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## EC07-1895 Pesticide Selection Guide for Plant Diseases Affecting Woody Ornamentals and Herbaceous Perennials in Nebraska

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# Pesticide Selection Guide for Diseases Affecting Woody Ornamentals and Herbaceous Perennials in Nebraska

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This publication contains a list of the most prominent disease problems affecting the woody ornamental industry in Nebraska. While not intended to be a comprehensive list of *all* potential disease problems, this publication also contains information on pesticides registered for control of diseases affecting woody ornamentals and herbaceous perennials in Nebraska.

## Disclaimer

Federally registered pesticides, that are also registered with the Nebraska Department of Agriculture for the control of listed diseases in this publication, are presented under the management section for most listed diseases. In several instances the specific disease may not be listed on the pesticide label. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Section 2(ee) allows for the use of a pesticide to be applied on a label-listed site (host plant) if the label does not limit use for the specific pests listed on that host. This is allowable only if the pesticide is known to have activity against a similar pest or the pest is considered to be in the same group. In some instances the pesticide label is worded very broadly for ornamental use and may not list the host.

A pesticide label is a legal document and the law requires that pesticide applicators follow label instructions for use and disposal. This publication does not replace or supersede any information on the pesticide label. Neither the University of Nebraska–Lincoln Department of Plant Pathology nor the Nebraska Department of Agriculture assumes liability resulting from the use of listed products in this publication. Users should always read and follow the pesticide label.

Pesticide registration and labels change frequently. It is important to maintain current information regarding pesticide applications, labeled usage, worker protection, material safety data sheets (MSDS), and pesticide labels. Current information can be found at the following Web sites:

- Nebraska Department of Agriculture Pesticide Registrations: [www.kellysolutions.com/ne/pesticideindex.htm](http://www.kellysolutions.com/ne/pesticideindex.htm)
- Greenbook: [www.greenbook.net](http://www.greenbook.net)
- Crop Data Management Systems (CDMS): [www.cdms.net](http://www.cdms.net)

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## How To Use This Guide

This guide is divided into six main sections. The first section, ***Developing a Successful Disease Management Program***, presents information on developing and implementing an IPM program for diseases affecting woody ornamentals and herbaceous perennials.

In the second section, ***Host/Pest Guide to Plant Diseases on Woody Ornamentals and Host/Pest Guide to Plant Diseases on Herbaceous Perennials***, woody plants and herbaceous perennials are listed alphabetically by common name and each additionally includes the plant diseases commonly associated with each host.

The third section, ***Select Agent and High Risk Pathogen List for Woody Ornamentals and Herbaceous Perennials***, lists high risk pathogens that have been identified by USDA, APHIS under the Agricultural Bioterrorism Protection Act of 2002 as a severe threat to plant health or products.

In the fourth section, ***Woody Ornamental Hosts and Diseases, and Herbaceous Perennial Hosts and Diseases***, woody ornamentals and herbaceous perennials are listed alphabetically by common name, including the diseases commonly associated with each plant. Fungicide/bactericides active ingredients listed represent the best information available and do not constitute a complete list. They are intended for disease control in the nursery and landscape. They are not intended for disease control on trees producing fruit for consumption. These pesticides are **NOT** listed in order of effectiveness or safety.

The fifth section, ***General Disease Guide on Woody Ornamental and Herbaceous Perennials***, describes abiotic and biotic diseases commonly associated with woody ornamentals and herbaceous perennials.

The final section, ***Fungicide/Bactericide Information***, contains the names of common active ingredients of fungicides and bactericides listed in this publication. They are arranged alphabetically including the corresponding chemical group names, trade names and manufacturers.

# Developing a Successful Disease Management Program

Disease management is essential in maintaining plant health in nursery and landscape environments. This section focuses on developing an effective disease management program for the diseases affecting woody ornamentals and herbaceous perennials in Nebraska.

## Implementing an IPM Program

Integrated Pest Management (IPM) is an ecosystem-based strategy aimed at long-term prevention of pests, or the injury they cause, by combining several management strategies including biological control, resistance, cultural methods, sanitation, and chemical control.

Planning ahead is important in establishing a successful disease management program. For example, choice of site, cultivars, plant spacing, irrigation, fertility regimes, and weed control methods for nursery and landscape plantings can greatly influence the types and levels of disease that develop. Effectively managing a given disease requires understanding the nature of the disease: the time of year it occurs, the environmental conditions that favor its development, the symptoms, and the biology of the disease-causing organism.

Five major components are common to all IPM programs: pest identification; field monitoring; control action guidelines; pest prevention; and integration of various management strategies including sanitation, cultural practices, host resistance, and biological and chemical control.

**Pest Identification.** Causes of disease are diverse and include biotic (living) causes (pathogens) such as fungi, bacteria, viruses, nematodes and phytoplasmas, and abiotic (non-living) factors such as environmental stresses, nutrient deficiencies, and chemical injury. Because of this, management strategies effective against one disease may not be effective against another. Therefore, diseases must be accurately diagnosed before management actions are taken. Plant samples showing disease symptoms can be taken to your local extension office or submitted to the Plant and Pest Diagnostic Clinic at UNL for accurate diagnosis. See page 47 for details.

**Field Monitoring.** Diseases can be recognized by the symptoms they cause. These symptoms are varied and include leaf spots, leaf and twig blights, yellowing of foliage, wilting, stunting, water soaking, galls, mosaic or mottling, ring spots, cankers, and plant decay. Different pathogens can cause similar symptoms. Diseases can also be recognized by observing signs of the pathogen on the plant part in question. Examples of pathogen signs include mycelium, fruiting structures, or spores

of a fungus; bacterial ooze; or cysts or egg masses of a nematode. For optimum control, it is essential to detect disease at the very first appearance. This can be accomplished through a regular, systematic scouting program.

**Scouting for Diseases.** Scouting is a critical component of an integrated disease management program in the nursery or landscape. Scouting is usually carried out by a trained employee and should be done regularly. It can be specific or general. A general scouting program focuses on many different plant species and includes observations on all aspects of plant health. A specific scouting program focuses on specific crops or diseases. Such a program must be knowledge-based and can be expensive and time-consuming. This is because several diseases can occur during a given period and the time and money spent on scouting for each disease individually can be considerable depending on the number of diseases. Scouting in a nursery can be done in blocks of plants. A block can be scouted in a number of different patterns. The most commonly used patterns are zig-zag, W-shaped and X-shaped. Scouting involves stopping at selected intervals and examining plants for above- and below-ground disease symptoms.

**Record-Keeping.** During disease monitoring, keep records of symptoms, plant parts on which symptoms are observed, how widespread the symptoms are, prevailing environmental conditions (especially prior to symptom appearance), and the disease level. Disease levels can be expressed as incidence (percentage of infected plants) or severity (percentage of symptomatic tissue). Severity can be expressed on a scale other than percent, for example on a 0-5 or a 0-10 scale. Scouting records, if properly kept all year round for several years, can be used to detect patterns. For example, the time of year a particular disease usually appears or the environmental conditions usually associated with a given disease, can be determined from multiple years of records. Control action guidelines can be developed from this information.

**Control Action Guidelines.** Tolerable injury level is defined as the pest density (or level of damage) where the cost of pest control is less than the cost of the damage caused by the pest. A more widely used term resulting from this concept is economic injury level. The term aesthetic injury level is used for ornamental pests. This level is defined as the pest density or level of pest damage the public will tolerate. Aesthetic tolerances vary widely among people. For many pests, it is too late to treat by the time the tolerable injury level is reached. A more useful control action guideline is the treatment threshold, also known as the economic threshold. It specifies the pest density at which to treat to prevent unacceptable loss. For many pests and especially for diseases, treatment must be applied before unacceptable levels are reached. Diseases are best managed preventively based

on knowledge about the disease, environmental conditions and host susceptibility.

**Pest Prevention.** Preventing disease occurrence is basic to an IPM program for nursery and landscape plantings. Some ways to prevent disease include starting with pathogen-free planting stock and growing media; planting disease resistant, locally adapted cultivars; choosing appropriate planting sites and spacing in the landscape; using cultural practices favorable to plant growth but unfavorable to disease; and maintaining plant health by using best management practices.

**Integrating Disease Management Strategies.** No single disease management strategy is adequate. The best approach to managing disease is to integrate as many available strategies as possible. The following section outlines the various strategies that can be combined into an effective integrated disease management program.

## Disease Management Options

Information for controlling diseases in nursery and landscape plantings with an IPM strategy is detailed below. Some strategies are effective against several diseases whereas some are effective against specific diseases.

### Sanitation

Sanitation reduces the amount of inoculum and inoculum carryover from one crop to the next. Sanitation is accomplished by removing dead or dying plants or plant parts; disinfecting containers, benches, machinery, tools, and personal protective equipment and clothing; and using pathogen-free planting stock and growing media. Cull piles of infected or dead plant material should not be left outside greenhouses or near nursery and landscape plantings where pathogens or pathogen vectors can easily travel to healthy plantings. Containers and growing media should be covered until used to prevent contamination with pathogens.

### Cultural Practices

Using cultural practices to manage diseases works by minimizing plant contact with a pathogen, creating a balance of environmental conditions favorable to the plant but unfavorable to the pathogen, and eradicating or reducing the amount of inoculum. There are several cultural practices that can be used to manage diseases in the nursery or landscape.

**Fertilization.** A proper fertilization regimen ensures plants get adequate nutrients for optimum growth. Healthy, vigorously growing plants are less prone to pathogen attack than plants weakened by inadequate fertilization. Over-fertilizing promotes succulent growth which increases susceptibility. Know when to fertilize and

the appropriate fertilizer amounts for each plant species.

**Irrigation.** Just like fertilization, proper irrigation is necessary for optimum plant growth. Over-watering can promote conditions favorable to disease development since most pathogens require free water to infect plants. Overhead irrigation should be avoided or, if used, applied early in the morning and not late in the afternoon or in the evening.

**Plant Spacing.** Good air circulation within the canopy keeps the foliage dry, an unfavorable condition for germination of pathogen spores. To promote good air circulation in the nursery, arrange plants in rows oriented to the direction of air flow. Don't crowd them. Good air circulation also ensures that all plants get enough of the carbon dioxide and oxygen they need for photosynthesis and respiration, respectively.

**Aeration and Drainage of Soil or Growing Media.** For healthy and vigorous root growth, the soil or growing media should be well aerated and drained. Water-logged soil conditions prevent oxygen from reaching the roots and promote root diseases, especially those caused by water molds such as *Phytophthora* and *Pythium*. It is important to know water requirements for each plant species since some plants require wet soils.

**Selection of Planting Site.** When planting in the landscape, it is important to select plant species well adapted to the local environment. Choice of planting site can greatly influence plant health. Avoid sites not suitable for optimum plant growth.

**Mulching.** Proper mulching promotes plant health. Mulch should be 2 to 3 inches deep and at least 6 inches from a tree trunk. Inorganic mulches increase soil temperature and susceptibility of plants to diseases. Over-mulching or piling the mulch against the trunk can lead to buildup of excessive moisture, which promotes root rot. It also can cause disease problems associated with death of the inner bark tissue or wounds created by rodents.

**Pruning.** Certain diseases of woody ornamentals can be managed by pruning. Examples are fire blight, galls, cankers, and shoot or branch dieback. For some diseases such as fire blight, pruning is best done during the dormant season. Pruning should be avoided during rainy weather to prevent disease spread. Disinfect pruning tools between cuts.

### Biological Control

Biological control is an option for managing diseases of woody ornamentals and herbaceous perennials. However, used alone, biological control products often are not adequate. Usually the disease-suppressing microorganisms in the biological control products require time to

reproduce and build up populations on the plant surface, in the soil or in growing media. This means that initial populations of these microorganisms may not provide maximum protection immediately following application. Biological control products targeting soil-borne diseases tend to work better in containers than in the field.

### Host Resistance

Many plant pathogens tend to be host-specific, so plant a diversity of species in the landscape. This increases the likelihood that some species will survive in the event of a severe outbreak of a disease to which one or a few plant species are susceptible. In areas where there is a history of a disease problem, plant resistant cultivars if available.

### Chemical Control

**Pesticides Used to Control Diseases.** With good sanitation, environmental control, cultural management and use of resistant cultivars, many woody ornamental and herbaceous perennial crops can be produced at high quality with little or no use of chemicals. When necessary, fungicides, bactericides and nematocides can be used to control diseases caused by fungi, bacteria and nematodes, respectively. Of these pesticides, fungicides are the most widely used to control diseases in the nursery and landscape. There are no chemical control alternatives for viruses and phytoplasmas. Diseases caused by viruses (for example, rose mosaic) and phytoplasmas (for example, aster yellows) can be managed to some extent by controlling their insect vectors. See *Pesticide Selection Guide for Insects and Mites Affecting Woody Ornamentals and Herbaceous Perennials in Nebraska*, EC1566, for more information.

Fungicides should be used in combination with other IPM practices. Fungicides are commonly used when favorable conditions for disease development cannot be avoided and/or when highly susceptible cultivars are planted. There are two general groups of fungicides: protectant and systemic.

**Protectant Fungicides.** Protectant fungicides remain on the surface of the plant where they are deposited. They kill the pathogen or pathogen spores on contact, hence they are also called contact fungicides. To be effective, protectant fungicides must be applied before infection occurs. Protectant fungicides kill by targeting multiple sites (metabolic processes) in the pathogen.

**Systemic Fungicides.** Systemic fungicides are absorbed and translocated within the plant. They are most effective when applied preventively, or before disease occurs. However, they can eradicate established infections and therefore offer both protectant and curative activity. Systemic fungicides usually target a single site (metabolic process) in the pathogen. Curative

activity of systemic fungicides is effective only if disease development has not progressed too far. Once inside the plant, systemic fungicides are protected from wash-off and weathering. Therefore, their residual activity is generally longer than that provided by protectant fungicides.

**Fungicide Mode of Action.** Fungicide mode of action describes the specific mechanism by which the fungicide alters normal growth of the target pathogen. There are many different groups of fungicides including: carbamates, carboxamides, DMI fungicides and QoI fungicides, for example. Grouping of fungicides is based mainly on their mode of action.

**Fungicide Application Timing.** Timing of fungicide applications is critical in achieving effective disease control. Fungicide timing depends on the disease and host species. In mature landscapes, fungicide applications are rarely needed. If you need to apply fungicides on herbaceous perennials in the landscape, apply at the first appearance of disease. On trees in the landscape, start fungicide applications early in the spring and repeat at intervals specified on the label. For control of a specific tree disease using fungicides, consult your local extension office for a fungicide spray schedule. In the nursery, timing of fungicide applications should be based on regular scouting for disease detection. As a rule of thumb and based on disease history from several years of scouting records, fungicide applications should be made when disease first appears or when environmental conditions favor disease development.

### Management of Fungicide Resistance

**Fungicide Resistance.** Fungicide resistance is the ability of a fungal pathogen to develop tolerance to a fungicide that was previously toxic. That is, the fungus becomes insensitive to a fungicide to which it was previously sensitive. Resistance to a specific fungicide is caused by a genetic mutation in a pathogen population resulting in a resistant strain of the pathogen. Due to selection pressure, the resistant strain gradually builds up its population and, with time, the fungicide becomes more and more ineffective.

**Cross Resistance.** A genetic mutation in a pathogen that confers resistance to a particular fungicide can often cause the pathogen to become resistant to another fungicide with the same mode of action. This is known as cross-resistance.

**Mechanisms of Fungicide Resistance.** Mechanisms of fungicide resistance include change in fungicide binding site, detoxification (rendering the fungicide harmless), and reduced fungicide penetration. Development of resistance to multisite fungicides (protectants) is rare or slow because multiple mutations in the pathogen



would have to occur simultaneously, which is unlikely. Development of resistance to single site fungicides (systemic fungicides), on the other hand, is common because only a single mutation is needed.

**Strategies for Managing Fungicide Resistance.** The following are strategies for management of fungicide resistance:

- Do not use a given fungicide in isolation. Rotate it or apply it as a mixture with one or more fungicides with different modes of action.
- Limit the number of treatments applied during a single growing season and apply only when necessary as dictated by host susceptibility or environmental conditions favorable to disease development.

- Apply fungicides at the manufacturer's recommended dose.
- Ensure thorough coverage of the plant surface to avoid sublethal doses on parts of the plant. Sublethal doses can result in resistance buildup in the pathogen population.
- Avoid eradicant use, that is, apply fungicides preventively (even if they are systemic), or at the very first appearance of disease.
- Apply fungicides in combination with other IPM practices.

# Select Agent and High Risk Pathogen List on Woody Ornamentals and Herbaceous Perennials

Plant diseases covered in this publication:

Chrysanthemum White Rust  
Plum Pox  
Sudden Oak Death

## Host/Pest Guide to Plant Diseases on Woody Ornamentals

Plant diseases and hosts covered in this publication:

### Ash

Ash Rust  
Anthracnose  
Canker  
Leaf Spot

### Azalea/Rhododendron

Crown and Root Rot  
Leaf Spot  
Powdery Mildew  
Sudden Oak Death

### Birch

Leaf Spot  
Rust

### Boxwood

Canker  
Leaf Spot

### Buckthorn

Crown Rust

### Catalpa

Powdery Mildew  
Verticillium Wilt

### Cedar/Juniper

Cedar-Apple Rust  
Cedar-Hawthorn Rust  
Cedar-Quince Rust  
Cercospora Blight  
Tip Blight

### Cotoneaster

Fire Blight  
Leaf Spot

### Dogwood

Canker  
Crown Canker  
Leaf Spot  
Powdery Mildew

### Elm

Anthracnose  
Dutch Elm Disease

### Euonymus

Crown Gall  
Powdery Mildew

### Fir

Canker  
Sudden Oak Death  
Tip Blight

### Firethorn

Fire Blight  
Scab

### Forsythia

Canker

### Hackberry

Hackberry Mosaic

### Hawthorn

Cedar-Hawthorn Rust  
Cedar-Quince Rust  
Fire Blight  
Leaf Spot

### Honeysuckle

Leaf Blight  
Powdery Mildew

### Lilac

Powdery Mildew  
Root Rot  
Sudden Oak Death  
Twig Blight

### Linden

Leaf Spot

## Host/Pest Guide to Plant Diseases on Woody Ornamentals (continued)

### Locust

Canker

### Magnolia

Leaf Spot  
Powdery Mildew  
Root Rot  
Sudden Oak Death

### Maple

Anthraxnose  
Leaf Spot  
Tar Spot  
Verticillium Wilt

### Mountain Ash

Canker  
Fire Blight  
Rust

### Nut Trees (hickory, pecan, walnut, etc)

Anthraxnose  
Leaf Spot  
Scab

### Oak

Anthraxnose  
Leaf Spot  
Oak Leaf Blister  
Oak Wilt  
Sudden Oak Death  
Verticillium Wilt

### Pine

Brown Spot  
Needle Blight  
Needle Cast  
Pine Gall Rust  
Pine Wilt Nematode  
Tip Blight

### Pome Fruits (apple, pear, etc)

Canker  
Cedar-Apple Rust  
Cedar-Quince Rust  
Crown, Root and Stem Rots  
Crown Rot  
Fire Blight  
Frogeye Leaf Spot  
Scab

### Poplar (aspen, cottonwood)

Canker  
Leaf Rust  
Leaf Spot

### Privet

Crown and Root Rot  
Powdery Mildew  
Twig Blight

### Redbud

Canker  
Verticillium Wilt

### Rose

Black Spot  
Botrytis Blight  
Brown Canker  
Powdery Mildew  
Rose Mosaic  
Rose Rosette  
Rust

### Serviceberry

Cedar-Quince Rust  
Fire Blight  
Powdery Mildew

### Spirea

Fire Blight  
Leaf Spot

### Spruce

Canker  
Needle Cast  
Tip Blight

### Stone Fruits (cherry, plum, peach, etc.)

Black Knot  
Brown Blossom Rot and Twig Blight  
Canker  
Leaf Curl  
Leaf Spot - Bacterial  
Leaf Spot - Fungal  
Plum Pox  
Powdery Mildew

### Sycamore

Anthraxnose  
Powdery Mildew

### Viburnum

Leaf Spot  
Powdery Mildew  
Sudden Oak Death

### Willow

Canker

### Yew

Crown and Root Rot  
Sudden Oak Death

# Host/Pest Guide to Plant Diseases on Herbaceous Perennials

Plant diseases and hosts covered in this publication:

## **Ajuga**

Crown Rot

## **Aster**

Aster Yellows

Botrytis Stem Rot and Flower Blight

Fusarium Wilt

Leaf Spot

Powdery Mildew

Rust

## **Chrysanthemum**

Botrytis Blight

Foliar Nematode

Leaf Spot

Powdery Mildew

Verticillium Wilt

White Rust

## **Columbine**

Crown and Root Rot

Powdery Mildew

## **Daylily**

Anthracnose

Daylily Rust

Leaf Streak

Root Rot

## **Delphinium**

Crown and Bud Rot

Leaf Spot

Powdery Mildew

## **Geranium (perennial)**

Botrytis Blight

Leaf Spot - Bacterial

Leaf Spot - Fungal

Rust

Stem and Root Rot

## **Hibiscus**

Crown and Root Rot

## **Hosta**

Crown and Root Rot

Foliar Nematode

Hosta Virus X

## **Iris**

Crown and Root Rot

Leaf Spot - Bacterial

Leaf Spot - Fungal

Sclerotium Root Rot

## **Peony**

Botrytis Blight

Crown and Root Rot

Leaf Spot

White Mold

## **Periwinkle (vinca)**

Crown and Root Rot

Stem Blight

## **Phlox**

Gray Mold

Leaf Spot

Powdery Mildew

# General Diseases on Woody Ornamentals and Herbaceous Perennials

Plant diseases covered in this publication:

## Abiotic Diseases

- Air Pollutants
- Drought
- Frost
- Nutrient Deficiency
- Scorch
- Sun Scald
- Tatters
- Winter Desiccation

## Biotic Diseases

- Cankers
- Crown and Root Rot
- Leaf Spot
- Nematodes
- Phytoplasmas
- Powdery Mildew
- Rust
- Viruses

## Select Agent and High Risk Pathogen List for Woody Ornamentals and Herbaceous Perennials

At the time of this publication's printing, none of these select agents or high risk pathogens have been identified in Nebraska. These diseases and descriptions are included for awareness. If plant material is suspected to be infected with one of these diseases, please contact Nebraska Department of Agriculture (NDA) personnel for more information. It is best for regulatory personnel to examine plant material and determine if it requires sampling. NDA personnel are trained in the proper method of sampling and submission to a diagnostic facility for examination.

Disease (Pathogen)	Description	Management
<b>Plum Pox</b> ( <i>Plum pox potyvirus</i> , PPV)	<p>This viral disease affects stone fruits (<i>Prunus</i> spp.). It is transmitted in a non-persistent manner by aphids and potentially by humans during the grafting process.</p> <p>Symptoms may be expressed on leaves, fruits, flowers and seeds. Leaves may exhibit yellowing or chlorosis in ring patterns or along the veins. Infected fruits may have symptoms of yellow or light green rings. Plum or apricot fruits may also be deformed with depressions. Flowers of infected <i>Prunus</i> spp. may have ring patterns or streaking. In general, fruit quality, size and quantity are adversely affected in PPV infected trees.</p>	<p>Management of PPV involves conducting field surveys, eradicating infected trees, planting certified nursery stock, controlling aphids and using resistant cultivars if available.</p> <p>Plum Pox Virus was placed on the Agricultural Bioterrorism Select Agent listing in June 2002, and then removed in March 2005, because it does not spread easily and would be difficult to spread intentionally. Regardless, it does remain a highly regulated pathogen.</p>
<b>Sudden Oak Death</b> ( <i>Phytophthora ramorum</i> )	<p><i>Phytophthora ramorum</i> can infect many woody trees and shrubs, including plants in the Red Oak group, <i>Rhododendron</i> spp. and several plants in the family <i>Ericaceae</i>. Symptoms of <i>P. ramorum</i> infection are difficult to differentiate from those caused by other pathogens on the potential hosts. Overall symptoms of this disease include bark cankers, leaf lesions or blight, and twig dieback; symptoms may vary depending on the host. Leaf lesions appear the same from the top and bottom of the leaf as they penetrate through the tissue. Lesions may be concentrated along the leaf midvein, leaf edges, or anywhere that water tends to collect.</p> <p>An updated host list for <i>P. ramorum</i> can be found at the following APHIS PPQ Web site: <a href="http://www.aphis.usda.gov/ppq/ispm/pramorom">http://www.aphis.usda.gov/ppq/ispm/pramorom</a>.</p>	<p>If plant material is suspected of being infected with <i>P. ramorum</i>, the Nebraska Department of Agriculture personnel should be contacted. Plants found to be infected are destroyed, as there are no chemical control measures currently available. Because <i>P. ramorum</i> is a regulated organism, state regulatory officials will coordinate the destruction and disposal procedures.</p> <p>Regulation of Sudden Oak Death is explained in Title 7, Code of Federal Regulations (CFR) 301.92.</p>

**Select Agent and High Risk Pathogen List for Woody Ornamentals and Herbaceous Perennials (continued)**

<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>
<b>White Rust</b> <i>(Puccinia horiana)</i>	Chrysanthemum White Rust is a quarantine-significant pest in the United States. Symptoms include small white to yellow lesions on the upper leaf surface, which may turn brown over time. Pustules form on the leaf's underside directly beneath the lesions seen on the upper surface. Pustules may be buff to pink in color initially and turn white with age. Symptoms may be slowed during hot, dry conditions as the disease is favored by cooler, wet weather.	NDA personnel should be contacted if chrysanthemum is suspected of being infected with white rust.  Chrysanthemum White Rust is not established in the United States and is a pest of quarantine significance (Title 7, Code of Federal Regulations (CFR) 319.37-2(a), 319.37-5(c)), requiring appropriate regulatory measures when found.

## Woody Ornamental Hosts and Diseases

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Ash</b>	Ash Rust ( <i>Puccinia sparganoides</i> )	Yellow lesions on leaves, petioles and green twigs; lesions become swollen and distorted and develop into gall-like growths; bright orange clusters appear on the gall-like growths; lesions eventually turn brown and wither; cankers develop on twigs and leaves fall to the ground.	Control alternate grass host (Cordgrass ( <i>Spartina</i> spp.)) near nurseries; foliar fungicide application.	myclobutanil, propiconazole, thiophanate-methyl
	Anthracnose ( <i>Gnomoniella fraxinii</i> )	Presence of pinpoint-sized, purple to brown lesions on fallen leaflets and rachises; blotchy black lesions appear on older succulent foliage; lesions turn tan as they mature; lesions on expanding leaves cause leaf distortion; small, elliptical cankers on young twigs; twig dieback.	Sanitation; improve air circulation; foliar fungicide application.	mancozeb, myclobutanil, thiophanate-methyl
	Canker ( <i>Cytospora</i> spp., <i>Fusicoccum</i> spp. and <i>Nectria</i> spp.)	Discolored, sometimes sunken area with a distinct border on branches and twigs; internal discoloration under bark; may girdle small branches.	Prune out affected areas.	None recommended
	Leaf Spot ( <i>Mycosphaerella</i> spp.)	Lesions on leaves are light-colored with discrete margins; lesions coalesce to form larger necrotic areas; premature defoliation with severe infections.	Sanitation; irrigate early in the morning; foliar fungicide application.	chlorothalonil, mancozeb, thiophanate-methyl
<b>Azalea/ rhododendron</b>	Crown and Root Rot ( <i>Armillaria mellea</i> , <i>Phytophthora</i> spp., <i>Pythium</i> spp. and <i>Rhizoctonia solani</i> )	Plants wilt; leaves turn yellow; leaves droop downward; stunting; brown lesion on the stem at soil line; roots are reddish-brown, brown, or black in color.	<i>Armillaria</i> and <i>Rhizoctonia</i> – sanitation; drench fungicide application.	<i>Armillaria</i> and <i>Rhizoctonia</i> – azoxystrobin, iprodione, trifloxystrobin
			<i>Phytophthora</i> and <i>Pythium</i> – sanitation; improve soil drainage; resistant varieties; drench fungicide application.	<i>Phytophthora</i> and <i>Pythium</i> – etridiazole, fosetyl-aluminum, mefenoxam



## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Azalea/ rhododendron</b> (continued)	Leaf Spot ( <i>Botrytis cinerea</i> , <i>Cercospora</i> <i>rhododendri</i> , <i>Colletotrichum</i> <i>azaleae</i> , <i>Phyllosticta</i> spp. and <i>Septoria azaleae</i> )	<i>Botrytis</i> – alternating light and dark-colored areas on leaves.  <i>Cercospora</i> – brown circular to irregular lesions; lesions become tan in center; yellow halo. <i>Colletotrichum</i> – small, olive to rusty brown lesions. <i>Phyllosticta</i> – marginal leaf area with lesions; lesions dark brown and zonate; frequently cover half the leaf area. <i>Septoria</i> – yellow lesions turning dark brown at the center; red or purple margins; premature defoliation.	Sanitation; prune out affected areas; increase air circulation; foliar fungicide application.	fludioxonil, iprodione, propiconazole
	Powdery Mildew ( <i>Erysiphe penicillata</i> )	White, powdery lesions on young leaves; eventually the lower or upper surface of leaves are covered with white growth.	Sanitation; good air circulation; lowering humidity levels at night, in greenhouses; foliar fungicide application.	myclobutanil, propiconazole, pyraclostrobin
	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Brown to black lesions with diffuse margins, often water-soaked; lesions follow along the mid-vein or anywhere water tends to collect; shoot tip and stem blight with brown to black discoloration; blighting of entire leaf.	See select agent and high risk pathogen section page 13.	
<b>Birch</b>	Leaf Spot ( <i>Colletotrichum gloeosporioides</i> , <i>Cylindrosporium betulae</i> and <i>Septoria betulae</i> )	<i>Cylindrosporium</i> and <i>Septoria</i> – small lesions without defined borders. <i>Colletotrichum</i> – larger brown lesions with brown to black borders.	Sanitation; foliar fungicide application.	mancozeb, thiophanate-methyl, trifloxystrobin
	Rust ( <i>Melampsorium betulina</i> )	Angular brown lesions with yellow borders on the upper surface of leaf; powdery, bright orange-yellow pustule on the lower leaf surface.	Sanitation; foliar fungicide application.	myclobutanil, thiophanate-methyl, triadimefon

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Boxwood</b>	Canker ( <i>Nectria</i> spp., and <i>Pseudonectria</i> <i>rouselliana</i> )	Leaves are light green to yellow; leaves eventually turn tan; leaves turn upward and lie close to branch; twig dieback; small, sunken cankers on branches.	Sanitation; prune out affected areas.	None recommended
	Leaf Spot ( <i>Macrophoma</i> <i>candollei</i> and <i>Volutella buxi</i> )	<i>Macrophoma</i> – conspicuous black dots on leaves; fairly uniform on surface. <i>Volutella</i> – cream-colored to light pink, mealy-appearing growth on the lower leaf surface.	Sanitation; prevent winter desiccation; foliar fungicide application.	azoxystrobin, iprodione, thiophanate-methyl
<b>Buckthorn</b>	Crown Rust ( <i>Puccinia coronata</i> )	Swollen, yellow-green lesions on upper leaf surface; white tube-like structures on lower leaf surface with orange-yellow spores in spring to early summer; alternate hosts are oats, ryegrass and bluegrass.	No management recommended as this is not a significant problem affecting overall plant health.	None recommended
<b>Catalpa</b>	Powdery Mildew ( <i>Erysiphe</i> spp.)	Powdery white patches on leaves; leaves may appear wrinkled; can cause premature defoliation.	Sanitation; foliar fungicide application.	myclobutanil, thiophanate-methyl, trifloxystrobin
	Verticillium Wilt ( <i>Verticillium</i> <i>albo-atrum</i> )	Small, yellow foliage; leaf scorch; slow growth; dieback of shoots and branches; sudden wilting and collapse of tree; streaking of vascular tissue of wood.	Sanitation; avoid root injury; avoid water stress; soil fumigation if replanting susceptible species.	dazomet
<b>Cedar/Juniper</b>	Cedar-Apple Rust ( <i>Gymnosporangium</i> <i>juniperi-virginianae</i> )	In the autumn, greenish-brown globose to kidney-shaped galls appear on twigs; in the spring, the galls become gelatinous and bright orange-yellow in color.	Remove galls; avoid overhead irrigation; foliar fungicide application.	mancozeb, propiconazole, thiophanate-methyl
	Cedar-Hawthorn Rust ( <i>Gymnosporangium</i> <i>globosum</i> )	In the autumn, greenish-brown globose to kidney-shaped galls appear on twigs; in the spring, the galls become gelatinous and bright orange-yellow in color.	Remove galls; avoid overhead irrigation; foliar fungicide application.	mancozeb, propiconazole, thiophanate-methyl
	Cedar-Quince Rust ( <i>Gymnosporangium</i> <i>clavipes</i> )	Cigar-shaped galls on small twigs; in the spring, galls become gelatinous and bright orange-yellow in color.	Remove galls; avoid overhead irrigation; foliar fungicide application.	mancozeb, propiconazole, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Cedar/Juniper</b> (continued)	Cercospora Blight ( <i>Cercospora sequoiae</i> var. <i>juniperi</i> )	First appears on inner branch needles and in lower portions of tree; needles are dull brown or red in color; needles eventually drop; small, hair-like fungal structures are visible on dead needles.	Prune out affected areas; improve air circulation; avoid over-fertilization; avoid overhead irrigation resistant varieties; foliar fungicide application.	azoxystrobin, thiophanate-methyl, triadimefon
	Tip Blight ( <i>Kabatina juniperi</i> and <i>Phomopsis juniperovora</i> )	<i>Kabatina</i> – terminal 2 to 6 inches of branches turn dull green and then red or yellow; small, ash-gray to silver lesions dotted with black fruiting bodies are present at the base of the needle, tips eventually turn brown and drop; symptoms appear in February and March, before Phomopsis. <i>Phomopsis</i> – foliage is dull red or brown; foliage eventually turns an ash-gray; small gray lesions on the foliage; small, black fruiting bodies develop within the lesion; branch tips may become girdled; repeated blighting can cause witches'-broom, discoloration of foliage, stunting and plant death.	Prune out affected areas; improve air circulation; avoid over-fertilization; avoid overhead irrigation; resistant varieties; foliar fungicide application.	mancozeb, pyraclostrobin, thiophanate-methyl
<b>Cotoneaster</b>	Fire Blight ( <i>Erwinia amylovora</i> )	Young shoots wilt and quickly turn a scorched brown to black; dead tips may have a shepherd's-crook shape.	Remove infected plants or prune out affected areas; grow plants in full sun; avoid overhead irrigation; foliar bactericide application.	copper
	Leaf Spot ( <i>Entomosporium mespili</i> )	Small, irregular, reddish brown lesions on the upper and lower leaf surface; symptoms develop on the lower portion of the plant first; white bumps present in center of lesion; leaf yellowing and defoliation.	Sanitation; improve air circulation; avoid overhead irrigation; foliar fungicide applications.	azoxystrobin, mancozeb, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Dogwood</b>	Canker ( <i>Botryodiplodia theobromae</i> and <i>Cytospora</i> spp.)	Smaller and paler leaves; premature color change and drop; blackened or water-soaked areas on the bark; black liquid oozes from canker.	Prune out affected areas.	None recommended
	Crown Canker ( <i>Phytophthora cactorum</i> )	Reduction in the number and size of leaves; leaf color is lighter; wilting; leaves turn prematurely yellow or red; premature defoliation; gradual dieback of twigs and branches; canker develops on the lower trunk near the ground line; dark-colored ooze from canker; sapwood discolored.	Sanitation; avoid wounding the crown region.	None recommended
	Leaf Spot ( <i>Ascochyta cornicola</i> , <i>Botrytis cinerea</i> , <i>Cercospora cornicola</i> and <i>Septoria cornicola</i> )	<i>Ascochyta</i> – grayish brown, square to round leaf lesions; brown to red halo; leaves blacken and wither. <i>Botrytis</i> – large, irregularly shaped, brown blotches. <i>Cercospora</i> – angular to irregularly shaped tan to brown lesions; heavily spotted leaves turn yellow; premature defoliation. <i>Septoria</i> – angular brown leaf lesions; broad purple border.	Sanitation; improve air circulation; avoid overhead irrigation; foliar fungicide application.	iprodione, thiophanate-methyl, trifloxystrobin
	Powdery Mildew ( <i>Erysiphe pulchra</i> and <i>Phyllactinia guttata</i> )	White, granular textured colonies on the upper and lower leaf surface; reddish discoloration, curling, stunting, or scorching of the young leaves.	Sanitation; increase air circulation; resistant cultivars; foliar fungicide application.	myclobutanil, pyraclostrobin, triadimefon
<b>Elm</b>	Anthraxnose ( <i>Stegophora ulmea</i> )	Small yellow lesions on the upper leaf surface as they unfold; white to light-yellow halo surrounding lesion; lesions rapidly expand and coalesce; lesion may girdle petioles; successive infections may cause witches'-brooms of the twigs.	Sanitation; avoid close spacing; avoid overhead irrigation; foliar fungicide application.	mancozeb, myclobutanil, thiophanate-methyl
	Dutch Elm Disease ( <i>Ophiostoma ulmi</i> )	Leaves of individual branches turn yellow and wilt; leaves eventually turn brown; dark brown streaking in the sapwood.	Remove infected trees; resistant varieties.	None recommended

## Woody Ornamental Hosts and Diseases (continued)

<i>Host</i>	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Euonymus</b>	Crown Gall ( <i>Agrobacterium tubefaciens</i> )	Cream-colored galls on branches or crown area; aged galls become rough and brown; plants may be stunted; lack normal green color; die back during severe winters.	Remove infected plants; soil fumigation if replanting with susceptible variety.	dazomet
	Powdery Mildew ( <i>Erysiphe penicillata</i> )	Small, scattered white patches of fungal mycelia on leaves and tender stems.	Sanitation; prune out heavily affected areas; improve air circulation; reduce humidity in greenhouses; foliar fungicide applications.	thiophanate-methyl, triadimefon, trifloxystrobin
<b>Fir</b>	Canker ( <i>Cytospora</i> spp. and <i>Sphaeropsis</i> spp.)	Discolored, sunken bark with brown, dead cambium underneath; resinosis and fungal fruiting bodies may occur in canker margins; small branches may be girdled.	Prune out affected areas during dry weather; minimize stress and mechanical damage.	None recommended
	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Needle blight; death of new shoots and small branches.	See select agent and high risk pathogen section page 13.	
	Tip Blight ( <i>Sirococcus strobilinus</i> )	Branch tips, especially on the current year's leader, turn brown and often curl; fruiting structures may be present at base of needles.	Avoid overhead irrigation; increase light penetration; foliar fungicide applications.	chlorothalonil, mancozeb, thiophanate-methyl
<b>Firethorn (Pyracantha)</b>	Fire Blight ( <i>Erwinia amylovora</i> )	Blighting of flowers and expanding twigs and leaves; blighted area appears black to brown; diseased twigs curl downward forming a shepherd's crook.	Sanitation; prune out affected areas; avoid overfertilization; resistant varieties; foliar bactericide application.	copper, fosetyl-aluminum, streptomycin sulfate
	Scab ( <i>Spilocaea pyracanthae</i> )	Velvety, soot-like areas on shiny green leaves; leaves turn yellow then eventually dark brown; premature defoliation; black lesions on new twig growth; twig girdling and dieback; infected fruit turns black; fruit skin becomes rough and scabby.	Sanitation; avoid overhead irrigation; resistant varieties; foliar fungicide application.	myclobutanil, mancozeb, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Forsythia</b>	Canker ( <i>Sclerotinia sclerotiorum</i> )	Scattered branches suddenly wilt; sunken canker on affected branches; bits of white, fluffy fungal growth (mycelium) and black sclerotia present in canker.	Sanitation; prune out affected areas; increase air circulation.	None recommended
<b>Hackberry</b>	Hackberry Mosaic ( <i>Hackberry mosaic virus</i> )	Yellow block patterned chlorosis on leaves; leaf areas affected are generally square in shape.	Remove infected plants.	None recommended
<b>Hawthorn</b>	Cedar-Hawthorn Rust ( <i>Gymnosporangium globosum</i> )	Small, pale yellow lesions on upper leaf surface; lesions are slightly raised; lesions eventually turn a shiny yellow-orange; in midsummer, off-white to light orange tubes protrude on lower leaf surface.	Prune out affected area; foliar fungicide applications.	mancozeb, propiconazole, thiophanate-methyl
	Cedar-Quince Rust ( <i>Gymnosporangium clavipes</i> )	Petioles, thorns and twigs swell and turn orange; spindle-shaped galls; twig galls expand and girdle stems; black flat lesions form on fruit.	Prune out affected area; foliar fungicide application	mancozeb, propiconazole, thiophanate-methyl
	Fire Blight ( <i>Erwinia amylovora</i> )	Young twigs and branches die from tips; burned appearance; branches may bend into a shepherd's crook; dead leaves generally remain attached.	Prune out affected areas; avoid over-fertilization; resistant varieties; foliar bactericide application.	copper, fosetyl-aluminum
	Leaf Spot ( <i>Entomosporium mespili</i> )	Small, irregular, reddish-brown lesions on the upper and lower leaf surface; raised bumps appear in the center of lesions; tissue between lesions turns yellow; coalescing lesions may blight entire leaf.	Sanitation; avoid overhead irrigation; foliar fungicide application.	chlorothalonil, myclobutanil, trifloxystrobin
<b>Honeysuckle</b>	Leaf Blight ( <i>Insolibasidium deformans</i> )	New leaves are crinkled and rolled; interveinal tissues turn yellow and brown; brown lesions with yellow halos; leaves eventually turn brown and curl; white spores are visible on the lower leaf surface; premature defoliation.	Sanitation; prune out severely affected areas; avoid overhead irrigation; increase air circulation; foliar fungicide application.	mancozeb, myclobutanil, thiophanate-methyl
	Powdery Mildew ( <i>Erysiphe</i> spp.)	Leaves covered with a powdery white to gray-colored fungal growth (mycelium); new leaves distorted and stunted.	Sanitation; improve air circulation; decrease humidity in greenhouses; foliar fungicide application.	myclobutanil, propiconazole, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Juniper – See Cedar</b>				
<b>Lilac</b>	Powdery Mildew ( <i>Erysiphe alni</i> )	Grayish-white fungal growth on leaf surface; new leaves distorted; premature defoliation.	Sanitation; improve air circulation; foliar fungicide application.	azoxystrobin, thiophanate-methyl, triadimefon
	Root Rot ( <i>Armillaria mellea</i> , <i>Cylindrocladium</i> spp. and <i>Thielaviopsis basicola</i> )	Plants stunted and yellow; plants wilt and die; white fungal growth (mycelium) between the bark and the wood; dark brown to black lesions scattered on the roots.	Drench fungicide application.	flutolanil, thiophanate-methyl, trifloxystrobin
	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Brown to black leaf lesions with diffused margins, lesions are often water soaked.	See select agent and high risk pathogen section page 13.	
	Twig Blight ( <i>Pseudomonas syringae</i> )	Brown lesions on leaves; lesions enlarge and coalesce; leaves become misshapen; leaves eventually die; twig girdling; shoots turn black, droop over and die.	Sanitation; prune out affected areas; avoid overhead irrigation; foliar bactericide application.	copper
<b>Linden</b>	Leaf Spot ( <i>Cercospora microspora</i> )	Brown circular lesions with dark brown borders; lesions coalesce; premature defoliation with severe infection.	Sanitation; improve air circulation; foliar fungicide application.	fludioxonil, mancozeb, thiophanate-methyl
<b>Locust</b>	Canker ( <i>Cytospora</i> spp. and <i>Thyronectria austroamericana</i> )	Thin, chlorotic foliage; premature defoliation; failure of spring leaf development; twig dieback; yellow or orange-brown to black discolored areas; cankers are flattened, sunken, oval areas on the undersides of branches or along the trunk.	Sanitation; prune out affected areas; resistant varieties.	None recommended
<b>Magnolia</b>	Leaf Spot ( <i>Colletotrichum gloeosporioides</i> and <i>Phyllosticta magnoliae</i> )	<i>Colletotrichum</i> – angular brown lesions; yellow halo; blister-like fruiting body develops on upper surface of the lesion; pink spore mass oozes from fruiting body. <i>Phyllosticta</i> – tiny purple to black lesions on upper leaf surface; center of lesions turn off-white; faint yellow halo.	Sanitation; improve air circulation; avoid overhead irrigation; foliar fungicide application.	azoxystrobin, mancozeb, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Magnolia</b> (continued)	Powdery Mildew ( <i>Erysiphe penicillata</i> )	White to buff-colored, cottony fungal growth (mycelium) on leaf surface; premature defoliation.	Sanitation; improve air circulation; foliar fungicide application.	chlorothalonil, sulfur, thiophanate-methyl
	Root Rot ( <i>Phytophthora cinnamomi</i> )	Yellowing of leaves; sudden wilting of leaves; slowed shoot growth; premature defoliation; limb dieback; plant death.	Sanitation; avoid over watering; improve soil drainage; dranch fungicide application.	etr Diazole, fosetyl-aluminum, propamocarb hydrochloride
	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Brown to black leaf lesions with diffused margins, often water soaked.	See select agent and high risk pathogen section page 13.	
<b>Maple</b>	Anthrachnose ( <i>Discula campestris</i> and <i>Kabatella</i> spp.)	Light brown, purple or black lesions on leaf surface; large, irregular, dead areas on leaf; leaf scorch; leaves curl and turn black; premature defoliation.	Sanitation; improve air circulation; foliar fungicide application.	chlorothalonil, myclobutanil, thiophanate-methyl
	Leaf Spot ( <i>Phyllosticta minima</i> )	Tan to brown circular to irregular lesions; purple-brown margins; small, black fruiting bodies may be visible on upper surface of lesion.	Sanitation; avoid overhead irrigation; foliar fungicide application.	mancozeb, thiophanate-methyl, triadimefon
	Tar Spot ( <i>Rhytisma</i> spp.)	Initially, small, pale yellow lesions; lesions enlarge and yellow color intensifies; a black lesion develops in each yellow lesion; black lesion grows in diameter and thickness.	Sanitation; foliar fungicide application.	mancozeb, myclobutanil, triadimefon
	Verticillium Wilt ( <i>Verticillium albo-atrum</i> )	Leaves turn yellow at the margins; margins eventually turn brown and dry; sudden wilting of leaves; typically only one side of the tree wilts; the wood is chocolate-brown in color in bands, streaks or flecks; tree death.	Sanitation; remove infected plants; avoid root injury; avoid water stress; soil fumigation if replanting with susceptible species.	dazomet
<b>Mountain Ash</b>	Canker ( <i>Cytospora</i> spp.)	Brown, circular or irregular sunken cankers on branches; cankers enlarge and girdle branch; black fruiting bodies on infected bark; yellow spore ooze from fruiting bodies during wet weather.	Sanitation; prune out affected areas.	None recommended



## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Mountain Ash</b> (continued)	Fire Blight ( <i>Erwinia amylovora</i> )	Flower clusters killed; dark brown to black cluster color; long, slightly sunken cankers at new growth plate; slime may ooze from the canker in warm weather.	Prune out affected areas; avoid over fertilization; foliar bactericide application.	copper
	Rust ( <i>Gymnosporangium cornutum</i> )	Reddish-brown to purple lesions on upper leaf surface; horn-like structures on lower leaf surface in late summer; branches can be affected; premature defoliation and branch dieback.	Remove galls on affected juniper species (alternate host); foliar fungicide application.	mancozeb, propiconazole, thiophanate-methyl
<b>Nut Trees</b> (hazelnut, hickory, pecans, walnuts, etc.)	Anthracnose ( <i>Colletotrichum</i> spp. and <i>Genomonia leptostyla</i> )	Tiny dark-brown or black circular to irregularly circular lesions; generally lesions enlarge; yellowish to golden leaf tissue borders lesions; premature defoliation; fruit have sunken, dark lesions.	Sanitation; improve air circulation; resistant varieties; foliar fungicide application.	chlorothalonil, thiophanate-methyl, triadimefon
	Leaf Spot ( <i>Cristularilla pyramidalis</i> , <i>Microstroma juglandis</i> and <i>Mycosphaerella</i> spp.)	<i>Cristularilla</i> – Grayish brown lesions on leaf surface; concentric ring formations on lower leaf side; center of lesions turn a light brown and become darker brown toward the edge. <i>Microstroma</i> – Light green, spotty discoloration on leaf surface; lesions vary in size and may coalesce; lower leaf surface has powdery, white, fuzzy lesions. <i>Mycosphaerella</i> – lesions first appear on lower leaf surface as small yellow lesions which turn white then brown and are visible on upper leaf surface; leaf scorch; trees have a yellowish appearance.	Sanitation; improve air circulation; resistant varieties; foliar fungicide application.	chlorothalonil, thiophanate-methyl, triadimefon
	Scab ( <i>Cladosporium</i> spp.)	Initially small, circular, olive-green lesions on leaves; lesions eventually turn black; lesions expand and coalesce.	Sanitation; improve air circulation; resistant varieties; foliar fungicide application.	chlorothalonil, propiconazole, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Oak</b>	Anthracnose ( <i>Apiognomonia quercinia</i> )	Leaf symptoms range from large areas of browning especially along leaf margins and veins to scattered small necrotic lesions; leaves have a scorched appearance; twig dieback; premature defoliation.	Sanitation; prune out affected areas; foliar fungicide application.	myclobutanil, propiconazole, thiophanate-methyl
	Leaf Spot ( <i>Tabakia dryina</i> )	Dark to reddish brown circular lesions; yellow halo; lesions may coalesce to form irregular blotches; premature defoliation.	Sanitation; increase air circulation; foliar fungicide application.	azoxystrobin, myclobutanil, thiophanate-methyl
	Oak Leaf Blister ( <i>Taphrina caerulescens</i> )	Yellow, blister-like, circular raised areas on the upper leaf surface; gray depressions on the lower leaf surface; blisters eventually turn a reddish-brown with pale yellow margins.	Sanitation; foliar fungicide application.	chlorothalonil, myclobutanil, thiophanate-methyl
	Oak Wilt ( <i>Ceratocystis fagacearum</i> )	Subtle off-green color shift in the upper tree crown; leaves wilt from the top of the crown downward; individual leaves discolor having a "bronzed" appearance; progresses around the leaf margins from the tip to the base; leaves cast rapidly; defoliation occurs within a few weeks for red oaks; disease progresses slower in white oaks; tree death.	Remove infected trees; avoid tree wounding; can spread with root grafts.	None recommended
	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Rapid browning of leaves which remain attached to branches; bleeding from discolored cankers on lower trunk or branches.	See select agent and high risk pathogen section page 13.	
	Verticillium Wilt ( <i>Verticillium</i> spp.)	Leaves turn yellow at the margins; margins eventually turn brown and dry; sudden wilting of leaves; typically only one side of the tree wilts; the wood is chocolate-brown in color in bands, streaks or flecks; tree death.	Sanitation; remove infected plants; avoid root injury; avoid water stress; resistant varieties; soil fumigation if replanting with susceptible variety.	dazomet
	<b>Pine</b>	Brown Spot ( <i>Mycosphaerella</i> spp.)	Reddish brown, resin-soaked lesions on needles; spotted needles turn yellow; eventually needles turn brown from the tips back.	Sanitation; avoid shearing during wet weather; resistant varieties; foliar fungicide application.

## Woody Ornamental Hosts and Diseases (continued)

<i>Host</i>	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Pine</b>	Needle Blight ( <i>Dothistroma pini</i> )	Deep-green bands; yellow and tan lesions on needle; bands and lesions turn brown to reddish brown; ends of needles turn light green, tan and brown; base of needle remains green; needles may develop extensive browning.	Sanitation; avoid shearing during wet weather; resistant varieties; foliar fungicide application.	chlorothalonil, thiophanate-methyl, triadimefon
	Needle Cast ( <i>Cyclaneusma minus</i> and <i>Lophodermium seditiosum</i> )	<i>Cyclaneusma</i> – light green to yellow lesions on needles; lesions develop into brown bands; needles turn yellow and then brown; fruiting bodies develop on the brown bands; mature fruiting bodies expose a waxy, white to yellowish surface. <i>Lophodermium</i> – small pale lesions, which turn yellow and then a reddish-brown; yellow margins; lesions enlarge to give the needle a mottled appearance; needles brown and die; premature needle drop.	Improve air circulation; avoid prolonged periods of needle wetness; avoid water stress; avoid nutrient deficiencies; resistant varieties; foliar fungicide application	iprodione, thiophanate-methyl, triadimefon
	Pine Gall Rust ( <i>Endocronartium harknessii</i> )	Conspicuous, perennial, globose galls on stems; from May to June, powdery orange-yellow spores are produced on the galls; very young galls are sometimes spindle shaped rather than spherical.	Remove infected plants or prune out affected areas.	None recommended
	Pine Wilt Nematode ( <i>Bursaphelenchus xylophilus</i> )	Yellowing and then browning of needles; brown needles remain attached; little resin flow in dead material; trees often decline quickly.	Sanitation; remove infected plants.	None recommended
	Tip Blight ( <i>Sphaeropsis sapinea</i> )	Current year shoots are stunted, brown and die; infected tissue is resin soaked; affected shoots become bent or curled; black fruiting bodies appear at the base of dead needles, shoot tissue and on pine cone scales.	Sanitation; prune out affected areas; avoid shearing during wet weather; foliar fungicide application.	iprodione, myclobutanil, thiophanate-methyl
<b>Pome Fruits (common and ornamental apple, crabapple, pear, quince, etc.)</b>	Canker ( <i>Botryosphaeria</i> spp. and <i>Nectria</i> spp.)	Girdling of the tree; dieback of branches and limbs; small circular or elliptical areas of brown tissue; wood within the young cankers appears water-soaked.	Sanitation; prune out affected areas; resistant varieties.	None recommended

## Woody Ornamental Hosts and Diseases (continued)

<i>Host</i>	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Pome Fruits</b> (continued)	Cedar-Apple Rust ( <i>Gymnosporangium juniperi-virginianae</i> )	Small, yellow to orange lesions on upper leaf surface; black dots appear in the lesions; tiny orange-colored tubes form on lower leaf surface opposite of the lesions.	Resistant varieties; foliar fungicide application.	myclobutanil, pyraclostrobin, thiophanate-methyl
	Cedar-Quince Rust ( <i>Gymnosporangium clavipes</i> )	Infects only the fruit not the leaves; slightly raised purplish area on the calyx end of the fruit; mature fruit, lesions are sunken and dark green or purple; powdery, fluorescent orange spores.	Resistant varieties; foliar fungicide application.	myclobutanil, pyraclostrobin, thiophanate-methyl
	Crown, Root and Stem Rot ( <i>Rosellinia necatrix</i> and <i>Xylaria mali</i> )	Premature leaf coloration and defoliation; absence of new shoot growth; leaves are smaller than normal; fruit stop growing and may shrivel; white fungal growth (mycelium) present on roots; roots are brittle and easily broken.	Remove infected plants; discontinue irrigation to that area of production; drench fungicide application.	flutolanil, PCNB, thiophanate-methyl
	Crown Rot ( <i>Phytophthora</i> spp.)	Delayed bud break; leaf discoloration; twig dieback; fruit remain small and color prematurely; premature leaf coloration and defoliation; partial or complete girdling of the trunk; roots are reddish-brown in color; water-soaked areas of necrotic tissue at the root base; wood first appears orange to red-brown which eventually turns dark brown.	Sanitation; improve soil drainage; resistant rootstocks; drench fungicide application.	fosetyl-aluminum, propamocarb hydrochloride
	Fire Blight ( <i>Erwinia amylovora</i> )	Blighting of flowers expanding to twigs and leaves; blighted area appears black to brown; diseased twigs curl downward forming a shepherd's crook.	Sanitation; prune out affected areas; avoid over-fertilization; resistant varieties; foliar bactericide application.	copper, fosetyl-aluminum, streptomycin sulfate
	Frogeye Leaf Spot ( <i>Botryosphaeria obtuse</i> )	Circular leaf lesions; irregular purple margins; lesions eventually become brown with defined margins; enlarged and defined margins gives a "frogeye" appearance.	Sanitation; prune out affected areas; foliar fungicide application.	mancozeb, myclobutanil, trifloxystrobin
	Scab ( <i>Venturia</i> spp.)	Olive green lesions appear on leaves; lesions are often concentrated around leaf veins which are discolored; leaf growth is distorted; brown to black lesions on foliage, fruit and stems; fruit have rough "scabby" areas.	Sanitation; resistant varieties; foliar fungicide application.	mancozeb, myclobutanil, thiophanate-methyl

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Poplar (aspen, cottonwood)</b>	Canker ( <i>Cytospora</i> spp. and <i>Nectria cinnabarina</i> )	Yellow or orange-brown to black discolored areas on trunk and branches; liquid ooze from canker area; cankers, sunken dead areas of bark; reddish brown discoloration of the wood.	Sanitation; prune out affected areas; resistant varieties.	None recommended
	Leaf Rust ( <i>Melampsora</i> spp.)	Small, yellow-orange pustules scattered on the lower leaf surface; premature defoliation with severe infection.	Sanitation; improve air circulation; avoid overhead watering; resistant varieties; foliar fungicide application.	mancozeb, thiophanate-methyl, triadimefon
	Leaf Spot ( <i>Glomerella</i> spp., <i>Marssonina</i> spp. and <i>Septoria</i> spp.)	<i>Glomerella</i> – irregular dead areas on leaf margin. <i>Marssonina</i> – dark brown to reddish brown lesions; yellow halos; lesions coalesce into brownish black, vein-limited blotches. <i>Septoria</i> – tan circular lesion with black margins; irregular brown to black lesions that coalesce.	Sanitation; improve air circulation; avoid overhead watering; foliar fungicide application.	chlorothalonil, thiophanate-methyl, triadimefon
<b>Privet</b>	Crown and Root Rot ( <i>Armillaria mellea</i> )	Leaves are small; growth is slow; dieback of branches; black fungal strands resembling shoestrings may be found in the soil around the roots; rotted bark may show white fungal growth (mycelia) on the underside.	Remove affected plants.	None recommended
	Powdery Mildew ( <i>Erysiphe penicillata</i> )	White dusty appearance on the upper leaf surface; premature defoliation with severe infection.	Sanitation; improve air circulation; foliar fungicide application.	sulfur, thiophanate-methyl, triadimefon
	Twig Blight ( <i>Glomerella cingulata</i> )	Leaves above the canker turn pale green then brown; girdling; infected bark is brown; wood discolored brown or grayish-black.	Sanitation; prune out affected areas; resistant varieties; foliar fungicide application.	chlorothalonil, myclobutanil, thiophanate-methyl
<b>Redbud</b>	Canker ( <i>Botryosphaeria dothidea</i> and <i>Nectria galligena</i> )	Depressed or flattened area of bark; areas have darker color and a water-soaked appearance; older and larger cankers may be concentric or target-shaped with callous ridges; branch girdling.	Sanitation; prune out affected areas.	None recommended

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Redbud</b> (continued)	Verticillium Wilt ( <i>Verticillium dahliae</i> )	Leaves turn yellow at the margins; margins eventually turn brown and dry; sudden wilting of leaves; typically only one side of the tree wilts; the wood is chocolate-brown in color in bands, streaks or flecks; tree death.	Sanitation; remove infected plants; avoid root injury; avoid water stress; soil fumigation if replanting with susceptible variety.	dazomet
<b>Rhododendron – See Azalea</b>				
<b>Rose</b>	Black Spot ( <i>Diplocarpon rosae</i> )	Black lesions, circular or irregular in shape; lesions have feathery margins; yellow halo surrounding the lesion; pre-mature defoliation.	Prune out affected areas; avoid overhead irrigation; avoid excessive watering; foliar fungicide application.	azoxystrobin, propiconazole, thiophanate-methyl
	Botrytis Blight ( <i>Botrytis cinerea</i> )	Small flecks on petals; circular brown lesions on petals; petal tips or sides become brown and soft; cankers develop on canes; grayish-brown fungal growth (mycelium) on the plant.	Prune out affected areas; prevent moisture condensation in greenhouses; use of ultraviolet-absorbing vinyl film on greenhouses; foliar fungicide application.	fludioxonil, iprodione, thiophanate-methyl
	Brown Canker ( <i>Cryptosporella umbrina</i> )	Small red to purple lesions on current year's canes; lesions enlarge into whitish necrotic lesions; lesions have a reddish-purple margin; in moist weather, cankers can be covered with yellow spore masses (tendrils).	Prune out affected areas; foliar fungicide application.	iprodione, thiophanate-methyl, trifloxystrobin
	Powdery Mildew ( <i>Podosphaera pannosa</i> var. <i>rosae</i> )	Early symptoms are slightly raised red areas on upper leaf surface; white fungal growth (mycelium) appears as discrete patches on leaf surface; young leaves may become twisted and distorted.	Lower humidity levels at night in greenhouses; resistant varieties; foliar fungicide application.	myclobutanil, sulfur, triadimefon
	Rose Mosaic ( <i>Rose mosaic virus</i> )	Chlorotic line patterns, ring lesions and mottling in leaves; vein-banding may occur during prolonged periods of high temperatures; infected plants tend to be less vigorous; more sensitive to winterkill.	Remove infected plants; use virus-indexed propagative plants.	None recommended

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Rose</b> (continued)	Rose Rosette (unidentified)	Leaflet distortion and wrinkling; bright red leaf pigmentation, witches-broom; phyllody; canes are excessively thorny; slow to mature.	Remove infected plants; mite transmitted.	None recommended
	Rust ( <i>Phragmidium</i> spp.)	First appears on leaves as powdery masses of orange spores on lower leaves; mature pustules appear as orange or brown lesions on upper leaves; young stems and sepals may become distorted.	Sanitation; prune out affected areas; prevent condensation in greenhouses; foliar fungicide application.	azoxystrobin, myclobutanil, thiophanate-methyl
<b>Serviceberry</b>	Cedar-Quince Rust ( <i>Gymnosporangium clavipes</i> )	Petioles, thorns and twigs swell and turn orange; spindle-shaped galls, twig galls expand and girdle stems.	Foliar fungicide application.	mancozeb, myclobutanil, thiophanate-methyl
	Fire Blight ( <i>Erwinia amylovora</i> )	Blighting of flowers, expanding to twigs and leaves; blighted area appears black to brown; diseased twigs curl downward forming a shepherd's crook.	Sanitation; prune out affected areas; avoid over fertilization; resistant varieties; foliar bactericide application.	copper, fosetyl-aluminum
	Powdery Mildew ( <i>Podosphaera clandestine</i> )	Leaves, twigs and fruit covered with a powdery white to gray-colored fungal growth (mycelia); new leaves eventually roll upward, pucker, blister and drop; infected shoots are stunted.	Sanitation; increase air circulation; resistant varieties; foliar fungicide application.	myclobutanil, sulfur, thiophanate-methyl
<b>Spirea</b>	Fire Blight ( <i>Erwinia amylovora</i> )	Blighting of flowers, expanding twigs and leaves; blighted area appears black to brown; diseased twigs curl downward forming a shepherd's crook.	Sanitation; prune out affected areas; avoid over fertilization; resistant varieties; foliar bactericide application.	copper, fosetyl-aluminum
	Leaf Spot ( <i>Cylindrosporium</i> spp. and <i>Phleospora filipendulae</i> )	Small, yellowish lesions on leaves; eventually lesions turn reddish-brown to purple in coloration; lesions enlarge and coalesce; premature defoliation.	Sanitation; increase air circulation; avoid overhead irrigation; foliar fungicide application.	chlorothalonil, myclobutanil, trifloxystrobin

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Spruce</b>	Canker ( <i>Cytospora</i> spp.)	Branch dieback with sunken, discolored areas on branches or trunk, often oozing resin; fungal fruiting bodies may be seen in canker margins.	Prune out affected areas in dry weather; minimize stress and mechanical damage.	None recommended
	Needle Cast ( <i>Rhizosphaera kalkhoffii</i> )	Needles, especially on lower branches, turn purplish-brown and fall from tree; small black fungal fruiting bodies occur in regular rows (through stomata) on affected needles.	Minimize stress; prune out affected areas; foliar fungicide application.	azoxystrobin, mancozeb, thiophanate-methyl
	Tip Blight ( <i>Sirococcus conigenus</i> )	Branch tips, especially on the current year's leader, turn brown and often curl over; fungal fruiting bodies may be present at base of needles.	Minimize amount of foliar wetness; increase light penetration; foliar fungicide application.	chlorothalonil, mancozeb, thiophanate-methyl
<b>Stone Fruits</b> ( <b>apricot, cherry, chokecherry, nectarine, peach, plum, etc.</b> )	Black Knot ( <i>Apiosprina morbosum</i> )	Abnormal growth of bark and wood tissue forming small, light-brown swellings; swellings rupture as they enlarge; in summer, the knots turn darker and elongate; in fall knots become hard, brittle, rough and black; eventually knots enlarge and encircle the entire twig or branch.	Sanitation; prune out affected areas before bud break; foliar fungicide application.	copper, thiophanate methyl, trifloxystrobin
	Brown Blossom Rot and Twig Blight ( <i>Monilinia</i> spp.)	Flower parts turn light brown; petals may look water soaked; areas of buff-colored or gray spores; flowers adhere through harvest or even winter; twigs may become girdled; profuse gumming on necrotic twigs; fruit has small, dark lesions that enlarge rapidly.	Sanitation; prune out affected areas; avoid over fertilization; foliar fungicide application.	mancozeb, myclobutanil, pyraclostrobin
	Canker ( <i>Cytospora</i> spp. and <i>Leucostoma cincta</i> )	Dead twigs and dieback; leaves droop; leaves discolor through shades of green to various shades of brown; leaves remain attached; cankers are dark and depressed areas; margins are sharp and distinct; young cankers exude gummy sap at the margins and may have a sour, sap odor; wood is discolored.	Sanitation; prune out affected areas; avoid overhead irrigation.	None recommended



## Woody Ornamental Hosts and Diseases (continued)

<i>Host</i>	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Stone Fruits</b> (continued)	Leaf Curl ( <i>Taphrina</i> spp.)	Leaves are deformed and display a variety of colors ranging from light green and yellow to shades of red and purple; leaves become wrinkled, puckered and curled; as leaves mature, they may appear dusty in appearance due to the spores being produced; leaves turn brown, shrivel and drop.	Sanitation; resistant varieties; foliar fungicide application.	chlorothalonil, mancozeb, triadimefon
	Leaf Spot - Bacterial ( <i>Xanthomonas pruni</i> )	Small circular to somewhat irregular shaped leaf lesions; pale green to almost white lesions on lower leaf surface; lesions enlarge to angular purple, brown to black; light yellowish-green halos; center of lesions drops out giving the leaf a ragged, shot hole appearance.	Improve air circulation; resistant varieties; foliar bactericide application.	copper, fosetyl-aluminum
	Leaf Spot - Fungal ( <i>Cercospora circumscissa</i> and <i>Septoria pruni</i> )	<i>Cercospora</i> – round reddish-brown necrotic lesions; center of lesions becomes light brown with brownish-red edges; lesions may coalesce to form large necrotic areas; necrotic tissue drops out; premature defoliation. <i>Septoria</i> – small, circular, necrotic lesions; necrotic tissue drops out.	Sanitation; foliar fungicide application.	mancozeb, triadimefon, trifloxystrobin
	Plum Pox ( <i>Plum pox potyvirus</i> )	Symptoms can be on leaves, fruits, flowers and seeds; chlorotic or yellow areas, often in ring patterns appear; overall, fruit quality, size and quantity are adversely affected.	See select agent and high risk pathogen section page 13.	
	Powdery Mildew ( <i>Podosphaera</i> spp.)	Leaves, twigs and fruit covered with a powdery white to gray-colored fungal growth (mycelium); new leaves eventually roll upward, pucker, blister and drop; infected shoots are stunted.	Sanitation; increase air circulation; resistant varieties; foliar fungicide application.	myclobutanil, sulfur, trifloxystrobin
<b>Sycamore</b>	Anthracnose ( <i>Apiognomonia veneta</i> )	Necrotic lesions or blotches on leaf surface; dark-brown fruiting bodies on leaf; emerging shoots and new leaves suddenly die; buds die before the bud cap breaks.	Sanitation; prune out affected areas; increase air circulation; foliar fungicide application.	myclobutanil, thiophanate-methyl, triadimefon

## Woody Ornamental Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Sycamore</b>	Powdery Mildew ( <i>Erysiphe</i> spp. and <i>Phyllactinia guttata</i> )	Leaves and twigs covered with a powdery white to gray-colored fungal growth (mycelium); new leaves distorted and stunted.	Sanitation; increase air circulation; foliar fungicide application.	myclobutanil, sulfur, thiophanate-methyl
<b>Viburnum</b>	Leaf Spot ( <i>Pseudomonas syringae</i> pv. <i>viburnii</i> )	Dark colored, mostly angular and water-soaked lesions on leaves; infected twigs may blacken and shrivel.	Prune out affected areas; increased air circulation; avoid overhead irrigation; foliar bactericide application.	copper
	Powdery Mildew ( <i>Erysiphe penicillata</i> )	White to grayish powdery growth on leaf surface; leaves appear distorted and/or have necrosis; late in season, small orange to black dots (cleistothecia), may be visible.	Sanitation, improve air circulation and sunlight penetration; foliar fungicide application.	myclobutanil, sulfur, thiophanate-methyl
<b>Willow</b>	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Stem lesions leading to wilting and death; leaf blighting.	See select agent and high risk pathogen section page 13.	
	Canker ( <i>Cytospora chrysosperma</i> )	Circular to oval, brown, sunken areas in the smooth bark of branches and trunks; enlarges and outer bark may become black, brown, gray, reddish-brown or yellow; inner bark turns black; sapwood appears reddish-brown to black and water-soaked.	Sanitation; prune out affected areas.	None recommended
<b>Yew</b>	Crown and Root Rot ( <i>Phytophthora</i> spp.)	General decline and dieback; needles yellow and drop; rotting of the crown and roots with brown to red discoloration.	Improve drainage; drench fungicide application.	etridiazole, fosetyl-aluminum, mefenoxam
	Sudden Oak Death ( <i>Phytophthora ramorum</i> )	Needle blight; shoot tip dieback.	See select agent and high risk pathogen section page 13.	

## Herbaceous Perennial Hosts and Diseases

Host	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Ajuga (bungleweed)</b>	Crown Rot ( <i>Sclerotium rolfsii</i> )	Discoloration and wilting of lower leaves; rapid death of plant; rotted roots; strands or mats of white fungus at base of plant with small, round, seed-like bodies (light colored at first, changing to buff and then brown).	Remove infected plants; drench fungicide application.	azoxystrobin, flutolanil, PCNB
<b>Aster</b>	Aster Yellows (Phytoplasma-like organism)	Plants are stunted with short internodes and have yellow foliage; many secondary shoots grow sometimes on one side of the plant; flowers are greenish, deformed or absent.	Remove infected plants; control insect vectors (leafhoppers) (see general pests page 45).	None recommended
	Botrytis Stem Rot and Flower Blight ( <i>Botrytis cinerea</i> )	Water-soaked, decayed, brown lesions are visible on flowers; leaves may be rotted; stems may be girdled; affected plant parts may have gray masses of spores.	Sanitation; avoid overhead irrigation; improve air circulation; avoid overcrowding plants; keep humidity low; foliar fungicide application.	fenhexamid, pyraclostrobin, thiophanate-methyl
	Fusarium Wilt ( <i>Fusarium oxysporum</i> f. sp. <i>callistephi</i> )	Plants become yellow and wilt, often on one side; brown discoloration of vascular tissue; older plants are stunted; the stem is blackened at the base and a pink spore mass can be seen at ground level.	Sanitation; plant pathogen-free or fungicide-treated seed; avoid over-fertilization; rotate to other crops for 4 or more years; resistant varieties.	None recommended
	Leaf Spot ( <i>Alternaria</i> spp., <i>Cercospora</i> spp. and <i>Septoria</i> spp.)	Various shapes of brown, black, yellow or red spots on leaves. Spots may coalesce and cover large areas on the leaves; in severe cases leaves may die.	Sanitation; improve air circulation; avoid overhead irrigation; foliar fungicide application.	azoxystrobin, fludioxonil, iprodione
	Powdery Mildew ( <i>Golovinomyces cichoracearum</i> )	White powdery growth appears mainly on older leaves and the stem; premature defoliation.	Sanitation; improve air circulation; avoid overhead irrigation; foliar fungicide application.	propiconazole, pyraclostrobin, triadimefon

## Herbaceous Perennial Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Aster</b> (continued)	Rust ( <i>Coleoporium asterum</i> and <i>Puccinia</i> spp.)	Bright orange-yellow spore pustules on leaf underside; yellow lesions may appear on leaf upperside; discoloration, drying and death of leaves.	Improve air circulation; do not plant near alternate host (various sedges, grasses and pine); foliar fungicide application.	myclobutanil, propiconazole, thiophanate-methyl
<b>Chrysanthemum</b>	Botrytis Blight ( <i>Botrytis cinerea</i> )	Brown, water-soaked lesions on petals; stems may be girdled; gray masses of spores may be seen.	Sanitation; improve air circulation; foliar fungicide application.	fludioxonil, triadimefon, trifloxystrobin
	Foliar Nematode ( <i>Aphelenchoides</i> spp.)	Leaves appear yellow; vein-limited, dark green or brown, angular lesions or blotches appear on leaves; progressing from older leaves.	Sanitation; use nematode-free stock plants; avoid overhead irrigation; control weeds which may serve as host.	None recommended
	Leaf Spot ( <i>Septoria</i> spp.)	Brown, tan or yellow lesions on leaves, often developing from the base of the plant upward; lesions may be circular, angular or irregular in shape; leaves may yellow and die.	Sanitation; avoid overhead irrigation; use cuttings from culture-indexed stock; plant in a new location each year or rotate with other crops; foliar fungicide application.	azoxystrobin, iprodione, triadimefon
	Powdery Mildew ( <i>Golovinomyces cichoracearum</i> )	White to gray powdery growth develops on leaves and stem; leaves may be discolored, stunted or deformed; severely infected leaves may dry and die.	Keep humidity low; provide adequate light; improve air circulation; foliar fungicide application.	azoxystrobin, sulfur, triadimefon
	Verticillium Wilt ( <i>Verticillium</i> spp.)	The margins of lower leaves become yellow and wilt; eventually entire plant wilts and dies; early symptoms often appear on one side of the plant; severely infected plants are stunted and often do not produce marketable flowers.	Sanitation; use verticillium-free planting stock; resistant varieties; soil fumigation, if replanting with susceptible variety.	dazomet

## Herbaceous Perennial Hosts and Diseases (continued)

<i>Host</i>	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Chrysanthemum</b> (continued)	White Rust ( <i>Puccinia horiana</i> )	Pale green, yellow or tan lesions appear on the upper surface of leaves; the corresponding lesions on the lower leaf surface are pinkish white at first, then develop into raised pinkish pustules which turn whitish at maturity.	See select agent and high risk pathogen section page 14.	
<b>Columbine</b>	Crown and Root Rot ( <i>Phytophthora</i> spp., <i>Pythium</i> spp., <i>Rhizoctonia solani</i> and <i>Thielaviopsis</i> <i>basicola</i> )	Plants stunted and yellow; wilting; may appear to have nitrogen deficiency; roots are brown to black; roots are rotted.	<i>Phytophthora</i> and <i>Pythium</i> – sanitation; improve soil drainage; drench fungicide application.	<i>Phytophthora</i> and <i>Pythium</i> – etridiazole, fosetyl-aluminum, propamocarb hydrochloride
			<i>Rhizoctonia</i> and <i>Thielaviopsis</i> – sanitation; drench fungicide application.	<i>Rhizoctonia</i> and <i>Thielaviopsis</i> – flutolanil, pyraclostrobin, thiophanate- methyl
	Powdery Mildew ( <i>Golovinomyces</i> spp.)	Leaves covered with a powdery white to gray-colored fungal growth (mycelium); new leaves distorted and stunted.	Sanitation; improve air circulation; decrease humidity; select varieties with high tolerance; foliar fungicide application.	iprodione, myclobutanil, sulfur
<b>Daylily</b>	Anthracnose ( <i>Colletotrichum</i> spp.)	Leaves turn yellow; large dead streaks down the center of the leaves.	Sanitation; remove infected tissue; avoid overhead irrigation; foliar fungicide application.	mancozeb, myclobutanil, thiophanate- methyl
	Daylily Rust ( <i>Puccinia</i> <i>hemerocallidis</i> )	Yellow lesions or streaks on upper leaf surface; bright yellow-orange masses of spores on lower leaf surface.	Sanitation; prune out affected tissue; foliar fungicide application.	myclobutanil, propiconazole, thiophanate- methyl
	Leaf Streak ( <i>Aureobasidium</i> <i>microstictum</i> )	Small, reddish-brown flecks and brown lesions; central yellow streak along midvein that begins at the leaf tip; entire leaf turns yellow.	Sanitation; prune out affected tissue; avoid over- head irrigation.	None recommended

## Herbaceous Perennial Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Daylily</b> (continued)	Root Rot ( <i>Fusarium</i> spp. and <i>Rhizoctonia solani</i> )	Slender, grassy foliage; few flower stalks; yellowing of foliage; wilting; roots and crowns rotted; roots are brown or black.	Protect crowns from frost damage; improve soil drainage; drench fungicide application.	fludioxonil, thiophanate-methyl, trifloxystrobin
<b>Delphinium</b>	Crown and Bud Rot ( <i>Sclerotium delphinii</i> )	Sudden wilting and death of plants; lower leaves may yellow; in severe infections, plants can easily be pulled up; hard, yellow-brown, buff-colored sclerotia are scattered in the soil near diseased plants.	Sanitation; do not plant into soil known to have the pathogen; drench fungicide application.	azoxystrobin, fludioxonil, triadimefon
	Leaf Spot ( <i>Pseudomonas syringae</i> pv. <i>delphinii</i> )	Also known as black lesion or black blotch; irregular tarry black lesions develop on leaves, flower buds, petioles and stems; lesions may coalesce into large areas or blotches.	Sanitation; avoid overhead irrigation; foliar bactericide application.	copper
	Powdery Mildew ( <i>Erysiphe polygoni</i> , <i>Golovinomyces cichoracearum</i> and <i>Podosphaera macularis</i> )	White powdery growth on leaves, stems and blossoms.	Improve air circulation; avoid over crowding plants; foliar fungicide application.	azoxystrobin, myclobutanil, sulfur
<b>Geranium</b> (perennial)	Botrytis Blight ( <i>Botrytis cinerea</i> )	Brown, water-soaked lesions develop on leaves, stems and flowers; gray spore masses may be seen on dead tissue.	Sanitation; improve air circulation; avoid overhead watering; foliar fungicide application.	fenhexamid, pyraclostrobin, thiophanate-methyl
	Leaf Spot - Bacterial ( <i>Xanthomonas campestris</i> pv. <i>pelargonii</i> )	Yellow to brown lesions appear on leaves, stems and petioles; lesions enlarge and form dark angular blotches and may have yellow margins; roots and stem vascular tissue may become black but not rotted; plants may wilt and die.	Sanitation; avoid overhead irrigation; use pathogen-free planting stock; resistant varieties, foliar bactericide application.	copper, fosetyl-aluminum
	Leaf Spot - Fungal ( <i>Alternaria</i> spp. and <i>Cercospora</i> spp.)	<i>Alternaria</i> – lesions appear on lower leaf surface; lesions are small and blister-like and are surrounded by red or yellowish margins. <i>Cercospora</i> – lesions are small, pale, and sunken; later lesions turn gray and appear to have dark raised centers due to production of numerous spores.	Sanitation; improve air circulation; avoid overhead irrigation; foliar fungicide application.	chlorothalonil, triadimefon, trifloxystrobin

## Herbaceous Perennial Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Geranium</b> (perennial) (continued)	Stem and Root Rot ( <i>Phytophthora</i> spp., <i>Pythium</i> spp. and <i>Rhizoctonia</i> spp.)	Foliage yellows and may wilt and die; basal stems or root may decay; blackening at the soil line may occur.	<i>Phytophthora</i> and <i>Pythium</i> - sanitation; use pathogen-free planting stock; avoid over watering; improve soil drainage; drench fungicide application.	<i>Phytophthora</i> and <i>Pythium</i> - etridiazole, fosetyl-aluminum, mefenoxam
			<i>Rhizoctonia</i> - sanitation; use pathogen-free planting stock; drench fungicide application.	<i>Rhizoctonia</i> - flutolanil, iprodione, thiophanate- methyl
	Rust ( <i>Puccinia pelargonii-zonalis</i> )	Yellow to dark lesions or concentric rings appear on leaves; reddish-brown pustules appear mostly on the lower leaf surface; leaves may yellow and drop.	Plant rust-free stock; improve air circulation; avoid overhead irrigation; foliar fungicide application.	iprodione, propiconazole, triadimefon
<b>Hibiscus</b>	Crown and Root Rot ( <i>Fusarium</i> spp., <i>Phytophthora</i> spp., <i>Pythium</i> spp. and <i>Rhizoctonia</i> spp.)	Small and unthrifty plants; appear to be lacking fertilizer; roots are mushy and wet; roots are also brown to black.	<i>Fusarium</i> and <i>Rhizoctonia</i> - sanitation; drench fungicide application.	<i>Fusarium</i> and <i>Rhizoctonia</i> - fludioxonil, flutolanil, thiophanate- methyl
			<i>Phytophthora</i> and <i>Pythium</i> - sanitation; improve soil drainage; drench fungicide application.	<i>Phytophthora</i> and <i>Pythium</i> - fosetyl-aluminum, mefenoxam, propamocarb hydrochloride
<b>Hosta</b>	Crown and Root Rot ( <i>Sclerotium rolfsii</i> )	Lower leaves turn yellow, then brown; leaves wilt from the margins back toward the base; upper leaves soon collapse; wilted leaves can be easily pulled from crown; bases of petioles are brown in color and mushy; white fungal growth (mycelium) present on the rotted tissue and surrounding soil; small spheres, about the size of mustard seeds, sprinkled on soil surface.	Remove infected plants; drench fungicide application.	flutolanil, pyraclostrobin, thiophanate- methyl

## Herbaceous Perennial Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Hosta</b> (continued)	Crown and Root Rot ( <i>Fusarium</i> spp., <i>Pythium</i> spp. and <i>Rhizoctonia solani</i> )	Uneven shoot emergence; decline of the plant; leaves turn yellow and then tan; leaves wither; stunted plants; roots have cortical decay; roots are brown or black in color; discoloration of the root vascular system.	<i>Fusarium</i> and <i>Rhizoctonia</i> – sanitation; drench fungicide application.  <i>Pythium</i> – sanitation; improve soil drainage; drench fungicide application.	<i>Fusarium</i> and <i>Rhizoctonia</i> – flutolanil, thiophanate- methyl, trifloxystrobin  <i>Pythium</i> – fosetyl-aluminum, mefenoxam, propamocarb hydrochloride
	Foliar Nematode ( <i>Aphelenchoides</i> <i>fragariae</i> )	Linear lesions between the veins; striped appearance of the leaf; angular, water-soaked lesions between the veins; lesions become brown and eventually turn black; stunting; leaf proliferation or bunching of leaves around the crown; multicolored leaves; plant death.	Sanitation; remove infected plants; avoid overhead irrigation; dormant plants treated with warm water (120°F) for 15 minutes.	None recommended
	Hosta Virus X ( <i>Hosta virus X</i> )	Blue or green markings on a light colored leaf; markings follow leaf veins; markings bleed out into surrounding tissue giving a mottled appearance; leaves appear lumpy and puckered; dried, brown lesions and twisted, deformed leaves.	Remove infected plants.	None recommended
<b>Iris</b>	Crown and Root Rot ( <i>Fusarium oxysporum</i> )	Stunted, yellow leaves; brown sunken lesions on roots; pale brown or reddish lesions on bulb.	Remove infected plants; improve soil drainage; avoid over watering; drench fungicide application.	azoxystrobin, PCNB, thiophanate- methyl
	Leaf Spot - Bacterial ( <i>Xanthomonas</i> <i>tardicrescens</i> )	Large irregular lesions that first appear near the leaf tip margins; lesions appear watery at first and then turn light brown; lesions become larger and develop whitish or grayish centers; lesions follow the leaf veins.	Sanitation; prune out affected tissue; foliar bactericide application.	copper, phosphorous acid
	Leaf Spot - Fungal ( <i>Didymellina</i> <i>macrospore</i> )	Small brown lesions; reddish borders and margins that turn yellow.	Sanitation; improve air circulation; foliar fungicide application.	iprodione, thiophanate- methyl, triadimefon



## Herbaceous Perennial Hosts and Diseases (continued)

<i>Host</i>	<i>Disease (Pathogen)</i>	<i>Description</i>	<i>Management</i>	<i>Active Ingredient</i>
<b>Iris</b> (continued)	Sclerotium Root Rot ( <i>Sclerotium rolfsii</i> )	Slimy rot at the base and the growing ends of the rhizomes; mycelial webbing on the rhizome; tan to brown bodies on the fungal growth (mycelium).	Remove infected plants; improve soil drainage; avoid over watering; drench fungicide application.	flutolanil, PCNB
<b>Peony</b>	Botrytis Blight ( <i>Botrytis cinerea</i> )	Stalks suddenly wilt and fall over; young buds turn black and dry up; larger buds turn brown and covered with a brown or gray mass of spores; typically the stalks are rotted before infected buds; large, irregular, dark brown blotches on leaves.	Sanitation; in the fall cut all stalks at ground level or below; foliar fungicide application.	fludioxonil, mancozeb, thiophanate-methyl
	Crown and Root Rot ( <i>Phytophthora cactorum</i> )	Cankers along the stem; infected stems and roots are dark brown to black and leathery; wet rot in the crown.	Remove infected plants; improve drainage; drench fungicide application.	fosetyl-aluminum
	Leaf Spot ( <i>Cladosporium paeoniae</i> )	Glossy and purplish-brown lesions on the upper leaf surface; chestnut-brown lesions on lower leaf surface; leaves slightly distorted; elongated, reddish-brown streaks on stem.	Sanitation; improve air circulation; in the fall cut all stalks at ground level or below; foliar fungicide application.	mancozeb, potassium salts, thiophanate-methyl
	White Mold ( <i>Sclerotinia sclerotiorum</i> )	Entire plant or portion wilts; stem turns a light tan color; stem dry and stringy; white fungal growth (mycelium) growth on stems; irregularly shaped, hard black sclerotia are present inside the tan colored stem.	Remove infected plants; improve air circulation; drench fungicide application.	flutolanil, pyraclostrobin, thiophanate-methyl
<b>Periwinkle (vinca)</b>	Crown and Root Rot ( <i>Rhizoctonia solani</i> and <i>Thielaviopsis basicola</i> )	Yellowing of young growth; brown canker at the soil line; roots are off-white, gray or black in color.	Sanitation; avoid overwatering; drench fungicide application.	flutolanil, PCNB, thiophanate-methyl
	Stem Blight ( <i>Phoma exigua</i> var. <i>exigua</i> )	Dark brown to black girdling lesion on stems; runners wilt and dieback to the base; lesions may extend the entire length of stem; dark lesions may form on leaves.	Avoid frequent irrigation; foliar fungicide application.	copper, potassium salts, thiophanate-methyl

## Herbaceous Perennial Hosts and Diseases (continued)

Host	Disease (Pathogen)	Description	Management	Active Ingredient
<b>Phlox</b>	Gray Mold ( <i>Botrytis cinerea</i> )	Initially appears as white fungal growth (mycelium) on any plant part but primarily on dead and dying leaves and flowers; mycelium darkens to a gray color; smoky-gray "dusty" spores develop.	Sanitation; prune out affected areas; in greenhouses prevent high humidity; increase air circulation; foliar fungicide application.	iprodione, thiophanate-methyl, trifloxystrobin
	Leaf Spot ( <i>Septoria</i> spp.)	Dark, brown circular lesions; centers are light gray, almost white; leaves die prematurely.	Sanitation; prune out affected tissue; foliar fungicide application.	chlorothalonil, triadimefon, trifloxystrobin
	Powdery Mildew ( <i>Erysiphe cichoracearum</i> and <i>Sphaerotheca macularis</i> )	Leaves covered with a powdery white to gray-colored fungal growth (mycelium); new leaves distorted and stunted.	Sanitation; improve air circulation; decrease humidity; select varieties with high tolerance; foliar fungicide application.	azoxystrobin, myclobutanil, sulfur

# General Disease Guide on Woody Ornamentals and Herbaceous Perennials

<i>Disease</i>	<i>Description</i>	<i>Management</i>
<b>Abiotic Agents</b>		
<b>Air Pollutants</b>	<p>All plant species can be affected.</p> <p>Symptoms typically confined to foliage; may mimic some nutrient deficiencies; marginal leaf burn; leaf growth may be distorted; plants grow slowly.</p>	<p>Position air intakes for greenhouse production away from any potential pollutant sources; maintain adequate ventilation and air circulation.</p>
<b>Drought</b>	<p>All plant species can be affected.</p> <p>Plants wilt during warmest portion of the day; plants grow slowly and may exhibit nutrient-deficiency symptoms; stunted plants; pale green color.</p>	<p>Maintain adequate water for healthy plant growth; plant species vary greatly in their water needs.</p>
<b>Frost</b>	<p>All plant species can be affected.</p> <p>Terminal leaves may appear black or blighted; newest growth is more susceptible than older growth; plant areas exposed to wind have more damage; in the landscape low-lying areas are more severely affected.</p>	<p>Water plants during light frost periods to avoid injury; cover plants with protective layers; mulch plants to maintain soil temperature.</p>
<b>Nutrient Deficiency</b>	<p>All plant species can be affected.</p> <p>Symptoms vary from interveinal chlorosis to entire leaf discoloration; position of symptom on the plant will also vary with nutrient deficiency; plant may appear to be stunted; overall plant growth and flowering may be reduced.</p>	<p>Analyze growth media or soil to ensure proper balance of nutrients; pH may need to be adjusted; in some cases root and crown rots may be the cause of the deficiency symptom and may need to be managed.</p>
<b>Scorch</b>	<p>Commonly observed on many shade trees and shrubs.</p> <p>Extremely high temperatures coupled with dry winds result in leaves appearing burned or blighted, typically on leaf margins with more damage on the terminal portion of the leaves; symptoms typically more severe on side more exposed to wind; often occurs after transplanting due to root injury and limited water availability.</p>	<p>Deep watering will increase water availability in nursery production systems; mulch plants to maintain high soil moisture; shade cloth may be needed in some instances; plants with this problem will typically be those known to be environmentally sensitive for the area.</p>
<b>Sun Scald</b>	<p>Commonly observed on thin-barked trees for canker damage and on all plant species for foliar damage.</p> <p>Condition most commonly refers to canker-like trunk damage on thin-barked trees. Symptoms on sun-facing side of tree; bark is split and loose as a result of freezing and thawing during winter months; Condition may also refer to some foliar damage observed during very cool humid nights followed by warm sunny days – leaves may have bands or stripes associated with growth during the cooler night-times of warmer season plants.</p>	<p>Commercial wraps or placing a material in front of the tree on the sun-facing side will prevent sunscald damage to thin barked trees.</p> <p>If foliar symptoms are observed under greenhouse conditions – the greenhouse temperature cycle may need to be adjusted.</p>

## General Disease Guide on Woody Ornamentals and Herbaceous Perennials (continued)

<i>Disease</i>	<i>Description</i>	<i>Management</i>
<b>Abiotic Agents</b>		
<b>Tatters</b>	<p>Most commonly observed on oaks.</p> <p>Leaves appear shredded or as if they were severely fed upon by insects; damage is confined to one emergence group of leaves on the entire plant.</p>	<p>Condition is thought to be a result of cold temperatures when the young leaf tissues are newly emerging; exact cause is not proven.</p>
<b>Winter Desiccation</b>	<p>Injury commonly observed in evergreens.</p> <p>Foliage is reddish-brown in color with damage at terminal ends of foliage (commonly needles); damage mostly on outer portion of the branches and often more severe on wind-facing side of plant.</p>	<p>Maintain adequate soil moisture throughout the winter months to avoid winter desiccation; mulch plants to maintain soil moisture.</p>

# General Disease Guide on Woody Ornamentals and Herbaceous Perennials

<i>Disease</i>	<i>Description</i>	<i>Management</i>
<b>Biotic Agents</b>		
<b>Canker</b>	<p>Affects most species of woody plants.</p> <p>Symptoms vary from localized lesions on twigs to swollen areas on large branches; areas with pitch deposits; blistering areas on the bark; sunken areas on twigs; lesion with or without fruiting structures of the fungus; bacterial ooze; off-colored areas on twigs and stems.</p>	<p>Sanitation: remove canker 3-4 inches below the affected area for fungal cankers and 7-10 inches below for bacterial cankers and twig blights; avoid drought stress; avoid overhead irrigation; protective fungicide sprays in nursery production.</p>
<b>Crown and Root Rot</b>	<p>Affects all plant species, but greater problem with herbaceous perennials.</p> <p>Slow growth of plant; leaf wilt and drop of lower leaves; wilt and death of entire plant; may exhibit nutrient deficiency symptoms; discolored roots or lack of roots; discoloration of internal crown area when plant crown area is split.</p>	<p><i>Fusarium</i> spp. and <i>Rhizoctonia solani</i> are favored by well drained soil conditions; increase watering to reduce potential damage.</p> <p><i>Pythium</i> and <i>Phytophthora</i> spp. are favored by wet conditions – avoid over watering.</p> <p>Sanitation: pasteurize soils and do not directly replant into affected pots; drench fungicide application may be needed.</p>
<b>Leaf Spot</b>	<p>Affects all plant species.</p> <p>Lesion description varies with pathogen and plant species involved; foliage affected in all cases; initially lower leaves are more severely affected than upper leaves of plant canopy in many plant species.</p>	<p>Avoid overhead irrigation; avoid crowding plants; increase air circulation; resistant cultivars available in many plant species; foliar fungicide applications on susceptible cultivars.</p>
<b>Nematodes</b>	<p>Mostly herbaceous perennials affected (not all species).</p> <p>Foliage appears blighted with linear lesions between leaf veins; lesions may appear water-soaked initially and become brown and eventually black in color; leaf proliferation or leaf bunching may be evident around the crown; leaves may be off-color.</p>	<p>Remove affected plants; avoid overhead irrigation; dormant plants may be heat-treated with warm water (120°F for 15 minutes).</p>

## General Disease Guide on Woody Ornamentals and Herbaceous Perennials (continued)

<i>Disease</i>	<i>Description</i>	<i>Management</i>
<b>Biotic Agents</b>		
<b>Phytoplasmas</b>	<p>Affect mostly herbaceous perennials in the Asteraceae plant family.</p> <p>Distorted growth of flowering plant parts; often flowerhead will appear distorted with leaves emerging from head or additional flowers emerging from head; flower petals can be off-color and; distorted increase in flowerhead number may occur; overall plant growth may be reduced and plant appears stunted.</p>	<p>Sanitation – remove affected plants; avoid contact among plants as phytoplasmas can be transmitted with sap; control insect vectors (mainly leaf hoppers with phytoplasmas), refer to <i>Pesticide Selection Guide for Insects and Mites Affecting Woody Ornamentals and Herbaceous Perennials in Nebraska</i>, EC1566; no cure available for infected plants.</p>
<b>Powdery Mildew</b>	<p>Affects most plant species.</p> <p>Cottony or dust-like appearance, mostly on upper surface of leaves; occurs typically in overcast or shaded growing conditions; overall plant growth and development is slowed; defoliation may occur with severe infection; leaves may appear curled on leaf margins.</p>	<p>Increase air circulation; reduce humidity levels in greenhouses; resistant cultivars available in many species; foliar fungicide application.</p>
<b>Rust</b>	<p>Wide range of plant species affected, but not all.</p> <p>Leaves primarily affected; lesions on leaves which contain pustules (rough areas on the plant part with large amounts of spores); pustule color will range from orange to brown to black; severe infection results in defoliation; in some species fruits may be affected.</p>	<p>Avoid overhead irrigation; avoid placing plant species in close proximity with alternate hosts (specific to some rusts); resistant cultivars available in many species; fungicide application.</p>
<b>Viruses</b>	<p>Affect all plant species, but most commonly a problem in herbaceous perennials.</p> <p>Plants may be stunted; leaves appear mottled and/or blistered; foliar symptoms typically more severe in newer leaves; reproductive parts may be affected and appear mottled or absent; symptom severity will vary as environmental conditions change (<i>i.e.</i> some favored by cool temperatures).</p>	<p>Use certified pathogen-free stock and cutting plants; rogue out affected plants; control insect vectors (vary with specific virus), refer to <i>Pesticide Selection Guide for Insects and Mites Affecting Woody Ornamentals and Herbaceous Perennials in Nebraska</i>, EC1566; no cure for infected plants.</p>

## Fungicide/Bactericide Information

<i>Active Ingredient</i>	<i>Trade Names</i>	<i>Classification (Group Name)</i>	<i>Manufacturers</i>
azoxystrobin	Heritage	Quinone outside Inhibitors ( <b>QoI</b> –fungicide)	Syngenta
captan	Captan, Captevate	Phthalimides	Arysta, Bonide
chlorothalonil	Daconil Ultrex, Echo, Spectro	Chloronitriles	Cleary, Sipcam, Syngenta
copper	Kocide, NU-Cop, SpinOut	Inorganic	Griffin, Micro Flo, SePro Corporation
dazomet	Basamid	Soil Fumigant	Certis
etridiazole	Banrot, Terrazole, Truban	Heteroaromatics	Chemtura, Scotts-Sierra
fenhexamid	Decree, Elevate	Hydroxyanilides	SePro
fludioxonil	Hurricane, Medallion	PhenylPyrroles ( <b>PP</b> - fungicide)	Syngenta
flutolanil	ProStar	Carboxamides	Bayer
fosetyl-aluminum	Aliette, Chipco Signature Fungicide, Lesco Prodigy Signature	Phosphonates	Bayer, Lesco
iprodione	26/36 Fungicide, Armortech, Chipco 26019 N/G Fungicide	Dicarboximides	Bayer, Cleary, Etigra
mancozeb	Dithane, Fore Rainshield, Protect	Dithiocarbamates	Cleary, Dow, Lesco Inc.
mefenoxam	Mefenoxam 2, Subdue	PhenylAmides ( <b>PA</b> – fungicide)	Sipcam, Syngenta
myclobutanil	Eagle, Systhane	DeMethylation Inhibitors ( <b>DMI</b> – fungicide)	Dow
PCNB (pentachloronitrobenzene)	Lesco Revere 10G Turf and Ornamental Fungicide, Turfcide	Aromatic Hydrocarbons ( <b>AH</b> – fungicide)	Chemtura, Lesco
phosphorous acid	Phostrol	Phosphonates	Nufarm Americas
potassium salts	Alude, Fosphite, Rampart T&O Fungicide	Phosphonates	Cleary, Loveland Products, Nufarm Americas
propamocarb hydrochloride	Banol	Carbamates	Bayer
propiconazole	Banner, Orbit, PropPensity	DeMethylation Inhibitors ( <b>DMI</b> – fungicide)	Dow, Sipcam, Syngenta
pyraclostrobin	Insignia	Quinone outside Inhibitors ( <b>QoI</b> –fungicide)	BASF
streptomycin sulfate	Firewall	Glucopyranosyl antibiotic	Cerexagri
sulfur	Kumulus	Inorganic	Bonide
thiophanate-methyl	Banrot, Spectro, Tee-off	Methyl Benzimidazole Carbamates ( <b>MBC</b> – fungicide)	Cleary, OHP Inc., Sipcam
triadimefon	Bayleton, Lesco Systemic Fungicide, Strike	DeMethylation Inhibitors ( <b>DMI</b> – fungicide)	Bayer, Lesco, OHP
trifloxystrobin	Compass O	Quinone outside Inhibitors ( <b>QoI</b> –fungicide)	OHP/Bayer

# Using the Plant & Pest Diagnostic Clinic at UNL

The Plant & Pest Diagnostic Clinic (P&PDC) is operated by UNL Extension and offers skilled and objective diagnostic services by professionals from the Departments of Plant Pathology, Entomology, and Agronomy and Horticulture. In addition to accurate diagnosis of your pest problems, you will be provided with the most current information and recommendations to assist with management.

There is a fee associated with every specimen analysis, based upon diagnostic materials or equipment used in diagnosis. An affordable basic sample fee covers most identifications based upon a visual examination. Additional charges are associated with laboratory culturing of disease pathogens, rearing of insects or assays for viruses or nematodes. For sample preparation and mailing, follow the guidelines listed below:

## Sample Collection

1. Collect sample representative of symptoms, and also include healthy tissue for comparison. Plant material that has been dead for some time may not exhibit clear symptoms or be useful.
2. Send a **complete sample** composed of roots, stems, leaves, flowers and fruit when possible. One leaf is not enough. Also send multiple plants or multiple branches from a tree or shrub showing a range from healthy to unhealthy or damaged. Time of flowering is crucial when requesting a weed or plant ID. Try to send more than one insect.
3. Provide as much information about the sample as possible. This information includes a description of symptoms, age and variety of plant, moisture availability, soil type, disease and chemical history of site, plant part(s) affected, time of symptom development, distribution of symptoms, level of infestation (insects), occurrence of severe weather, and any other information that may be helpful in diagnosing the problem.
4. Photographs, sketches or maps can be very useful.
5. Insects should be sent in a **crush-proof container**. Soft-bodied (insect larvae, aphids, mites and spiders) or tiny specimens should be placed in a tight-sealing bottle with a preservative such as alcohol. Hard-bodied specimens (beetles, bugs, moths, ants and flies) should be wrapped in loose tissue and placed in a crush-proof container. Living specimens (whether soft or hard-bodied) should be placed with the host plant or damaged material along with some loose tissue into a ventilated container.

## Sample Shipment

1. **Place plant material in a sealable plastic bag and do not add water.** If the sample is damp or wet, wrap it with absorbent toweling prior to placing in the plastic bag. If roots are in soil, enclose them in a separate plastic bag with the soil intact. If you suspect the sample problem is a pest/pathogen of concern including a **select agent/high risk pathogen**, then it is a good idea to **double bag using sealable plastic bags**.
2. Keep the sample fresh and in good condition. All samples should be placed into sturdy containers for mailing, such as cardboard boxes, mailing tubes or reinforced padded envelopes. **Do not mail samples later than Thursday morning**, as samples may deteriorate over the weekend. Samples retain good quality when refrigerated if it is necessary for you to hold them. Do not forget to include complete sample information and submitter contact information.

For more information, contact staff at the Plant & Pest Diagnostic Clinic:

Plant and Pest Diagnostic Clinic  
University of Nebraska–Lincoln  
448 Plant Sciences Hall  
P.O. Box 830722  
Lincoln, NE 68583-0722  
(402) 472-2559



## Pesticide Safety Telephone Hotlines

### Non-Emergency Telephone Numbers

- National Pesticide Information Center ..... (800) 858-7378  
— for medical and consumer information on pesticides
- Chemical Referral Center (weekdays only) ..... (800) 262-8200  
referrals to manufacturers on health and safety  
related to chemicals, 9:00 a.m. - 6:00 p.m. EST

### Emergency Telephone Numbers

- The Poison Center, Omaha ..... (800) 222-1222  
for aid in human poisoning cases
- Pesticide Accident Hotline (CHEMTREC) ..... (800) 424-9300  
for help involving spills, leaks, fires
- Nebraska State Patrol..... (800) 525-5555  
to report chemical spills or releases  
to report motor vehicle accidents

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