ID-89

University of Kentucky
College of Agriculture,
Food and Environment
*Cooperative Extension Service*

# How Dry Seasons Affect Woody Plants

*Nicole Ward Gauthier, Plant Pathology, and Susan Fox and Kathy Wimberley, Horticulture*

Pattern, frequency, and amounts of rainfall are important components to plant health. Water is an essential plant component, making up 70 percent to 90 percent of plant mass. Growth, photosynthesis (manufacture of food), nutrient transport, important chemical reactions, and the production of secondary metabolites are all dependent upon water uptake from roots. Water expands and enlarges new cells within stems and leaves, which holds them upright (turgor pressure).

During dry seasons and drought conditions, plants become stressed (Figure 1). Growth ceases, nutrient transport slows, and plants wilt as cells become water-deficient. Severe, long-term, or consecutive drought events may cause permanent damage.

## Water Uptake in Plants

The driving force for transport of water throughout plants is transpiration. Evaporation from pores (stomata) on leaf surfaces creates a negative pressure that draws water up through plants. During periods when rainfall accumulation amounts are below average or when rainfall distribution is uneven, plant health declines. Thus, water is a vital resource for plant life.

Plant water and mineral uptake begins at delicate root hairs on feeder roots. Ninety percent of these root hairs are located on root tips that often occur in the top 12 to 15 inches of soil, and usually extend well beyond the driplines of trees. Thus, upper layers of soils require adequate moisture for optimum water and mineral uptake, and plant health. Under hot, dry conditions, water availability may be reduced to feeder roots and they can become permanently damaged. Damaged roots are unable to absorb and transport water to upper plant parts.

The physical characteristics of soils largely govern water-holding capacity and availability. For example, clay and clay loam soils have high water-holding capacities. Fine-textured clay soils hold much of their stored water for long periods of time. Conversely, course-textured soils (sands and sandy loams) have lower capacities to provide plant-available water. These coarse-textured soils cannot store enough water to last longer than a few days after rain or irrigation.

**Figure 1.** Water loss during drought reduces the amount of water and nutrients taken up by roots and, thereby, amounts reaching leaves and needles.

Compacted soils have lower water-holding capacities than non-compacted soils. When a given volume of soil is compacted, soil particles are crushed together and pore space reduced. Machinery, vehicular traffic, and even human or animal traffic can cause compaction, especially when soils are moist or wet. Plants in compacted soils often suffer from drought conditions.

**Figure 2.** Conifers such as pines do not wilt; instead needle tips turn brown in response to drought.

**Figure 3.** Water deficiency in leaves may cause scorch of leaf margins.

## Symptoms and Effects of Drought

**Wilting**—As leaves in some plant species lose water turgor, wilting is often the first visible effect. Lack of moisture usually affects all leaves on multiple branches or entire plants. Leaves that are exposed to afternoon sun and prevailing winds are usually affected first and most severely. During early stages of drought and soil drying, wilt may be temporary, and leaves will be turgid again by the next morning. In more severe drought conditions, plants wilt permanently and do not recover overnight. Extent of wilt may also depend upon physical properties of leaves. While most plants lose leaf water during dry conditions, visible signs depend upon leaf thickness and support tissue within leaves.

**Leaf scorch**—In some species, leaf scorch can occur in response to a water deficit. Older leaves, which are thick and rigid, and most conifer leaves may not wilt. Instead, they may turn brown entirely or just at tips (Figure 2) or margins (Figure 3). As conditions progress, marginal or tip browning may spread into areas between veins (Figure 4). After that, oldest leaves on weak branches turn brown and begin to fall. Species most susceptible to leaf scorch include flowering dogwood, maple, horse chestnut, ash, elm, and beech.

**Leaf drop**—Wilted or scorched leaves often drop. In this process an abscission layer is formed between twig and leaf, and nutrients are reabsorbed back into the plant from the leaf prior to dropping. This leaf loss improves the root-to-shoot ratio, helping to reduce transpiration. However, reduced photosynthesis can cause plant stress. Note that in some species, leaves do not abscise; they die and remain attached.

**Root loss**—In dry soils, roots are unable to absorb sufficient water. They lose turgor, thereby losing contact with soil. Root hairs may become suberized (coated with waxy suberin), which prevents water loss. However, this process permanently reduces the ability of that root hair to take up water, even when soil moisture increases. Full water uptake and photosynthesis is not fully restored until new roots are produced.

**Dieback**—If drought conditions progress or worsen, both roots and woody tissues are affected. As feeder roots dry and lose functionality, water uptake is reduced, and stems are deprived of water and nutrients. Dieback is a common symptom of severe drought conditions (Figure 5). Even when soil moisture is replenished, root loss may not allow for sufficient uptake. This continued deprivation can result in continued abscission of twigs and branches. The dieback process resizes the canopy so it is proportionally similar to root capacity.

**Figure 4.** Extensive leaf scorch includes browning of leaf margins that spreads to tissue between veins.

**Increased susceptibility to diseases and insects**—Stressed and declining plants are more susceptible to insect and disease than vigorous plants. In fact, some diseases and insects only affect damaged or stressed plants. These pests and pathogens are called secondary invaders. In some instances, infection or infestation by these secondary invaders deliver the "final blow" to drought stressed trees.

**Susceptibility to winter injury**—Stressed and declining plants are often more susceptible to winter injury. Cold injury takes several forms, including black heart in stems of trees and shrubs, sunscald and frost splitting of tree trunks, winter burn of conifer foliage, and dieback of overwintering broad-leaved plants. Plants can be injured or killed by low temperatures at any time of the year, but especially in autumn when plants are not yet hardened off.

**Loss of next year's growth**—Drought impact may be seen the following year in reduced leaf formation and reduced shoot expansion. In addition, the resulting reduced cambial growth limits food supplies for the next season's growth. Trees that have shed leaves as a drought response may form new buds in late summer or fall when rains return. If these buds do not fully harden, they may be subject to winter kill and result in a sparse crown the following season.

### Other Effects of Drought Stress

**Short-term drought**—Even short-term drought can have negative effects on woody plants. After soil moisture is replenished, stomata can take a long time to reopen, delaying adequate exchange of gasses and production of plant carbohydrates (energy). Stressed trees may also direct energetic resources to production of seeds and cones (energetic partitioning to reproduction) rather than to growth. These factors create additional stress to plants.

**Long-term drought**—During periods of repeated or extreme drought conditions, plants may suffer long-term effects from tissue loss. Growth can remain stunted for many years due to loss of critical tissue.

## Plant Care during Extended Drought Conditions

Healthy plants are better able to tolerate stressful events, including drought. Vigorous plants often have deeper, more extensive root systems that can use water from broader areas. Therefore, maintaining plant health is the first step in protecting woody plants from drought. During dry seasons, gardeners must take extra steps to reduce plant damage.

**Supplemental irrigation**—Wilting is one of the first symptoms of water stress. If plants begin to wilt, they should be watered before permanent damage occurs. Often, herbaceous plants, such as annual bedding plants, are early indicators of dry soils. Ideally, gardeners should use a moisture meter to monitor soil moisture.

### Examples of Stress-Induced Diseases

Botryosphaeria and Cytospora cankers on wounded deciduous and evergreen plants

Verticillium wilt on drought-stressed redbud and maple, and many other hosts

Diplodia and Stigmina needle casts on weakened pine and spruce

Armillaria root rot (Figure 7) on a wide range of woody plants, especially stress-weakened trees

Seridium canker on drought and water-stressed Leyland cypress

### Insects Attracted to Stressed Trees

Borers (Figure 6), such as two-lined chestnut borer and flat-headed apple tree borer, on deciduous trees

Bark beetles on stressed deciduous and evergreens

Scale insects on water-stressed trees

Tip moths and twig girdlers on small branches and twigs

Gall-makers on stressed deciduous trees

**Figure 5.** Prolonged water deficiencies cause death of woody tissue, leading to dieback.

Shallow rooted plants and newly planted woody plants (less than five years old) require higher soil moisture, and thereby more frequent irrigation, than established plants. New trees and shrubs should not be planted during summer, as they are extremely sensitive to fluctuations in soil moisture.

The number of irrigations and the amount of water required during dry summers depends upon the water-holding capacity of the soil, rooting depth of the plants (age and/or establishment), and environmental conditions. The following guidelines are generalizations for watering trees and shrubs. Gardeners should consider site-specific factors as well as plant species when scheduling irrigation.

**Frequency of watering**—Where plants are well-established and in well-drained soil, a thorough watering once every two weeks often is sufficient. Newly planted trees and shrubs require watering every five to 10 days.

A single deep watering is better than the same amount of water applied more frequently in smaller doses. Deep watering encourages plants to root more deeply, as opposed to surface rooting, which occurs with frequent, shallow irrigations.

Conditions conducive to water loss (day temperatures 90°F or above, night temperatures above 70°F, reduced humidity, etc.) result in increased need for irrigation. Dense, clay-type soils retain more water than medium- or coarse-textured soils, so these soils do not need watering as often.

**Time of watering**—Early morning or late evening water applications reduce water loss to evaporation compared with afternoon water applications. Apply water at a slow rate to allow water to filter into (infiltrate) soil and to prevent runoff. If using overhead irrigation, water early in the day so leaf surfaces dry more quickly, thus reducing risk for infection by foliar pathogens that favor leaf wetness.

**How much water to apply**—Often, 1½ to 2 inches of water every two weeks is sufficient for keeping root zones moist. This varies with plant size and species, and with soil and site. Newly planted trees and water-loving trees may require 3 inches of water when temperatures climb above 90°F degrees. These include birches, alders, poplars, tulip poplars, pin oaks, and silver maples. Drought-tolerant trees require less water once established in the landscape.

**Where to water**—Water should be applied evenly across root zones where root hairs and feeder roots are growing. Tree roots often extend 1½ to 2 times the diameter of the dripline, so irrigation should cover entire root zones. Watering at the trunk will not provide water to the feeder roots.

**Avoid overwatering**—Increased efforts to prevent drought stress may lead to excessive irrigation. Overwatering is common in clay and clay loam soils, which have high water-retention properties and do not drain quickly. Additionally, low-lying areas are often at risk for overwatering if nearby soils dry out more quickly when uniform irrigation is scheduled for all zones.

**Figure 6.** Some diseases, such as Armillaria root rot (honey mushrooms), favor stress-weakened trees.

**Reduction of competitor plants**—Remove cover crops around trees and shrubs. Kill or remove grass around them as well.

**Mulch**—Organic mulch (bark, wood chips, pine straw, leaves, or grass clippings) up to 2 to 3 inches deep should be extended to the edge of root zones (at least to driplines) to conserve soil moisture. Avoid placing mulch within 6 inches of tree root flares, keeping trunks dry while minimizing potential for girdling by pests. Refer to *Mulch Myths* (HO-106) for more information.

**Limit pruning**—Do not prune plants in extremely hot, dry weather.

**Fertility**—Low-level fertilizer applications, based on soil test report recommendations, may be helpful to trees recovering from a drought.

## Plant Selection

**Plants with good survival records during drought**—Some native plants in Kentucky have had a good record of survival during past dry periods. These plants have potential for planting in poor landscape sites (shallow soils, compacted soils, and other disturbed soils):

**Table 1.** Plants with good survival records during drought.

| Botanical name | Common name |
|---|---|
| *Carya* spp. | Hickory (pignut, shagbark) |
| *Celtis* spp. | Hackberry (hackberry, dwarf hackberry) |
| *Cercis canadensis* | Eastern redbud |
| *Chionanthus virginicus* | Fringetree |
| *Cladrastris kentuke*a | Yellowwood |
| *Corylus americana* | American hazelnut |
| *Ginkgo biloba* | Ginkgo |
| *Gymnocladis dioicus* | Kentucky coffeetree |
| *Juniperus* spp. | Junipers (Eastern redcedar) |
| *Nyssa sylvatica* | Black gum (black tupelo) |
| *Pinus* spp. | Pines (shortleaf, pitch, Virginia, loblolly) |
| *Quercus* spp. | Oaks (blackjack, chestnut, post, willow, shingle, southern red, overcup, Shumard, northern red, black, scarlet, bur, pin, white) |
| *Rhus* spp. | Sumacs (smooth, staghorn) |
| *Robinia pseudoacacia* | Black locust |
| *Sassafras albidum* | Sassafras |
| *Ulmus* spp. | Elms |

**Figure 7.** Borers are attracted to stressed plants.

**Plants with poor survival records during droughts**—These plants have shown widespread decline and death during past dry periods in Kentucky:

**Table 2.** Plants with poor survival records during drought.

| **Botanical name** | **Common name** |
|---|---|
| *Acer palmatum* | Japanese maple |
| *Acer saccharum* | Sugar maple |
| *Cornus* spp. | Dogwood |
| *Fagus* spp. | Beech |
| *Picea abies* | Norway spruce |
| *Pinus strobus* | White pine |
| *Tsuga* spp. | Hemlock |

## Additional Resources

### Web Sites

Entomology Extension Publications (ENTFacts): http://www2.ca.uky.edu/entomology/dept/entfacts.asp

Horticulture Extension Publications for Homeowners: http://www.uky.edu/hort/home-horticulture

Plant Pathology Extension Publications: http://www2.ca.uky.edu/agcollege/plantpathology/extension/pubs.html

UK Ag Weather Center Irrigation Manager: http://weather.uky.edu/ky/agmodels.php#Irrigation_Manager

### Publications

*Leaf Scorch and Winter Drying of Woody Plants* (PPFS-W-OR-17): http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-OR-W-17.pdf

*Mulch Myths* (HO-106): http://www2.ca.uky.edu/agc/pubs/ho/ho106/ho106.pdf

*Principles of Home Landscape Fertilization* (ID-72): http://www2.ca.uky.edu/agc/pubs/id/id72/id72.pdf

*Stress and Decline in Woody Plants* (ID-50): http://www.ca.uky.edu/agc/pubs/id/id50/id50.htm

*Transplant Shock: Disease or Cultural Problem* (PPFS-OR-W-19): http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-OR-W-19.pdf

*Trees and Compacted Soils* (HO-93): http://www2.ca.uky.edu/agc/pubs/ho/ho93/ho93.pdf

## Acknowledgement

We are grateful to Sarah White, Nursery Extension Specialist at Clemson University, for her review of this document.

**Figures**

**1:** Nicole Ward Gauthier; **2:** Robert L. Anderson USDA Forest Service, Bugwood.org; **3, 4, 7:** Cheryl Kaiser, UK Plant Pathology **5, 6:** William Fountain, UK Horticulture