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Extension

CHECKLIST
DISEASE MANAGEMENT

General Cultural Practices for Disease Prevention

- ✓ Minimize prolonged leaf wetness. Moisture plays an important role in disease cycles, as moisture is needed for most microorganisms to spread, germinate, and infect plant material. Reducing the duration of leaf wetness reduces the potential for disease infection. When possible, water should only be applied to the soil or growing medium to avoid wetting the foliage. If overhead irrigation practices cannot be altered, watering should occur at night or before midday to prevent prolonged leaf wetness and break up the period of leaf wetness. Properly spacing plants that are pruned to improve air circulation and sunlight penetration also improves drying of foliage.
- ✓ Prune out infected twigs and branches and rake up leaf-spotted leaves. Dispose of these materials away from the affected plants. Plant debris, such as fallen leaves and twigs, serve as overwintering sites for disease-causing propagules. Plants which exhibited disease symptoms one season can potentially be infected the next season if plant debris is not removed.
- ✓ Select plants that are best suited to the site conditions and provide adequate water and nutrients. Plants with good vitality are more likely to limit infections and recover from plant diseases and other stresses than weakened plants.
- ✓ When working with plants, such as during propagation, work in blocks or sections. After each section, disinfect tools and wash hands. This will reduce the chance that disease will be spread to fresh cuts. Prune or take cuttings during dry weather. Disinfect tools with a commercial disinfectant, 70% alcohol, or 10% bleach solution. Rinse tools after using bleach as it will corrode metal.
- ✓ Do not reuse growing media.
- ✓ Keep hose nozzles off the ground at all times, especially in greenhouses.
- ✓ Use new containers or containers that have been cleaned of debris and then disinfected.
- ✓ Prepare growing mix on a large slab or platform located above the level of water runoff. Assign equipment that is only used on the slab. Avoid unnecessary foot traffic on the slab.
- ✓ Minimize plant contamination by runoff water and soil splash. Build gravel beds with the center higher than the edge. Place gravel on top of porous plastic sheets.
- ✓ Regularly monitor root health as part of scouting program.
- ✓ Promptly remove diseased plants from the growing area to reduce innoculum.
- ✓ Quarantine recoverable plants to monitor and treat them.
- ✓ The disposal site for seriously diseased plant material should be away from the growing area, storage area, propagation area, and water source.
- ✓ Quarantine all plant material new to the nursery. Practice prompt disease management.
- ✓ Space plants for good air movement and sunlight. This results in rapid drying of foliage and better spray coverage.
- ✓ Avoid irrigation extremes which predispose plants to root diseases. Avoid over-watering plants resulting in saturated growing media.
- ✓ Grow trees well adapted to the site and resistant to diseases common in the area.
- ✓ Identify key (high maintenance) plants that require regular interventions. These plants may not only be more disease-prone, but their appearance has high value to the client.

- ✓ Consider the cost-benefits of all available interventions.
- ✓ Monitor weather data and scouting reports to anticipate disease development.
- ✓ Spray only when needed and when most beneficial. Apply chemical controls when moisture, temperature, and age of plants support their use.
- ✓ Examine new plants closely and aim toward transplanting only healthy plants.

Propagation Areas

- ✓ Routinely monitor propagation areas every two days. Check misting system for proper functioning. Monitor the wetness of rooting media.
- ✓ Monitor seedlings for damping off and vegetative cuttings. Look for localized symptoms such as root lesions, cutting end rot, leaf spots, and shoot blights.

Production Areas

- ✓ Monitor production areas every 10 to 14 days. Examine a minimum of 5% of the plants in each bed. During subsequent inspections inspect different plants. Check both old and new growth. Generally monitor plants randomly. However, carefully monitor plants closely on windward side of block and sides of the bed that border uncultivated areas.
- ✓ Maintain good records of observations. When disease is found, look closely at similar plants.
- ✓ Monitor roots for root rot symptoms. Look for reduced plant vigor, off-colored foliage, small leaf size, and wilted leaves. Remove plants from containers and examine peripheral roots. Indications of root rot are dark roots with poor integrity and lack of roots in the lower 1/3 of the media.
- ✓ Quarantine all plants received from outside of the nursery for at least 3 weeks. Inspect plants weekly. Correct or discard problem plants.

DISEASE MANAGEMENT

Basic Tree Pathology

Tree pathology is the study of the ways microorganisms and environmental conditions cause damage to trees and the most important management strategies to help them recover. Pathogenic microorganisms cause damage to trees because they use up materials the trees need to thrive or just stay alive. Some pathogens secrete biochemicals that kill or disrupt plant cells as well as stop transport of water and minerals. Healthy trees sustain themselves by photosynthesizing to produce carbohydrates. They convert these materials to energy and actively develop new roots, shoots, and leaves to absorb and transport water and minerals as well as store energy reserves. Many trees diseases seriously interfere with these processes. Leaf spots and blights reduce photosynthesis. Rotted roots reduce water and nutrient absorption. Branch cankers and vascular wilts interfere with water and mineral transport. Some root and stem infections reduce stored energy reserves.

Parasitic living microorganisms (pathogens) cause infectious or biotic diseases. A parasite gets food from another living organism. On the other hand, a saprophyte meets its carbohydrate needs by decomposing dead plant or animal material.

Joseph O'Brien, USDA Forest Service

Symptoms develop because of a disease infection. In addition, visible signs of the pathogen sometimes arise. A symptom is the response of the plant to infection, such as wilted leaves, dead branches, and brown spots on leaves. Whereas a sign is evidence of the actual damaging agent, for instance pepper-flake-sized fruiting structures and mats of mycelia (the thread-like fibers that make up the "body" of the fungus), or in the case of a bacterial disease, fire blight, amber-milky bacterial ooze.

Common Terms Used to Describe Symptoms and Signs of Tree Diseases

Anthracnose: a fungal infection characterized by brown-tan leaf spots and blotches, stem cankers, and shoot blights.

Blight: rapid death of leaves, flowers, and/or shoots.

Canker: dead region of bark and sapwood on a stem, branch, or twig.

Chlorosis: normally green foliage develops a yellow to whitish hue due to the loss of or the failure to develop the green pigment (chlorophyll) needed for photosynthesis.

Conk: a rigid, spore-bearing, fruiting structure (a sign) that sticks out of the stem or branch wherein the wood decay or sapwood rotting fungus lives.

Crown rot: discolored, dead cambium sapwood that can extend up the stem and down into the roots. Crown rot causes the disruption of water transport to the foliage and

branches above the rotted basal stem and root flares.

Dieback: death of shoots, branches, and roots from their ends, which often progresses and kills the entire plant part.

Gall/knot: a swollen or overgrown plant part due to an infection by certain pathogens as well as insect infestations.

Leaf blister: a localized bulging/distorted area on the surface of affected leaves.

Leaf blotch: an unevenly shaped dead area on leaves, which often expands until the leaf dies or drops off.

Leaf spot: a rounded, well-defined lesion that is usually limited in size.

Necrosis: the death of plant parts, which then dry out and turn brown.

Needle cast: a fungal disease of needles that kills them and causes their premature loss.

Root rot: infected roots collapse, turn brown, readily fall apart, and no longer take up water and minerals for the plant.

Rust: a host-specialized, fungal disease of living foliage, branches, stems, and fruit. In most rust diseases of trees, one or more stages in the life cycle of the rust fungus produce spores that are rust/orange colored.

Scab: an uneven, discolored, raised spot on the surface of infected leaves or fruit. A disease that develops these symptoms on infected plant parts.

Scorch: browning of leaf edges or needle tips due to inadequate water uptake or transport to the foliage as well as excessive transpiration from the foliage. Scorch may develop because of stem, vascular, or root diseases. However, unfavorable environmental conditions in which replenishment of moisture cannot keep up with its loss, such as extended periods of dryness, soil compaction, physical damage to stems or roots, and winter sunscald, can cause the same symptoms.

Low vigor: a reduction in tree growth or development. Symptoms associated with low vigor include small foliage, thin crowns, shorter than normal shoot elongation, lack of sufficient roots, premature fall coloration, and branch dieback.

Wilt: limpness of leaves and stems due to excessive water loss or a lack of water to these plant parts.

Witches' broom: dense, broom-like cluster of shoots caused by phytoplasmas, fungi, insects, or de-icing salt.

Causes of Infectious Disease

Several types of microorganisms cause diseases on woody ornamentals and trees including nematodes, viruses, phytoplasmas, parasitic higher plants, fungi, and bacteria.

Nematodes

Nematodes that feed on woody ornamentals and trees in New England are small, cylindrical, worm-like microbes that primarily feed on roots, with the notable exception of the pine wood nematode. Diagnosis of nematode diseases involves extraction of nematodes from plant material or soil, microscopic examination and identification of adults, and then counting the types of nematodes present to determine if they are parasitic on the plant of concern and are present in sufficient numbers to cause damage.

Virus

A nucleic acid covered with a protein coat makes up the body of a virus. Plants infected with a virus may show no obvious symptoms, have subtle foliar discoloration and stunted growth, or

exhibit distinctly patterned discoloration, distorted growth, and branch dieback. Viruses that cause serious problems for woody ornamentals and trees become systemic within the vascular system of the plant. Viruses are not visible using optical microscopes. Laboratories that detect viruses collect juices from affected plants and then use "indicator plants" and serological assays to determine if a virus is present.

Phytoplasmas

Phytoplasmas are close relatives of bacteria, but are much smaller and lack a cell wall. The most common diseases of woody ornamental plants in the Northeast caused by phytoplasmas are ash yellows and lilac witches' broom.

St. Paul Archive, USDA Forest Service, Bugwood.org

Parasitic Higher Plants

Parasitic higher plants are seed plants that have tubular structures that penetrate the outer surface of host plant stems and branches and remove water, minerals, and carbohydrates. Two examples include dwarf mistletoe on members of the pine family, and dodder, which primarily attacks herbaceous plants, but weakens low growing woody plants by penetrating the green twigs on these plants. Eastern dwarf mistletoe is a pathogen of several species of spruce in New England.

Fungi

Fungi are common tree wood decomposers, root-inhabiting mycorrhizae, and tree disease infecting microbes. Moist, thread-like structures referred to as mycelia, make up over 95% of the body of a fungus. They reproduce as seed-like structures called spores. Spores survive periods of severe weather in resistant stages or structures. When weather conditions are more favorable (wet and cool), spores develop and fruiting structures release them when they mature. Spores start most fungal infections. Wind, rain splash, soil, insects, contaminated tools, and people spread spores from infected plants to healthy or wounded plants. Spores need prolonged periods of wetness to germinate on and penetrate into plants. Some typical symptoms caused by fungal diseases include leaf spots/blotches, shoot blights, wilt, discolored foliage, cankers, galls, root rot, and leaf blisters. Signs of fungal disease and decomposition of dead wood range from pepper-flake-sized fruiting structures to mushrooms and conks as well as rhizomorphs, mats of mycelia, and, rarely seen, oozing ribbons of spores.

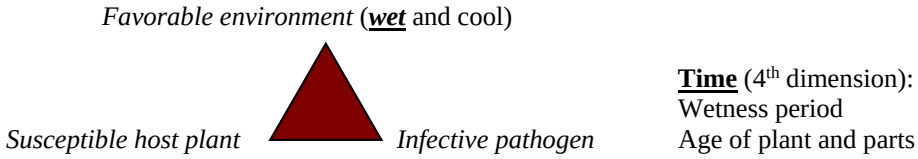
Bacteria

Bacteria are tiny, single-celled microorganisms. Most are decomposers that recycle dead plant and animal materials, while only a few cause plant diseases. Many bacteria are mobile in liquid.

When they infect plants they do not grow larger; on the other hand, they rapidly multiply in number. Bacteria reproduce very quickly by a special process of division in which they split in half (binary fission). There are no fruiting structures and there is no process of sexual reproduction. Rain splash, soil, insects, cutting tools, and people are the primary means of bacterial dispersal. Individual bacteria infect plants by swimming in water on the plant surface, penetrating natural openings and wounds, and once they have a nutrient source, engaging in binary fission. Symptoms of bacterial infection include angular leaf spots, shoot, flower and shoot blights, cankers, wilt, fruit rot, and galls. The only common sign of infection is bacterial ooze that exudes from the margins of certain bacterial cankers or blights.

Conditions Necessary for Disease

A practical way to picture the process of infection is the disease pyramid. There are three conditions necessary for infection: a susceptible host plant, an infective pathogen, and a wet plant surface. The fourth component that completes the pyramid is time. Time (along with temperature in certain situations) influences the infection process in a couple of ways. First, immature plants and their tender, green parts are more vulnerable to infection than mature plant tissues with disease resistant biochemical and structural defenses. Secondly, the longer the plant surface remains wet the more time there is for spores and bacteria to infect the plant. Air temperature can play an important role in this situation. If it is too cold (below 40^{o} F), the chill does not kill the pathogen, but the microbe is not biologically active enough to initiate growth and establish an infection. On the other hand, once the air temperature approaches 85^{o} F, water evaporates quickly and the warmth inhibits the development of many fungi. The optimal temperature range for fungal infections is 60^{o} to 75^{o} F.



Disease development

There are a series of steps in the development of a fungal or bacterial disease infection in woody ornamentals and trees. The process begins with the release of inoculum (infectious parts of plant pathogens). These are usually spores from fungi and the whole microbe in the case of bacteria. An infective pathogen enters a susceptible plant if conditions are wet long enough. Once inside the plant, it depends on whether the pathogen finds materials it can use to nourish itself as to whether a true infection happens. As the pathogen consumes minerals and carbohydrates from the plant and releases enzymes and hormones that affect plant growth, symptoms begin to appear. If the disease microbes find what they need to thrive, they grow, multiply, and move within the plant. Once they are well established, they can produce spores in the case of fungi or form bacterial ooze on the margin of some infections that allow them to spread to other parts of the plant or to nearby plants. This whole process can take a few days or several months depending on the pathogen. As a final point, the pathogen needs to survive unfavorable weather, especially cold and dryness, in order to be available to infect plants next growing season. Each pathogen has a resistive structure or an ability to go into a resting state that allows it to stay alive during unfavorable conditions. This completes the disease cycle for the current season, but also allows it to restart the following spring.

Managing Infectious Diseases
Effective disease management begins with understanding disease development. Infection is a process and effective interventions begin with avoidance of the conditions that enhance that process and providing good plant care to help trees defend themselves from extensive damage. Remove infected plants and plant parts to reduce inoculum available to initiate new infections. Maintain plant vitality to optimize resistance. Water during extended periods of dry weather, while ensuring there is adequate soil drainage. Prune to provide sound branch structure as well as good sunlight penetration and air movement to avoid long periods of leaf wetness. When replacement of high maintenance plants is possible, an effective means of disease management is to grow those well adapted to the site and resistant to diseases common in the area. Resistant plants defend themselves with biochemical and structural responses that preexist or that they make in reaction to infection to prevent or limit growth of the pathogen.

When plants are of high value, proper chemical treatments are useful tools to prevent or minimize damage from certain fungal and bacterial diseases. Apply or inject trees with chemical materials to kill or inhibit growth of the pathogen, to protect healthy plants, or before infection is extensive. Most protective fungicides must be on or in plants in advance of the pathogen to effectively defend them from subsequent infections. Apply sprays so there is thorough coverage to all vulnerable surfaces, so the fungicide forms a protective barrier. Broad-spectrum protective fungicides are, for the most part, ineffective after symptoms appear/infection happens. They are not absorbed or translocated within infected portions of plants. Untreated new plant growth that develops after prior treatments is vulnerable to infection during wet seasons, so reapply sprays at labeled intervals. Systemic fungicides have variable movement within treated plants. Some are locally systemic in foliage, while translocation of others is more extensive within plants. Fungicides injected into stems and root flares move upward from the point of injection into branches and foliage and may be effective for longer periods. A caution about the repeated use of systemic fungicides is that the pathogen can develop resistance to it. To impede this process, alternate use of specific systemic fungicides with broad-spectrum, protective fungicides. The systemic fungicide does most of disease control, while the protective fungicide kills resistant pathogens that might otherwise become the dominant agent of disease on the plants.

Cultural Practices for Disease Prevention
Details of how to implement management approaches with specific diseases of woody ornamentals are available in the *Woody Ornamental Pest Management Guide* available from University of Massachusetts Extension; however, the following cultural practices will help prevent diseases.

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For detailed management information for woody plant diseases, also refer to UMass Extension's Professional Management Guide for Diseases of Trees and Shrubs.