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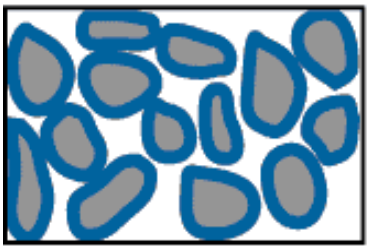
# The Effect of Soil Saturation on Trees and Other Plants



**Non-compacted soil. Note the amount of pore space.**

**Compacted soil. Note the reduction in pore space.**

Adequate soil drainage, or lack of adequate drainage (also called soil saturation) is influenced by soil texture (percent of sand, silt and clay) and soil structure (arrangement of soil particles). The presence of water, land slopes, impervious subsurface layers, and compacted soil surface can also affect drainage. After a rain and normal drainage, an ideal silt loam soil for growing trees would consist of 50% solid (45% mineral, 5% organic matter) and 50% pore space (25% air, 25% water). Growth and maintenance of root systems require large quantities of oxygen for respiration. When oxygen content drops below 10%, root growth of most plants will be limited. In urban situations construction activities (compaction, cut and fill, topsoil removal) may have altered the native soil. Available pore space is greatly reduced in compacted soil.

Flooding can cause the air filled pores in the soil to become filled with water. This creates a condition which greatly limits the amount of oxygen roots can obtain. Generally soils have 10–30% of the volume composed of air–filled spaces but the percentage decreases as water content increases. Excess soil moisture can actually interfere with water uptake by oxygen-deprived roots. The result ranges from increased stress and reduced growth to injury, to death of trees or other plants. The deposit of sediments during flood conditions also contributes to poor soil aeration. Deposits of silt or sand as shallow as three inches can be injurious, especially to newly planted trees.

Oxygen deficiency appears to be the most important environmental factor causing stress, reduced growth, injury and death to trees and other plants in saturated soils. Strong currents, waves, or suspended matter may cause soil around the base of the tree to be washed away, exposing tree roots. Exposed roots can lead to not only tree stress but can make the tree more vulnerable to toppling due to wind gusts.

**An example of soil saturation related thinning and canopy dieback.**

Tree vigor at the time of flooding or saturation influences tolerance. Vigorously growing, healthy trees withstand flooding better than less vigorous trees. Trees that have undergone prolonged stress from causes such as poor fill dirt, compaction, drought or prolonged soil saturation, will be more prone to injury or death.

The longer trees are exposed to flooding, the greater the potential for injury. Short periods of flooding during the growing season can be tolerated by some trees. However, if flooding is recurrent and keeps the soil saturated or prevents recovery from previous flooding, injuries will accumulate and serious damage may occur.

## Symptoms

Flood-stressed trees exhibit a wide range of symptoms including leaf yellowing, leaf drop (thinning), reduced leaf size and shoot growth, water sprouts (sprouts along the stem or trunk), and dieback of portions of the canopy. These symptoms may 1) progress into tree decline and death, 2) reoccur for several years and then eventually disappear, or 3) subside as early as the next year indicating rapid tree recovery.

## Secondary Pests

Flood-stressed trees are prime candidates for attack by "secondary pests." Flooding, drought, and premature defoliation impair tree defense mechanisms and trigger biochemical responses that release carbohydrates, sugars, and other nutrients which seem to invite insect and fungal pathogen attack. Several disease-causing fungi and insects invade trees that are weakened or stressed. Because these pests typically won't attack trees that are not already weakened, they are called "secondary pests."

Insects and diseases play a major role in determining the survival of water–damaged trees. Insect borers, such as ambrosia beetles and bark beetles such as the ips beetle, often attack flooded trees. Stem boring insects such as phloem borers and wood borers are the major "secondary" insects of concern.

Flooded trees are prone to be infected with a group of fungi called the water molds. Pathogens such as Phytopthora and Pythium are members of this group and suited for waterlogged soil conditions. Plant roots stressed by reduced oxygen in waterlogged soils emit amino acids and ethanol that attract disease spores to root surfaces.

## Strategy

Areas known to be flood-prone require careful selection of trees and other plant material. Choosing plant species adapted to the existing conditions minimizes the need for intensive management and will reduce potential damage and death of the plant material. The best approach to managing flood -stressed trees is to enhance their vigor by following proper tree-maintenance practices and eliminating additional stresses.

## Conclusion & Tree List for West Central Florida

The biology of flood tolerance is poorly understood, and studies conducted to determine flood tolerance have sometimes resulted in contradictory conclusions. These results are caused in part by the physiological responses of the tree as it interacts with environmental conditions. Still, it is generally accepted that some tree species show greater tolerance to flooding than others.

The science of flood tolerance has not enough to allow a precise statement on the adaptability of a species to a specific flooding situation. Because many factors are involved, flood tolerance predictions must be evaluated cautiously.

The following table lists trees relatively common in West Central Florida.

| | | |
|---|---|---|
| T ------ | Tolerant | able to survive flooding for one growing season with significant injury or death if flooding is repeated the following year |
| ST ---- | Slightly tolerant | able to survive flooding or saturated soils for consecutive days during the growing season |
| I ------- | Intolerant | unable to survive more than a few days without major injury or death |

## References: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| Botanical name | Common name | T | ST | I |
|---|---|---|---|---|
| Acer rubrum | Red Maple | X | | |
| Betula nigra | River Birch | | X | |
| Cereis canadensis | Redbud | | | X |
| Cornus florida | Flowering dogwood | | | X |
| Celtis lavigata | Sugar hackberry | X | | |
| x Cupressocyparis leylandii | Leyland cypress | | | X |
| Fraxinus pennsyvanica | Green ash | X | | |
| Ilex cornuta | Chinese holly | | X | |
| Ilex opaca | American holly | X | | |
| Liquidambar styraciflua | Sweetgum | X | | |
| Lirodendron tulipifera | Tulip tree | X | | |
| Magnolia virginiana | Sweetbay magnolia | X | | |
| Magnolia grandiflora | Southern magnolia | X | | |
| Morus rubra | Red mulberry | | | X |
| Pinus palustris | Longleaf pine | | | X |
| Pinus taeda | Loblolly pine | | | X |
| Platanus occidentalis | Sycamore | | X | |
| Prunus serotina | Black cherry | | | X |
| Quercus nigra | Water oak | | X | |
| Quercus phellos | Willow oak | | X | |
| Quercus shumardii | Shumard oak | | | X |
| Quercus virginiana | Live Oak | | X | |
| Salix babylonica | Weeping willow | X | | |
| Taxodium distichum | Bald cypress | | | |
| Thuja occidentalis | Arborvitae | | | X |
| Ulmus alata | Winged elm | | X | |
| Ulmus americana | American elm | | X | |
| Ulmus parvifolia | Drake or Chinese elm | | X | |