EXTENSION

UtahState UNIVERSITY

Fruit Tree Disease:
Cytospora Canker

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

Cytospora Canker or Perennial Canker is one of the most common diseases of fruit and shade trees in Utah. This canker disease is caused by a fungus called *Cytospora*. There are several species of *Cytospora* that attack many different hosts, but the symptoms and control are essentially identical for all of them. The host range of *Cytospora* is broad, including peach, cherry, apricot, apple, poplar, willow, birch, aspen, and many other broadleaf trees. Stone fruits are more susceptible to perennial cankers than are pome fruits.

SYMPTOMS

Cytospora is considered a weak parasite and invades only weakened or stressed trees. It gains entry through injuries in the bark caused by machinery, sun scald, frost, pruning wounds, broken branches, mechanical shakers, and insect injury. Cankers on trunks or branches are sunken and range in color from brown to gray depending on the host species. The canker expands slowly over a period of months or years and may eventually girdle the branch, causing it to die. The fungus may produce small (1 mm) pimple-like bumps in which black fungal structures called pycnidia are embedded. The presence of pycnidia can be confirmed by slicing the bark with a knife where raised areas are evident. Pycnidia are quite common and obvious on mountain ash, cherry, and birch.

CAUSE

During warm, wet weather, brown to orange-colored masses of spores (analogous to seeds) are extruded from the pycnidia in a tendril-like mass. These spores are carried by rain or blown by wind to susceptible sites where they cause new infections. Optimum conditions for Cytospora infections occur in the spring when daytime temperatures are 60 to 80F. The fungus continue to grow and produces spores during the warm weather months.

CONTROL

Preventing infection is the best way to control *Cytospora.* There are no fungicides which are effective in controlling the pathogen once it is in the tree. No single method of control can be used to prevent this disease; therefore, it is necessary to use several of the methods described below to maintain healthy plants.

Maintain high tree vigor. Trees should be watered deeply during dry summer months to prevent drought stress. Fertilize in the spring to keep trees vigorous. Avoid late summer applications of nitrogen because it stimulates growth in autumn which does not harden off before winter. Trees stressed with iron chlorosis are particularly susceptible to Cytospora infections. The roots of birch trees are quite shallow and are damaged or killed by high soil temperatures and drought on south or west facing slopes. Keep soil cool and moist by frequent irrigation.

Prune out and destroy dead or diseased twigs and branches. Do not leave stubs or narrow crotches. Prune on a regular basis so that large cuts will not be necessary. Pruning wounds are susceptible to infections, so prune in the early spring and not when rain is imminent. Treat pruning cuts larger than one inch in diameter with a paint of 1% thiram or 3-10% Copper Naphthenate. Asphalt pruning paints are not effective. An application of benomyl as a spray immediately following the pruning of a fruit orchard may reduce new infections. Benomyl is no longer registered for use on ornamental trees.

Prevent sunscald by painting the trunk of thin-barked trees with white latex paint. The trunks of newly planted trees should be wrapped with burlap or white-colored tree wraps to prevent sunburn. These techniques will also reduce winter damage which occurs on the southwest side of trunks.

Control borers and other wood-attacking insects. Avoid mechanical injury to tree with lawn mowers, lawn trimmers, ladders, shakers, or other equipment. Woodpiles are an important source of inoculum for the disease. To prevent infections on nearby trees, destroy any wood that appears to have pycnidia.

EXTENSION

UtahState UNIVERSITY

Fruit Tree Disease:
Fire Blight

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

Many ornamental plants of the Rose family are susceptible to a bacterial disease called fire blight. Ornamental members of this family include pyracantha, hawthorn, cotoneaster, mountain ash, and crabapple. This disease is generally more serious in pear and apple orchards because of the loss of production it causes. Damage to ornamentals is usually not economically important, but it can be extensive and unsightly. Flowers, fruit, and new leaves can be killed, as well as twigs and branches if the pathogen produces girdling cankers.

SYMPTOMS

Fire blight damage is typically first noticed when twigs wilt and die. Close examination of the wilted twig reveals flowers or leaves that appear to be scorched. Small droplets or strands of bacterial ooze may be present. Bacterial ooze is often a white, amber, or red liquid or is varnish-like upon drying. Other characteristic symptoms include a bacterial canker at the leading edge of the infection, and a shepherd's crook at the tip of the plant growth. Symptoms seen later in the season include a progressive wilting of the branch as the bacterial canker advances down the stem. Most infections occur through the flowers, preventing the development of berries on pyracantha or hawthorn.

CAUSE

The bacterium, *Erwinia amylovora*, over-winters on the margins of cankers produced on twigs or branches. The pathogen becomes active in the spring and begins to ooze out of the margins of cankers. The bacteria in the ooze are transported to flowers by splashing rain or insects. The bacteria multiply on the exterior of floral parts, but infection generally does not occur until rain or heavy dew move the bacteria to infection sites in the flower. Infected flowers wilt rapidly and turn brown or black. Small droplets of bacterial ooze may be visible on infected tissue. The infection may progress into the spur, twig, or branch, depending on the susceptibility of the host. Infections may also occur in tender stem and leaf tissues. Hail or sucking insects injure the plant and allow the bacteria to gain entrance into twigs.

CONTROL

Cultural techniques are important for the control of fire blight. Avoid overfertilizing with nitrogen. Excessive fertilizer promotes new growth which is more susceptible to blight infections. Do not sprinkle irrigate susceptible plants, it spreads bacteria. During dormancy, inspect plants carefully for any cankers or blighted twigs. Remove and destroy infected tissues. Make cuts 8-12 inches below any visible cankers. Prune out infected stems in the spring if the infection is progressing into larger twigs or branches. Dispose of infected plant parts by burning or in the trash. Bactericides need only be applied during flowering when plants are most likely to be infected. Start applications

when the daily mean temperature exceeds 62 F (average maximum and minimum temperature from midnight to midnight) and repeat every 5 days. Treatments are only necessary when rain occurs during bloom period. Effective bactericides are streptomycin sulfate (Fire Blight Spray) and fixed coppers (e.g. Bordeaux, basic copper sulfate, copper oxychloride, copper oxide, and copper hydroxide). Follow label directions listed for ornamentals.

EXTENSION

Utah State University

Fruit Tree Disease:
Apple Powdery Mildew

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

Powdery Mildew is the most common disease on apples in Utah. It is caused by the fungus *Podosphaera leucotricha*. This fungus frequently infects new vegetative growth, causing reduced vigor, leaf malformation, and reduced viability of buds. Early infection of apple fruitlets results in a weblike russeting on the mature fruit. It may also reduce the vigor of trees and reduce return bloom. Young trees and vigorously growing shoots are the most susceptible.

CAUSE

The fungus over-winters as fungal strands (mycelium) in leaf or fruit buds which were infected the previous season. Infected buds are not as plump as healthy buds, and they often don't seal properly, resulting in a "feathered" appearance. The buds are more sensitive to cold temperatures and will often die if the temperatures drop below 18F. However, even at lower temperatures some of the mildew survives in infected buds and inoculum is always available. The fungus also produces small black structures called cleistothecia, but the spores from cleistothecia do not play a major role in new infections.

New infections occur in the spring when infected buds open and the dormant fungus resumes growth on the developing tissues. These primary infections result in a white, powdery mass of spores which are easily spread by wind and splashing rain. Secondary infections result when these spores infect developing terminals. Late summer infection of buds results in over-wintering inoculum inside the buds.

CONTROL

Plant varieties of apple resistant to powdery mildew. Cultivars such as Jonathan, Idared, Rome, and Gala are susceptible whereas Red and Golden Delicious are more resistant. Pruning infected buds during the dormant season has not proven to be an effective cultural practice and is not recommended in commercial orchards. However, it might be practical for home owners to remove infected shoots as they appear early in the spring. Chemical control with fungicides is necessary when growing susceptible varieties.

Early spring applications of a fungicide are necessary to prevent secondary spread of the mildew in apples. Neglecting control early in the year will result in poor control during the season. Start at the pre-pink and repeat every two weeks until insecticide sprays begin. At that time, combine the fungicide with insecticide used for codling moth control and repeat as needed for insect control about every two to three weeks. Be vigilant with fungicide applications when the buds are setting in July to reduce the amount of over-wintering infected buds. A good mildew control program in the current year reduces the amount of over-wintering inoculum and subsequent fungicide applications.

Fungicide options for controlling mildew include sulfur, the strobilurin fungicides (Sovran, Flint), the SI scab fungicides (Nova, Rubigan, Procure), or the SI mildewcide

(Triadimefon). Triadimefon is a generic substitute for Bayleton, which is no longer marketed for tree fruits. Mildew is NOT controlled by dodine, captan, Vangard, Scala, Polyram, or the mancozeb fungicides. Benlate and Topsin M may still control mildew in some orchards, but mildew is resistant to these benzimidazole fungicides in most orchards.

EXTENSION

Utah State University

Ornamental Tree Disease: Verticillium Wilt

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

Verticillium wilt, caused by the fungus *Verticillium albo-atrum*, can infect over 300 known plant hosts. It is a pathogen on many vegetable and fruit crops as well as ornamental trees. The fungus enters plants through the roots and spreads systemically throughout the water conducting vessels. This plugs the vascular system, resulting in the familiar wilt symptom. Depending upon how much of the root system is infected and where the fungus spreads in the tree, the disease may be very mild or it may kill the tree in one year. Highly susceptible trees include maple, catalpa, elm, ash, black locust, lilac, Russian olive, horse-chestnut, stone fruits, and the golden rain tree. Linden may be susceptible under some conditions.

SYMPTOMS

Symptoms are usually most conspicuous in midsummer during hot, dry periods. Leaves suddenly wilt and dry up. This may occur on the whole tree, but frequently only one side or just a few branches are damaged. If affected branches are cut, a ring of discolored wood can be seen. If the bark is peeled back, longitudinal streaks on the sapwood may be evident. These can be gray, brown, or greenish, depending on the tree species. They may be hard to see sometimes, and should not be confused with streaks found around wounds in otherwise healthy trees. Confirmation of *Verticillium* can only be obtained by culturing the pathogen in a diagnostic laboratory.

Verticillium wilt may kill a small tree in one season, but larger trees may take several years to die or may recover completely. Several strains of *Verticillium albo-atrum* exist; some are more virulent than others. If a tree is affected over several successive years, it may not die but will be very stunted in growth. Sometimes a tree may have a mild case of the disease and not show symptoms until it is stressed. An infected tree may wall off the fungus from further growth and grow normally if it is properly cared for.

CONTROL

Verticillium is a naturally occurring organism. It is very difficult to eradicate it from the soil. The best prevention is to keep trees healthy and vigorous with proper fertilization and infrequent, deep watering during the growing season. Do not plant susceptible trees in old vegetable gardens because of high populations of *Verticillium* will probably be present in the soil. With infected trees, the first step is to prune out all affected branches at least one foot below any discoloration in the wood. Cuts should be clean and tools disinfected after each cut with a 10% solution of bleach. Pruned branches should be destroyed. If a tree is so severely affected that it is obviously going to die or is already dead, remove it and do not plant another susceptible tree in the same spot. When transplanting, avoid injury to roots and plant resistant species.

Resistant Trees (but not immune)

Apple (Malus)
Beech (Fagus)
Birch (Betula)
Crabapple (Malus)
Fir (Abies)
Hawthorne (Crataegus)
Honey Locust (Gleditsia)
Linden (Tilia)
Mountain Ash (Sorbus)
Mulberry (Morus)
Oak (Quercus)
Pear (Pyrus)
Pines (Pinus)
Poplar (Populus)
Spruce (Picea)
Sycamore (Platanus)
Walnut (Jugulans)
Willow (Salix)
Zelkova (Zelkova)

EXTENSION

Utah State University

Ornamental Tree Disease:

Aspen Leaf Spot

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

Many trees in the genus *Populus* (which includes aspen) and also in *Salix* (the willows) are affected by a leaf spot caused by several species of the fungus *Marssonina*. These trees commonly occur in Utah, and the leaf spot is seen frequently in home plantings and in the canyons and other native habitats. In aspen, *Marssonina* infections result in leaf spotting and premature defoliation.

SYMPTOMS

Leaves are first infected in early spring. Fungal spores are spread by wind and rain to young emerging leaves where small, dark brown flecks with light centers develop. These spots gradually enlarge and coalesce to form large necrotic (dead) blotches on the leaves. Areas around the dark spots usually turn chlorotic or yellow. Within the infection sites, fungal fruiting bodies called acervuli may form. These produce white masses of spores that push through the leaf epidermis and are easily spread by water to cause new infections.

Leaf petioles and terminal shoots are also susceptible to infection. They develop the same type of lesion. Heavy infections of *Marssonina* can cause premature defoliation in the spring and again in the fall if frequent rains occur. Repeated spring defoliation in several successive years may result in the death of the tree. Fall infections and defoliation are not considered to be detrimental to the tree.

Quite often, symptoms of iron deficiency will mimic those of aspen leaf spot. In general, iron deficient leaves are lighter green or yellow overall and not just around the dead areas as in leaf spot. Necrotic lesions associated with iron deficiency are usually limited by the veins while those of leaf spot cross over the veins. It is common to see both conditions on the same leaves.

CONTROL

The fungus survives in infected leaves and twigs over the winter. To reduce the fungal inoculum for next year, fallen leaves may be raked up in the autumn and composted or discarded. Sprinkler irrigation of foliage should be strictly avoided since the splashing water spreads the fungal spores and increases the relative humidity in the planting. Avoid close planting. Allow space for air circulation. Prune out lower branches to improve air circulation and reduce humidity. Trees that are deficient in iron are more susceptible to leaf spot. Therefore, the correction of iron chlorosis by avoiding over-irrigation and treating with chelated iron products will improve tree vigor and make trees more resistant to the fungus.

Some selections or clones of aspen are resistant to leaf spot and should be used when available. However, the susceptibility of trees available in the nursery is usually unknown or variable. If you find that your trees are infected every year, then you might consider removal and replacement with a known resistant selection or another species. Protective fungicide sprays may be applied at bud break and repeated at 10-14 day intervals as long as wet weather continues in the spring. Dry weather slows the spread

of spores so fungicides are unnecessary at these times. The following fungicides are registered for use on shade trees. Apply the fungicide solution until it begins to drip from the leaves.

Chemical	Active Ingredient	Product
Tetrachloroisophalonitrile	chlorothalonil	Broad Spectrum Fungicide Daconil Daconil Lawn and Garden
Copper	copper sulfate, lime	Bordeaux mixture
Fixed Copper	copper hydroxide	
	basic copper sulfate	Kocide 101, Champ
	copper oxychloride sulfate	Microcop, Tri-basic WP COCS, Copro

EXTENSION

UtahState UNIVERSITY

Ornamental Tree Disease: Anthracnose

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

Anthracnose is a fungal disease common throughout Utah on Maple, Sycamore, Oak and Ash. Although in most years it does not cause significant damage, it can be very destructive during years when extended cool wet spring conditions occur. Consecutive years with conditions conducive to disease can seriously weaken trees and may cause death if the conditions persist and control measures are not implemented.

The group of fungi that cause anthracnose produce spore bearing structures called acervuli. The acervuli erupt through the plant tissue and are evident as small black dots on twigs. The fungi that cause anthracnose are *Kabatiella apocrypta* in Maple, *Apiognomonia veneta* in Sycamore, *A. quercina* in Oak and *A. errabunda* in Ash.

SYMPTOMS

The first symptoms occur on leaves as small water soaked lesions. They are usually found along main veins of leaves, but can also occur between the veins. The spots enlarge and eventually turn tan, reddish-brown or black, depending on the species and cultivar of tree affected. Acervuli are then produced by the fungus in the necrotic tissue. Sycamore leaves can become infected as they emerge from buds resulting in blighting of the entire leaf cluster.

Infections on twigs and branches initially appear as discolored depressed areas in the bark followed by splitting bark. Severe infections may even result in death of small branches. Cankers usually develop raised margins resulting from the healing process in the tree. Sycamore branch infections result in multiple lateral shoots called witches brooms.

DISEASE CYCLE

The fungi over-winter in fallen leaves, petioles, twigs or branches. Under cool moist spring conditions the fungi mature and produce spores that are dispersed by wind and rain. Spores that contact susceptible host tissue infect and grow throughout the adjacent tissue leading to the characteristic leaf spot symptoms.

CONTROL

Cultural controls are only marginally effective for anthracnose and are mostly aimed at sanitation by reducing over-wintering sites of the fungi. The effectiveness of sanitation is often minimal because there are many external sources of spores that are blown into the area. Cultural controls should be considered if the tree or adjacent trees have a history of anthracnose. Recommended cultural controls include:

1. Rake and destroy fallen leaves.
2. Prune out and destroy infected twigs and branches.
3. Maintain tree vigor with adequate water and fertilization.
4. Plant resistant cultivars. Sycamore cultivars Bloodgood, Columbia and Liberty are reported to be resistant. Check with your local nursery for resistance information regarding other tree species.

It is usually not necessary to use chemicals to control anthracnose because the fungus only infects when wet conditions persist. Most trees can withstand occasional infections without any serious damage. However chemical controls should be implemented in addition to the cultural controls when cool, wet spring weather occurs year after year. Chemical applications should begin at bud swell and continue at labeled rates and intervals during wet weather. **Table 1** lists registered chemicals for control of anthracnose on Maple, Sycamore, Oak and Ash. Be sure to check the label for specific information about labeled uses and rates.

Table 1 Registered products as of January 2000.

Chemical	**Rate**	**Notes**
Banner MAXX	Maple 5 to 8 fl oz/100gal water	24 hour re-entry
Sycamore	6 to 8 fl oz/100gal water	24 hour re-entry
Oak	16 oz/100gal water	24 hour re-entry
Champ Formula 2	Sycamore 1.3 to 2 pints/Acre	24 hour re-entry
Cleary's 3336 WP	Maple 12 to 16 oz/100 gal water	12 hour re-entry
Sycamore	12 to 16 oz/100 gal water	12 hour re-entry
Oak	12 to 16 oz/100 gal water	12 hour re-entry
Ash	12 to 16 oz/100 gal water	12 hour re-entry
Daconil Weather Stik	Maple 1.4 pints/100 gal water	48 hour re-entry
Sycamore	Daconil 12.5%	48 hour re-entry
Oak	Daconil 12.5%	48 hour re-entry
Ash	Daconil 12.5%	48 hour re-entry
Fore (80%mancozeb)	Maple 1.5 lb/100 gal water	24 hour re-entry
Oak		
Ash		
Kocide DF	Sycamore 2 to 3 lb/Acre	24 hour re-entry
Nu-Cop 50DF	Sycamore 2 to 3 lb/100 gal water	24 hour re-entry
Bayleton	Consult current label for this fungicide before use.	

EXTENSION

Utah State University

Ornamental Tree Disease: Slime Flux

Sherman V. Thomson/Extension Plant Pathologist
Scott C. Ockey/Plant Disease Diagnostician

SYMPTOMS

Slime flux, often called bacterial wet-wood, is a bacterial disease found in many different types of trees. In some trees, particularly willow, this disease results in a white to gray foam that bubbles out from under the bark. In other cases, as with elm and cottonwood, infection results in wet gray to brown areas on limbs and trunk. In the latter case, the slime runs down the bark, discoloring plant tissues and resulting in a build-up of dry scum. Slime flux (wetwood) is a bacterial fermentation of tree tissue, resulting in the disagreeable odor associated with this problem.

The bacteria enter through open wounds in the bark. Wounds as small as cat scratches can serve as avenues of infection; however, more trees are attacked through wounds from improper pruning, boring insects, poor branch angles, tree houses, and lawn mowers. The latter can be avoided by replacing grass around the base of trees with a mulch of gravel or bark or remove grass with herbicides. Improper pruning wounds can be avoided by learning proper pruning techniques. Avoid topping trees.

CAUSE

There are two types of slime flux in Utah, the heartwood type and bark/cambial type. Each type needs to be discussed separately because the treatment is different for each.

The bacteria attacking heartwood result in the build-up of internal pressure up to 60 pounds per square inch. This can cause bursting of the infected tree, but more often the pressure forces the ooze out through cracks that extend from the heartwood (inner portion) to the bark surface. Flux runs down the tree trunk, killing the bark tissue it contacts. It also drips to the ground where it kills grass or other plants, leaving large yellowish, dead areas. Trees are rarely killed with this type of infection.

CONTROL

There is no cure for the heartwood infection that is common in elms, cottonwoods, and other poplar species. Drilling a hole in the infected area and inserting a plastic pipe to drain off the ooze can relieve the internal pressure. This prevents the unsightly slime from running down the trunk or killing the grass, but does not eliminate the infection.

Bark/cambial infections frequently result in death of the tree within 1-2 years. In willow, the bacteria tend to be limited to the tissue between the outer bark and the wood called the cambium. Fermentation produces the offensive odor and slime, but attempting to alleviate the problem by inserting a tube does not relieve the problem. If the fluxing is noted soon enough, the tree can be saved. Waiting and hoping the problem will correct itself often results in a dead tree.

Trees suffering from bark/cambial infections may be saved by promptly cutting away diseased tissue. On small branches it is best to prune the infected branch off at a lateral. With larger branches or trunk infections, remove all discolored bark down to the

wood. Cut around the infected trunk or branch until you come to healthy, yellow-green cambium. In some cases this means removing a lot of bark. If the infection encompasses more than half of the trunk, it is probably best to treat with a chain saw at ground level and start over again with a less susceptible tree.

The next step consists of shaping the wound to allow it to heal properly. Remove infected bark creating an oval shape. The long part of the oval should be parallel with the trunk or limb. Make the margins of the cut smooth and clean. Sterilize the knife with rubbing alcohol between cuts to prevent spread of the bacteria.

The final step involved cleaning the wound with a disinfectant such as rubbing alcohol or a 10% solution of bleach (1 part household bleach and 9 parts water). Watch the treated area for evidence of recurring disease activity. If tissue on the edge of the wound begins to flux, a spot of diseased tissue may have been missed.

Heartwood infections:
Elm
Poplar (Cottonwood)
Boxwood
Russian Olive
Ash

Cambial Infections:
Willow
Mountain Ash
Aspen
Poplar (Cottonwood)
Fruitless Mulberry

EXTENSION

Utah State University

Fruit Tree Disease:
Peach Leaf Curl

Michael A. Ellis Ohio State University

Leaf curl is a springtime disease that occurs on peach, nectarine and related ornamental plants. The disease, though not a problem every spring, can be severe during cool, wet springs that follow mild winters. The leaf curl fungus damages peach trees by causing an early leaf drop. This weakens the trees, making them more susceptible to other diseases and to winter injury. Weakened trees also will produce fewer fruit the following season. Yield may be further reduced when blossoms and young fruit become diseased and drop.

SYMPTOMS

Symptoms of leaf curl appear in the spring. Developing leaves become severely distorted (thickened and puckered), and have a reddish or purple cast. Later, as spores form on the leaf surface, the leaves become powdery gray in color. Shortly after this, the leaves turn yellow or brown and drop.

There is no secondary spread of this disease from leaves infected in the spring to new leaves produced later in the growing season. Once infected leaves drop, no further symptoms will appear during that growing season. Diseased twigs become swollen and stunted, and may have a slight golden cast. They usually produce curled leaves at their tips. Though rarely seen, flowers and fruit may also become diseased. They drop shortly after they are infected. Diseased fruit has shiny, reddish, raised, warty spots.

LIFE CYCLE

Peach leaf curl is caused by the fungus, *Taphrina deformans*. The fungus survives the winter as spores (conidia) on bark and buds. Infection occurs very early in the growing season. During cool, wet spring weather the conidia infect new leaves as they emerge from the buds. Host plant tissues are susceptible for only a short period. As the tissues mature they become resistant. The fungus produces another type of spore (ascospore) on the upper surface of the diseased leaves. During wet weather, ascospores produce additional conidia by budding. These conidia are carried to other parts of the tree by rain and wind, where they will over-winter until the next spring. Environment can limit leaf curl infection. This partially explains why the disease does not occur every year. Leaf curl is worse when the weather is cool and wet. Low temperatures are thought to retard maturation of leaf tissue, thus prolonging the time infection may occur. The fungus can penetrate young peach leaves readily at temperatures between 50 and 70 degrees F, but only weakly below 45 degrees F. Rain is necessary for infection.

CONTROL

Leaf curl is not difficult to control. Since the fungus survives the winter on the surface of twigs and buds, a single fungicide spray, thoroughly covering the entire tree, will provide control. If leaf curl does result in significant defoliation in the spring, the fruit on affected trees should be thinned to compensate for the loss of leaves. Over-cropping the tree will weaken it and make it more susceptible to winter injury.

EXTENSION

UtahState UNIVERSITY

Ornamental Tree Disease: Orange Rust

Michael A. Ellis Ohio State Universtiy

Orange rust is the most important of several rust diseases that attack brambles. All varieties of black and purple raspberries and most varieties of erect blackberries and trailing blackberries are very susceptible. Orange rust does not infect red raspberries.

Unlike all other fungi that infect brambles, the orange rust fungus grows "systemically" throughout the roots, crown and shoots of an infected plant, and is perennial inside the below ground plant parts. Once a plant is infected by orange rust, it is infected for life. Orange rust does not normally kill plants, but causes them to be so stunted and weakened that they produce little or no fruit.

SYMPTOMS

Orange rust-infected plants can be easily identified shortly after new growth appears in the spring. Newly formed shoots are weak and spindly. The new leaves on such canes are stunted or misshapen and pale green to yellowish. This is important to remember when one considers control, because infected plants can be easily identified and removed at this time. Within a few weeks, the lower surface of infected leaves are covered with blister-like pustules that are waxy at first but soon turn powdery and bright orange. This bright orange, rusty appearance is what gives the disease its name. Rusted leaves wither and drop in late spring or early summer. Later in the season, the tips or infected young canes appear to have outgrown the fungus and may appear normal. At this point, infected plants are often difficult to identify. In reality, the plants are systemically infected, and in the following years, infected canes will be bushy and spindly, and will bear little or no fruit.

LIFE CYCLE

Orange rust is caused by two fungi that are almost identical, except for a few differences in their life cycles. *Arthuriomyces peckianus* occurs primarily in the northeastern quarter of the United States and is the causal agent for the disease in Ohio. *Gymnoconia nitens* is a microcyclic (lacks certain spores) stage of *A. peckianus*. *G. nitens* is the more common orange rust pathogen on erect and trailing blackberries in the Southeast.

In late May to early June, the wind and perhaps rain-splash spreads the bright orange aeciospores from the pustules on infected leaves to healthy susceptible leaves where they infect only localized areas of individual mature leaves. When environmental conditions favorable for infection occur, the spores germinate and penetrate the leaf. About 21-40 days after infection, small, brownish black telia develop on the underside of infected leaflets. The teliospores borne in these telia germinate to produce a basidium, which in turn produces basidiospores. These basidiospores then infect buds on cane tips as they root. They also may infect buds or new shoots being formed at the crowns of healthy plants in the summer.

The fungus becomes systemic in these young plants, growing into the crown at the base of the infected shoot, and into newly formed roots. As a result, a few canes from the crown will show rust the following year. The fungus overwinters as systemic,

perennial mycelium within the host. Orange rust is favored by low temperatures and high humidity. Temperatures ranging from 43 to 72 degrees F favor penetration and development of the fungus, but higher temperatures decrease the percentage of spore germination. At 77 degrees F, aeciospores germinate very slowly, and disease development is greatly retarded. Spore germination and plant penetration have not been observed at 86 degrees F. Aeciospores require long periods of leaf wetness before they germinate, penetrate, and infect plants.

CONTROL

Whenever possible, start with disease-free, certified nursery stock. When diseased plants first appear in early spring, dig them out (including roots) and destroy them before pustules form, break open, and discharge the orange masses of spores. If plants are not removed, these spores will spread the disease to healthy plants.

Remove all wild brambles from within and around the planting site. Wild brambles serve as a reservoir for the disease.

Maintain good air circulation in the planting by pruning out and destroying old fruited canes immediately after harvest, thinning out healthy canes within the row, and keeping the planting free of weeds.

Fungicide sprays are generally not considered an effective control method for orange rust.

EXTENSION
UtahState UNIVERSITY

Ornamental Tree Disease: Cedar Rust

Jim Chatfield Ohio State Universtiy
Stephen Nameth Ohio State Universtiy
C. Wayne Ellett Ohio State Universtiy

In some cases these diseases are minor problems, but cedar quince rust and cedar hawthorn rust can be a major problem on hawthorns and cedar apple rust is a major economic consideration in commercial apple production.

SYMPTOMS

Cedar apple rust: On junipers, tan to brownish round to kidney-shaped fungal galls are present in winter and early spring. With moist weather, gaudy bright orange masses of gelatinous spores develop from these galls, and galls swell to several times their original size. Spore masses are several inches in diameter, with a central core and radiating hornlike tendrils, and are highly visible during moist weather in mid-spring.

On apple and crabapple, bright orange-yellow leaf spots develop on upper surfaces of leaves in late spring followed by light colored, fringed cup-shaped structures on lower leaf surfaces several weeks later. Damage on junipers is generally minor and involves presence of the galls and twig dieback. On apples and crabapples, fruit infections and leaf drop also can occur.

Cedar hawthorn rust: On junipers, galls are somewhat smaller than with cedar apple rust disease. Galls continue to produce spores on junipers for more than one year, compared to only one season of spore production with cedar apple rust.
On hawthorn, leaf spots are similar to above and occasionally green twigs are deformed by the fungus.

Cedar quince rust: Infected areas on juniper are much less spectacular than with cedar apple rust, with a cushion-like mat of orangish fungal growth developing on spherical galls in spring.

Cedar quince rust causes the greatest damage of the three rusts to ornamental rosaceous hosts, especially to hawthorns, because of extensive, unsightly fruit infestations, stunting and death of fruits and swelling and distortion of twigs. Infected leaves brown and die. Fruits become covered with orangish-pink spore horns. Unsightly spherical cankers developing on stems can last more than one year.

CAUSE

Rust fungi have complicated disease cycles with a number of different spore types that will not be detailed here. A crucial factor relative to control on these cedar rusts, however, is that there is no repeating spore cycle on the rosaceous hosts. In other words, spores produced on hawthorn will not reinfect hawthorns or other rosaceous plants-they will only reinfect junipers later in the season. Spores produced on juniper will not reinfect junipers-they will only infect the rosaceous host. The alternating host plant is necessary for survival of the fungus.

Spores produced on the juniper host are blown during moist weather to the rosaceous hosts in mid-spring at a time when new growth has emerged. The fungus then causes leaf spots on upper leaf surfaces and while growing in the leaf two strains of the fungus mate and emerge as a new spore form on the lower leaf surface. These spores are then blown back to junipers in mid summer to fall, develop galled areas on the junipers over a one and a half year period and the cycle begins again. Windborne spread of spores between the hosts of several hundred yards is not unusual and spread can be a matter of miles.

CONTROL

Application of fungicides. Protective fungicides can be applied several times starting with prebloom on hawthorn and bud break on crabapples if the disease is chronically a problem at a given site. These applications are to protect the plant from spores being disseminated from the juniper host in mid-spring. Since there is no repeating cycle of this disease on the rosaceous host, further applications after this springtime spread from juniper are unnecessary. Commonly recommended fungicides include: Mancozeb (Fore, Dithane, Mancozeb); Chlorothalonil (Daconil*); Triadimefon (Bayleton, Strike) and propiconazole (Banner). It is the user's responsibility to follow all label instructions.

When you diagnose cedar rust disease from infected hawthorn or crabapple fruits and leaves it is far too late to spray for that year.

Sprays are rarely recommended to protect the juniper host from spores being disseminated from the rosaceous host in late summer and fall.

Eradication of the other host plant. One approach sometimes suggested is to eliminate junipers from around plantings of rosaceous hosts, and vice versa. Concerted efforts to eradicate junipers were historically tried in concentrated apple growing regions.

This practice is limited to some extent by practicality in terms of the widespread occurrence of junipers, long distance spread of the fungi involved, the rights of juniper lovers, and the fact that in most situations cedar diseases are not so serious that such extreme measures are needed. Nevertheless, it is prudent to separate highly susceptible junipers and rosaceous hosts to the extent possible in nursery and landscape situations.

One simple practice where only a few plants are involved is to remove galls from junipers. This is easier to do with cedar apple rust and cedar hawthorn rust, since galled areas are more inconspicuous with cedar quince rust.

Use plants with genetic resistance. A number of juniper species and cultivars and a number of rosaceous plant species and cultivars have varying levels of resistance and susceptibility to these three diseases and where disease pressures are historically high these plants should be used.

EXTENSION

Utah State University

Turfgrass Disease:
Snow Mold

Sherman V. Thomson; Extension Plant Pathologist
Scott C. Ockey; Plant Disease Diagnostician
Cornell University Extension

SYMPTONS

Typhula Blight or gray snow mold, caused by *Typhula incarnata* and related species, is a true snow mold and appears as roughly circular bleached patches up to 2 feet in diameter. The infected grass may be matted and surrounded by a white to gray halo of fluffy fungal growth soon after the snow melts. Examination of the diseased plants reveals tiny tan or brown spherical bodies (sclerotia) on or imbedded in infected leaves. The severity of the disease will vary, and it is particularly severe when turf has been subjected to a prolonged deep compacted snow cover. Although the disease is unsightly, it rarely causes death of the grass.

Fusarium Patch or pink snow mold caused by *Fusarium nivale*, produces similar-looking patches. In contrast to Typhula Blight, a pinkish cast might be observed under wet conditions, and no tan sclerotia are associated with diseased plant tissue. This disease can become severe when turf is subjected to prolonged periods of cool, wet weather from early autumn to late spring, and it does not require snow cover for development as Typhula Blight does. Pink snow mold may cause the rotting of the turfgrass crowns and, therefore, the death of the turfgrass and is worst when snow covers unfrozen ground.

CONTROL

Both diseases can be culturally reduced by avoiding midfall (October) applications of fertilizer which could stimulate succulent (and therefore disease-susceptible) new growth just before freezing weather begins, by continuing to mow turf as long as it continues to grow in the fall, and by avoiding compaction of snow. For gray snow mold apply heavy rates of compost to cover dormant turf.

Remove excess compost in early spring before turf resumes growth. Where winter diseases have caused damage, the matted grass should be raked up in order to encourage new spring growth. For Pink Snow Mold decrease thatch and increase phosphorus. Also improve drainage. Make sure last mowing in fall doesn't leave long matted grass. If reseeding areas where these diseases have been a problem, consider using turfgrass varieties which exhibit some resistance to infection. The following varieties have tolerance to Pink Snow Mold: Kentucky bluegrasses: Flyking, Nassau, Shasta, Victa. Fine fescues: Biljart, Jamestown, Koket, Scaldis.

Apply fungicides before long-lasting snow cover. Systemic fungicides should not be applied to dormant turf. If the occurrence of winter disease have been severe or wide-spread in past years, or if susceptible varieties or species are being grown, a preventative fungicide program may be necessary. It does no good to treat in spring because resting structures have already been formed.

Chemical pesticides are available. If you choose to use chemical pesticides, contact your local Cooperative Extension office for specific recommendations. Apply fungicides to previously affected areas in fall and spring. Fungicides: Banner, Chipco 26019, Cleary 3336, Fore, Fungo, Rubigan, Terraclor (PCNB), Thiram, Vorlan

EXTENSION
UtahState UNIVERSITY

Turfgrass Disease:
Melting Out

L.P. Pottorff, W.M. Brown Jr. and A.J. Koski
Colorado University Extension

Leaf spot and melting out diseases are caused by several species of fungi that used to be classified in the single genus *Helminthosporium.* Most plant pathologists use this name because it is commonly accepted by turf professionals. There are two diseases in this leaf, crown and root disease complex. The first disease is leaf spot caused by the fungus *Bipolaris sorokiniana*. The second disease, melting out, is the more serious of the two and is caused by the fungus *Drechslera poae*.

Both fungi attack cool season turfgrasses (Kentucky bluegrass, ryegrass and tall fescue). Leaf spot disease appears during cool, moist weather, spring or fall, while melting out disease is active during warmer weather.

SYMPTOMS

Leaf spot. Symptoms first appear as small, purple to black specks on the leaf blades (Figure 1). These spots become elliptical and may be surrounded by a dark purple border. Tissue in the center of the spot may die and turn a beige or straw color. If the spot extends across the leaf, the blades wither and die.

Melting out. This disease also starts out as a black to purple leaf spot. As the disease progresses, the fungus works its way to the plant's base and attacks the roots and crown. Basal tissues near the ground become dark brown and rot. This stage is called melting out because the grass gradually thins and "melts out" the diseased area. The turf appears yellowish, thin and shabby with irregular patches of dead grass. When these areas are raked, the dead grass plants are easily removed.

CAUSE

The pathogens responsible for leaf spot and melting out survive from year to year as spores or mycelium (fungal threads) in dead plant debris, in the thatch layer, and in infected plant parts.

Both diseases are favored by dry periods alternating with cloudy, wet weather and cool to moderate temperatures. The diseases are enhanced by the use of susceptible cultivars, excessive nitrogen fertilizer, excess water, and a short mowing height.

CONTROL

Leaf spot and melting out are diseases of stressed turf. The severity of the disease can be controlled by proper cultural practices that maintain the grass at optimum vigor.

Use resistant varieties when establishing or re-establishing a lawn. Core aerate the lawn once a year (spring or fall) to help reduce thatch buildup and improve soil condition. Mow grass as necessary to maintain a height of 2 1/2 to 3 inches. Make sure mower blades are sharp. Never remove more than one-third of the grass blade at a time. Water to a depth of 6 to 8 inches as infrequently as possible without creating water stress. Water in the morning or midday so the leaf blades dry as quickly as

possible. Avoid excessive applications of nitrogen fertilizer, which induce tender, succulent growth and more susceptible tissue.

Fungicides are rarely needed to control leaf spot disease. However, if melting out disease has occurred repeatedly in the same areas over a number of years, a fungicide may be warranted. Broad spectrum fungicides such as chlorothalonil (Daconil Ultrex, Daconil Zn, Daconil Weather Stik – use of these products on home lawns is prohibited), iprodione (Chipco 26019 – prohibited at residential sites), or mancozeb (Fore) should give adequate control. Chemicals are most effective when combined with cultural controls.

Remove loose thatch before treatment. If a preventive spray program is used, apply the first fungicide at the first sign of leaf spot once the grass begins to grow in the spring. Make additional applications according to label directions as need develops. Turf should not be drought-stressed prior to spraying or irrigated immediately after application. Be sure to follow the instructions on the fungicide label for specific rates to use and timing of application.

EXTENSION

Utah State University

Turfgrass Disease:
Necrotic Ringspot

Sherman V. Thomson; Extension Plant Pathologist
Scott C. Ockey; Plant Disease Diagnostician

The fungus, *Ophiosphaerella korrae*, causes necrotic ring spot. This fungus survives in soil, and infects the crowns, roots and rhizomes of grass plants. Hosts are Kentucky bluegrass, red fescue and annual bluegrass. There are some references to necrotic ring spot occurring on creeping bentgrass, but it is not considered a serious disease of this host. Severe damage most frequently occurs on Kentucky bluegrass turfs in the third or fourth year following sodding.

SYMPTOMS

Symptoms of necrotic ring spot are visually indistinguishable from those of summer patch. Affected turf shows 6- to 12-inch circular patches of straw-colored plants. In turfs with a heavy thatch, deteriorating plants collapse creating doughnut-shaped depressions and giving the affected area a pockmarked look. Many of the patches have a small tuft of healthy grass in the center creating a ring or frogeye appearance. Infection spreads outward until some of the patches coalesce, producing a large blighted area. Plants growing in sites where the disease occurred the previous year often break dormancy late and appear stunted.

Plants at the edges of the patches are easily pulled as roots, rhizomes and crowns are progressively infected. These tissues are dark brown in comparison to the tan color of healthy tissues. Stripping back leaf sheaths reveals brown to black lesions on the crowns. Infected rhizomes and roots are similarly discolored. Microscopic examination reveals thread-like fungal hypha growing over infected roots and rhizomes.

CAUSE

Necrotic ring spot commonly occurs in May and June following cool, wet weather. The onset of warm weather in summer slows disease development, but symptoms may reappear during heat and drought stress. The disease occurs in more acid-type soils and is more acute in compacted sites. On non-compacted soils, the roots may actually outgrow the infection. Dense turf with heavy thatch tends to be more prone to infection since the pathogen reproduces on old stems and rhizomes.

CONTROL

1. Aerate to reduce thatch in early spring.
2. Nitrogen fertilizer should be applied frequently and at low rates when the grass is actively growing. Use an acid type fertilizer like ammonium sulfate.
3. Keep mowing height at 2.5 - 3 inches.
4. Water infrequently but deeply.
5. Apply fungicides where necrotic ringspot has been a problem.
6. Replant with several grass species with resistance.

Fungicides:* Chipco 26019, Fungo, Rubigan, Banner Max, Heritage, Eagle, Sentinel

EXTENSION

Utah State University

Turfgrass Disease:

Summer Patch & Necrotic Ringspot

Sherman V. Thomson; Extension Plant Pathologist
Scott C. Ockey; Plant Disease Diagnostician

Summer patch and necrotic ringspot of turf are common fungal diseases in the lawns of Utah. Summer patch is cause by *Phialophora graminicola* and necrotic ringspot by *Leptosphaeria korrae*.

SYMPTOMS

Necrotic ringspot of turf is a cool weather disease. It usually occurs during the months of March through May, and September through November. Symptoms consist of dead circles or arches that range in size from several inches to several feet in diameter. Often, the disease will create a "frog-eye" or "doughnut" in the lawn. A "frog-eye" is a small, circular patch of green lawn surrounded by a ring of dead or dying grass. Microscopic examination of the grass crown and leaf sheaths reveals the presence of dark hyphae of the fungus.

Summer patch is a warm weather disease. Symptoms are present during the months of May through September. The symptoms are similar to those of necrotic ringspot, consisting of the dead circles and arches that range in size from several inches to several feet in diameter. The summer patch fungus also produces the microscopic, dark hyphae on the surface of the grass crowns and the leaf sheaths. These hyphae tend to be larger than those found with necrotic ringspot but are much less common on the plant tissue.

CULTURAL CONTROLS

Cultural techniques that prevent the lawn from becoming stressed will help prevent these two diseases. In early spring or fall, the lawn should be aerated. Aeration improves water penetration and reduces thatch, thus alleviating conditions that cause stress. Nitrogen fertilizer should be applied frequently at low rates or in slow release forms such as sulfur coated urea or IBDU. This avoids undesirable flushes of growth which are more susceptible to disease. Mow the lawn at a height of 2-3 inches often enough so that only 30-40% of the leaf length is removed per mowing. In most soils, the lawn should be watered infrequently and deeply. Sandy soils will require more frequent, light irrigation. Wet the entire rot zone when irrigating.

CHEMICAL CONTROLS

Cultural techniques provide the most reliable control of these diseases, but in difficult situations fungicides may be necessary. Summer patch can be controlled with Tersan 1991, Fungo 50, Rubigan, and Cleary's 3336. The turf area to be treated should be irrigated the night before. The next day the fungicides should be applied and irrigated in before they dry on the foliage. These fungicides are best used as a preventative. Bayleton can also control summer patch, but it must be applied before the fungus becomes active in early summer.

Fungicides available for the control of necrotic ringspot of turf include Tersan 1991, Fungo 50, Rubigan, and Chipco 26019. These fungicides should be applied in the same manner as those mentioned for summer patch control.

EXTENSION

Utah State UNIVERSITY

Turfgrass Disease: Fairy Ring

L.P. Pottorff
Colorado University Extension

Fairy ring is a common disease of Kentucky bluegrass and most other turfgrass species. It is caused by many mushroom fungi that live in the soil and thatch layer. Damage often is unsightly and sometimes a serious problem even on well-maintained lawns. Fairy rings develop over a wide range of fertility levels and soil and climatic conditions. The disease tends to be worse on lawns maintained at low soil moisture and fertility levels.

SYMPTOMS

Early symptoms of infection appear as circular or partial ring-bands of lush green grass that vary from less than 1 foot to many feet in diameter. Most rings range from 3 - 12 feet. Eventually the deep green grass in the ring-band dies. Mushrooms or puffballs of the fungus may appear in the rings following periods of wet weather.

CAUSE

How fairy rings begin is unknown. Fungi that cause fairy rings commonly live in forest areas. It is thought that they begin to grow on a source of organic matter such as an old stump, dead roots, or wood left over from building construction that was buried during the landscaping process. The fungi grow radially outward in the soil or thatch layer of the turfgrass. Fungi that cause fairy ring live by decomposing organic litter that is abundant in the turfgrass thatch. The lushness of the stimulated zone occurs because the fungi release nitrogen as they decompose the organic matter in the thatch and soil.

The dead zone contains grass plants that may be killed or dormant, mostly as a result of insufficient soil moisture. This ring of drought-stressed plants occurs because of an extensive network of mycelium or dense mold produced by the fungus. This mycelial layer prevents water from infiltrating into the soil and reaching turf roots.

CONTROL

To prevent the disease, don't bury organic debris, such as stumps and waste lumber, before establishing a lawn. Maintain optimum growing conditions for turfgrass with proper watering, fertilization and thatch control.

To control an established fairy ring, aerate the entire diseased area every 4 inches, plus an additional 2 feet beyond its visible limits. Disinfect core cultivators after use to prevent accidental spread of the fungus into healthy grass. Following aeration, soak the infected area with water. Add a wetting agent to help water penetrate. Hand water these areas to prevent over-watering of adjacent healthy turfgrass.

Areas of dark green grass often can be masked with light applications of nitrogen fertilizers that stimulate adjacent turf growth.

When the disease is severe, it may be necessary to renovate the affected turf. Fungicides drenched into the soil are not recommended; their success has been very limited. Prostar fungicide provides suppression.

EXTENSION

Utah State UNIVERSITY

Turfgrass Disease: Powdery Mildew

L.P. Pottorff
Colorado University Extension

Powdery mildews are one of the most widespread and easily recognized plant diseases. They affect virtually all kinds of plants: cereals and grasses, vegetables, ornamentals, weeds, shrubs, fruit trees, and broad-leaved shade and forest trees.

SYMPTOMS

Even though there are several types of powdery mildew fungi, they all produce similar symptoms on plant parts. Powdery mildews are characterized by spots or patches of white to grayish, talcum-powder-like growth. Tiny, pinhead-sized, spherical fruiting structures that are first white, later yellow-brown and finally black, may be present singly or in a group.These are the cleistothecia or over-wintering bodies of the fungus.

The disease is most commonly observed on the upper sides of the leaves. It also affects the bottom sides of leaves, young stems, buds, flowers and young fruit. Infected leaves may become distorted, turn yellow with small patches of green, and fall prematurely. Infected buds may fail to open.

CAUSE

The severity of the disease depends on many factors: variety of the host plant, age and condition of the plant, and weather conditions during the growing season. Powdery mildews are severe in warm, dry climates. This is because the fungus does not need the presence of water on the leaf surface for infection to occur. However, the relative humidity of the air does need to be high for spore germination. Therefore, the disease is common in crowded plantings where air circulation is poor and in damp, shaded areas. Incidence of infection increases as relative humidity rises to 90 percent, but it does not occur when leaf surfaces are wet (e.g., in a rain shower). Young, succulent growth usually is more susceptible than older plant tissues.

Powdery mildews are host specific -- they cannot survive without the proper host plant. For example, the species *Uncinula necator*, which causes powdery mildew on grape and linden, does not attack lilac. Similarly, *Microsphaea alni* affects elm, catalpa, lilac and oak but not turfgrass.

Powdery mildews produce mycelium (fungal threads) that grow only on the surface of the plant. They never invade the tissues themselves. The fungi feed by sending haustoria, or root-like structures, into the epidermal (top) cells of the plant. The fungi over-winter on plant debris as cleistothecia or mycelium. In the spring, the cleistothecia produce spores that are moved to susceptible host tissue by splashing raindrops, wind or insects.

CONTROL

Several practices will reduce or prevent powdery mildews. Many plants, such as roses, vegetables and Kentucky bluegrass, are developed to be resistant or tolerant to

powdery mildew. Inquire about resistant varieties before a purchase. If resistant varieties are unavailable, do not plant in low, shady locations.

Once the disease becomes a problem avoid late-summer applications of nitrogen fertilizer to limit the production of succulent tissue, which is more susceptible to infection. Avoid overhead watering to help reduce the relative humidity. Remove and destroy all infected plant parts (leaves, etc.). For infected vegetables and other annuals, remove as much of the plant and its debris in the fall as possible. This decreases the ability of the fungus to survive the winter. Do not compost infected plant debris. Temperatures often are not hot enough to kill the fungus. Selectively prune overcrowded plant material to help increase air circulation. This helps reduce relative humidity and infection.

If cultural controls fail to prevent disease buildup or if the disease pressure is too great, an application of a fungicide may be necessary. These include:
sulfur, neem oil (Rose Defense, Shield-All, Triact), triforine (Ortho Funginex), ornamental use only, or potassium bicarbonate (Kaligreen, First Step). Chemicals are most effective when combined with cultural controls.

Apply fungicides at 7 to 14 day intervals to provide continuous protection throughout the growing season. Follow the instructions on the fungicide label for use on specific plant species, varieties, rates to be used, timing of applications, and waiting periods before harvest.

An alternative nontoxic control for mildew is baking soda (similar to the potassium bicarbonate listed above) combined with a lightweight horticultural oil (Sunspray). Researchers at Cornell University have discovered the fungicidal properties of this combination against powdery mildew on roses. Applications of 1 tablespoon baking soda plus 2.5 tablespoons of Sunspray oil in 1 gallon of water are still experimental. Use it at your own risk.