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Woody Plant Disease Management Guide for Nurseries and Landscapes

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Woody plants are susceptible to a variety of diseases, and various cultural and environmental stresses increase their susceptibility. For example, climatic and environmental conditions often predispose plants to disease. Levels of susceptibility and resistance also can differ between related species or cultivars. During development of some cultivars, for instance, disease resistance is forsaken for other traits such as flowering or growth habits. In many cases, humans, insects, or pathogens create entry wounds for other pathogens. Some pathogen populations can be undisruptive but may eventually build to dangerous levels. Furthermore, nursery and landscape plants often are susceptible to diseases that might not be a problem in natural habitats. Plants grown outside of their natural habitats are more likely to become stressed; these stressful conditions often are precursors to disease development.

Management of woody plant diseases usually combines preventative and curative practices, including a focus on plant health, sanitation, cultivar selection, and pesticides.

Cultural Practices

Proper care of trees and shrubs often prevents many nursery and landscape problems. Susceptibility to disease is influenced not only by current conditions, but also by conditions and care during previous years. Stresses induced by adverse growing conditions, maltreatment, and lack of care are favored by various pathogens.

Many problems in nurseries and landscape plantings may be avoided by:

- Selecting proper plant materials
- Creating proper planting sites
- Avoiding unnecessary wounding
- Providing routine care (including fertilization, timely watering, and pruning)
- Using preventative disease- and insect-control measures as needed

Stresses often are alleviated or moderated by proper plant care. Several University of Kentucky Cooperative Extension Service publications, available at each county Extension office and on the Web [www.ca.uky.edu/agcomm/pubs.asp], cover this topic.

Nursery and Landscape Hygiene

Strict hygiene is necessary to retain disease-free plants and clean soil. Some pathogens overwinter on fallen infected leaves, while others use nearby plants as overwintering reservoirs. Additionally, plant pathogenic fungi, bacteria, nematodes, and viruses are carried into the nursery or landscape and spread by footwear, tools and machines, moving water, blowing soil, and insect

Cedar-apple rust (left) and cedar-quince rust (right) on juniper (Photo by University of Gerogia CES)

vectors. Nurseries especially are vulnerable to outbreaks of contagious diseases, so extra precautions are necessary.

- Purchase clean nursery stock. Do not order or accept plants that are likely to be infected with nematodes, crown gall bacteria, highly destructive soil-borne fungi, viruses, or phytoplasmas. Certified clean nursery stock sometimes is warranted.
- Prune or remove infected plants to eliminate sources of inoculum (spores or bacterial cells that serve as the pathogenic material that initiates disease). When collecting cuttings in the field, inspect stock plants carefully and avoid any plants that show disease symptoms or abnormalities.
- Rogue (destroy) diseased plants or prune diseased parts from plants as soon as disease is observed. Burn or bury the discards. Never leave diseased cuttings in nurseries or landscapes. Do not compost diseased plants or cuttings.
- Disinfest tools regularly when pruning or when collecting cuttings. An easy, effective way to do so is to swab or dip cutting blades with rubbing alcohol, a 1:5 solution of Lysol™ concentrated disinfectant, or a 1:5 solution of bleach (undiluted bleach is corrosive to metal tools). Commercial sanitizers also are available.
- Equipment moving between nursery blocks should pass through a central area where it can be washed to remove soil. For example, equipment may be parked on a bed of coarse rock or a steel grating set over a pit, so that contaminated soil does not wash through the nursery.
- Wash boots and hand tools as well as mechanical equipment.
- Divert surface water into ditches or culverts to prevent its movement from one nursery block to another.
- Remember that irrigation water can carry pests and pathogens. Select a clean source, and keep it from becoming contaminated. See your county Extension agent for advice on recycling irrigation water.
- Restrict traffic from outdoor areas to indoor propagation areas. Clean footwear with a germicidal agent such as LF-10 or Amphyl at entrances.

Using Pesticides

Most of the diseases listed in this publication do not require regular chemical treatments for control. Use routine chemical application for disease control only when the plant is of high value and a particular disease is a known threat (has occurred in previous seasons, is present in nearby landscapes, is expected in an operation, or is especially devastating).

Foliar sprays. Small trees and shrubs may be sprayed with hand-pumped, bucket, hose-end, backpack, or small power sprayers. Large trees often must be sprayed with large spray machines for proper coverage.

Timing of pesticide applications varies by pathogen. Most pathogens favor wet or humid conditions (rain, irrigation, fog), therefore some persistent diseases may require protectant sprays before conducive conditions occur. Additional sprays might be needed during long periods of such conditions.

Pathogens often have optimal conditions for infection and colonization. While some prefer cool, wet spring and fall weather, others prefer warm summer weather. If preventative pesticide applications are used, it is essential to first consider the growing conditions. Diseases often are best controlled when fungicides and bactericides are applied before or soon after infection begins. Systemic pesticides can eradicate new infections, but damaged leaves often retain discoloration or visual damage.

Coverage rates vary with pesticide formulations. When using broad spectrum, protectant fungicides, it is essential to cover every leaf, twig, and branch that may become infected by the pathogen. Systemic fungicides, on the other hand, are transported throughout the plant, so complete coverage is less important. Familiarity with pesticide labels improves an applicator's ability to make decisions regarding pesticide formulations.

Some spray mixtures require wetting, spreading, or sticking agents (surfactants). These surfactants are particularly necessary when pesticides are applied to waxy leafed or hard-to-wet broadleaf evergreens or conifers. Follow directions on labels, which include restrictions regarding the selection of compatible surfactants.

Injections and implants. Control of diseases of certain trees is most effective by injecting fungicides into the sapstream at the trunk's base or on the flare roots. Injections are useful when sprays are not practical or effective, such as when the plant is too large or the pathogen is confined to vessel tissue. Annual injections are not recommended, as the injury caused by injection is probably more damaging than the problem being addressed. Implants are less effective than injections and rarely are used.

Soil drench. Soilborne pathogens often require treatment of soils. However, some systemic pesticides applied to the foliage translocate to plant roots where they protect roots and crowns. Pesticides can be

applied in bands directly to soil, in trenches before planting, or through drip irrigation. Pesticide labels indicate which application methods are most effective.

Soil fumigation. General-purpose soil fumigants are designed to eradicate soil-inhabiting organisms including fungi, bacteria, nematodes, insects, plants, and seeds. Highly restricted materials usually are not available to small and medium-sized growers; only large commercial operations are prepared to manage this costly option.

Chemicals for Disease Management

Fungicides are listed alphabetically in Table 1 by common chemical name, followed by trade name, usage information, and remarks. Pesticide recommendations change periodically, so label instructions should be followed precisely. Some fungicides are labeled for commercial production and cannot be applied in landscape situations, while other pesticides are not labeled for greenhouses or closed environments. Therefore, it is essential that applicators follow label instructions and contact an Extension agent or state specialist if more information is needed.

Table 1. Chemicals for Disease Management

Common Chemical Name	Trade Name(s)	Target Organism(s) or Disease(s)	Comments
Azoxystrobin	Heritage	– Anthracnose – Powdery mildew – Some rusts – Late blight	Preventive and curative; systemic; may control other fungal diseases not listed
Bordeaux mixture Copper sulfate + hydrated lime	Bordo-mix	– Fungal and bacterial pathogens	Broad spectrum; organic; may be phytotoxic to some *Ilex* spp. or young foliage of other plants, especially during hot weather; effective as dormant spray
Captan	Captan Captec Orthocide	– Foliar fungal pathogens	Broad spectrum; preventive; not effective for water molds such as *Phytophthora* or *Pythium*
Chlorothalonil	Daconil Bravo Echo Manicure	– Fungal diseases – Powdery mildew – Needle diseases	Broad spectrum
Copper (fixed)	Copper Sulfate Tribasic Copper	– Fungal diseases – Bacterial diseases	General protectant fungicide and bactericide; may be phytotoxic to new spring growth, especially *Ilex* spp.; approved for organic production
Copper hydroxide	Kocide Champion	– Mildews – Leaf spots – Fungal diseases – Bacterial diseases	General protectant; may be phytotoxic; may discolor foliage
Copper sulfate + hydrated lime			See Bordeaux mixture
Copper sulfate pentahydrate	Phyton 27	– Fungal diseases – Botrytis gray mold – Powdery mildew – Bacterial diseases	Labeled for a wide variety of diseases; can be used for landscape, nursery, and greenhouse ornamentals; not phytotoxic like many other copper-based products; injectable for Dutch elm disease
Cyazofamid	Segway	– Downy mildew – Damping off – Root rots – Stem rots	Control of oomycetes (water molds) such as *Pythium, Phytophthora*, and downy mildew pathogens
Etridiazole (Ethazole)	Terrazole Truban	– Damping off – Root rots – Stem rots	Soil drench effective against oomycetes (water molds) such as *Pythium* and *Phytophthora*
Ethazole + thiophanate methyl	Banrot	– Soil-borne diseases	Soil drench effective against fungal and oomycete soil-borne diseases including *Pythium, Phytophthora, Rhizoctonia, Fusarium,* and *Thielaviopsis*

Table 1. Chemicals for Disease Management *(continued)*

Common Chemical Name	Trade Name(s)	Target Organism(s) or Disease(s)	Comments
Fenahexamide	Decree	– Botrytis gray mold – Powdery mildew	Gray mold control in ornamentals and fruit; powdery mildew control in ornamentals
Fenarimol	Vintage Rubigan	– Powdery mildew – Apple scab	Locally systemic fungicide; not for use in nurseries and greenhouses; no longer available in 2013
Fludioxonil	Medallion	– Foliar diseases – Botrytis gray mold – Stem and crown rots – Root rots	Foliar fungal pathogens such as *Rhizoctonia, Alternaria, Septoria, Cercospora*; soil-borne pathogens *Fusarium, Rhizoctonia, Sclerotium, Thielaiopsis;* not effective against oomycetes (water molds); for use on commercial ornamentals only
Fosetyl-Al	Aliette	– Downy mildew – Root rots	Foliar and soil drench; systemic; controls *Pythium, Phytophthora*, and downy mildew pathogens on ornamentals, fruit, and nuts; not compatible with copper fungicides
Gallex	Galltrol Norbac-84	– Crown gall	Preventative and curative biological control
Iprodione	Chipco Rovral	– Fungal disease	Broad spectrum fungicide; nursery and greenhouse use only
Mancozeb	Dithane M-45 Mancozeb Protect T/O	– Foliar diseases	General protectant fungicide
MBC phosphate	Lignasan BLM ElmPro Elm-Noculate Fungisol	– Dutch elm disease	Injectable systemic fungicide
Mefenoxam	Subdue	– Downy mildew – Root rots – Crown rots – Foliar blight – Sudden oak death	Systemic soil drench for control of oomycetes (water molds) such as *Pythium* and *Phytophthora*; treatment for foliar blights caused by oomycetes, including *Phytophthora ramorum*; seed and foliar treatment for downy mildew
Myclobutanil	Eagle	– Powdery mildew – Rusts – Leaf spots – Leaf blights	Systemic protectant and curative treatment for a variety of fungal diseases, including *Cercospora* leaf spots
Pentachloronitrobenzene PCNB Quintozene	Terraclor PCNB	– Root rots – Stem rots	Controls root and stem rots caused by fungi such as *Rhizoctonia* and *Sclerotium* spp.; not effective against oomycetes (water molds)
Phosphorus acid	Alude Vital	– Downy mildew – Root rots – Collar rots – Crown rots – Bacterial blight	Fully systemic fungicide for treatment of oomycetes (water molds), such as *Pythium*, *Phytophthora*, and downy mildew
Piperalin	Pipron	– Powdery mildew	For use in greenhouses for roses and other ornamentals
Propamocarb	Banol	– Leaf blights – Root rots	For control of oomycetes (water molds) such as *Pythium* and *Phytophthora* in commercially-grown ornamentals. Not for use in landscapes.

Table 1. Chemicals for Disease Management *(continued)*

Common Chemical Name	Trade Name(s)	Target Organism(s) or Disease(s)	Comments
Propiconazole	Alamo Banner Immune	– Anthracnose – Leaf spots – Leaf blights – Scab – Powdery mildew – Rusts – Dutch elm disease – Oak wilt	Locally systemic fungicide. Alamo is an injectable fungicide for management of Dutch elm disease and oak wilt; not for use in greenhouses
Pyraclostrobin + boscalid	Pageant	– Foliar diseases – Soil-borne diseases	Broad spectrum fungicide; restricted for use in commercial landscapes, nurseries, and greenhouses
Streptomycin sulphate	Ag-Strep Agrimycin Phytomycin Streptomycin	– Bacterial diseases	Effective against bacterial pathogens only; not effective cure for existing infections. Ineffective at low temperatures; may cause phytotoxicity at high rates during hot weather. Efficacy favored by slow drying conditions. Not labeled for urban landscapes
Sulfur	Sulfur dust Thiolux Liquid lime-sulfur	– Powdery mildew – Fungal diseases – Some insects & mites	Preventative treatment for fungi and some insects and mites. Phytotoxic on *Viburnum* spp. May injure plants at temperatures above 90˚F; not compatible with oil-based pesticides; sulfur does not mix safely with many pesticide formulations; consult label
Thiabendazole	Arbortect	– Dutch elm disease – Sycamore anthracnose	Injectable fungicide
Thiophanate-methyl	AllBan Cleary's 3336 Topsin M	– Foliar diseases – Root rots	Broad spectrum fungicide with systemic properties; not effective against oomycetes (water molds); foliar spray or soil drench, usually combined with other fungicides
Thiophanate-methyl + mancozeb	Zyban	– Fungal diseases	Broad spectrum fungicide with systemic curative and protective properties
Triadimefon	Bayleton Strike	– Flower blights – Leaf blights – Stem blights – Powdery mildew – Rust	Systemic fungicide for various diseases of ornamentals; not for landscape use
Triflorine	Funginex	– Rose diseases – Powdery mildew	Systemic treatment for rose diseases
Trifloxystrobin	Compass	– Leaf spots – Powdery mildew – Black root rot – Stem and root rots	Broad spectrum fungicides for control of a wide range of diseases, including rots caused by *Rhizoctonia*; protects against some diseases caused by oomycetes (water molds); nursery and greenhouse use only
Triflumizole	Terraguard	– Foliar diseases – Root rots – Petal blights – Powdery mildew – Rusts	General protectant fungicide; not effective against soil-borne diseases caused by oomycetes (water molds); can be used as a foliar spray, soil drench, or soak for cuttings in greenhouses and nurseries
Ziram	Ziram	– Fungal diseases	General protectant fungicide for roses and tree and vine fruit

Nematode Control

Soil-borne nematodes can be controlled using nematicidal fumigants like chlorinated hydrocarbon compounds applied before planting. Follow guidelines listed previously for soil fumigation.

Soybean cyst nematode, a quarantine pest in many states, is commonly associated with various nursery weeds. To comply with clean stock certification requirements, nurseries shipping balled-and-burlapped plant material to certain states must obtain a state phytosanitary certificate verifying that soil is free of soybean cyst nematode. See ID-110 and HO-99, and your Cooperative Extension agent for more information.

General recommendations for disease management

Bacterial leaf spots and blights. Remove diseased leaves and infected plant material. Thin plants and increase spacing to improve air circulation. Eliminate overhead irrigation to prevent moisture accumulation on the foliage and splashing that spreads the pathogen. Avoid handling wet plants to reduce spread of bacterial cells. Copper-based fungicides and bactericides limit disease spread. Streptomycin-based bactericides are labeled for commercial use only. Fungicides are not effective against bacterial pathogens.

Bacterial leaf scorch. There are no effective control options. The pathogen is transported by leaf hoppers and spittlebugs, but vector control usually is not possible. No cure exists for bacterial leaf scorch. Both foliar and injectable bactericides are inconsistent and are not long-term solutions. Destroy infected plants when possible. In landscapes, newly symptomatic branches can be pruned out to remove the pathogen. This method may prolong tree life but will not eradicate the disease or pathogen. Retaining vigor may help prevent infection. Replace infected trees with resistant hosts such as:

- *Fagus sylvatica* (beech)
- *Quercus acutissima* (sawtooth oak)
- *Tilia spp.* (linden)
- *Liriodendron tulipifera* (tulip poplar)
- *Ulmus parvifolia* (Lacebark or Chinese elm)
- *Celtis laevigata* (hackberry)
- *Carya spp.* (hickory)
- *Zelkova serrata* (Japanese zelkova)

Bacterial leaf scorch of sweet gum
(Photo by J. Hartman)

Bacterial leaf scorch of red oak
(Photo by J. Hartman)

Refer to PPFS-OR-W-12 for a complete listing of resistant and susceptible plants.

Crown gall. Do not take cuttings from infected plants. Pretreat cuttings or liners with Galltrol-A or Norbac 84. Destroy heavily infected plants. Prune out and destroy galls on high value landscape plants. Disinfest tools between cuts. Apply Gallex to exposed galls. Do not plant susceptible hosts in locations where crown gall has been a problem. *Euonymus alatus* is resistant to crown gall.

Genera resistant to crown gall include:

- *Betula* (birch)
- *Berberis* (barberry)
- *Buxus* (boxwood)
- *Carpinus* (hornbeam)
- *Catalpa* (catalpa)
- *Cedrus* (cedar)
- *Cephalotaxus* (plum yew)
- *Cercis* (redbud)
- *Cryptomeria* (Japanese cedar)
- *Fagus* (beech)
- *Ginkgo* (ginkgo)
- *Gymnocladus* (Kentucky coffeetree)
- *Ilex* (holly)
- *Kalmia* (mountain laurel)
- *Koelreuteria* (golden raintree)
- *Larix* (larch)
- *Liquidambar* (sweetgum)
- *Liriodendron* (tulip poplar)
- *Magnolia* (magnolia)
- *Mahonia* (mahonia, grape holly)
- *Nyssa* (blackgum)
- *Picea* (spruce)
- *Pinus* (pine)
- *Pieris* (Japanese pieris)
- *Pyracantha* (pyracantha, firethorn)
- *Pseudolarix* (false larch)
- *Sambucus* (elderberry)
- *Tamarix* (tamarisk)
- *Taxodium* (bald cypress)
- *Tilia* (linden, basswood)
- *Tsuga* (hemlock)
- *Zelkova* (Japanese zelkova)

Dieback, decline, and cankers. Keep trees well-watered, especially during periods of low rainfall. Pathogens causing diseases such as cankers and root and crown rots may

be secondary invaders in declining plants. Overwatering also may be problematic. Prune out dead and dying branches. Prevent decline by routine care and proper tree placement. Avoid salt exposure and soil compaction. Sever girdling roots as needed. Control damaging insects. Aerate compacted soil in root zone. Abiotic conditions such as environmental or cultural conditions may cause dieback.

Anthrose canker on sycamore
(Photo by J. Hartman)

Chestnut blight trunk cankers
(Photo by J. Hartman)

Downy mildew. Provide growing site with good air movement and sunlight penetration by pruning and properly spacing plants. Reduce overhead irrigation to keep foliage dry. Rake and destroy fallen infected leaves in autumn. Apply azoxystrobin, copper, cyazofamid, fosetyl-AL, mancozeb, or phosphorus acid. Scheduled fungicide applications may be required for high value or commercial crops when conditions favor disease.

Fire blight. Use resistant species or cultivars. Remove fire blight-infected limbs and branches 12 inches below diseased tissue. If possible, delay pruning until winter when the risk of spreading bacteria is significantly reduced. Sanitize tools between cuts. Prune out cankers and blighted branches from November through March, making cuts below the visible limits of infection; pruning from April through October has little value in fire blight control and, in fact, may spread the disease. Never prune or work in orchards or landscapes when leaves or limbs are wet. Avoid excessive fertilization. Protect plants during the flowering stage with three applications of Bordeaux mixture, copper, or streptomycin between first bloom and full bloom. Streptomycin is not labeled for urban landscapes. Several new biological control agents are available, such as Serenade® and BlightBan®.

Fireblight on Callery Pear
(Photo by J. Hartman)

Fungal leaf spots and leaf blights, including anthracnose. Sprays are usually not needed except when aesthetics are of primary importance. Provide a growing site with good air movement and sunlight penetration by pruning and properly spacing plants. Rake and destroy fallen infected leaves in autumn. If disease was severe the previous year and cool, wet conditions are expected in spring, spray with azoxystrobin, Bordeaux mixture, chlorothalonil, copper (fixed), fludioxonil, iprodione, mancozeb, myclobutanil, propiconazole, pyraclostrobin, thiophanate-methyl, or triadimefon. Fungicide specificity varies per pathogen. Refer to "Chemicals for Disease Management" on pages 3-5, and read fungicide labels to verify that specific plants and diseases are listed. Timing of applications varies by pathogen. Bacterial diseases are not controlled with fungicides and therefore should be treated differently.

Anthracnose on sycamore leaf
(Photo by C. Kaiser)

Powdery mildew. Provide growing site with good air movement and sunlight penetration by pruning and properly spacing plants. Apply azoxystrobin, fenarimol, mancozeb + thiophanate-methyl, myclobutanil, propiconazole, sulfur, thiophanate-methyl, triadimefon, trifloxystrobin, triflumizole, or ziram at regular intervals. Check fungicide labels for specific instructions.

Powdery Mildew on dogwood
(Photo by J. Hartman)

Root rots, cutting rots, and crown rots. Provide good sanitation, including clean plant materials and growing media. Good soil drainage is essential. Remove and destroy diseased plants if possible. Avoid root and crown injury where pathogens can enter. Fungicide drenches may be used if labeled for the specific crop. Two pathogen groups are responsible for root rots. For root rots caused by water molds, use products containing mefenoxam, fosetyl-Al, phosphorus acid, or etridiazole. For *Rhizoctonia* or other fungal rots, use azoxystrobin, iprodione, mancozeb, paraclostrobin, PCNB, thiophanate-methyl, or trifloxystrobin. Crown rots are usually not treatable; remove and destroy infected plants.

Rusts. Provide a growing site with good air movement and sunlight penetration by pruning and properly spacing plants. Remove alternative hosts. Use resistant species or cultivars when possible. Fungicides may be used for preventative control if disease was severe during the previous year and wet conditions are expected. Otherwise, curative treatments should be made when symptoms first appear using a fungicide with azoxystrobin, chlorothalonil, myclobutanil, propiconazole, pyraclostrobin, thiophanate-methyl, triadimefon, or trifloxystrobin. Fungicide specificity varies with the pathogen; refer to "Chemicals for Disease Management" on pages 3-5 and to product labels. Timing of applications varies by pathogen.

Verticillium wilt. Practice strict nursery hygiene. It is difficult to disinfest contaminated soil even by using soil fumigation. Rogue infected nursery plants. In the landscape, prune out infected branches or remove severely infected plants. Fertilize and water landscape plants to reduce plant stress. Replace diseased plants with resistant species.

Plants with resistance to Verticillium wilt include:

- *Asimina triloba* (papaw)
- *Betula* spp. (birch)
- *Buxus* spp. (boxwood)
- *Cercidiphyllum japonicum* (katsuratree)
- *Carpinus* spp.(hornbeam)
- *Cornus* spp. (dogwood)
- *Crataegus* spp. (hawthorn)
- *Ginkgo biloba* (ginkgo)
- *Fagus* spp. (beech)
- *Gleditsia triacanthos, inermis* (thornless honeylocust)
- *Ilex* spp. (holly)
- *Juglans* spp. (walnut)
- *Liquidambar styraciflua* (sweetgum)
- *Malus* spp. (apple, crabapple)
- *Morus* spp. (mulberry)
- *Platanus* spp. (sycamore, planetree)
- *Populus* spp. (poplar)
- *Pyracantha* spp. (pyracantha, firethorn)
- *Quercus* spp. (oak)
- *Pyrus* spp. (pear)
- *Salix* spp. (willow)
- *Sorbus alnifolia* (Korean mountainash)
- *Tilia* spp. (linden, basswood)
- *Zelkova serrata* (Japanese zelkova)
- Needled evergreens

Recommendations for common diseases of landscape plants

Abelia (abelia)

Leaf spot. See suggestions under "General Recommendations."

Powdery mildew. See suggestions under "General Recommendations."

Acer (maple)

Anthracnose. See suggestions under "General Recommendations."

Bacterial leaf scorch. No effective treatment is available. Retaining vigor may help prevent infection. Replace trees with non-susceptible hosts listed in "General Recommendations."

Fungal cankers. Fertilize and water as needed to provide good growing conditions for maintaining plant health. Avoid injuries. Remove and destroy cankered branches or excise trunk cankers when bark is dry.

Phyllosticta and other leaf spots. Chemical control is not required. Rake and destroy fallen leaves. If disease is a recurring problem, use preventative fungicides as indicated under "General Recommendations."

Taphrina leaf blister. Sprays usually are not needed. A single dormant application of lime sulfur will control this disease.

Tar spot. Rake and destroy fallen leaves. Sprays usually are not needed.

Verticillium wilt. See "General Recommendations."

Verticillium wilt with vascular streaking on maple (Photo by J. Hartman)

Tar spot on maple (Photo by C. Kaiser)

Aesculus (horsechestnut, buckeye)

Abiotic scorch. Provide adequate water.

Guignardia leaf blotch, leaf spots. Destroy fallen leaves in autumn. Spray with chlorothalonil or mancozeb two to four times at 10- to 14-day intervals beginning when buds open. Weather conditions and severity of disease determine number of applications needed. *Aesculus parviflora* reportedly is resistant to leaf blotch.

Amelanchier (serviceberry)

Fire blight. See "General Recommendations" above.

Powdery mildew. See suggestions under "General Recommendations."

Rust. See suggestions under "*Malus*."

Betula (birch)

Leaf spots, leaf rust. Rake and destroy fallen leaves. Fungicides are not necessary.

Buxus (boxwood)

Macrophoma and other leaf spots. Use sanitation measures as indicated in "General Recommendations." Fertilize and protect from winter injury to maintain vigor. Sprays are not needed.

Pseudonectria canker. Plant in well-drained soil, and protect from drying winter winds. Prune infected branches back to healthy wood. In spring, if possible, remove and destroy old leaves lodged in branches. A strong stream of water helps.

Chamaecyparis (false cypress, Japanese cypress)

Phytophthora root rot. Provide good soil drainage. Drench soils with mefenoxam, fosetyl-Al, ethidiazole/ethazole + thiophanate-methyl, or etridiazole. See suggestions under "General Recommendations."

Carya (hickory)

Fungal leaf spots. Rake and destroy fallen leaves. Fungicides usually are not necessary. If disease has been severe, sprays may be warranted. See suggestions under "General Recommendations."

Castanea (chestnut)

Chestnut blight, *Cryphonectria (Endothia) parasitica*. There is no cure for this disease. American chestnut is extremely susceptible, but resistant/tolerant hybrid cultivars have been developed by crossing American chestnut with Asian species. Chinese chestnut is mostly disease-tolerant. Another chestnut revitalization program uses a biological control method involving "hypovirulent" fungal strains. These weakened strains of the fungus are injected into trees as competitors against lethal strains.

Catalpa (catalpa)

Fungal leaf spots. Rake and destroy fallen leaves. Sprays are usually not necessary. If disease has been severe, see suggestions under "General Recommendations." Spray when leaves are unfolding, when leaves reach full size, and two weeks later.

Verticillium wilt. See suggestions under "General Recommendations."

Cedrus (cedar)

See "Juniper."

Celtis (hackberry)

Witches' broom, caused by *Sphaerotheca phytoptophila* and eriophyid mites. No practical control for affected trees is available. *C. sinensis* (Chinese hackberry) is resistant.

Cercis (redbud)

Anthracnose and other leaf spots. See suggestions under "General Recommendations."

Botryosphaeria canker. Prune and destroy affected branches when foliage is dry. Control borers, and avoid other injuries. Provide water during dry periods.

Verticillium wilt. See suggestions under "General Recommendations."

Cornus (dogwood)

Botrytis flower and leaf blight. Disease is serious only in wet years. If wet weather occurs during bloom, spray once with thiophanate- methyl or iprodione. Improve air circulation.

Canker and dieback. Maintain vigorous tree growth. See suggestions under "General Recommendations."

Dogwood anthracnose (discula anthracnose, lower branch dieback). Prune diseased branches back to sound wood, and destroy them. Rake and destroy fallen leaves. Avoid trimmer and mower wounds as well as other injuries. Maintain vigor by applying mulch; water during dry periods. Do not transplant dogwood trees from the wild. See "General Recommendations." Fungicide applications should begin at bud break and continue at 10- to 14-day intervals.

Anthracnose on dogwood
(Photo by J. Hartman)

Resistant dogwoods include:

- *Cornus kousa*
  - Milky Way
- *C. kousa x florida*
- *C. racemosa*

Susceptible dogwoods:

- *C. kousa*
  - *var. chinensis*
  - Autumn Rose
  - Moonbeam
  - Wolf Eyes

Fungal twig blights and cankers. Prune diseased branches back to sound wood, and destroy pruned branches. Maintain vigor by mulching. Water during dry periods.

Leaf spot anthracnose. Use resistant cultivars. See suggestions under "General Recommendations." Preventative fungicides may be necessary for commercial nursery stock. Begin applications at bud break and continue treatments until all new growth matures in late spring or early summer. Cultivars resistant to spot anthracnose also are resistant to powdery mildew. See cultivar selection under "Powdery mildew."

Phytophthora crown canker. To help prevent infection, avoid mechanical injuries, especially to the lower trunk and roots, and control borers. Infected nursery trees should be destroyed. For established landscape plantings, prune branches by removing discolored wood down to heartwood if necessary, cutting into healthy wood approximately 1½ inches around the edge of the canker. Trees with cankers that encircle more than one-half the stem should be removed, and the area should not be replanted with dogwoods for several years. Provide good soil drainage. Mefenoxam, used as a soil drench, will suppress crown canker.

Phytophthora canker on maple
(Photo by J. Hartman)

Powdery mildew. See suggestions under "General Recommendations." Fungicides may be applied when fungal colonies are first visible and re-applied at regular intervals. Selection of disease-resistant cultivars is the most effective means of control.

Nearly all cultivars of *Cornus kousa* and *C. kousa x florida* are highly resistant to both powdery mildew and spot anthracnose. Examples include:

- *C. florida*
  - Cherokee Brave
- *C. kousa*
  - Milky Way
  - Satomi
  - Temple Jewel
- *C. kousa x florida*
  - Aurora
  - Galaxy
  - Stellar Pink

Septoria and other fungal leaf spots, and spot anthracnose. Sprays usually are not necessary. If disease was severe the previous year and spring conditions are wet, apply sprays at bud break and 10 and 20 days later. See suggestions under "General Recommendations."

Cotoneaster (cotoneaster)

Fire blight. See suggestions under "General Recommendations." *Cotoneaster apiculatus* is a resistant species.

Crataegus (hawthorn)

Fabraea leaf spot. Destroy or compost fallen leaves. Spray fungicides when leaf buds open and repeat 10 and 20 days later. Additional applications might be necessary during wet seasons. See suggestions under "General Recommendations."

Resistant hawthorns include *Crataegus crus-galli* Cockspur and *C. phaenopyrum* Washington.

Fire blight. See suggestions under "General Recommendations."

Rusts, caused by *Gymnosporangium spp.* See suggestions under "General Recommendations." Eliminate nearby red cedar and common juniper to whatever extent practical. Spray with triadimefon, chlorothalonil, mancozeb + thiophanate-methyl, or propiconazole. Begin a spray schedule when orange rust masses develop on cedars (April through May). Make three or four applications at seven- to 10-day intervals.

Resistant cultivars include *C. crus-galli* Cockspur and *C. phaenopyrum* Washington.

Eleagnus (autumn olive, Russian olive)

Canker, dieback. Prune out and destroy infected branches.

Euonymus (euonymus)

Crown gall. Refer to "General Recommendations" for management recommendations and a listing of genera resistant to crown gall.

Powdery mildew. See suggestions under "General Recommendations." Apply fungicide weekly beginning when disease symptoms first appear.

Forsythia (forsythia)

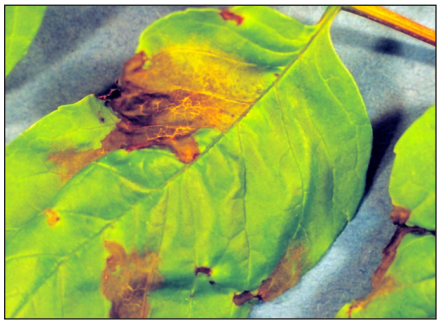
Cercospora leaf spot. See "General Recommendations." Fungicides usually are not necessary.

Phomopsis gall. Prune affected branches.

Fraxinus (ash)

Anthracnose and other leaf spots. See "General Recommendations."

Bacterial leaf scorch. No effective control is available. Retaining vigor may help prevent infection. Replace trees with non-susceptible hosts; see "General Recommendations."



Anthracnose leaf spot on ash
(Photo by J. Hartman)

Gleditsia (honeylocust)

Leaf spots. Rake and destroy fallen leaves. See "General Recommendations."

Powdery mildew. No chemical control needed. See suggestions under "General Recommendations."

Thyronectria canker. Avoid injuries; alleviate stressful growing conditions.

Tolerant cultivars are Shademaster and Imperial.

Hydrangea

Bacterial wilt. Remove diseased leaves, if possible. Eliminate overhead irrigation. Apply a copper-based pesticide in late spring to limit disease spread.

Bud blight, gray mold, petal blight. Practice strict nursery hygiene. Destroy fallen petals and leaves. Space plants for maximum air circulation. Avoid overhead irrigation, if possible. Fungicide usually is not necessary, but in severe cases plants may be sprayed with fungicides such as iprodione, mancozeb, or thiophanate methyl. See suggestions under "General Recommendations."

Cercospora and other fungal leaf spots. See suggestions under "General Recommendations."

Powdery mildew. See suggestions under "General Recommendations."

Rust. Spray chlorothalonil, triadimefon, or propiconazole just before disease is expected and again two weeks later. See suggestions under "General Recommendations."

Viral diseases. There is no cure for viral infections in hydrangea. Remove infected plants, if possible. If plants cannot be removed or if symptoms are minimal, prune and destroy symptomatic canes. Sanitize tools between cuts. Viruses are systemic, so even symptomless canes are infected; do not propagate virus-infected plants.

Yellows, aster yellows. Once plants are infected, there is no treatment for yellows disease. The pathogen is transmitted by leafhoppers, but must establish and reproduce in host plants before transmission can occur. Remove infected plants before replication and spread. Control weeds that can serve as reservoir hosts. Manage leafhopper vectors, especially in greenhouses.

Ilex (holly)

Black root rot. Practice strict nursery hygiene and sanitation. Exclude the pathogen from the nursery by using disease-free stock plants. Avoid use of unsterilized agricultural soils in containers, and sanitize previously used nursery containers. Promote good plant growth and reduce stress. In the nursery and landscape, a soil drench using etridiazole, thiophanate methyl, or trifloxystrobin may be applied as a preventative or curative if infection is not yet severe. Destruction of infected plants is recommended.

Ilex cornuta is a resistant species.

Fungal leaf spots. Rake and destroy fallen leaves.

Sooty mold. Manage honeydew-producing insects such as aphids, scales, whiteflies, and planthoppers.

Juglans (walnut, butternut)

Fungal leaf spots. Destroy fallen leaves. Apply three fungicide applications as suggested under "General Recommendations" at two-week intervals, beginning when leaves begin to unfold.

Thousand cankers. Remove diseased trees, and burn all parts. Thousand cankers disease is spread by the walnut twig beetle. No cure exists for thousand cankers disease.

Juniperus (juniper, red cedar)

Cedar-apple, cedar-hawthorn, and cedar-quince rusts, caused by *Gymnosporangium* spp. Do not plant juniper hosts near flowering crabapple, hawthorn, quince, and other rosaceous plants. Manually remove galls and infected twigs in early spring if infection is nominal. Refer to Table 2 on page 12 for resistant cultivars.

Cedar-hawthorne rust on hawthorne
(Photo by J. Hartman)

Kabatina tip blight (the most damaging tip blight in Kentucky). Prune out infected shoots. Chemical controls have not been developed. Refer to Table 2 for resistant cultivars.

Phomopsis. If possible, prune out and destroy infected shoots. Avoid overhead irrigation. Rogue and destroy infected plants when disease is first seen in young plantings. Spray with azoxystrobin, copper, mancozeb, propiconazole, or thiophanate-methyl plus a spreader-sticker at two-week intervals throughout the growing season. Refer to Table 2 for resistant cultivars.

Phytophthora root rot. Provide good soil drainage. Drench soils with mefenoxam, fosetyl-Al, phosphorus acid, or etridiazole. See suggestions under "General Recommendations."

Kalmia (mountain laurel)

Fungal leaf spots, Phytophthora leaf spot. Hand pick infected leaves and prune infected shoots; destroy fallen leaves. If disease has been severe in recent years, spray as suggested under "General Recommendations" at bud break and again 10 and 20 days later.

Phytophthora root rot. Provide good soil drainage. Drench soils with

Table 2. Resistant cultivars of *Juniperus*			
Resistant species/cultivars	**Cedar rusts**	**Kabatina**	**Phomopsis**
J uniperus ashei	X		
J. Chinensis—Blue Point	X		
Columnaris Hetzii	X	X	
Grey Owl	X		
Hetzii	X		X
Iowa			X
Keteleeri	X	X	X
Perfecta	X	X	
Pfitzeriana	X	X	X
Pfitzeriana Glauca	X		
Saybrook Gold		X	X
Spartan		X	X
J. conferta—Blue Pacific			X
J. communis—Hibernica	X	X	X
J. communis var *depressa*			X
J. Horizontalis—Bar Harbor		X	
Wiltonii	X		
J. procumbans	X		
J. procumbans—Nana		X	
J. rigida	X		
J. sabina—Broadmoor	X	X	X
J. scopulorum—Wichita Blue	X		

mefenoxam, fosetyl-Al, phosphorus acid, or etridiazole. See suggestions under "General Recommendations."

Koelreuteria (goldenrain tree)

Nectria canker. Prune back to sound wood. Fertilize and water to maintain vigor.

Verticillium wilt. See suggestions under "General Recommendations."

Lagerstroemia (crape myrtle)

Cercospora leaf spot. See suggestions under "General Recommendations." Cultivars that are resistant to powdery mildew usually also are resistant to Cercospora leaf spot. Azoxystrobin, copper, and myclobutanil may be used if disease is severe.

Powdery mildew. See suggestions under "General Recommendations."

Liriodendron (tulip poplar)

Fungal leaf spots, Phytophthora leaf spot. Handpick infected leaves, and prune infected shoots. Destroy or compost fallen leaves. If disease has been severe in recent years, spray as suggested under "General Recommendations" at bud break and again 10 and 20 days later.

Phytophthora root rot. Provide good soil drainage. Drench soils with mefenoxam, fosetyl-Al, phosphorus acid, or etridiazole. See suggestions under "General Recommendations."

Powdery mildew. There is no need for chemicals to control this disease. Use cultural practices as suggested under "General Recommendations."

Verticillium wilt. See suggestions under "General Recommendations."

Magnolia (magnolia)

Leaf spots. If disease has been severe in recent years, spray as suggested under "General Recommendations."

Sooty mold. Manage honeydew-producing insects such as aphids, scales, whiteflies, and planthoppers.

Malus (apple, flowering crabapple)

Crabapple cultivars are available that are resistant to multiple diseases. The following flowering crabapple cultivars are moderately to highly resistant to powdery mildew, scab, fire blight leaf spot, and rust (see also ID-68):

- Adams
- David
- Donald Wyman
- Jewelberry
- Molten Lava
- Profusion
- Red Jewel
- Robinson
- Sentinel
- Sugar Tyme
- Velvet Pillar
- White Cascade
- *Malus sargentii*
- *M. zumi Calocarpa*

Scab on pyracantha
(Photo by J. Hartman)

Fire blight. See "General Recommendations." Remove non-valuable pear, apple, quince, and similar plants from the vicinity.

Timing of antibiotic applications is based on weather conditions during bloom; however favorable condi-

tions do not exist in all years or in all nurseries or orchards. Commercial growers may use the MARYBLYT computer program to help them make management decisions (PPFS-FR-T-07). MARYBLYT calculates the risk of fire-blight infections based on daily temperatures, rainfall, and plant developmental stage. Otherwise, spray with streptomycin when 25 percent of blossoms are open and again when 75 percent of blossoms are open. If temperatures are above 65 degrees, use fixed copper instead of streptomycin to prevent injury. Streptomycin is not labeled for urban landscapes.

Frogeye leaf spot and black rot canker. Leaf spot does not cause severe damage, but infections can threaten stems and branches. Eliminate dead twigs and branches.

Powdery mildew. Provide a sunny, well-ventilated planting site. Use disease-resistant plants. Prune away shading vegetation. For fungicide options, see "General Recommendations."

Rust caused by *Gymnosporangium* spp. Eliminate nearby red cedar and common juniper where possible, or remove and destroy cedar rust galls and rust-infected juniper twigs. Spray with myclobutanil, propiconazole, triadimefon, or other fungicides listed under "General Recommendations." Make three applications at 14- to 21-day intervals beginning when orange rust masses develop on junipers (April through May).

Scab. Rake and destroy all fallen leaves and fruits in the fall. To control primary infections in the spring, spray trees during pink-bud stage, petal-fall, and at 10 and 20 days after petal-fall. Pyraclostrobin, chlorothalonil, propiconazole, mancozeb, thiophanate-methyl, or mancozeb + thiophanate-methyl can be used. Apply before rain if possible, and extend the treatment schedule during rainy seasons. Use disease-resistant crabapples.

Picea (spruce)

Cytospora canker. Avoid injuries, and retain vigorous growth. Remove and destroy all diseased branches. Do not prune in wet weather. Disinfest tools between cuts. Chemical control measures are not available. Colorado blue spruce is most susceptible to this disease.

Needle blight. Sprays normally are not needed. This disease most often is found on trees weakened by other factors. Chlorothalonil applications are effective when made in early and late June for three consecutive years.

Phytophthora root rot. Provide good soil drainage. Drench soils with mefenoxam, fosetyl-Al, phosphorus acid, or etridiazole. See suggestions under "General Recommendations."

Rhizosphaera needlecast. Sprays normally are not needed. This disease most often is found on trees weakened by other factors. Chlorothalonil applications in early and late June may help. Colorado blue spruce is highly susceptible, and Norway spruce is resistant.

Pieris (andromeda)

See "Rhododendron."

Pinus (pine)

Gall rusts of two- and three-needle pines (Eastern gall rust, Western gall rust). In nurseries, cull seedlings with stem swellings. In landscapes, remove branch galls and rogue heavily galled trees in early spring. Apply fungicides once when yellow pustules erupt through bark on galls. See "General Recommendations."

Needlecast and needle blight diseases of two- and three-needle pines. Space trees and prune branches to promote air circulation. If rainy conditions persist between mid-April and October or if trees become infected, apply chlorothalonil, mancozeb, or thiophanate-methyl every four weeks. Four applications can be made at monthly intervals mid-April through June for brown spot needle blight and Naemacyclus needle cast or in early July for Lophodermium needle cast.

Tip blight on pine
(Photo by J. Hartman)

Needle rust of two- and three-needle pines (Coleosporium). Goldenrod and aster plants are alternate hosts and should be removed before August of each year.

Pine wilt nematode. Remove and destroy affected trees.

Tip blight of two- and three-needle pines. Prune and destroy affected cones, twigs, and branches during dry weather in autumn. Spray with thiophanate-methyl at bud break, again as candles are beginning to elongate, and finally when needles are emerging from needle sheaths. Use a spreader-sticker.

White pine decline, a non-infectious disease. This condition is not caused by a pathogen. Provide a planting site with acidic soil and little clay. Avoid soil compaction, planting too deeply, overmulching, drought-prone sites, and tree injuries. Remedial sulfur applications to acidify soil may benefit trees.

White pine root decline, a fungal disease. Remove and destroy infected trees. Choose well-drained planting sites. Control wood-boring insect vectors of this disease.

Spores of the tip blight fungus (black pycnidia)
(Photo by J. Hartman)

Platanus (planetree and sycamore)

Anthracnose. Anthracnose is generally only an aesthetic problem. When control is necessary, prune out infected twigs and branches. Rake and destroy fallen leaves. See fungicide suggestions listed under "General Recommendations." Make a first application before trees break bud, a second at bud break, and a third when leaves are expanding. Trees also can be protected by thiabendazole injections.

Populus (poplar, aspen, cottonwood)

Fungal cankers. Mulch and water trees as needed to reduce stress. Avoid wounding. Prune out and destroy infected branches during dry weather. Destroy severely affected trees. Lombardy poplar is extremely susceptible.

Leaf rust. Spray triadimefon in early summer just before disease is expected and again two weeks later.

Prunus (cherry, flowering cherry, peach, flowering almond)

Black knot. Remove and destroy knotted twigs, and excise knots on large limbs when trees are dormant. Spray with thiophanate-methyl when dormant and at pink-bud stage, full bloom, and three weeks later.

Crown gall. See "General Recommendations" for crown-gall control. For management of galls on established trees, use Gallex according to label instructions.

Coccomyces leaf spot. Rake and destroy fallen leaves. Spray propiconazole or captan at petal fall and twice more at two-week intervals. Spray a single application after fruit drop, if needed.

Monilinia shoot blight (brown rot). Remove and destroy infected twigs if possible. Spray captan, chlorothalonil, or propiconazole as blossoms open and again 10 days later.

Pyracantha (firethorn)

Bacterial leaf spot. Improve air circulation. Remove diseased leaves, if possible. Eliminate overhead irrigation. Use copper-based fungicides in late spring to limit disease spread.

Fire blight. See "*Malus*" fire blight control and "General Recommendations."

Scab. Spray with pyraclostrobin, propiconazole, chlorothalonil, thiophanate-methyl, mancozeb, or mancozeb + thiophanate-methyl at full bloom and two and four weeks later.

Pyrus (pear)

Fire blight. See "*Malus*" and "General Recommendations" for fire blight control. Bradford, Aristocrat, and other flowering pear cultivars are susceptible to this disease, yet not normally heavily infected.

Fire blight on spurs of callery pear
(Photo by J. Hartman)

Quercus (oak)

Actinopelte leaf spot. Normally, there is no need for fungicides. Rake and destroy fallen leaves. Propiconazole sprays may help.

Anthracnose. See suggestions under "General Recommendations."

Armillaria shoestring root rot. This disease most frequently affects trees weakened by other agents, such as stress. There are no effective control options.

Bacterial leaf scorch, *Xylella*. There are no effective control options. Refer to "General Recommendations."

Bacterial wetwood. See recommendations under "*Ulmus*."

Dieback, decline. This condition is not caused by a pathogen. Keep trees well-watered, especially during dry periods from May through July. Control of damaging insects is important for prevention of dieback and decline. Alleviate soil compaction in the root zone. Prune out dead and dying branches to improve tree appearance.

Phyllosticta leaf spot. Chemical control is not required. Rake and destroy fallen leaves. If disease is a recurring problem, use preventative

fungicides as indicated under "General Recommendations."

Powdery mildew. Usually there is no need to control this disease with fungicides. See "General Recommendations."

Taphrina leaf blister. Spray once before bud swell with mancozeb or chlorothalonil.

Tubakia leaf spot. Improve tree vitality, prune out dead wood, and prevent stress. Remove fallen leaves. Fungicides are not necessary.

Rhododendron (azalea, rhododendron)

Azalea gall. Remove and destroy galls.

Botryosphaeria canker and dieback. Remove and destroy infected plant parts, disinfecting tools between cuts. Avoid adverse growing conditions, i.e. drought or freezing.

Fungal leaf spots. Handpick infected leaves, if possible. Spray at bud break and 10 and 20 days later with thiophanate-methyl or mancozeb.

Lichens. Use cultural practices that promote plant vigor. Lichens typically are a sign of poor plant health and plant decline. Lichens do not damage plants.

Phytophthora shoot dieback and foliar blight. Avoid wetting leaves. Retain plant vigor with proper fertility, pH, and air circulation. Prune and destroy infected twigs. Reduce shade, if possible. As new leaves appear, spray mancozeb or chlorothalonil as preventatives, making two applications 10 to 14 days apart. Applications of mefenoxam, phosphorus acid, or fosetyl-Al are effective against water mold infections.

Root rot and wilt, caused by *Phytophthora* and other fungi. Plant shrubs only in soils with good drainage. Avoid overwatering. Adjust soil pH to 4.0 to 4.5 by amending with acid peat or sulfur. Apply soil drench fungicides such as propamocarb, mefenoxam, etridiazole, phosphorus acid, or ethazole + thiophanate-methyl.

Rosa (rose)

Black spot. Spray chlorothalonil, captan, mancozeb, propiconazole, or ziram at 7- to 14-day intervals beginning as leaves expand. Shorten intervals during wet weather. Advanced fungicides such as trifloxystrobin can be used in rotations. Some rose varieties are sensitive to chlorothalonil.

Black spot on rose
(Photo by J. Hartman)

Crown gall. See "General Recommendations."

Downy mildew. Avoid wetting leaves. Provide good air circulation. Chemical control must begin as early as possible during the disease cycle. Fosetyl-Al and copper + mefenoxam should be rotated at intervals indicated on labels.

Powdery mildew. See suggestions under "General Recommendations." Select fungicides that also control black spot.

Rose rosette. No control is available. The pathogen is transmitted by mites; miticides and removal of diseased plants may reduce spread. Rose rosette also is spread through grafting stock.

Stem canker, brown canker, graft canker. Prune and destroy infected canes.

Rose rosette virus
(Photo by J. Hartman)

Syringa (lilac)

Bacterial blight. Prune and destroy dead twigs. Improve air circulation, and avoid overhead irrigation.

Powdery mildew. See "General Recommendations" for powdery mildew control.

Resistant lilacs (non-vulgaris types) include *Syringa patula* and *S. reticulata*.

Thuja (arborvitae)

Tip blights. See "Juniperus" for tip blight control.

Ulmus (elm)

Bacterial wetwood and slime-flux. There is no cure for this disease, but bacteria do not weaken wood or harm trees. Practice good sanitation to prevent transmission by pruning tools.

Dutch elm disease. This disease is vectored by elm bark beetles, which spend a portion of their lifecycle in dead or dying elm trees. Therefore, all dead or dying elm trees or unhealthy branches of elm trees should be eliminated within 1,000 feet of the trees to be protected. Make

a dormant application (March or April) of insecticide for control of elm bark beetles. Pruning is sometimes effective if symptoms are detected while confined to a small branch. Inject Arbotect 20-S, Lignasan (Correx, Elmpro), Fungisol, or Phyton 27 into the lower trunk and root flare for protection or therapy. See publication PPFS-OR-W-02 for more information on Dutch elm disease.

In general, native elms are susceptible to Dutch elm disease and phloem necrosis; elms of European origin vary in susceptibility to Dutch elm disease; elms of Asiatic origin are resistant, though not immune.

Dutch elm disease on elm
(Photo by J. Hartman)

The following are hybrids with Asian or European parentage and thought to be resistant to Dutch elm disease:

- Dynasty
- Frontier
- New Horizon
- Pioneer
- Prospector

Ulmus parvifolia (Chinese elm) also is reportedly resistant to Dutch elm disease.

Yellows/phloem necrosis. Yellows is caused by a prokaryotic pathogen that is transmitted by leafhoppers. Like Dutch elm disease, the yellows pathogen is more pathogenic in North American elm species. Typically, elm resistant to Dutch elm disease also are resistant to elm yellows disease. See recommended cultivars in "Dutch elm disease," above.

Viburnum (viburnum)

Bacterial wilt, bacterial blight. Remove diseased stems and leaves, if possible. Eliminate overhead irrigation. Copper-based fungicides applied in late spring may limit disease spread.

Phytophthora foliar blight. Avoid wetting leaves. Retain plant vigor with proper fertility, pH, and air circulation. Prune and destroy infected twigs. Reduce shade, if possible. As new lesions appear, spray mefenoxam, phosphorus acid, or fosetyl-Al.

Phytophthora root rot. Provide good soil drainage. Drench soils with mefenoxam, fosetyl-Al, phosphorus acid, or etridiazole. See suggestions under "General Recommendations."

Powdery mildew. See "General Recommendations." Resistant cultivars include *Viburnum burkwoodii* Mohawk and *V. carlcephalum* Cayuga.

Zelkova (Japanese zelkova)

Anthracnose. See "General Recommendations."

Armillaria root rot. This disease most frequently affects trees weakened by stress and other agents. No curative control options are available. Do not plant trees in soil where Armillaria root rot has been a problem.

Nectria canker. Retain plant vigor, and avoid plant stress. Remove diseased plants.

Crown gall. See "General Recommendations." For galls on established trees, use Gallex according to label directions. Do not plant trees in soil where crown gall has been a problem.

Dutch elm disease. See suggestions under "Ulmus."

For More Information

Fungicides for Management of Landscape Woody Ornamentals: http://www.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-OR-W-14.pdf

Jones, R.K., ed. "Diseases of Woody Ornamental Plants and Their Control in Nurseries." North Carolina State University Cooperative Extension Service.

Nursery and Landscape Information: www.uky.edu/Ag/Horticulture/comnursery.html

Pirone, P.P. "Diseases and Pests of Ornamental Plants." John Wiley & Sons.

Sinclair, W.A., Lyon, H.H., and Johnson, W.T. "Diseases of Trees and Shrubs." Cornell University Press.

Woody Ornamental Diseases and Disorders: www.ca.uky.edu/agcollege/plantpathology/extension/pubs.html#OrnamentalWoody

Woody Plant Information: www.uky.edu/Ag/Horticulture/homewoodies.html

This revision was adapted from Woody Plant Disease Control Guide for Kentucky by Hartman, Witt, Hershman, McNiel.

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