Tree Root Stress

To understand tree stress, it is important to understand the fundamental needs of trees.A tree must have space, heat, light, water, oxygen, carbon dioxide, and nutrients. Most trees require symbiotic fungi and bacteria.All of these constituents must be available in adequate amounts to assure the tree's long-term survival.Either excess or deficiency of any of these components will cause stress or tree death.

Almost all soils provide the elements necessary for the production of carbohydrates. The loss of carbohydrates reduces reserves, causing stress on mature trees. The application of fertilizer on mature trees, to correct stress, should only be done with caution and for a reason.

Insects and diseases are usually the result of damage and stress caused by environmental factors. While selective or exclusive insects feed on specific species and stressed trees, non-selective insects will infest and feed on any healthy tree. Many diseases result from slowly developing imbalances between the tree crown and roots.

As urban trees grow, their root development is often restricted by limited space and poor quality soils. The crown continues to increase disproportionately in size until stress occurs. Current research projects focus on improving the quality of the root environment through mulching, soil amendments, soil replacement, and elimination of competition. Simultaneously, growth regulators are being studied for their potential in reducing crown growth while enhancing root development.

Drought Stress
Trees can lose up to 95% of their roots during transplanting and are consequently subject to water stress. Root replacement is a gradual process requiring several years of care. The most common stress for trees is caused by either a lack of, or a surplus of, water in the soil.

The lack of water shuts down the movement of materials in the tree and causes such severe osmotic pressure imbalances that living cell membranes simply collapse inside and the cell dies. If enough cells die, the whole tree will die Root growth stops in most species when soil moisture is reduced to 12% – 14%.The deposition of a waterproof layer in the walls of cells near the root surface is accelerated in dry soil.As the absorbing surface is diminished, the roots do not regain their capacity for water uptake until new root tips are produced at least one week later. If the soil becomes too dry, some of the smaller roots may die.

Excess water displaces oxygen and results in a build up of methane in the soil. Oxygen starved roots are weakened and are often invaded by organisms that can move into other parts of the tree.Excess water can also cause extreme osmosis, which saturates succulent tissue, weakens membranes, and causes cell death. An increase in moisture content above 40% induces almost no additional root growth.

Oxygen Stress
Oxygen starved roots cannot respire efficiently and energy reserves cannot be utilized, which results in root death.If large roots die, decay fungi invade and structural integrity is then compromised. Weakened by the progressive loss of roots, a tree canopy slowly begins to deteriorate, from the top down.The minimum soil atmosphere for good root growth is 8 – 10% oxygen.

Trees that Tolerate Low Oxygen
Alder Alnus

Birch Betula
Ash Fraxinus (use in non-EAB areas)
Tupelo Nyssa
Poplar Populus
WillowSalix
Baldcypress Taxodium

Nutrient Stress

There are 17 essential elements required for healthy trees.The most essential elements, in order of quantity needed are: nitrogen (N), potassium (K), calcium (Ca), phosphorous (P), magnesium (Mg), sulfur (S), iron (Fe) chlorine (Cl), copper (Cu), manganese (Mn), zinc (Zn), molybdenum (Mo), boron (B), sodium (Na), and cobalt (Co).Trees use nutrients to feed themselves by making sugar (carbohydrates) in the leaves that can be used right away, or stored as starch for future needs.Nutrients are released from the soil particles by soil organisms that break down and release the nutrients found in organic matter andy the natural effects of sun, wind, freezing, and rain that make minerals available.
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All of these treatments listed below must be on an as needed basis. The arborist can solve nutrient problems by:

- Not planting species preferring low pH in soils with a high pH and vice versa,
- Improving the drainage,
- Modifying the soil pH,
- Applying suitable fertilizer,
- Applying a chelate as a soil drench if a micro-nutrient is needed,
- Applying multiple and repeated injections

It is important to keep newly planted trees watered and pruned and to keep weeds away from their bases to avoid excess stress.

Fertilization

Trees in urban and suburban environments are often under high stress conditions.
Fertilizer applications may reduce, but cannot eliminate, environmental stresses.

Temperature Stress

Root growth starts just before shoot growth in the spring. Maximal root growth in most tree species occurs in early summer when temperatures reach 65° – 89°F (18° – 32°C) depending on species, with maximum temperatures for active growth reported at 77° – 100°F (25° – 38°C). Roots of most woody species are killed at temperatureshigher than 104°F (40°C). Active growth resumes in the late summer or early autumn when soil moisture and temperature become favorable.In temperate climates, root growth slows in the autumn as the soil cools and plants enter dormancy. Minimum temperatures for root growth ranging from 35° – 52°F (2° – 11°C) have been reported. Substantial root growth can continue in areas with mild winter temperatures. Roots can continue to grow in non-frozen soil, but cold soil temperatures will reduce the rate of growth. Root tissues of woody plants can be killed at soil temperatures of 23° to -4°F (-5° to -20°C).

Compaction Stress

The compacted, poorly drained soils at many urban sites pose special problems. Species with high root-to-shoot ratios seem to have a greater ability to penetrate hard soil layers. Roots also tend to follow the path of least resistance. To penetrate the deeper, denser soils, roots often use old root channels, animal tunnels, and pockets of loose soil, cracks, and fissures.

Diagnosis of Problems

The first sign of any serious root problem is top decline. Look for signs to determine whether a tree is growing well by observing the amount of stem growth over the past few years. Most trees will show anywhere from 6 – 18 inches (15 – 46 cm) of twig growth in one year according to species and sun orientation on the tree. If the tree shows wide variation of growth in the past three years, it is safe to say that the tree is under stress.Cankers on the stems, stem tip dieback, off-color foliage, early fall color, and early defoliation are also signs that a tree may be stressed by root or soil problems.

Insufficient rooting space, roots severed during transplanting or construction, poor soil drainage, soil compaction, and an inability to take nutrients up from the soil can contribute to a weakened root system and eventual decline of the tree.

One of the more difficult problems to eliminate is root rot. To detect rots, look for mushroom-like fungi growing at the base of the tree. In the case of wood rot fungi, the conks may be found growing out of the trunk or main branches in the canopy.Wet weather often triggers the formation of these structures. They can easily be confused with fungi growing on dead organic debris near a tree. Trees may survive for many years with wood or root rots.Do not remove a tree simply because it has a conk. If the tree becomes a threat to life or property because of potential to fall or blow over, remove the tree as soon as possible.

By carefully digging in the root zone, it is possible to determine the health of the roots. Do this near the drip line at two or three spots. Healthy roots are brown on the outside and white internally or at the very tips of the roots.If the roots have a soft, brown outer layer that easily pulls off the center of the root, then a root rot may be involved.

To help a tree in decline.Use approved cultural practices to improve tree vitality, including weekly watering of 1 – 2 inches (2 – 4 cm) of water during periods of extended drought, and if a soil test indicates a problem, fertilize in late fall or early spring as needed. Also, cut out dead branches in the dormant season and keep foot traffic off of the root system. These measures may help the tree continue to live for many years.

Tree Case Management