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Agricultural Extension Service
The University of Tennessee

SP 533

Trees for Poorly Drained Soils in the Landscape

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Preparation for planting is the key to success in establishing landscape plants. Preparation includes site analysis, design, plant selection and installation, as well as planning for follow-up care and maintenance. Site analysis and proper planting assure rapid plant establishment and healthy growth, provided environmental factors are favorable. However, proper planting involves much more than just digging a hole and sticking a plant in it. By taking a little extra time to plant properly, you can avoid future costly maintenance problems.

Soil compaction and drainage

Many landscape plants die because they are planted in soil that is too wet or too dry. Soil with good porosity throughout the rooting depth allows large quantities of water to move through the soil profile without affecting plant roots unless there is a naturally high water table at the site. Typically, a soil contains about 50 percent solid materials and about 50 percent pore space, filled by air and water. In poorly drained soils, most of the pore space is filled with water for long periods, leaving too little air. In compacted soils, the solid material composes about 60 to 80 percent of the total make-up. In this case, the remaining pores are very small and do not drain easily, leading to wet conditions.

Many landscape sites do not have ideal drainage. During rainy weather, water may stand on the soil surface or drain very slowly. Poor drainage is a common problem and a major cause of plant death in Tennessee landscapes. Some trees, such as white pines, are susceptible to fungal root diseases when grown on wet sites. Consistently wet soils often have an odor caused by anaerobic bacteria in the soil.

Poor drainage can occur naturally. Bright soil colors indicate good water drainage, while a dull color or gray could indicate poor drainage. The USDA-Natural Resource Conservation Service recognizes seven drainage classes. Soils that are considered a challenge in landscape sites are somewhat poorly drained, poorly drained, and very poorly drained. Somewhat poorly drained soils remain wet for prolonged periods, but not all the time. Poorly drained soils drain so slowly that the soil remains wet for a large portion of the year. These conditions are caused by a high water table or a slowly permeable layer within the soil profile. Very poorly drained soils occur when the water table remains at or near the surface most of the year. These soils are often found in depressed sites and are frequently ponded. Natural poor drainage may be due to natural hardpans or heavy clay in the subsoil, to seepage from higher areas or to a locally high water table.

Poor drainage often occurs when contractors remove topsoil during construction of new homes, leaving only subsoil. The amount of topsoil reapplied may be unknown. A plant sitting in a hole dug through 3 inches of topsoil and 9 inches of yellow clay will have a tough time surviving. Also, during construction, heavy equipment compacts the soil,

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River birch (*Betula nigra*) is a tree that tolerates wet conditions.

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Poor planting site due to drainage problems in an urban setting.

which reduces air space. What little air space is left fills with water after a rain. Roots suffocate and die from lack of air. Shoots soon die from lack of water, since the roots are no longer functional. Poor drainage also is often a result of improper shaping of the yard, leading to ponding in low areas or around the foundation, or due to failure to properly remove runoff water from roofs, downspouts and streets.

An easy method to determine the drainage of a site is to dig a hole 12 inches long, 12 inches wide and 12 inches deep. Fill the hole with water. If the water drains in fewer than three hours, the drainage is excellent, and plants suited for dry locations will perform well. However, this method should be done only when the soil is moist. Poorly drained soils may drain excessively when the soil is dry giving the false impression of good drainage. Distributing large amounts of compost or organic material throughout the soil medium can greatly improve the water-holding capacity of the soil.

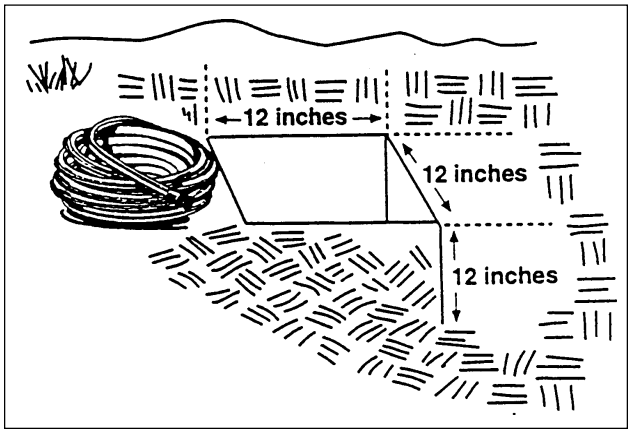

Figure 1. Drainage hole test.

If the water takes from three to 12 hours to drain, then the drainage is adequate for most landscape plants (about 1 inch per hour). If it takes more than 12 hours, then the drainage is poor. But before corrective action is taken, dig a little deeper to see if there is an impermeable layer of soil that is restricting water movement. Although it is difficult to change the soil, you can alter the site to minimize the poor physical drainage. Check several locations in the landscape. Select trees that are tolerant of the wet conditions or change the site to meet the needs of the plants.

Even if soil has not been removed or added during construction, the drainage patterns of unaltered native soils also may change. A hard pan may occur in areas that have had a lot of heavy equipment and traffic. A hard pan is a layer of soil, about 12-15 inches deep, that is extremely compacted and can obstruct good soil drainage. Deep tilling is recommended to break up this compacted layer of soil.

In areas where it would be difficult to use equipment, dig a dry well to break through the hard pan. After the planting hole is dug, use a post hole digger to dig a hole about 12-15 inches deep in the bottom of the planting hole. Fill this hole (dry well) with porous material, such as gravel. Then plant the ornamental tree. The dry well should allow the soil to drain below the hard pan layer. This method will only work properly if the well actually goes all the way through the restrictive layer. If it doesn't, the well will hold water like the rest of the planting hole.

Another way to handle a drainage problem is to raise the height of the soil. Elevate the site by adding 10-12 inches of well-drained topsoil, compost or other organic matter to raise the planting zone. The amendment should be tilled into the soil to provide a homogenous medium for the plants. The root zone of the tree is then adequately above any poor

Botanical Name	Common Name	Height	Comments
Acer rubrum	Red Maple	40-60'	One of the most popular landscape plants. Often found in native bottomlands that may be flooded or under water for several months. On landscape sites, these trees tolerate moist areas, but not flooding. Several cultivars to choose for growth habit and fall color.
Asimina triloba	PawPaw	25-30'	Small native tree grown as a single or multi-trunk. Flowers before leaves unfurl in spring. Sweet tasting fruit has considerable nutritional value. Good yellow fall leaf color. Needs moist fertile soil.
Betula nigra	River Birch	40-70'	Medium to fast growth rate. Attractive exfoliating bark. Best adapted to moist soils and is usually found on native sites along stream banks and bottomlands.
Carpinus caroliniana	Hornbeam	20-30'	Small tree, often used as a multi-trunk tree. Dark green foliage in summer and smooth slate gray bark. Fall leaf color is variable with orange, yellow, and red. Does well in moist soils and can tolerate some short-term flooding.
Celtis spp.	Hackberry and Sugarberry	50-70'	An urban-tolerant tree with gray and warty bark projections that are attractive in winter. Small fruits are relished by birds. Best growth is on river floodplains where soils are moist. Rounded, vaselike crown is susceptible to ice damage.

Botanical Name	Common Name	Height	Comments
Crataegus viridis 'Winter King'	Winter King Hawthorn	20-35'	Small vase-shaped tree. Flowers in mid-May. Red fruit is showy in late summer. Fall leaf color is red to purple. The species occurs often in creek and river bottoms.
Fraxinus pennsylvanica	Green Ash	60-70'	A bottomland species that tolerates flooding. Often found along water courses. Glossy green leaves turn yellow in the fall. Oval, upright crown form with opposite branching pattern.
Ilex decidua	Possum Haw	10-25'	This native plant can be grown as a small tree or shrub. Foliage is shiny green with attractive red fruit during winter. Several cultivars available from nurseries.
Liquidambar styraciflua	Sweetgum	60-75'	Natural habitat is river bottoms and is adaptable to many soils including poorly drained. One of the best trees for fall leaf color. Star-shaped leaves turn red, purple, yellow, and orange colors. Narrow, pyramidal crown form.
Magnolia virginiana	Sweet Bay Magnolia	20-25'	Small semi-evergreen tree. White flowers bloom sporadically during early to mid summer. Tolerates moist soils and occasional flooding.
Nyssa sylvatica	Black Gum	30-50'	One of the most consistent native trees for outstanding red fall color. Leaf color develops early in the fall. Canopy is somewhat pyramidal or rounded. Endures a wide range of soil moisture, but prefers an acid soil.
Platanus occidentalis	Sycamore	75-100'	Large native tree with showy exfoliating bark exposing whitish inner bark. Not often planted as a landscape tree, but allowed to stay if located on an existing site. Naturally found along stream banks and used in stream bank stabilization plantings. If used in a landscape, allow a large area because it develops a massive canopy.
Quercus lyrata	Overcup oak	40-60'	Medium size native oak that develops a large canopy spread. Tolerates considerable flooding; often found in the backwater of the Mississippi River. Great food source for fowl and wildlife.
Quercus macrocarpa	Bur Oak	60-70'	Large oak that is usually found in floodplains. May be too large for residential landscapes, but ideally suited for parks and large open areas.
Quercus phellos	Willow Oak	40-50'	Popular landscape oak because it has a distinct pyramidal canopy and transplants easily. Found on native sites in bottomlands and floodplains. Landscape performance is dependent on adequate moisture and pH. Develops chlorotic foliage in limestone soils.
Salix babylonica	Weeping Willow	30-40'	Graceful weeping tree. Needs a moist site for good growth. *S. alba* "Tristis' is a noteworthy selection with golden yellow stems. Willows are prone to limb breakage.
Taxodium distichum	Bald-cypress	50-80'	Fast-growing native tree with a pyramidal canopy. Can tolerate dry sites as well as wet sites. On extremely wet sites 'knees' may develop. Cypress ponds are commonly found in West Tennessee.
Ulmus americana	American Elm	60-80'	Majestic, vase-shaped, large tree. Susceptible to Dutch Elm Disease. Urban-tolerant to wind, drought, and salt. Prefers moist soils and tolerates short-duration flooding. *U. alata and U. rubra* - winged and slippery elm - also tolerant of poorly drained soils.

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Overcup oak (*Quercus lyrata*) is recommended for poorly drained soils.

internal drainage. The addition of organic amendments should be addressed on a case-by-case basis. Organic amendments, such as peat moss, rotted animal waste or composted yard waste, are applied to soils to improve their nutrient- and water-holding capacity and improve the tilth (condition) of the soil.

Adding an organic amendment to an individual planting hole is not recommended. Extensive research has determined that organic amendments placed in the planting hole do not result in a larger root system or encourage root penetration into the native soil. When a planting hole is amended, the structure and texture of the soil in the hole differ from that of the surrounding native soil. This encourages the roots to stay within the confines of the hole and discourages them from growing into the surrounding soil. The water movement between the surrounding native soil and the soil in the hole is disrupted and the planting hole can act like a sponge, holding excess moisture after rain or irrigation.

Organic matter should be incorporated uniformly throughout the projected root zone, as opposed to putting it into the planting hole. At least a 1 percent increase in organic matter is required to have an effect on the water- and nutrient-holding capacity of a soil. To achieve a 1 percent increase in organic matter, apply 500 pounds of a stable, well-composted organic amendment per 1,000 square feet of bed area (50 pounds per 100 square feet) and incorporate to a 6-inch depth. A 25 percent increase in organic matter would be achieved by adding 3 inches of composted material to the soil surface and incorporating it to a 12-inch depth. Avoid using more than 50 percent organic matter, because plant problems may result from humic acids and other organic compounds. Apply the amendment uniformly over the existing soil that has been deep tilled (8-12 inches). Till or work the amendment in the soil until a homogenous mixture is developed.

Investigate surface and internal water drainage in the landscape. Check for areas where water collects, drains slowly or stands for long periods. Sometimes the problem can be solved by shaping the surface to allow runoff or by diverting excess water. Sometimes, the only way to overcome poorly drained soils is to install drain tile. In this extreme condition, make sure the drain tiles are installed to move soil water away from structures and ornamental trees. Drain tiles are an expensive technique to modify the planting area, but the results are typically worth the effort.

Recommended trees that tolerate poorly drained sites are listed in the table. In native locations, many of these trees are located in bottomlands that may flood or be under water for several months during the winter. But for most landscape sites, these trees tolerate moist areas, but not flooding.

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