



CMG GardenNotes #659

Understanding Tree Roots

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Functions of Tree Roots

Support/Anchorage

A tree's root system keeps its trunk and canopy upright against the forces of wind and gravity. The strength of anchorage provided by a tree's root system depends on a variety of factors including soil type, soil moisture levels, tree species, root health and the depth and width of a tree's root plate. Sandy and overly wet soils provide worse anchorage.

The "root plate" is the area close to the trunk that contains the primary structural roots. The root plate occupies an area about three to six times the diameter of the trunk at DSH\DBH (Diameter at 4.5ft). [Figure 1]

Absorption of Water and Mineral Nutrients

Roots absorb water and nutrients for use by the plant. Mineral nutrients are only absorbed from forms dissolved in the soil solution. In some species, the architecture of the tree's vascular system is such that specific roots supply correspondingly specific branches with water and nutrients. For example, in ring porous species such as the oaks (*Quercus* spp.), a given root or suite of roots supplies a specific branch or suite of branches which are often on the same side of the tree as the root. Similarly, in many conifers, water and nutrients move up the trunk in a spiral pattern supplying branches along the way. In this case damage to a root manifests in branches along the spiral the root supplied. The specific vascular architecture of many species is not known.



Figure 1. Upped tree shows extent of root plate.

Production of Plant Growth Hormones

Cytokinins, gibberellins, and abscisic acid are all produced by roots. Cytokinins are involved in cell division, cell differentiation, axillary bud growth, and leaf senescence.

Gibberellins are involved in stem elongation, bud break and other processes. Abscisic acid is involved in drought stress response, maintaining apical dominance, suppressing stem elongation, and promoting dormancy.

Storage of Energy As Sugars and Starches

Energy created through photosynthesis can be transported to the roots of a tree as sugars, and then is stored as starch.

Describing Tree Roots

Woody Roots, Also Called Transport Roots

There are larger roots that may be up to 1 cm to 30 cm (.4 to 12 inches) or more in diameter in some cases. These roots provide anchorage, serve as storage sites for starches and sugars and are part of the system that transports water, nutrients, and other compounds through the tree from fine feeder roots to leaves. **They absorb very little water or mineral nutrients from the soil.** [Figure 2]



Figure 2. Example of woody roots.

Specialized Woody Roots

- **Tap Root** – A primary root that grows downward from the seed radical. Some species exhibit taproots when younger but by the time they reach maturity few trees have a true deep taproot due to low soil oxygen levels deeper in the soil.
- **Sinker Roots** – Roots that grow downward from lateral woody roots. Formation of these roots is species and soil dependent. They are not common in landscape trees.

Fine Feeder Roots (Absorptive Roots)

These are smaller roots that are 2 mm (.4 to .008inches) or less in diameter. **These roots are the primary sites of water and mineral nutrient absorption.** They are often short lived and can be killed or suppressed by low soil oxygen levels, drought, or fluctuations in soil temperature. Such events are stressful but healthy trees rapidly reproduce fine feeder roots.

Fine feeder roots are commonly colonized by symbiotic fungi. These fungi can help extend the reach of the root system, aid in the mineralization of plant nutrients, increase the trees' drought tolerance and help it to resist some diseases.

It is common for fine feeder roots to form grafts with the fine feeder roots of other members of the same species.

Size And Extent of the Root System

Width

A mature tree's root system often occupies a much wider area than its canopy. Depending on the species of tree and soil conditions the spread of a trees' root systems may be two to five times the width of its canopy or even greater in some cases.

Depth

The depth of a tree's root system is governed by the availability of water, mineral nutrients, soil oxygen and the species of tree. In clayey, compacted or perpetually wet soils (soils with a shallow water table) roots tend to be shallower due to low soil oxygen levels in the deeper layers of such soils. In sandy soils, roots also tend to be massed near the soil's surface. Sandy soils have low levels of mineral nutrients and having a large concentration of roots near the surface allows trees to capture nutrients released from decomposing leaf litter. In loamy soils, tree roots tend to be deeper as there is sufficient oxygen and nutrients to support their growth.

The rule of thumb for estimating rooting depth in clayey, compacted, or perpetually wet soils is that 90-95% of roots will be in the top twelve inches and 50% will be in the top four inches of soil. In favorable soils conditions 90-95% of roots will be in the top thirty-six inches and 50% will be in the top twelve inches of soil.

Surface Area

The surface area of a root system is likely larger than that of the plants' leaves BEFORE you take into account symbiotic fungi.

Conditions That Adversely Affect Roots

Soil Compaction

Soil compaction occurs when soil is compressed, pushing soil particles closer together. This reduces the overall volume of pore space in a soil and particularly reduces the volume of larger air holding pores. In landscapes, compaction can be caused by foot traffic, maintenance equipment or other vehicle traffic and other factors. Many soils are compacted during construction. [Figure 3]

Compaction affects tree roots in several negative ways. It can lower soil oxygen levels which adversely affect root and tree health (see below). Compaction also increases the strength of soil making it physically harder for roots to grow through it. This can slow the establishment and growth of a tree.



Figure 3. Heavy equipment traffic compacts soils.

Low Soil Oxygen Levels

Roots require oxygen to perform respiration (the process that turns the products of photosynthesis into usable energy). As roots (and other soil life) consume oxygen it is replenished though diffusion from the atmosphere. When adequate oxygen is not in the soil, root growth slows. Low soil oxygen levels also leads to stomata (located on plant leaves) closing which reduces water and nutrient uptake, reduces translocation of water, nutrients and hormones within the plant and can potentially led to wilting. Low soil oxygen can also lead to root cells "self-poisoning" due to accumulation of the byproducts of anaerobic respiration.

Conditions Leading to Low Soil Oxygen Levels

Overwatering/Waterlogged Soils

In soils that are perpetually wet, soil pores are mostly filled with water (soil solution). Relatively few pores are filled with air. There also may be few clear contiguous pathways from the air-filled pores to the soil surface, slowing the rate of diffusion of oxygen between the atmosphere and the soil.

Compaction

Compaction reduces the overall volume of pore space in a soil and especially reduces the volume of “large” pore spaces. The “large” pores are those that tend to be filled with air after gravitational water has drained. They are also the easiest pathways for diffusion of gases. So, compaction reduces the volume of air-holding pores in soil and can reduce the rate of diffusion between the atmosphere and the soil.

Improper Mulching

Applying organic mulch too thickly can slow diffusion of gases, including oxygen, from the atmosphere into the soil. Generally, no more than four inches of organic mulch should be applied to avoid this. Plastic sheet or fabric mulches limit the exchange of gases between the atmosphere and the soil.

Grade Changes

Adding soil over the top of an established root system can have the same effect as adding a mulch layer that is too thick.

Other Common Root Issues

Girdling Roots

Girdling roots are roots that are wrapped around other parts of the plant. Stem girdling roots are roots wrapped around or growing across the stem of a tree. [Figure 4] Root girdling roots are wrapped around another root (somewhat less of a concern). Stems girdling roots compress newly produced phloem (and eventually xylem) which impairs the ability of the tree to move material through these tissues. This leads to stress and potentially, decline.

Symptoms

- Flat sections of a tree’s trunk where it enters the soil (non-flared).
- Swelling above and below the girdling root.
- Generally poor health or dieback without any obvious cause.

Causes of Girdling Roots

- Root deflection and circling at the edge of a container.
- Root deflection at edge of planting hole.

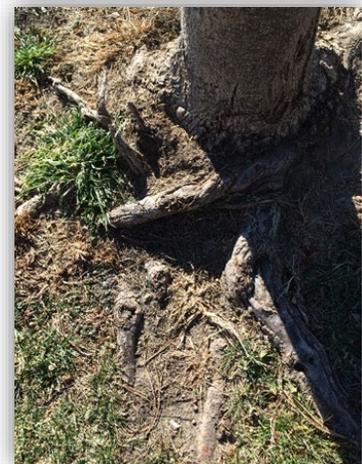


Figure 4. Girdling roots.

- Trees placed too deeply in nursery containers. This leads to roots growing upward and potentially to circling roots in a container above the root flare.
- Upward growing roots as the result of low soil oxygen due to deep planting, root pruning in the field during nursery production, or combination of the two.
- Mulch over the root ball or root flare.

Dealing With Girdling Roots

A root collar excavation, which is the process of removing the soil from the base of the tree, can be performed to expose the root flare and any girdling or potentially girdling roots. Girdling roots can then be removed, preferably back to a point where they will grow outward from the trunk. Some roots may be too in-grown to remove and may result in greater damage to the tree if removal is attempted. A certified arborist can be contacted to consult on and remove circling roots.

Proper management and pruning of root systems in nurseries and at planting as well as proper planting practices can prevent girdling roots from forming.

Surface Roots

Trees roots may develop at or partially above the soil surface creating a nuisance in turf and a potential health risk for the tree as exposed roots are often wounded by mowers or other landscape maintenance activities. **[Figure 5]**

Some trees are prone to developing surface roots. However, their formation is encouraged by low soil oxygen levels that are caused by compaction or overwatering or both.

Once surface roots develop, little can be done. A soil of coarser texture can be added over the surface roots but it is likely a short term solution. As roots increase in diameter they will surface again. Adding too much soil or too fine a soil can reduce soil oxygen levels and harm the tree. Mulching the area so that it no longer needs to be maintained as intensively is the best management option.



Figure 5. Surface roots.

Installation and maintenance practices that promote better soil aeration can help prevent surface roots. Such practices include amending soil with organic matter and regular core aeration of turf.

Suckering

Roots may produce adventitious shoots known as suckers. Suckers arise from adventitious or latent buds along a trees' root system. (They are different from seedlings with the result of seeds created through sexual reproduction.) Production of suckers is partially species dependent, and some species are more prone to suckering. Damage to roots from trenching, flooding, or other causes can also encourage suckering. Removing a tree can cause its remaining root system to sucker. Suckering can also be a response to general stress. **[Figure 6]**

What Can Be Done?

- Avoid planting species that are prone to suckering.
- Avoid damaging tree root systems.
- Try “Sucker Stopper” which is an artificial plant growth hormone that prevents buds from opening. Read label directions before using as it works better on some species than others.
- Try herbicides if you do not care about the health of the tree that is producing the suckers, herbicides can be used.
- Tolerate suckers.

Key Points for Talking With Clients About Tree Roots

- ✓ Tree root systems are much wider than their canopies, if space permits.
- ✓ Tree root systems are relatively shallow.
- ✓ Proper planting practices and species selection are the best way to avoid common root issues.



Figure 6. Suckers growing around base of tree.

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