The Plant Doctor's LANDSCAPE TIPS

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Photo 1: "Scrape and Doze" developments represent challenging sites for the installation, establishment and survival of trees and shrubs. Much of the reason for poor survival and performance of plants is the lack of any soil biology components.

Photo 2: These plants, installed in substandard clay subsoil (inset), are declining due to poor drainage, poor aeration and the lack of good soil biological components.

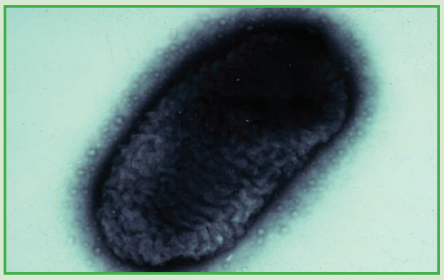

Photo 3: Bacteria are the most abundant microbes in soils, often achieving many hundreds of millions of cells in a single teaspoon of "healthy" soil. This bacterium measure approximately one micron in length (=one twenty five thousandths of an inch; Transmission Electron Micrograph).

Photo 4: Fungi are important decomposers and serve as nutrient storage facilities and recycling centers. In this photo, masses of fungal filaments enable us to see the otherwise microscopic individual filaments as it colonizes and decomposes plant refuse that will ultimately release nutrients for plant growth. (Photo origin: Dr. Rex Bastian, The Care of Trees)

URBAN SOILS AND PLANT HEALTH: SOIL BIOLOGY

INTRODUCTION:

Trees and other landscape plants have evolved over thousands of years to adapt to certain environments. Among some of those environmental conditions, soils are an important medium to which plants have adapted. Natural disasters such as glaciers scoured the land, leaving inhospitable subsoil in which many plants would not be able to grow. It might take hundreds to thousands of years and many successions of plants, beginning with weeds and grasses and eventually ending with mature climax forests composed of hardwood trees, to develop a soil ideal for trees and other plants we typically utilize in the landscape.

Equally important in this transition was the biological component of soils. In a rich, fertile soil ideal for turf, trees and other landscape plants, is a highly complex plethora of microorganisms and other critters that make up the soil food web. These biological components affect soil drainage, tilth, texture, pH, organic matter content, nutrition and other important factors that are absolutely essential for the development and maintenance of a good soil and healthy plants.

Many sites, where new landscapes are designed and installed, represent "disturbed sites" similar to natural disasters created by glaciers or human-disturbed sites such as those created by strip mining. "Scrape and doze" developments are typical of such disturbed sites (Photo 1). Typically, the top soil is hauled away and sold; compacted subsoil is the final medium into which new landscapes are anticipated for establishment. Such sites are often not only devoid of good quality soil and nutrition, but the soil biology is almost non-existent. In such sites it is quite challenging for plants to establish, grow and thrive. Landscapers and arborists are expected to install plants into these areas; subsequently, plants often decline or under "ideal maintenance" exhibit marginal health (Photo 2).

SOIL BIOLOGICAL COMPONENTS:

A naturally occurring, rich healthy soil is composed of a very complex mixture of biological and physical components. Following is a brief discussion on some of the major biological components, their relative populations and the contributions they make. These living entities each have specific purposes for existing and for making the soil an ideal growing medium for healthy plants. Within each of these categories of soil biological components, there are good and bad critters. Generally in a healthy soil, the beneficial critters far out-number the bad ones. It is a very complex interaction among these soil flora and fauna that is essential for maintaining healthy plants in our landscapes.

Table 1: Some Soil Biological Components in a "Healthy Soil"

Organsim	Population	per Soil Measure
Bacteria	100 Million-1 Billion	teaspoon
Fungi	1mile-40miles	teaspoon
Protozoan	100,000's	teaspoon
Nematodes	100's	teaspoon
Arthropods	10,000-25,000	cubic foot
Earthworms	10-50	cubic foot

Bacteria: Bacteria are usually one-celled organisms that are prokaryotic (without cell nuclei). They are very small, measuring only 1 micron or less (about one twenty five-thousandths of an inch-Photo 3). Among all of the soil's biological components, bacteria comprise the greatest populations and diversity. In one teaspoon of healthy soil, there may be 100 million to one billion bacterial cells (Table 1). There may be as many as 30,000 to 50,000 different species of bacteria in that teaspoon of soil, all performing a variety of functions that make that soil so rich and diverse. Bacteria decompose plant refuse and other organisms, store nutrients, fix nitrogen from the atmosphere, convert nitrate nitrogen to ammonium nitrogen (and ammonium to nitrate) and suppress diseases, among many other lifelong pursuits.

Fungi: People often think of fungi as detrimental to plant health; some are. However most fungi found in healthy soils are beneficial. Fungi are generally microscopic, but we often see some species of fungi as their reproductive structures we call mushrooms. Fungi typically grow microscopically as very fine filaments through the soil (Photo 4). These filaments may measure one mile to as much as forty miles in one teaspoon of soil. It is often these filaments that cause particles of soil to cling to one another. Fungi decompose plant refuse, store nutrients, bind soil together, act as "nutrient pumps," protect against other pathogenic fungi, among many other duties. Mycorrhizae are special kinds of fungi that can enhance plants' health by essentially forming additional "plant roots," which can gather extra nutrients.

Protozoans: Amoeba, paramecia, etc. comprise a relatively common group of organisms known as protozoans. Hundreds of thousands of protozoans (Table 1) may inhabit one teaspoon of soil. Protozoans are very important for nutrient cycling. They also feed on bacteria and may suppress some diseases.

Nematodes: Nematodes are small (virtually microscopic) worms that live in the soil (Photo 5). There may be 100's of nematodes per teaspoon of soil. Some may be plant pathogens; most are not. Nematodes may exhibit predation or parasitic characteristics on other organisms such as bacteria or other nematodes or arthropods or fungi.

Arthropods: Arthropods include mites, millipedes, centipedes, sow bugs, etc. These critters are essential for macerating plant refuse, predating on other creatures, burrowing, and contributing to the recycling of nutrients. There may be as many as 10,000 to 25,000 arthropods per cubic foot of soil.

Earthworms: Earthworms mix plant refuse with soil and, hence, contribute to improving organic matter content, aeration and drainage of soils. Populations of earthworms typically measure 10-50 per cubic foot of healthy soil (Photo 6).

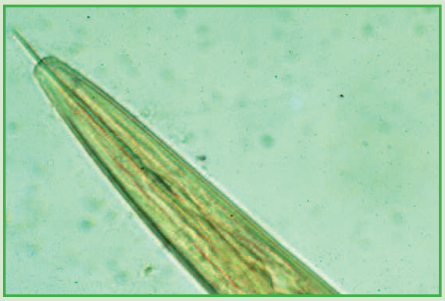

Photo 5: Nematodes are small worms that live in the soil. Some attack plants but most are beneficial in the soil food web. They may attain populations of 100's per teaspoon of soil.

Photo 6: Earthworms are very important for macerating large plant refuse and mixing it with soil so that other organisms in the food web cycle can perform their duties much more efficiently.

AMELIORATING URBAN SOILS & THEIR BIOLOGY DEFICIENCIES:

There are a variety of options we can use to attempt to fix soil biology problems. Some of the options and their merits are discussed. Of course, soil tests should also be performed to ascertain what physical and chemical modifications are needed.

Add fertilizers: A typical response to increase plant health in poor soils is to supply nutrition in the form of inorganic or organic fertilizers. While these supplements may temporarily increase plant health, they do not make any appreciable changes in the soil biology. Hence, fertilizers represent a temporary band-aid approach that does not result in enduring modifications to soil structure or soil biology issues.

Add Biological Components: There is an increasing number of products available on the market that proclaim to have "natural" microbes in them; presumably adding these organisms to a bad soil will make the soil better and plants healthier. Many of these products contain Mycorrhizae. It is questionable whether these products will change a bad soil into a good soil or whether the biological components in these additives will make plants healthier. Plants sometimes seem to respond to these products, but the response is probably due to the temporary invigoration of plants by nutrients that are often also contained in the product. These products will have a much better chance of being effective if the soil is modified with amendments and mulches (below), which favor the survival and long term existence of these biological components.

Add Amendments: Obviously, the best approach to correct poor soil conditions is prevention. First and foremost, the disturbance of soil should be kept to an absolute minimum. Where that is not possible, before plants are installed, a high quality soil can be distributed in place of the poor quality soil. While this might entail some expense, it is often more economical in the long term landscape investment because plant failures will be minimized and optimum plant health and growth will be the rewards. As is often the case, various professionals are called in, often in succession, to attempt to fix the difficult problems associated with plant failures or poor plant performance in substandard soil. With some difficulty, soil alteration and the addition of amendments can be accomplished after the plants have been installed; modifications can be made gradually through top dressing with good soil components and organic matter or by more drastic means. Vertical mulching involves soil coring or auguring followed by backfilling with a high quality media mix, perhaps containing some of those biological additives available on the market (above). Radial trenching involves adding a quality media to trenches made in a radial pattern from the trunk outward, so that as little damage to roots as possible is done.

Adding Mulch: In addition to amendments, mulch contributes to changes in the soil texture and soil biology and can offer a good bang for the buck of investment. Mulch should not be too deep, ideally should only be a couple of inches thick. Adding a little mulch each year or several times a season sometimes in conjunction with light tilling or coring etc. will gradually help to add organic matter and, with time will change the soil structure, hopefully inviting and sustaining a diverse plethora of soil biological components.

In human health, we are finding that white bread and other highly refined foods may not contribute adequate nutrition and fiber for optimal health considerations and may even be contributors to many of our human diseases such as obesity, heart disease, cancer and diabetes. In an analogous sort of way, plants will not perform as well in substandard "sterile soils" with simple additions of human refined fertilizers as compared to rich soils with abundant soil biology. There's an old saying that "if you build it they will come." Building a good soil with great soil biology will surely enhance the health and growth of our landscape plants.

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For more information, please feel free to email me at robertsd@msu.edu or contact a professional plant health-care provider. The author, MSU and MGIA do not endorse any particular products. If using pesticides, be sure to read and follow label directions.