

## University of Missouri Extension

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# Ice and Freeze Damage to Ornamental and Fruit Trees: Implications and Remediation

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Landscape and forest plants in the Midwest sustained extensive damage in 2007 from several storms of historic proportion. The purpose of this document is to place those events in historical perspective, to describe the types of damage observed and plant responses to it, to predict several long-term effects of this damage and to suggest approaches to remediation. Some of the weather events causing this damage were unprecedented in scope and severity. Consequently, it is difficult to predict in detail how damaged plants will respond over time, because there is little experience upon which to base projections.

## Background

### Freezing damage

Temperate zone woody plants survive freezing temperatures by developing a dormant condition in response to shortening days and cool temperatures in the fall. In the Midwest, many species do not attain full dormancy, with its associated freezing tolerance, until mid-November or later. Dormant, cold-hardened plants are able to survive temperatures well below 32 degrees F. As the temperature drops below 32 degrees, some of the water from inside cells migrates to spaces outside the cells. This water freezes and forms “extracellular ice.” Woody tissues tolerate this type of freezing conditions and are not harmed by extracellular ice formation. During extracellular freezing, the water inside living cells remains unfrozen, a condition called supercooling. As the temperature continues to drop, however, ice crystals eventually form inside the cells. These intracellular ice crystals rupture cell membranes, resulting in leakage of the cell contents. Thus, tissues injured by low temperatures often appear water-soaked and are flaccid.

During dormancy, woody plants require a certain number of hours when temperatures are below about 40 degrees F, before cambium and buds become active in response to warm temperatures. This tends to prevent plants from growing actively during short, unseasonably warm periods in midwinter. If plants are exposed to subfreezing temperatures before they can attain dormancy in fall, or after they begin growing in spring, they can be severely damaged at temperatures that would cause no harm during the dormant period.

During the widespread freeze event that occurred in April 2007, many woody plants were devastated because they were in active growth when the temperature suddenly dropped well below freezing for six consecutive nights. Most plants had received sufficient chilling by mid-March to break bud dormancy. Temperatures during the two weeks between March 21 and April 3 were commonly 20 degrees above normal for that time of year. This was the third-warmest March 21 to April 3 period in 118 years of weather records in Missouri. Then, when a frigid air mass descended on the Midwest, temperatures dropped quickly down to the mid 20s, causing death of expanding buds, flowers, leaves and bark on a wide range of woody plants. This was the coldest April 4 to 9 period in 118 years. This sudden drop from 20 degrees above normal to 20 degrees below normal during this period in spring was unprecedented.

## Ice storms

The National Weather Bureau lists Missouri among states with a high probability of experiencing storm events leading to ice accumulation up to 1/2-inch in thickness. However, according to weather statistics, ice accumulation of more than 1 inch is likely to occur only once every 50 years. The ice storm that occurred in southwest Missouri Jan. 12 to 14, 2007, deposited nearly 2 inches of ice in some parts of Greene, Polk, Dallas and Laclede counties in Missouri. A storm in mid-December 2007 deposited up to one inch of ice in central and northwest Missouri. In addition to extensive power outages, these storms caused massive splitting, bending and breakage of trees over wide areas of the state.

## Types of damage

Many types of damage were observed after the various storms of 2007. With the tremendous weight of ice that accumulated during the January and December ice storms, many trees had broken trunks and main branches, leaving large, jagged holes on the bark of the remaining stems and branches. Many trees exhibited bending, splitting and uprooting of unbroken trunks. Some freezing injury was evident to the new growth of plants within days of the April freeze. However, many plants showed evidence of severe damage to the cambium and bark, leading to dieback, bark splitting and weak growth of buds and shoots that appeared, initially, to have survived the freeze. Some trees and shrubs were killed back to or near the ground, with suckers arising from the soil line or lower trunk. In many cases, stem dieback led to a proliferation of vigorous, competing shoots at the uppermost point where the bark survived the freeze. In some cases, branches that had been pruned back to apparently live wood showed additional dieback from the pruning cut throughout the growing season.

## Possible long-term effects

The storms of 2007 are likely to have long-lasting effects on trees and shrubs. Branch loss due to dieback and breakage greatly reduced total leaf area on many plants. This stressed plants by reducing the carbohydrates available to roots. It also led to sunscald of exposed bark and, in some cases, to attack by stem borers and other insects. Wounds and dead branches will increase the incidence of decay, leading to more branch loss in the future. Opportunistic disease organisms, such as *Phytophthora* fungi and the crown gall bacterium, will take advantage of lesions to infect susceptible plant tissues. In some cases, damaged trees will be unstable due to imbalanced form and the weak attachments of epicormic branches, which grow from latent buds released by dieback.

## Remediation approaches

Remediation practices should aim to maintain reasonable vigor, promote the compartmentalization of wounds and re-establish a stable, well-spaced branching structure. In addition to pruning, cultural practices such as irrigation, mulching and moderate fertilization can help plants maintain vigor. Trees and shrubs require a certain level of vigor to be able to compartmentalize (wall off) decay resulting from wounds to limit its spread.

### Pruning

When a tree has less than 50 percent of its branches remaining, the best approach may be to remove it. Otherwise, use good pruning practices. **Never leave stubs.** Cut damaged branches back to laterals or to the trunk but **preserve branch collars** by making cuts that angle out from the trunk to the under side of the branch (Figure 1). Use the three-cut method for larger branches to **prevent bark stripping**.

If possible, spread the pruning over two or three seasons. Excessive pruning forces unmanageable, rank growth that is prone to breakage, insects and diseases.

Irrigate damaged trees to supplement rainfall to 1 inch of precipitation per week.

Use a rain gauge or calculate inches of irrigation applied (0.62 gallon per square foot = 1 inch). Make certain, however, that drainage is adequate to prevent waterlogging. Don't forget to water during drought and then start watering in the fall. This may stimulate late growth that may be susceptible to fall freeze events. Try to maintain uniform soil moisture content throughout the summer and fall.

Mulching may be the single most important cultural method to help damaged plants recover. Use a wide, shallow mulch ring no more than 4 inches deep and never more than an inch thick near the trunk. This conserves soil moisture and reduces competition between roots of turf and those of recovering ornamentals. Never allow broadleaf herbicides to wash into mulched areas.

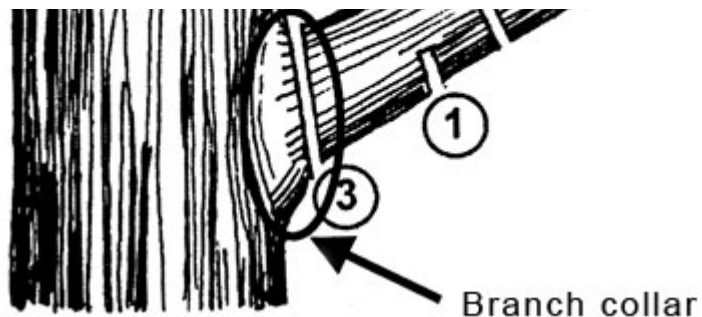
Base fertilization on soil test results. Avoid excessive application of soluble nitrogen fertilizer. This may force rank growth that will be crowded, drought inefficient and susceptible to insect and disease problems. Use less than 2 pounds of actual nitrogen per 1,000 square feet, split over multiple applications, using slow-release material if possible. Avoid fertilizing after July to reduce the probability of fall freeze injury. Keep fertilizers containing broadleaf herbicides well away from recovering plants.

Pest management is important during the recovery period. Storm-damaged plants may be affected by insects and diseases that normally do not cause problems. Minimize stress through mulching and irrigation practices. Inspect plants regularly for pest symptoms and signs. Identify the problems accurately and use labeled pest control measures quickly to minimize damage.



**Figure 1**

Pruning large branches with three cuts prevents stripping the bark and injuring the tree.



### Managing freeze-damaged fruit plants

The unprecedented freeze that occurred in spring 2007 will affect fruit harvested in 2008. One of the first things that growers are faced with in preparation for the upcoming growing season is pruning. When temperatures plummeted in April after an unusually warm March, many growers had already applied fertilizer. In more normal years, nitrogen fertilizer is used for reproductive and vegetative growth. However, with the loss of the fruit buds or fruit, nutrients normally diverted to the developing crop were available for the production of more vegetative shoots and leaves. Therefore, any nitrogen applied before (or after) the freeze promoted excessive vegetative growth. For this reason, fruit trees will require more hours of pruning this season. When pruning, the dead and diseased wood should be removed first. Second, thinning out unproductive branches and those that shade other fruit-bearing shoots will be necessary to ensure sustained fruit production.

Unlike blueberry, blackberry and peach, apple trees go into a cycle of alternate bearing (excessive fruit set the year after a season of low fruit production). In 2008 apple trees will likely have a heavy crop load (barring any erratic weather). It will be important to apply adequate fertilizer to produce quality fruit. However, splitting the total amount of recommended fertilizer into two applications (before bloom and after fruit set) or more will help provide better-sustained growth and help avoid leaching of the nitrogen if it is applied as ammonium nitrate. Using multiple fertilizer applications also gives the grower the opportunity to stop fertilizing if another catastrophic frost or freeze occurs. Multiple fertilizer applications are recommended for all fruit crops, starting pre-bud burst and ending by July 1. Fertilizer applications after this date promote late-season growth, delay hardening and increase fruit bud susceptibility to winter injury.

Fruit removal (i.e., thinning) will be important on peach and apple trees to balance the amount of fruit and vegetative growth. For apple, only one fruit per cluster should be retained. This should be done as early as possible, when the fruit is the size of a dime. For peach, strip off all small fruitlets, leaving 10 inches between each fruit. Peach branches often break when they are bearing too many fruit.

The incidence of pests may also be greater this growing season, depending on the pesticide applications used after the 2007 freeze. Many growers reduced their chemical applications or quit spraying completely after the freeze. Thus, uncontrolled pests from last year may increase pest populations this year. Fire blight on apple and pear trees may be worse this year on trees that were fertilized either before or after the 2007 freeze because of the excessive vegetative growth. Also, canker development may be worse than usual on peach trees after the April freeze and the low winter temperatures experienced recently. Because of the erratic weather, there may also be outbreaks of pests not normally seen in Missouri. Even though the true consequences of the freeze may not be known for a few years, woody fruit plants are often productive with optimum culture

following unseasonable weather events.

## Planning for a storm-tolerant landscape

Through experience, much has been learned over the past few years about the factors that make trees and shrubs in the Midwest vulnerable to storms. The species and condition of a tree are major determinants of the probability of ice or freeze damage. Thousands of silver maples and elms with poor structures due to prior topping or neglected pruning when young were destroyed in the ice storms of 2007. Japanese maples proved extremely vulnerable to freezing injury during the April freeze catastrophe. When replacing trees and shrubs, it is important to consult recommendations by tree experts regarding which species have historically exhibited the best tolerance to ice loads. One good reference on this subject is: *Trees and Ice Storms: The Development of Ice Storm-resistant Urban Tree Populations*, PDF by Richard Hauer, Jeffrey Dawson and Les Werner (2006), published by the University of Wisconsin-Stevens Point and the University of Illinois at Urbana-Champaign.

### Note

When storm-damaged trees are replaced, it is critical that new trees be sited correctly and pruned properly during the first few years after planting.

Storm-tolerant, large trees must be planted at least 45 feet from overhead utility wires. All trees should be pruned regularly when young to establish a crown with branches that are well distributed vertically and radially and are attached at an angle of at least 45 degrees from vertical. Additionally, occasional light pruning of older trees can reduce ice damage considerably when storms come. The storm damage of 2007 should be remembered so that Missouri homeowners and landscape managers can do what is possible to avoid unnecessary tree damage and power outages in the future.

Many large trees, even in southwest Missouri, survived the storms and are salvageable. Considering that storms of this magnitude are relatively rare, it would be unfortunate if cities and homeowners stopped planting large shade trees. If so, Missourians will sorely miss the many economic, environmental and aesthetic benefits provided by urban tree canopies.

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## Related MU Extension publications

- G6866, Pruning and Care of Shade Trees  
<http://extension.missouri.edu/publications/DisplayPub.aspx?P=G6866>
- G6867, First Aid for Storm-Damaged Trees  
<http://extension.missouri.edu/publications/DisplayPub.aspx?P=G6867>

Order publications online at <http://extension.missouri.edu/explore/shop/> or call toll-free 800-292-0969.



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