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THE PURDUE LANDSCAPE REPORT

In This Issue

Will the February Freeze Kill This Summer's Pests?

(Cliff Sadof, csadof@purdue.edu)

This past February was among the coldest and snowiest we had since 2014. Yet despite our discomfort, it won't be an issue for most insect pests that attack landscape plants. Most species regularly survive winters that are far colder. Indeed, the snow cover probably protected many insects from freezing in this year's winter weather.

Snowfleas on white bark in February. (Photo by Photo by Matthew Fleck, Jasper County, Indiana Parks and Rec).

Insects are cold blooded animals that have many ways of surviving freezing temperatures. Generally speaking, they use proteins and sugar alcohols that lower their freezing point and prevent ice crystals from damaging sensitive tissues. As such it, is not much different from the process that gives us runny noses on cold days to keep our noses from freezing.

Snowfleas are in a group of wingless insects called springtails. This species produces special antifreeze proteins to keep the snowfleas from freezing and allows them to feed in winter even when there is snow on the ground.

Many species of aphids that feed on herbaceous plants in the summer will feed on woody plants in the fall to ingest sugar alcohols that can be deposited into eggs and act as antifreeze.

Eggs of soybean aphid winter of stems of buckthorn contained antifreeze made from chemicals produced by this shrub. (Photo by J. Obermeyer)

Insects require energy and time to become fully adapted to cold temperatures. For this reason, they are most able to survive the cold when insects have time to adapt to cold gradually and stay adapted for the duration of winter. Fluctuating temperatures in the fall make it difficult for insects to rely only on temperature to start their hibernation process. Many species use the shortening days of late summer and autumn to guide them to enter a resting state, called diapause, that helps survive the winter.

In the spring when you dig up your garden you can find many insects that overwinter in the soil. These can include many pests, like the white grub stage of Japanese beetles, wireworms, cutworm caterpillars, and even pupae of hornworms. Fortunately, these pests share the soil with beneficial insects like ground beetles and ants that feed on pests as the weather warms. The soil insulates all these insects from weather extremes that cause rapid changes in soil temperature. A blanket of snow on the ground will reflect light and keep the soil temperatures even more constant and increase the likelihood of insect survival.

When multicolored Asian lady beetles winter in attics and wall voids of houses they can become a nuisance. Their survival this winter will help control many pests (Photo by J. Obermeyer).

Insects that winter as adults seek hollow logs or caverns for shelter that can buffer them from weather extremes. Around the time of the first frost, adult multicolored Asian ladybeetles and brown marmorated stink bugs will seek shelter in barns, attics, and wall voids to hibernate in our homes. Heat from our homes can confuse them and cause them to come out of hibernation and become pests in our homes.

Insects are much less able to tolerate rapid cold snaps called Arctic clippers than a long cold February. Warmer winters and punctuated by short intense cold periods and late spring frosts can kill insects who have been lulled out of winter dormancy just in time to be frozen.

In conclusion, although February's cold and snow did not kill the pests of 2021, they also spared the beneficial insects that can help them from becoming pests on landscape trees and shrubs. More importantly, the deep snow cover has likely provided them with moisture plants will need to thrive in the coming year.

Reference

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What do Trees Do in the Winter?

(Lindsey Purcell, lapurcel@purdue.edu)

So, what do trees do in the winter? Do they freeze up like unprotected water pipes? Or burst when it gets below freezing? Yes, the below-ground parts of a tree are kept insulated by mulch, soil and a layer of snow, and that is important to survival, but the exposed parts of a tree are not protected.

Surviving winter actually begins in fall when leaves turn color and drop to the ground.

Deciduous trees like maples and oaks, have a lot of water inside their trunks and branches and is the single most important substance for tree life, comprising nearly 80% of tree material. Although there is a little less inside the tree during the winter, if the temperature drops low enough, the water in even the most cold-hardy tree will freeze. Broadleaf, deciduous trees lose their leaves in the winter to reduce water loss inside the trunk and branches. Most needle-leaved trees, known as conifers, which include pines and spruce retain needles year-round – with exceptions of some deciduous evergreens such as larch and bald cypress– only losing older, or damaged needles. Needles are better at retaining water than broadleaves due to their small surface area and waxy outer coating limiting water loss to transpiration, the evaporation of water from leaves. A hard freeze or poorly timed drop in temperatures can be devastating to living tree cells since ice crystals can shred cell membranes, leading to dead leaves, branches, and even whole trees. Most trees live through the winter despite prolonged exposure to brutally cold air and wind and snow, with special strategies and planning.

Dormancy of trees can be divided arbitrarily into three phases: early rest, winter rest, and after-rest. Each of these phases is marked by a distinct set of physiological processes. The transition between the three phases is gradual and there are many metabolic and developmental processes going on in the buds and twigs. A tree begins its preparations in late summer as day length shortens to survive winter temperatures. Cold acclimation occurs gradually and fall color is a sign that the process is in place and pre-dormancy is beginning.

Evergreens are a little different and have a special waxy covering to reduce water loss during the winter.

When the tree enters the winter rest stage, research suggests three basic ways in which a tree prevents freezing. One is to change their membranes, so the membranes become more pliable; this allows water to migrate out of the cells and into the spaces between the cells. The relocated water exerts pressure against the cell walls, but this pressure is offset as cells shrink and occupy less space.

The second way a tree helps prevent freezing is to thicken the fluids within the cells. When days begin to get shorter, trees convert starch to sugars, which act as a natural antifreeze for the plant. The cellular fluid within the living cells becomes concentrated with natural sugars, which lowers the freezing point inside the cells, while the water between the cells is allowed to freeze. Because the cell membranes are more pliable in winter, they're squeezed but not punctured by the expanding ice crystals.

The third mechanism involves what has been described as a "glass phase," where the liquid cell contents become so viscous that they appear to be solid, a kind of "molecular suspended animation" and mimic the way silica remains liquid as it is supercooled into glass. This mechanism is triggered by the progressive cellular dehydration that results from the first two mechanisms and allows the supercooled contents of the tree's cells to avoid crystallizing.

All three cellular mechanisms are intended to keep living cells from freezing. That's the key for the tree; don't allow living cells to freeze.

Some trees like many birches can survive temperatures well below -100 F

A tree doesn't have to keep all of its cells from freezing, just the living ones which are primarily the phloem cells. This is significant, since much of a tree's living trunk is made up of cells that are dead, such as xylem cells. These dead cells can and do freeze, but even the lowest temperature doesn't have an adverse effect. While a majority of a tree's above-ground cells do indeed freeze regularly when exposed to subfreezing temperatures, the living cells remain unfrozen and active on a reduced level. There are living cells in the trunk that remain unfrozen even though they are right next to – and at the same temperature as – dead cells that are frozen solid!

This seemingly mystical combination of pliable membranes, natural antifreeze, and glasslike supercooling, with frost on the outside and viscous dehydration on the inside, helps trees avoid freezing injury to living cells. Trees are the largest, oldest living organism on our planet and don't grow older and larger without having very specific strategies for survival.

However, sometimes, trees aren't able to withstand extreme conditions, especially if nature provides an unusual change. While trees have evolved amazing strategies for withstanding the winter cold, sometimes it gets so cold that trees can explode. During spells of extreme cold or especially when trees haven't had time to acclimate before the cold arrives, the life-sustaining sap inside a tree can begin to freeze. Sap contains water so it expands when frozen, putting pressure on the bark, which can break and create an explosion, so to speak.

Proper winter care is critical to protect your trees with mulch and water to help trees make it through the winter months. For more information on winter tree care, check out this publication.

Bacterial Disease

(Janna Beckerman, jbeckerm@purdue.edu)

"What's great about bacteria is you have a surprise every day waiting for you because they're so fast, they grow overnight." Bonnie Bassler

Bacteria are microscopic, single-celled microorganisms. Their lives are sort of boring: They take in nutrients, they grow, and when the get to a certain size, they split in two. This can happen in as little as 20 minutes, and twenty minutes later, those two daughter cells split into four, and twenty minutes later, those four are eight…and by the end of the day, the bacteria could have reproduced to a degree (2^{72}=4,722,366,482,869,645,213,696) that makes rabbits seem like underachievers. It is important to understand this level of bacterial growth for two reasons: 1) you realize that the bacteria are everywhere, even when you don't see symptoms, and 2) they will become epidemic quickly when conditions meet their needs. Unfortunately, their needs are easily met, and protecting plants from them is a challenge.

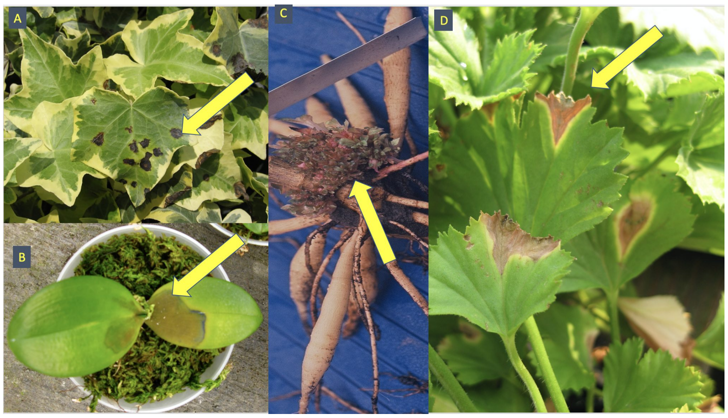

Figure 1. a. Ivy with Xanthomonas leaf spot, which caused black, angular lesion; b. Phaleanopsis orchids can become victim to soft rots, particularly if water is left standing in the crown of the plant; c. dahlia infected by Rhodococcus and proliferating stems; d. Xanthomonas blight on geranium.

Bacteria enter through wounds, and natural openings in the plant, usually stomata (microscopic openings on leaves that allow air exchange). Once inside the plant, they produce toxins that kill cells, enzymes that turn cells into mush, hormones that make cells grow in odd ways, chemicals called effectors that suppress plant defense, or a type of slime (called exopolysaccharides) that block water conducting vessels (Fig. 1 – photos A-D). You might know this slime by another name—xanthum gum—a food additive used in salad dressings to thicken it, and make it stick to the leaves. These bacteria stick to plants as well as French dressing sticks to lettuce!

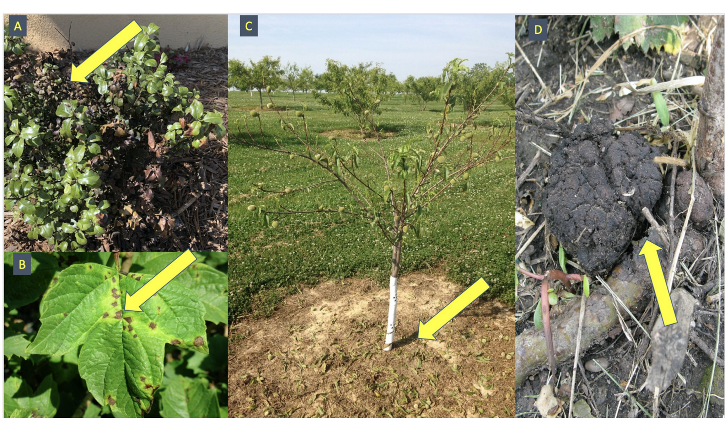

Figure 2. a. Fire blight on cotoneaster causes blackened foliage; b. angular leaf spot on hydrangea caused by Xanthomonas; c. Bacterial leaf spot of peach also infects and defoliates ornamental plums and cherries; d. Crown gall.

After the bacteria get into the leaves and begin to reproduce, symptoms develop. These symptoms usually appear between the leaf veins resulting in discrete, angular spots. Yellow or red halos often develop around the lesion. As lesions coalesce, the damage may appear more like blight, as opposed to a discrete spot (Fig. 2). In the last year, we've been seeing a lot of Xanthomonas leaf spot and Pseudomonas leaf spot on bedding plants, particularly begonia, in addition to vegetable and herb starts. In nursery crops, the fire blight pathogen, *Erwinia amylovora*, is a common and devastating problem (Table 1).

Table 1. Plant hosts and the causal bacterium that cause disease commonly observed in Indiana.

Plant Host	Type of Disease	*Pathogen*
Begonia	Leaf spot and blight	*Xanthomonas axonopodis* pv.*begonia*
Cyclamen	Soft rot	*Pectobacterium carotovorum*
Dahlia	Leafy gall/ Bud proliferation	*Rhodococcus fascians*
Euonymous	Crown gall	*Agrobacterium tumefaciens*
Geranium	Leaf spot	*Pseudomonas* spp.
Hedera	Leaf spot	*Xanthomonas hortorum*
Hydrangea	Leaf spot, blight	*Xanthomonas campestris*
Impatiens	Leaf spot	*Pseudomonas* ssp.
Lavandula	Leaf blight	*Xanthomonas hortorum*
Lilac	Leaf blight	*Pseudomonas syringae*
Malus, Pyrus, other rose family members	Fire blight	*Erwinia amylovora*
Narcissus	Soft rot	*Pectobacterium carotovorum*
Pelargonium	Leaf spot	*Pseudomonas* spp.
	Bacterial wilt	*Ralstonia solanacearum*
	Bacterial wilt/blight	*Xanthomonas hortorum*
	Soft rot	*Pectobacterium carotovorum*
Petunia	Leafy gall/ Bud proliferation	*Rhodococcus fascians*
Poinsettia	Leaf spot	*Xanthomonas axonopodis* pv. *poinsettiicola**
	Soft rot	*Pectobacterium carotovorum*
Prunus	Bacterial canker	*Pseudomonas syringae* pv. *syringae*
	Leaf spot, shothole	*Xanthomonas prunii*
Rosmarinus	Leaf spot	*Pseudomonas cichorii*
Rudbeckia	Leaf spot	*Pseudomonas cichorii*
Salix	Crown Gall	*Agrobacterium tumefaciens*
Salvia	Leaf spot	*Pseudomonas syringae*
Sedum	Soft rot	*Pectobacterium carotovorum*
Vaccinium	Leaf spot, blight	*Xanthomonas* spp.
Zinnia	Leaf spot	*Xanthomonas campestris* pv. *zinniae*

Even with a microscope, most plant infecting bacteria look surprisingly boring, like a pill–A very, very small pill. A key point to remember is that different species of *Xanthomonas* or *Pseudomonas* infect different species plants, which is indicated by the term 'pathovar', meaning variety of bacteria pathogenic to one host. *Xanthomonas campestris* pv. *zinniae* infects zinna, whereas *Xanthomonas vesicatoria* infects tomatoes and peppers. So, if you have infected zinnias, this pathogen will not spread to your tomatoes or peppers. Unfortunately, this pathogen produces symptoms that look a lot like *Pseudomonas cichorii*, a major pathogen on chrysanthemum, ivy, basil, and other plants. Unlike the host specific *Xanthomonas* species, *P. cichorii* is not picky about its host. Neither is the soft rot pathogen of bulbs and many bedding plants, *Pectobacterium carotovorum*. In fact, host specificity is not known to exist. A laboratory diagnosis is needed to confirm which type of bacterial problem your plants have.

Regardless of which bacteria you are battling, there are certain key management strategies that reduce bacterial growth and spread. Bacterial diseases of the foliage are favored by prolonged periods of leaf wetness, and high relative humidity. Due to bacterial reproduction, they are everywhere, including all over asymptomatic plants. With a stressed or injured host, and wet conditions, splashing water easily spreads bacteria to overlapping and nearby plants. These bacteria then enter the leaf through injuries and natural openings, with water facilitating spread and infection. Thus, the longer the plants are wet, the greater the opportunity there is for infection to occur, and the more you handle or work around plants, the more likely they will end up damaged. Key management points at this stage is reducing leaf wetness, minimizing splashing from irrigation, and avoid handling plants when they are wet. Workers should wash their hands regularly, and especially after handling infected plants, or plant debris. But hey, in the time of COVID, we should be doing this anyways! Any tools used should be disinfected (bleach, trisodium phosphate, or commercial disinfectant/disinfectant), as well.

Further protection against plant diseases can be provided by the use of copper-based pesticides. Copper is a multi-purpose biocide, capable of killing bacteria, water-molds and fungi—and damaging plants if care isn't taken. When using copper, be sure to use non-acidified water to minimize the risk of phytotoxicity. Frequent applications of copper are also recommended. Keep in mind that this is copper, and it is definitely not a 'silver bullet'! There are no pesticides that will cure infected plants or completely stop the spread of bacterial diseases. Thus, prevention is the key.

To prevent bacterial diseases from becoming established in your operation requires good sanitation practices, and a certain degree of ruthlessness. Diseased plants and plant debris should be promptly removed from the growing area. This material should not be composted, nor should you re-use contaminated potting media.

Some bacterial disease outbreaks in greenhouses or nurseries begin with the use of infected seeds or transplants (which may be asymptomatic). If you suspect this, be sure to provide as much information as you can regarding the outbreak (sowing date, growing media, management, etc.), and also provide the source of seed/plants when submitting samples for diagnosis. Not only can your diagnostic lab diagnose the dots, they may be able to connect them, and identify the source of bacterial outbreaks.

Some seed may be treated by surface sterilization. Keep in mind that surface sterilization will reduce germination, so it is only recommended if you have a history of problems with a certain crop or supplier. A general formula for tomato and pepper seed is: Forty minutes with continuous agitation in 2 parts Clorox Liquid Bleach (5.25% sodium hypochlorite) plus 8 parts water (e.g. 2 pints Clorox plus 8 pints water). Use 1 gallon of this solution for each pound of seed. Be sure to prepare fresh solution each time you treat seed, and then rinse seed in clean water and allow to dry prior to planting. Keep in mind that smaller seeds will require less time, or even less bleach. Test each seed crop before implementing, or you may create a new problem for yourself called 'zero germination'! Use 50 seeds, treated and untreated, in a germination test (https://extension.umaine.edu/publications/1013e/f) to compare and observe how lethal your seed disinfecting method is. Extended treatment times and higher rates of bleach will kill more bacteria—and more seeds. Remember to make sure your treatment isn't worse than the disease!

Bacterial growth is favored by warm, wet conditions (70-85 degrees F). Bacteria need opening or wounds for entry, so avoid working around plants when they are wet—any injury provides an infection court AND water to help spread bacteria. Avoid working around plants when wet. Improve plant spacing to reduce humidity and increase drying of plants, avoid watering later in the day, and overwatering plants. Bacteria can spread by splashing, wind driven rain, and even sprayers. Due to issues of copper resistance in many plant pathogens, and the reality that any applications will increase surface moisture and spread, eradicate any symptoms of bacterial disease prior to applying copper fungicides.

For woody ornamentals, pruning the infected area and disposal is key. However, keep in mind that the infection commonly extends beyond the symptomatic tissue. In other words, remove more—at least 12" more—beyond to where the symptoms end, to eradicate any traces of the pathogen.

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