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Cold Hardiness in Woody Landscape Plants

Its Role in Winter Survival and How to Maximize It

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Acclimation

Cold hardiness is a characteristic of plants that reflects the minimum temperatures that they can be exposed to and survive. Cold hardiness is not a fixed characteristic, however, but fluctuates widely during the year. At any given time, hardiness depends upon the rate of temperature drop, the duration of the minimum temperature and many other factors.

When a plant is actively growing during spring and summer, most of its tissues can be injured at temperatures between about 23°F and 28°F. As summer gives way to autumn, perennial plants in temperate climates become cold hardy by undergoing chemical and physical changes in a process known as cold acclimation. Tropical plants, which are incapable of acclimation, and temperate zone plants in which acclimation is inhibited fail to become cold hardy and are injured at temperatures just below freezing.

The acclimation process is extremely complex, and hardiness varies greatly, not only between different species and cultivars but between different tissues of a single plant. Overwintering buds, for example, are often less hardy than the adjacent wood. Roots seldom acclimate much and in some species can be killed at temperatures as high as 23°F. The roots of other species can survive near 0°F. Acclimation also depends upon the length of the growing season, the variation in daytime and nighttime temperatures, nutrition, water status and cultural practices.

Most woody species acclimate in three stages. Decreasing day length triggers the first of the three stages, which begins near the end of June. Even though air temperatures are warm or even increasing at this time, plants often slow their growth and begin to acclimate. In many woody species, terminal buds are set and all visible growth stops. In other species, growth continues at the shoot tips, but wood and bark that formed earlier in the season mature and begin to acclimate. Shoot maturation, which continues for several years, is often accompanied by the formation of dark pigments in the epidermis or bark and by the formation of protective layers of dead bark.

In the second stage of acclimation, decreasing nighttime temperatures in late summer or early fall accelerate the hardening process. By the time the first frost arrives, the wood and overwintering buds of cold hardy plants are able to survive mild subfreezing temperatures even though their leaves are killed by frost. As temperatures continue to decrease through fall and winter, the minimum survival temperatures of the stems and buds decrease.

Woody plants attain maximum cold hardiness when they are exposed to below-freezing temperatures that are not low enough to injure the plants. Maximum cold hardiness is temporary and is the third and final stage of acclimation.

Ice forms in most woody tissues at temperatures between 18°F and 28°F. Initially, ice forms between living cells but not inside of them. This ice does not damage acclimated living tissues but draws water out of the cells, making them better able to resist freezing stresses. When ice between the cells melts, the water moves back into the cells, and the temperature at which the cells are killed returns to what it was before ice formation. Excessive cellular dehydration can cause injuries.

As temperatures warm in late winter and early spring, plants lose their cold hardiness in a process known as deacclimation. Plants can also deacclimate during mid-winter thaws. A sudden return to freezing temperatures after a thaw can cause serious freezing injury to deacclimated tissues.

Factors That Inhibit Acclimation

Maximum cold hardiness is determined by a plant's genetic makeup and cannot be changed by cultural practices. Improper cultural practices, however, can inhibit acclimation and prevent plants from attaining their maximum cold hardiness. One of the best ways to avoid freezing injury to your plants is to avoid practices that interfere with acclimation. Plant-weakening stresses caused by poor nutrition, drought, insect and disease damage, shading and other factors all interfere with acclimation. Pruning in early fall can stimulate late growth and impede acclimation as

will defoliation, either by insects or as a cultural practice to allow fall digging in nurseries.

Maximizing Cold Hardiness

Select plants adapted to your growing site. This is the most important step in preventing winter injury. Remember that woody perennials remain in one place for years. Don't overestimate the warmth of your site or the hardiness of your stock.

Hardiness ratings based upon the U.S. Department of Agriculture's plant hardiness zone map are insufficient for properly selecting perennial woody plants because the map takes into account only average minimum winter temperatures. For woody perennials, the probability of a killing freeze is more important than average minimum temperature.

Take a tree cultivar that is considered hardy to −25°F. According to the USDA's plant hardiness map, you could safely plant this cultivar in zone 5 (−10°F to −20°F). However, if you live in a zone 5 location where the minimum winter temperature can occasionally drop to −30°F — even if only once in 20 years — you would be better off planting a tree that is hardy to −30°F or colder.

Bear in mind that the climate immediately around a plant, known as the microclimate, varies greatly over short distances. Also, the temperatures on one side of a building, hill or lake can differ markedly from those on the other sides. Evaluate your site carefully.

In general, choose plants that are rated at least one zone colder than your hardiness zone. If you question how well a particular plant will perform at your site, contact the University of Idaho Extension agricultural agent in your county.

Selecting very hardy plants from high-altitude growing sites can be risky. Plants such as subalpine fir (*Abies lasiocarpa*) that normally grow only at high elevations are adapted to very short growing seasons and often deacclimate quickly. Once deacclimation begins, the plants lose much of their cold hardiness and can be injured when cold temperatures return after extended mid-winter thaws. Alpine plants at lower elevations also often deacclimate very early in spring and can be injured during late frosts. Select plants that can acclimate and stay acclimated throughout the winter under your growing conditions.

Keep plants healthy. Plants damaged by insects, disease, drought, flooding, heat stress or shade produce insufficient winter food reserves and are unable to acclimate properly.

Prevent trees or shrubs from becoming drought stressed. Although some research indicates that putting trees through a mild drought increases their cold hardiness under certain conditions, this practice can cause other problems in trees and shrubs and should not be followed in the nursery or the landscape. Before the ground freezes in fall, water trees and shrubs deeply to ensure they have enough moisture to last the winter.

Proper soil moisture is especially important for evergreens, whose leaves continue to lose water through the winter. Dry soils also freeze deeper and more rapidly than moist soils, thereby increasing root damage. Organic mulches help to conserve soil moisture and insulate the soil from rapid temperature fluctuations.

Avoid excess nitrogen fertilizer. Most trees and shrubs require no more than about 2 to 4 pounds of nitrogen per 1,000 square feet of soil surface per year. Apply nitrogen in several doses during early spring and summer. Do not apply any after the middle of July. Potassium and phosphorus fertilizers can be applied at any time of year without interfering with acclimation. For more information on fertilization, contact the University of Idaho Extension agricultural agent in your county.

Avoid pruning between about mid-August and early November. Pruning after plants have become fully dormant generally does not affect hardiness, and wood that is dead, diseased or severely damaged by insects should be removed whenever it is found. When you must prune in fall, prune your hardiest varieties first and leave cold-tender varieties for later. The delay in pruning will give less hardy varieties more time to acclimate.

Prune and train trees and shrubs so that their leaves get the greatest possible exposure to sunlight. Shaded leaves don't produce much food or energy, and shaded wood and buds tend to be weak and easily injured by freezing.

Do not artificially defoliate trees with chemicals or by hand in order to meet fall digging schedules in nurseries. Acclimation is an active process that requires lots of energy and involves structural changes in plants. Leaves play an important role in acclimation because both energy and tissue-building materials start out as simple carbohydrates produced by photosynthesis in the leaves. Leaves also produce hormone-like substances that control plant metabolism. Furthermore, leaves detect changes in day length and other environmental cues that are important in acclimation. Such cues trigger the processes that keep plants in tune with their environments.

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