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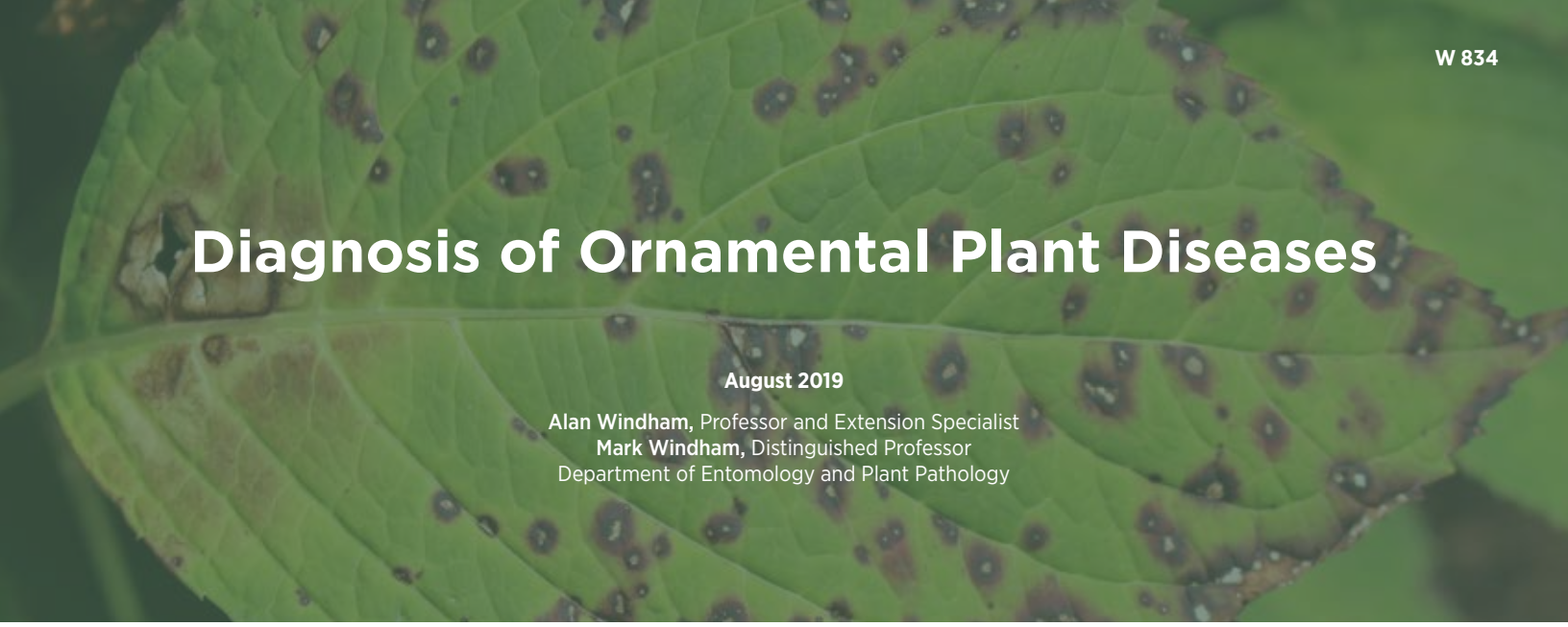

Diagnosis of Ornamental Plant Diseases

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The diagnosis of diseases of ornamental plants can seem overwhelming if you focus on the number of plant species grown in greenhouses, nurseries and landscape plantings. If you know when, where and what to observe, you can identify the cause of many plant problems. Nothing aids in diagnosis like experience. Over time you learn that certain plants have signature or key diseases. You also learn that certain types of diseases look similar on different plant species. Also, specific environmental conditions favor development of certain diseases. **Plant diseases** occur when three critical elements come together to make a **disease triangle.** They are a **pathogen, susceptible host plant** and a **favorable environment.** Plant pathogens may be present year-round, but only cause disease when environmental conditions favor infection and development of disease in a susceptible host. Plant disease diagnosis follows a progression of steps observing the host, pathogen and environmental conditions:

- **Identify the host** — Each plant species has a distinct group of diseases/plant pathogens. It's important to correctly identify the plant or you will be derailed from the start. Also, most references on plant diseases list them by host. This sounds like a simple concept, but flower, shrub and tree species are sometimes misidentified, making disease diagnosis more difficult.

- **Imagine a healthy plant** (what is normal) — Normal is conforming to a standard, such as usual, typical or expected shape, color, size, etc. It helps to know what a healthy plant species or particular cultivar should look like. Is it normal for this plant to have nodules on roots? Variegated foliage? Flattened stems? Knowledge of plant structure and characteristics is helpful when considering plant problems.

- **It pays to compare plants.** Is there a healthy species or cultivar to compare with one that is less desirable due to size, shape, color, conformation? Comparing symptoms of a diseased plant with the morphology of a healthy plant can yield clues that are helpful.

- **What plant parts are affected?** Leaf spots, mildews and blights are limited to leaves. Canker diseases are limited to stems and branches. Root rot is limited to roots, of course. Vascular wilt diseases damage xylem tissue conducting water to leaves.

- Look for **signs** and **symptoms** of disease. A **sign** of disease is the visible portion of a plant pathogen, such as white mycelium of fungi, that causes powdery mildew, or the orange spores associated with rusts. **Symptoms** refer to damage caused by the pathogen, including wilted leaves, yellow leaves, leaf spots, discolored vascular stem tissue (xylem), stunted plants, ring spots, mosaic, witch's broom (rosette), etc.

- **Living (biotic) or non-living (abiotic) causes of disease/plant problems.** Biotic pathogens that cause plant disease include fungi (the most prevalent pathogen group), bacteria, viruses, nematodes and phytoplasmas. Abiotic causes of plant problems include moisture (excess or deficient), temperature extremes, pesticide injury, soil pH extremes, and nutrient deficiencies or excess (high-soluble salts).

- **Document signs and/or symptoms of disease.** Use a digital camera to capture the signs or symptoms of disease. Take four to five images that "tell the story" of the problem. Suitable images include a comparison of a healthy and unhealthy plant side by side; an image of a whole plant; an image of the root system with the substrate or soil washed away; or an image of leaf spots, mildew or rust. These images can be very helpful to an Extension agent or diagnostician arriving at a diagnosis. Make sure the image is in focus and clearly shows the problem you are observing.

- **Collect a specimen.** If you decide you need an expert opinion to aid in plant problem diagnosis, collect a specimen. For most herbaceous plants, such as bedding plants or perennials, the specimen should include the whole plant; for woody plants, collect the portion of the plant with signs or symptoms of disease. Dead plants yield fewer clues than a live plant, as they may be colonized by fungi and bacteria after death, which makes diagnosis more difficult.

- **A diagnostic kit** with a few items is helpful for examining and collecting specimens. Carry a small magnifying glass (3-4X). You'll use the magnifying glass to triage specimens and to examine leaves and twigs for signs of disease. Carry a trowel to remove small plants or to collect roots or a soil sample. Hand pruners are useful for removing twigs or branches for further examination, and alcohol wipes for cleaning tools. Always carry plastic bags for collecting

specimens. Place specimens in a plastic bag with a dry paper towel. Do not add water as this may speed decay and make diagnosis more difficult. Refrigerate specimens if they can't be processed immediately. Take or ship them to a plant disease clinic promptly to preserve the specimen.

- **Disease diagnosis information on the web.** There's nothing wrong with using a search engine to search by keywords, such as the host and symptoms. Google images is very helpful for diagnosing plant problems, as are websites such as ipmimages.org. For a leaf spot disease on flowering dogwood, simply use the keywords "dogwood" and "leaf spot." Web pages associated with land-grant universities, Extension and botanical gardens are some of the best aids for diagnosing plant problems.

- For assistance with disease diagnosis, contact your county Extension office. For problems outside of your agent's experience, send samples to the Soil, Plant and Pest Center in Nashville. ag.tennessee.edu/spp/Pages/default.aspx

- Although not the subject of this publication, keep in mind that insects and mites can cause symptoms similar to those of some plant diseases.

Diseases of Ornamental Plants

There are common disease groups that affect many ornamental plant species. Examples include powdery mildew, leaf spots and crown rot diseases. Although they may be caused by different pathogens, often management strategies are similar within disease groups.

Powdery Mildew

Powdery mildew is easily identified by the presence of white-to-gray mycelium on affected leaves and/or flowers (Figure 1). The first sign of disease is usually isolated colonies of white fungal growth. With time, whole leaves may be covered with fungal growth. On some plants, such as elm and oak, mildew may be present only on the underside of leaves. On dogwood, crape myrtle, nandina and rose, infected leaves may be curled, twisted or otherwise distorted. Leaves may be abnormally red with little mycelium visible; on sedum, lesions are scabby and brown.

Hosts: apple, azalea, begonia, columbine, crabapple, crape myrtle, dogwood, euonymus, grape, hydrangea, lilac, magnolia, nandina, oak, phlox, rhododendron, rose, sedum, tulip tree, verbena, zinnia

Figure 1. *Powdery mildew on flowering dogwood (left), crape myrtle (center), and zinnia (right).*

Downy Mildew

Although downy mildew sounds similar to powdery mildew, the diseases are very different. Downy mildew is caused by fungal-like organisms from an entirely different taxonomic class. The pathogens that cause downy mildew are more closely related to pathogens that cause phytophthora and pythium root rots than the fungi that cause powdery mildew. Symptoms of downy mildew can range from leaf spots and defoliation to rapid blighting of diseased shoots. Angular leaf spots on rose may range from red to brown to black. Signs to look for include white-to-gray tufts of mycelium on the undersides of leaves, directly below chlorotic lesions (Figure 2). Look for mycelium early in the morning while the leaves are still wet.

Hosts: alyssum, basil, brambles, coleus, grape, garden impatiens, pansy, redbud, rose, rudbeckia, salvia, snapdragon, tobacco, viburnum

Figure 2. *Downy mildew on basil (left), coleus (center), and garden impatiens (right).*

Gray Mold (Botrytis Blight)

Gray mold may be found on herbaceous and woody ornamentals usually during cloudy, cool, moist weather. Stems, leaves and flowers may be attacked. Primarily a disease of herbaceous plants, woody ornamentals in overwintering structures may become infected. Symptoms of infection are blighting of flowers, tan-to-brown leaf spots, shoot blights and stem rot. A sign of disease is gray-brown mold on diseased plant parts (Figure 3).

Hosts: Almost any herbaceous or woody ornamental is susceptible to gray mold if conditions are favorable for the fungus.

Figure 3. *Gray mold (Botrytis blight) on geranium (left) and pansy (right).*

Rust (Leaf, Stem, Needle)

Signs include bright yellow, orange, reddish-brown or chocolate-brown raised pustules that are visible on the undersides of leaves (Figure 4). Gelatinous tubes of rust spores are produced from galls each spring on eastern red cedar infected with cedar-apple rust. Pine needle rust produces pustules on pine needles during spring. Early symptoms of leaf rusts on leaves are yellow leaf spots. Rust galls may appear on stems of pine, cedar and hawthorn. Twig rust may cause branch dieback on plants as diverse as hawthorn and hemlock.

Hosts: apple, aster, azalea, cedar, crabapple, daylily, fuchsia, geranium, grasses, hawthorn, hemlock, hollyhock, iris, Jack-in-the-pulpit, juniper, mayapple, morning glory, fd oak, pear, pine, potentilla, quince, serviceberry, snapdragon, sunflower

Figure 4. *Rust on morning glory (left); cedar-apple rust on apple and eastern red cedar (center and right).*

Leaf Spot Diseases

Leaf spot diseases, among the most common plant diseases, are usually caused by fungi, but a few may be caused by bacteria. Symptoms vary depending on the pathogen and host. Some common symptoms include frogeye or bull's eye spot marked with concentric rings; irregular, round tan spots with small black fruiting bodies; angular tan or black

spots; black or tan spots surrounded by a yellow "halo"; oval-shaped leaf spots; and tan-to-gray spots with red or purple margins (Figure 5). Fungal leaf spot diseases are usually favored by wet seasons, high humidity and/or frequent overhead irrigation. Many leaf spots cause premature defoliation and may lead to the death of plants affected over a period of years.

Hosts: ***alternaria leaf spot*** — aucuba, impatiens, marigold, zinnia; ***boxwood blight*** — boxwood, sweet box, pachysandra; ***bull's eye leaf spot*** — magnolia, maple; ***cercospora leaf spot*** — buckeye, crape myrtle, hydrangea, leucothoe, laurel, phlox, red bud, rose, zinnia; ***entomosporium leaf spot*** — Indian hawthorn, pear, photina, cleyera; ***phyllosticta leaf spot*** — holly, magnolia, maple, witch hazel; ***septoria leaf spot*** — dogwood

Figure 5. *Leaf spot diseases of iris (top left), boxwood (top center), and crape myrtle (top right); leaf spot diseases of hydrangea (bottom left), Indian hawthorn (bottom center), and maple (bottom right).*

Shot-hole Diseases

Some plants shed diseased leaf tissue in response to fungal or bacterial infections. Infected leaves are covered with circular "shot" holes where diseased tissue has fallen out (Figure 6). Infected leaves may become chlorotic and drop prematurely. Shot-hole diseases may be caused by fungi or bacteria. Damage from shot-hole disease may be confused with insect feeding. Remember, shot-hole disease only occurs on plants in the genus Prunus. Similar symptoms on other plants may be caused by insects.

Hosts: almond, apricot, cherry, cherry-laurel, peach, plum

Figure 6. *Shot-hole disease on flowering cherry (left) and laurel (right)..*

Anthracnose Diseases

Anthracnose refers to diseases that cause leaf, stem and/or fruit lesions. These diseases may appear as irregular leaf spots/lesions along leaf margins and across or between veins (Figure 7). In hydrangea, leaf lesions look similar to a zonate leaf spot. Anthracnose may kill entire leaves, young shoots and twigs, and cause premature defoliation. Diseased leaf tissue may fall out of leaf lesions. Stem cankers may form at the base of succulent shoots. Look for anthracnose diseases of shade and ornamental trees during April and May.

Hosts: ash, dogwood, euonymus, hosta, hydrangea, liriope, maple, oak, rohdea, sycamore

Figure 7. *Anthracnose on maple (left), dogwood (center), and sycamore (right).*

Needle Cast/Tip Blights

Needle cast diseases and tip blight diseases are essentially leaf spot diseases of conifers that lead to premature shedding of needles. During certain times of the year, distinct yellow-to-brown lesions are visible on pine needles. Infected needles turn brown and shed (Figure 8). Fungi that cause needle cast are generally weak pathogens that infect older needles in the interior of the tree's canopy. Black fruiting bodies of various fungi may be observed in single or multiple rows along the length of infected needles. Conifers infected with needle cast have brown needles and thin canopies.

The most common tip blight diseases of juniper include phomopsis blight, which attacks new flushes of growth in late spring or early summer, and kabatina blight of juniper, which attacks juniper injured from snow or ice in late winter through early spring. Tip blights rarely kill more than 4 inches of the terminal of juniper shoots.

Dothistroma blight is a serious disease of Austrian pine. It attacks needles late in the year and may kill half of the needle from the tip to the midpoint of the needle. Damage is often severe within 10-15 years of establishment, necessitating removal of the trees.

Hosts: ***cyclaneusma needle cast*** — Scots pine; ***lophodermium needle cast*** — Eastern white pine; ***ploioderma needle cast*** — loblolly pine; ***rhizosphaera needle cast, stigmina needle cast*** — spruce; ***phomopsis blight*** — juniper; ***kabatina blight*** — juniper, Leyland cypress; ***dothistroma blight*** — Austrian pine

Figure 8. *Needle cast/blight on conifers (top row and bottom left); tip blight on conifers (bottom right).*

Canker Diseases

Canker-causing fungi may live as endophytes on susceptible hosts. An endophyte is a fungus living on and/or in host tissue, but there are no signs or symptoms of disease. However, when the plant experiences significant stress, dieback begins as the fungus is now able to attack the host plant. Leaf death and twig dieback are some of the first symptoms of canker diseases. They are usually found on branches but may infect

trunks of young trees (Figure 9). The disease may be undetectable initially except by shaving the surface of a branch to reveal brown discoloration of bark and/or underlying sapwood. As cankers enlarge, oval, sunken areas may develop on branches. Large cankers may girdle and kill branches and entire plants if they develop on the trunk or main stems of shrubs. Gum production (gummosis) is often associated with fungal and bacterial cankers of cherry. Resin is often associated with canker diseases of junipers and cypress. Fire blight is a bacterial disease that may cause cankers on plants in the rosaceae family, such as apple and pear. Early symptoms may be blossom blight during bloom, followed by the shoot blight phase and signature symptoms such as shoots killed rapidly in the shape of a shepherd's crook. Water-soaked cankers may be found on the trunk and branches of infected plants.

Hosts: ***botryosphaeria canker*** — ash, crabapple, dogwood, juniper, laurel, Leyland cypress, red bud, maple, rhododendron; ***endothia canker*** — pin oak; ***Eastern filbert blight*** — filbert; ***fire blight*** — apple, cotoneaster, crabapple, hawthorn, pear, pyracantha, serviceberry; ***golden canker*** — pagoda dogwood; ***nectria canker*** — dogwood, pear, filbert; ***phomopsis canker*** — azalea, ash; ***seiridium canker*** — Leyland cypress, Arizona cypress; ***thyronectria canker*** — honey locust

Figure 9. *Canker diseases on pagoda dogwood (left), dogwood (center), and Leyland cypress (right).*

Leaf Galls

Conspicuous white, yellow, red or gray blisters or galls develop on leaves (Figure 10). Leaves may become puffy, puckered, thickened or curled. Infected leaves may drop early. The most common leaf gall diseases are azalea leaf gall, camellia leaf gall, peach leaf curl and oak leaf blister. Symptoms may be confused with insect- or mite-induced galls, which are much more numerous.

Hosts: ***leaf gall*** — azalea, blueberry, camellia, rhododendron; ***leaf blister*** — red oak, water oak, willow oak; ***leaf curl*** — peach, plum

Figure 10. *Fungal leaf galls on azalea (left), camellia (center), and peach (right).*

Crown Gall

Rough-surfaced, hard or soft, spongy, swollen tumors or galls up to several inches in diameter may form on stems or roots (Figure 11). Galls may be flesh colored, greenish or dark brown. They are usually found near or below the soil line, but may be found on stems or lower branches. Galls may form at wounds made during propagation, as the bacterium can be spread by dirty pruning tools. As they continue to develop and enlarge, surface layers may become warty, brown, woody and roughened. Plants with crown gall usually become unthrifty and possibly stunted. Plant death may eventually occur.

Hosts: apple, cherry, crabapple, euonymus, holly, maple, peach, plum, rhododendron, rose, willow, wisteria

Figure 11. *Crown gall on wisteria (left), rose (center), and apple (right).*

Stem/Crown Rot

Southern blight — Usually occurs in gardens, perennial borders and nurseries during hot weather, near midsummer. Symptoms include wilting and leaf scorch, followed by plant death. Signs of disease include white mycelium on the stem of infected plants and tan to reddish-brown round, spherical resting structures of the fungus (sclerotia) on the stem and soil surface (Figure 12).

Sclerotinia crown rot — Unlike southern blight, this disease usually appears during midspring to early summer when conditions are cool and moist. Affected plants usually wilt and die. White mycelium may be visible on stems near the soil surface. Black, oblong sclerotia may be present on the outer surface of herbaceous or woody plants or in the stem pith of herbaceous plants. Diseased stems should be split lengthwise and examined for signs of sclerotia (Figure 12).

Rhizoctonia stem rot/damping off — This disease is often the cause of damping off (stem rot) of seedling plants. Seedling annual or perennial flowers or woody ornamentals may be killed by this fungus after it attacks the stem near the soil surface (Figure 12). Diseased seedlings often fall over and die. In the field, the fungus may move short distances down the row, killing several adjacent plants. In propagation beds or flats, diseased plants may be killed in circular areas as the fungus moves outward.

Hosts: ***southern blight*** — Ajuga, apple, clematis, crabapple, forsythia, hosta, many annual and perennial flowers, rarely on some turf species; ***sclerotinia stem rot*** — campanula, coneflower, euonymus, several herbaceous flowers; ***rhizoctonia stem rot*** — many herbaceous plants and seedlings of woody plants and conifers

Figure 12. *Southern blight on mayapple (left), rhizoctonia stem rot on garden impatiens (center), and sclerotinia stem rot on geranium (right).*

Wilt Diseases

Wilt diseases are usually responsible for the slow-to-moderate decline of trees and some shrubs. Individual branches may discolor and die. Some wilts may affect only one side of the plant. A common symptom associated with wilt diseases is vascular discoloration (discolored sapwood) (Figure 13). Leaf scorch and a reduction in canopy size are additional symptoms. Wilt pathogens may be spread by insects (Dutch elm disease by elm bark beetles; bacterial leaf scorch by leaf hoppers). Bacterial leaf scorch is very common in sycamore, pin oak and other oaks in the red oak family.

Hosts: ***bacterial leaf scorch*** — elm, red maple, mulberry, sycamore, pin oak, shingle oak; ***Dutch elm disease*** — elm; ***verticillium wilt*** — ash, barberry, boxwood, buckeye, catalpa, daphne, elm, lilac, euonymus, smoke tree, maple; ***fusarium wilt*** — mum, more common on herbaceous plants

Figure 13. *Bacterial leaf scorch on pin oak (left), Dutch elm disease on elm (center), and verticillium wilt on maple (right).*

Root Rot Diseases

Plants affected with fungal root rots may be stunted, wilted, look generally unthrifty (mimic nutrient deficiency), and eventually die. Discolored, decayed roots are sure symptoms of root rot diseases (Figure 14). Poor drainage, standing water, improperly constructed landscape beds, planting infected plants and excessive irrigation favor phytophthora and/or pythium root rots.

Hosts: ***black root rot*** — Japanese holly, blue holly, inkberry, vinca, pansy, petunia; ***phytophthora root rot*** — azalea, dogwood, forsythia, fir, holly, juniper, Japanese maple, pieris, rhododendron, rose, yew; ***pythium root rot*** — bedding plants, herbaceous perennial plants

Figure 14. *Phytophthora root rot on juniper (left) and rhododendron (center); black root rot on holly (right).*

Nematode Diseases

Millions of nematodes may live in a square meter of soil; however, only a few are parasites of plants. Most plant parasitic nematodes attack plant roots; foliar nematodes attack foliage. Foliar nematode symptoms are dependent on the veination of the host. Plants with parallel veination, such as hosta, have tan-to-brown streaks. Plants with palmate veination have angular leaf spots (Figure 15). Nematode damage can be difficult to diagnose as most of the damage occurs below ground. Plants damaged by nematodes may appear stunted, unthrifty, discolored and have discolored roots with lesions or galls (Figure 15). One sure way to identify nematode problems is to submit a soil and/or root sample for analysis at a plant diagnostic laboratory; submit symptomatic foliage where foliar nematode is suspected.

Hosts: ***root knot nematode*** — abelia, aucuba, begonia, boxwood, dogwood, gardenia, holly, hydrangea, impatiens, ligustrum, nandina, petunia, photinia, rose; ***foliar nematode*** — African violet, anemone, begonia, brunnera, hosta, many perennials; ***lesion nematode*** — boxwood, juniper

Figure 15. *Foliar nematode damage to anemone (left) and galled roots on garden impatiens (root knot) (right).*

Virus Diseases

Plants infected with a virus exhibit a wide variety of symptoms, including mosaic, ringspots, stem lesions, rosette (witch's broom), oak-leaf pattern, stem pitting, stunting, flower break, etc. (Figure 16). Hosta virus X (HVX) is fairly common on hosta. HVX is most easily diagnosed on gold hosta cultivars where abnormal green stripes appear parallel with veination of leaves. Symptoms include stunted plants, necrotic streaks in leaves and muted variegation. Rose rosette is a viral disease transmitted by eriophyid mites. Virus diseases may be difficult to diagnose unless you are familiar with symptoms associated with specific virus diseases.

Hosts: ***hosta virus x*** — many common cultivars of hosta; ***impatiens necrotic spot virus*** — garden impatiens, New Guinea impatiens, over 350 ornamental plants; ***tobacco mosaic virus*** — petunia; ***tobacco rattle virus*** — dicentra, hosta; ***tomato spotted wilt virus*** — many herbaceous perennials; ***tomato ringspot virus*** — dogwood, fringetree, peach, cherry; ***rose mosaic and rose rosette*** — rose

Figure 16. *Virus symptoms: ring spot on garden impatiens (left), hosta virus x on hosta (center), and camellia yellow mottle (right).*

Abiotic Problems

Abiotic problems are caused by a variety of environmental and cultural stresses in nurseries, greenhouses and landscapes. Abiotic problems are some of the most common causes of injury or poor plant growth. It's been estimated that 40 percent to 50 percent of plant specimens submitted to plant disease clinics are affected by issues caused by abiotic factors. There are a variety of symptoms associated with abiotic problems, such as chlorosis (nutritional/pH problems); bark splitting (freeze injury); leaf scorch (drought stress, high-soluble salts); dieback of yew (excessive moisture, poor drainage); strapped-shaped leaves; cupped leaves; and dwarfed growth (herbicide injury). Air pollution damage is difficult to diagnose, but may include sulfur dioxide damage on white pine (tips of needles are red), and ozone damage to shade trees (bleaching of leaves) (Figure 17).

Figure 17. *Leaf scorch on maple due to drought (top left), herbicide injury to red maple (top right), winter injury to oak (bottom left), and poor drainage, yew (bottom right).*

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