.al., 1983). Compaction by traffic may be the trigger. Raindrops also tend to wash fine particles into the very fine pore spaces, thus clogging them. An exacerbating factor to the crust effect is the hydrophobic nature (water-repelling) of many urban soils. This feature is caused by the presence of ammonia and hydrocarbon coatings on the mineral particles (Wander, 1968). The combination of these effects is to reduce the wetting, and in turn, the infiltration of water into the soil, decreasing its moisture content even after a moderate rainfall. Since most microorganism activity and the fine roots occur near the soil surface, the crusting lowers the favorability of the subsurface environment for these activities.

Elevated Soil Reaction (pH)

The pH (soil reaction) is highly dependent upon the parent material from which the soil is derived, the climate (rainfall amount) of the region, the associated vegetation, the organic matter content, and the major nutrient elements contained in the soil. In urban soils, the pH is generally higher than their country counterparts. This is brought about by the weathering of incorporated calcium-containing mortar, cement, and other masonry products in the soil, the washing of water from building facades and concrete sidewalks onto the urban soil, and in some instances, the lack of frequent flushing by rainfall coupled with high evaporation levels (Chinnow, 1975). The use of de-icing salts in northern urban areas also contributes to the elevated pH. The effect of the elevated pH is to restrict the plant palette available to the landscape architect since plants in general have individual optimum ranges of pH for growth. Also, it favors certain types of root-disease bacteria and fungi, and requires the adjustment (lowering) of pH if acidiphilous plants are to be used in the design. For example, pin oak (Quercus palustris L.) suffers badly from iron chlorosis on soils with high pH (greater than

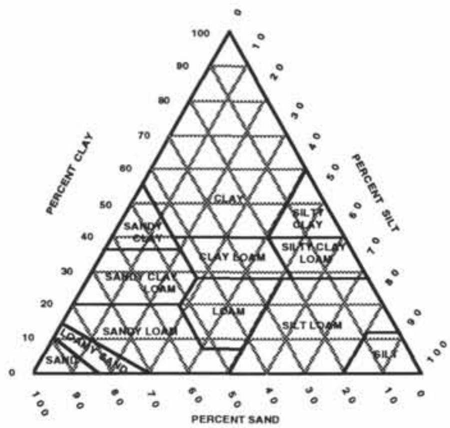
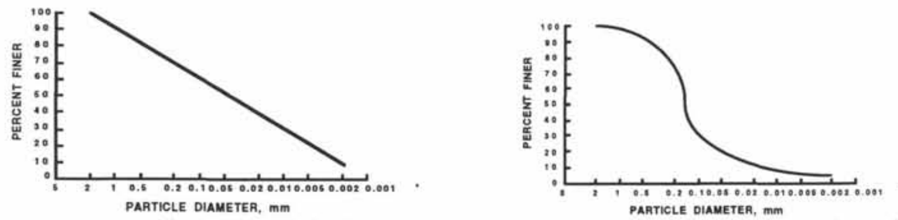


Figure 3. The USDA texture triangle.



(a) a well-graded soil. (b) a poorly graded

soil.

Figure 4. The particle size distributions of two contrasting soils.

about 6). Other oaks, such as bur oak (Quercus macrocarpa L.), seem to grow well in high pH soils. The soil microorganism population is not gravely affected by high soil pH, but there is a shift in the population to bacterial dominance from a combination of fungi, bacteria and actinomycetes with algae (Brady, 1990).

Increased Soil Temperatures

Heat buildup in urban areas is caused by the "heat island" effect. The accumulation and storage of heat by sidewalks, structures and the air just above the soil, as well as reflection from steel and glass, is transferred to the soil. Therefore, the average, the minimum and the maximum soil temperatures are greater than for the same soils outside the city. The effect is to dry out the soils and place the trees under greater moisture and heat stress. Crown temperature has been found to be a significant factor in determining the transpiration loss of urban trees (Potts, 1978). Soil microorganism activity is very temperature dependent, but lethal temperatures occur on bare soil only to about 2 to 3 centimeters of the surface. Redmond (1955) observed that a rise of 2 degrees C throughout a growing season caused the rootlet mortality of birch seedlings to increase from 6 to 60 percent. It appeared the altered root environment was unfavorable for mycorrhizal fungi but favorable to root infecting fungi that are normally innocouous. However, from a comparative view, as in a mulched soil, the microorganisms would occur even up into the mulch, suggesting that the loss of the benefit of microorganisms in the surface 2 or 3 centimeters could be significant in a shallow urban soil.

Interrupted Cycling of Nutrients and Organic Matter

In nature, trees occur in stands or groups. A closed or nearly closed canopy with branches of the crowns touching or overlapping is common. The deposition of litter on the forest floor and its subsequent decomposition by soil organisms, yielding simplified plant-available nutrients, creates the cycling so important to the sustained growth of the plant community. In urban areas, the trees usually occur as individuals providing little chance for organic matter cycling. Further, the leaves and other organic debris are usually removed as a nuisance. Containerized plants suffer even more from the lack of optimum nutrient availability because the soil volume is limited and the nutrients released over time by weathering are soon depleted. In a natural soil, the profile nutrients are renewed by the weathering of rock minerals over time. In an urban soil, this connection to weathering or weatherable soil material from below may not exist. Any nutrient deficiencies suffered by the higher plants also occurs within the microorganism population as well. The lack of functioning of the nitrifying bacteria (which have a high nutrient requirement) will in turn cause a general decrease or even a deficiency in soil nitrogen (Brady, 1990).

Presence of Toxic Substances and Anthropeic Contaminants

Almost all urban soil contains some amounts of anthropeic debris such as bricks, metal, glass, asphalt, wood, plastic, etc. Other contaminants may be present such as pesticides, hydrocarbons or heavy metals (Owe, et.al., 1982). All of these may be toxic to plants and/or humans in varying degrees, depending upon their concentrations in the soil (Bennett, 1974). They also have influence on the soil microorganism population, causing segments to be lacking or inactive, or perhaps favoring the detrimental segments. The physical debris usually causes mechanical impedance to root penetration, water movement and gaseous diffusion. Ingestion of plastic and glass particles have been found not to be harmful to earthworms (D. L. Dindal, personal communication), but other effects are unknown. Unfortunately, little can be done to remove these waste products, except by replacement of the soil itself as is done in some European countries.

Soil Specifications and Alternative Materials

The specification for soil is commonly described as "friable topsoil." For example, a recent project engineer and architect both requested the project soil be "of natural loam topsoil, well drained with appropriate organic matter content, of good tilth, and containing little debris, stones and roots." This specification is totally inadequate from the edaphic and arboricultural aspects. Present knowledge and construction operating conditions (liability!) require far more complex and detailed specifications. Just as engineering specifications have evolved with new knowledge so must soil specifications become more specific. There are other reasons why "topsoil" is no longer appropriate. True topsoil is very scarce in many parts of the country and material supplied as topsoil is not always as "advertised." Further, the increased emphasis on minimum or reduced off-site impact (the concept of sustainability) suggests that topsoil stripping and removal from the site is no longer a feasible alternative except in those cases where a structure will totally cover the area. The components of an acceptable soil specification are listed in Table 1 and are discussed below.

Table 1. Urban soil specification components.

TEXTURE VS. PARTICLE SIZE DISTRIBUTION
- Give percentages passing the array of sieve sizes for USDA diameter classes.
- Provide a particle size distribution curve.

ORGANIC MATTER CONTENT
- Specify content on a volume basis and should not exceed 25 percent.
- If amended, specify source and analysis for pH, nutrients and contaminants.

SOIL REACTION
- Should match the optimum range for stock being planted.
- Avoid extremes of pH or drastic adjustments.
- Specify the adjusting materials including their analyses.

SOLUBLE SALT CONTENT
- Can be expressed in various ways:
  1. total soluble salts which should be:
     less than 200 ppm, caution at 600 ppm, danger at 1000 ppm for humid regions.
  2. sodium adsorption ratio may be better than soluble salt content:
     greater than 12 is very adverse.
  3. Exchangeable sodium percentage also helpful:
     greater than 15.0, soil is sodic.

STONINESS AND DEBRIS CONTENT
- Should be limited by specific percentage and size limits:
  1. Less than 1 inch longest dimension.
  2. Less than 10 percent on volume basis.

CONTAMINANT CONTENT

- If area used for human food production or recreational activity, all concentrations should meet EPA and state standards.

Particle Size Distribution

The specifications by texture class such as sandy loam or loam is not satisfactory. There are wide ranges in the proportion of sand, silt and clay for texture classes in the USDA classification, and this is especially true for the sandy textures (Figure 3). Sand particle diameter ranges in size from 2.00 to 0.05 mm, a range of two magnitudes. The soil characteristics of waterholding capacity, infiltration rate, and bulk density can potentially differ significantly from a texture of coarse loamy sand to sandy loam. Even within the sandy loam class there are significant differences due to the influence of the fine and very fine sands. Silt content may also have the same effects in the medium textured soils.

Another consideration in the specification of texture is the necessity to choose a soil that is not self-compacting. Because disturbed soil or soil in mixtures has lost most of its natural structure, there is the potential for compaction. Certain textures are prone to self compaction while others are less so. The particle size distribution is a very reliable method to determine compaction resistance. Soils that are poorly graded, or have more uniform particle size in the sandy textures are compaction resistant. Well graded soils or those having a wide distribution of particle sizes, or those high in silt, are more compactable. Figure 4 shows the difference in particle size distribution of a well graded versus a poorly graded soil. For compaction resistance, the poorly graded soil is preferred, it has the disadvantages of low waterholding capacity and low or moderate fertility. Some organic matter may be added (but not too much) to improve these characteristics.

Organic Matter Content

Organic matter is an important component of soil and needs to be present in at least a minimum amount. It serves to lighten the soil, enhances the development of structure, acts as a source of energy for the soil-inhabiting organisms and a source of nitrogen, phosphorus and sulfur for plants upon its decomposition. Most forest soils have about four or five percent organic matter by weight in the topsoil and some agricultural soils may have as much as 10 to 15 percent. Because real topsoil is becoming scarce and expensive, it is necessary to include it in specifications. However, this is a case where too much of a good thing is bad. Too much organic matter will cause settlement and compaction, retention of excess moisture and result in anaerobic conditions that eventually leads to death of the plants.

Soil Reaction

Soil reaction (pH) provides an overall indication of the general chemical condition of the soil. Extreme levels, very acid or alkaline, indicate potential problems of nutrient deficiencies or toxic conditions. The pH range is normally 6.5 to 7.5. Many urban soils have elevated pH values from anthropeic contamination and must have the pH lowered for many urban plants.

Salt Content

In most humid temperate regions soluble salt content does not pose a problem to plant growth except where soils have a high content of sodium caused by the use of de-icing salts in northern climates. In semi-arid and arid climates, the accumulation of soluble salts is sufficient to create a high osmotic potential in the soil, making it more difficult for roots to absorb moisture and nutrients from the soil. In most areas soluble salt content should be less than 200 ppm, with 600 ppm being a danger signal. In dry areas with salt-tolerant plants, values as high as 3000 ppm may be satisfactory. Some samples taken by the author in Ottawa, Canada, bus station platforms had values approaching 4000 ppm. Flushing the soil, constructing barriers, or using alternate de-icing materials reduces the problem.

Stoniness and Debris Content

Stones and other solid debris interfere with root extension and water drainage, dilute the soil and increase the difficulty of cultivation. Because debris is common to almost all urban soil materials, all specifications should include the limits of debris size to about 1 inch and the volume to about 5 to 10 percent.

Contaminant Content

Soil contaminants include all pesticides, heavy metals, phytotoxic compounds and anthropeic materials that are present in concentrations above threshold levels. Generally, heavy metals are important only if food stuffs are to be grown in the urban soil, or the area is used for human recreation and the soil may ingested or inhaled. Copper, lead, cadmium, zinc, boron and ammonia are examples. Persistent herbicides and insecticides may also be dangerous to humans as well as to plants. Fungicides are generally not a problem unless present in excess quantities.

Techniques of Tree Planting

The planting of a tree is an ancient task and the various opinions on the technique probably haven't changed in as long (Whitcomb, et.al., 1976). However, there is increasing evidence that all is not well in the standard tree pit - roots and later, the tree dies as the result of poor water drainage and aeration status, roots are "pot-bound," and the tree ball appears not to be stable against windthrow and/or settlement. The cross-section of the standard tree pit appears in Figure 5.

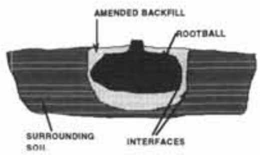
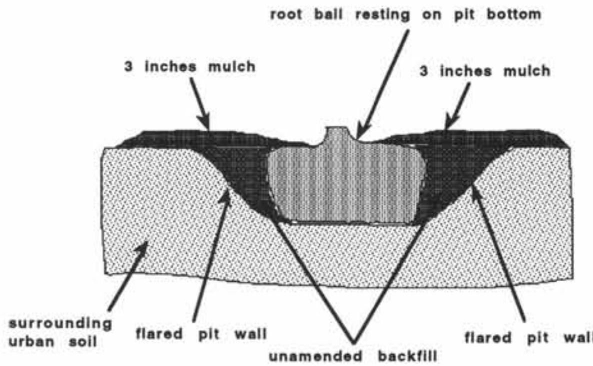


Figure 5. The standard tree pit.

Here, there are really three different soils to deal with: (1) the soil of the root ball itself; (2) the backfill soil; and (3) the surrounding urban or country soil. These soils will differ in their texture and structure, and thus in their porosity and pore distribution and size. The root ball soil is of the nursery where the tree was grown, the backfill soil is usually some specified mixture of soil and organic amendments of a porous nature to aid root penetration and drainage, and the urban soil exhibits the characteristics described above. These differences create at least two interfaces or discontinuities that may have profound effect on water and air movement as well as root growth and extension. The root ball soil usually is of sandy texture with moderate to rapid drainage, and medium waterholding capacity and fertility. The backfill soil is probably loam with sand and peat moss or compost added to as much as 10 to 15 percent or more. It has a great proportion of large pores to aid drainage and root penetration as in the greenhouse pot. Because of the large pores in the backfill, the root ball must be saturated before the water will flow from the ball into the backfill material. In addition, the surrounding urban soil is very likely compacted with a great proportion of small pores, usually filled with water, and the walls of the pit are smoothed by the excavation process, sometimes with a spade digger. The sharp contrast in pore size and the distribution patterns among these three soils actually create an impediment to the features that we are attempting improve. Roots may extend themselves nicely into the backfill, if not saturated, but soon become impeded when the root tip attempts to penetrate the surrounding compacted urban soil; thus, the roots become "pot -bound". Water may move through the root ball and into the backfill material when the former is saturated, but not when the latter is saturated. The backfill material becomes saturated easily because of its great pore space and ease of water movemen through it. Unfortunately, the water in the backfill is not drained since it rests on the compacted urban subsoil with its slow drainage, unless underdrainage in provided. This situation forms what has now become what is known as the "teacup effect" where the tree pit fills with water and the tree essentially dies "in its own juices." Further, when the backfill is saturated, the material loses it ability to support the weight of the root ball, and it settles into the soil below root collar depth, leading to the demise of the tree (Berrang, et.al., 1985).

There are various ways to overcome these problems. One is to use bare root stock--not always practical; use the excavated soil as backfill without amendments so as not to make the material "coarse"; roughen and loosen the sides of the tree pit; excavate the pit to the same depth of the height of the root ball, or plant on a pedestal of unexcavated soil; provide underdrainage where possible if the soil is compacted, or create a homogeneous, shared-rooting space planting design.



The new standard tree pit is illustrated in Figure 6. Its features include the root ball resting on the pit bottom with the pit depth being alittle less than the height of the ball, the flared walls of the pit which permit easier root extension into the surrounding soil, an unamended backfill, and mulch placed over the rootball and extending beyond the excavation to keep the adjacent soil moist and cool.

Post Installation Maintenance

Several aspects of soil management are considered in maintenance of the urban tree and shrub system. These range from planting technique through fertilization and irrigation to aeration and mulching.

Fertilization of urban vegetation takes on various complexions. It may range from simple broadcast fertilizer application of turf areas following standard turfgrass recommendations to specific fertilizers for bedding plants and subsurface fertilization of trees. Turfgrass management is rather straightforward alone, but when trees and their roots are part of the system, the management becomes more complex. Most fine feeder roots of trees are in the upper 12 inches of soil. Therefore, when you fertilize the turf, you are also fertilizing the trees. It has been estimated that open-grown tree roots extend outward two and one-half to three times the drip line of the tree; some oak roots may extend at least 60 feet. Second, few tree roots occur at greater depth and the standard practice of fertilizing deep auger holes in turf areas is unnecessary, despite the importance attributed to this practice in the past. Even in individual tree pits, surface application of fertilizer is satisfactory unless a heavy mulch is on the surface; then fertilize under the mulch. Fertilizer will even penetrate the new "geotech" materials since they are water permeable. A serious problem arises when certain herbicides are applied to turf areas with trees. Since the tree roots are shallow, there is danger that the herbicide may be harmful to the trees. Therefore, check carefully for the compatibility of the herbicide used. Incompatibility can exist in flower and shrub beds with interspersed trees. The pH and fertilizer requirements of the bedding plants may be entirely different from those of the trees. If they are so different, it is a design fault and should be corrected.

Maintenance of organic matter in urban soils is always a challenge. The mulching of beds is practiced widely. However, care must be exercised not to build up alternate layers of organic matter and soil that can create a poorly drained "soggy" mulch harmful to most plants. Renovation of beds by simply remulching may not be the solution to poor plant vigor especially on soils with restricted drainage or surplus water. Starting again from scratch, providing for a better drained soil and an improved mulching practice may be the best alternative. Broadcast application of composted materials to turf areas after "plugging" or an aeration operation will help to maintain organic matter in turf areas. Aeration of turf under trees presents the problem of harming the shallow feeder roots of the trees. Rototilling does more harm than good in this instance. Plugging machinery used on most golf courses will not penetrate a compacted urban soil to be of any benefit. A spike aeration machine may be a potential solution.

References

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