Tree and Shrub Problems in Kansas:

Diseases, Insects and Mites, and Environmental Stresses

K-STATE
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Tree and shrub problems in Kansas

Purpose and scope

Trees and shrubs are subject to many environmental and site-related stresses (abiotic stresses), infectious diseases (caused by fungi, bacteria, viruses, and nematodes), and arthropod pests (insects and mites). Many of these problems cause only minor damage and do not require control measures, even though the damage may appear to be serious. Other problems can be severe, resulting in the death of individual or whole groups of plants, such as the loss of many American elms from Dutch elm disease and the loss of many pines as a result of pine wilt.

This guide has been developed for tree-care professionals, rural landowners, K-State Research and Extension Master Gardeners, homeowners, and others who manage or have an interest in trees and shrubs. It provides an overview of different tree problems followed by an extensive itemized list of specific diseases, insects, mites, and environmental/abiotic stress problems of trees and shrubs common in Kansas, information on how to identify those problems, and guidelines for management. Specific pesticide information is not included, since products and labels change frequently.

The introductory section discusses:

1) Environmental and abiotic stress problems
2) Diseases
3) Insect and mite pests
4) General pest management and plant health strategies
5) Pesticide use for disease, insect, and mite management
6) Diagnosing problems

Listing of specific pesticides is beyond the scope of this guide. There are other sources for pesticide information, including the K-State Plant Disease Diagnostic Laboratory and Insect Diagnostic Laboratory at Kansas State University (Manhattan, Kansas). Contact information for the lab is listed in the "Diagnosing problems" section, on Page 20. The most important source of information about pesticides is the pesticide label itself. Pesticide applicators must read and understand the label before use. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer. See the section "Pesticide use for disease, insect, and mite management" on Page 18 for further information. You may also contact your local K-State Research and Extension office for information.

Environmental, cultural, and other problems

Nonliving factors, such as unfavorable weather, mechanical injuries, soil issues, or fertility imbalances, cause abiotic stress problems. These problems also are called environmental stresses, abiotic disorders, abiotic diseases, noninfectious disorders, and physiological disorders. In contrast to "biotic" diseases caused by living microbial organisms or insects, abiotic problems are not caused by living organisms, and they do not spread from plant to plant.

Why are we starting with abiotic stress problems? Abiotic problems are common, and they can make trees and shrubs more susceptible to diseases and insects. When diagnosing tree problems, always consider abiotic factors as a component of the diagnosis. In addition, when selecting a tree or shrub for a given location, be sure to consider soil type, drainage, pH, fertility, shade/light conditions, and other site characteristics. Choose the right plant for the right place based on those factors. General tips for promoting tree and shrub health are described in a later section. Site factors should be the number one concern in the plant selection process: choose plants according to site conditions.

Some of the most common abiotic problems of trees and shrubs are described below. Many of these abiotic disorders frequently occur together and increase the plant's likelihood of eventual infestation by insect or disease pathogens.

Environmental stresses

General drought stress

During drought, trees and shrubs do not receive adequate water to maintain necessary plant metabolism. Symptoms include wilt, leaf scorch (browning at leaf tips or margins), premature leaf shedding, fruit drop, and, in the case of young trees, transplant stress or death. New transplants and young trees with small root systems are most susceptible to moisture stress. Slow, deep watering at regular intervals throughout periods of prolonged dry weather (summer or winter) can help both young and mature trees. Note that prolonged periods of excessive water can cause similar symptoms, so be sure to evaluate the moisture conditions before taking action. Overwatering kills roots and can be as detrimental as insufficient watering.

Environmental scorch

The term environmental scorch describes tissue browning of leaves or needles. It can give a tree or shrub the appearance of being "burned." During hot, dry, windy weather, transpiration (water loss) from foliage (leaves or needles) occurs more rapidly than the roots are able to take up water from the soil. A quick shift in weather patterns from moderate temperatures to high 90s can lead to leaf scorch and premature shedding. The symptoms usually start at the leaf tip or margins (edges) (Photo 1a) and progress toward the middle and base of the leaf causing a full leaf scorch (Photo 1b). Additionally, environmental scorch typically begins on the newest leaves first. Entire leaves may become dry. Scorch occurs on coniferous and broadleaf evergreens as well (Photo 2), including in the winter, which is called winter desiccation (see below). Providing adequate water can reduce scorch.

Along with drought, environmental scorch results from other factors, such as a poor root system, root or trunk injuries, girdling roots, or damaging chemicals in the soil such as herbicides, salts, and excessive fertilizer. Avoid mechanical and chemical injuries to roots, which inhibit root water uptake. Plant trees and shrubs adapted to local conditions and water them regularly and deeply during dry weather. Appropriate use of mulch around trees and shrubs helps maintain even soil moisture (Photo 3a), but mulch should not be piled deeply or directly against the trunk (Photo 3b).

Winter desiccation

Winter desiccation (drying) is a common cause of injury to evergreens. Evergreens retain their leaves or needles throughout the winter and continue to transpire water. If the soil is dry or frozen, the plant cannot replace water lost from the leaves, resulting in scorching (browning) of needle tips (Photo 2) on windy winter days. See the discussion above on environmental scorch.

Winter injury/winter kill

Winter injury or winter kill is a common problem of both evergreen and deciduous trees and shrubs in Kansas. Individual branches or entire plants can die from low-temperature damage. The most obvious symptom is a failure to resume growth in spring. Sudden drops of temperature are more damaging than steady declines, particularly if they occur before cold acclimation (fall/winter dormancy) or after de-acclimation. Fluctuating winter weather patterns can cause trees and shrubs to break dormancy. Trees and shrubs in active growth from warm, wet autumns and late summer fertilization are also more easily damaged. Several steps can be taken to minimize winter injury. Trees and shrubs should be watered

thoroughly, but not excessively, in the fall before freezing weather sets in. Additional watering of conifers may be required during winter months if weather conditions are unusually warm and dry. Do not water when the ground is frozen.

Plant sensitive evergreens, such as spruce, where they will be protected from drying winds. Avoid using plant species that are not cold tolerant according to hardiness zone maps. Mulching prevents frost from penetrating deep into the ground and can help reduce winter injury. Do not fertilize trees in late summer or early fall because this could result in the production of succulent growth that is susceptible to winter injury.

Sunscald and southwest winter injury

Young trees or trees with thin, smooth bark, such as maple or linden, are susceptible to sunscald or southwest winter injury. This damage usually occurs in late winter when tree trunks are exposed to sunlight and warm temperatures during the day followed by a sudden drop in temperature after sunset. Large, irregular or elongated sections of the bark on the southwest side of the tree are killed.

Frost cracks

Frost cracks are longitudinal splits in the bark and wood, caused in part by old wounds and by differential contraction rates of the inner and outer wood in the trunk from exposure to temperature extremes. The trunks of young, thin-barked trees and shrubs on exposed sites should be wrapped or otherwise protected from direct or reflected sunlight during the winter months. Remove the wrap in the spring. The practices for preventing winter injury may also prevent frost cracks.

Transplant shock

Newly transplanted trees and shrubs can become stressed, and if not properly maintained may exhibit leaf scorch, leaf drop, and slow growth. Extensive root damage can occur during transplanting even with ideal care. Transplant shock can be reduced through proper site preparation, proper planting technique, and proper watering. Additional references should be consulted for details on appropriate planting methods. Transplanting in the fall or early spring allows roots to become established before the onset of hot, dry summer weather. Do not seed or sod turfgrass under the drip line of newly transplanted trees and shrubs because the grass competes with the tree or shrub for water and nutrients. Instead, apply mulch (such as compost, bark chips, or wood chips) 2 to 4 inches deep to help retain moisture (Photo 3a). Do not place mulch directly against the tree trunk (Photo 3b). Root systems are not fully established for several years after transplanting.

Soil, fertility, and pH problems

Wet soils/poor drainage

Soil is composed of water, minerals, organic matter, and pore spaces (air spaces). The pore spaces contain oxygen, nitrogen, carbon dioxide, and other gases. Roots require oxygen to function. When soil is saturated or compacted (see below), the pore space is reduced, decreasing oxygen availability and compromising root health. Heavy clay soils and low areas have poor drainage, leading to reduced oxygen and unhealthy roots. This condition is sometimes called "wet feet." Symptoms include branch dieback, wilting, leaf yellowing (indication of nutrient deficiency as a result of poor root function), scorch, small leaves, and a gradual reduction in plant vigor. Some tree and shrub species are particularly intolerant of wet soils including sugar maple, white birch, redbud, spruce, red oak, yew, pines, juniper, and arborvitae. In addition to abiotic problems, overly wet soils also promote certain root diseases. Select the plant according to site; wet sites require plants that tolerate moist conditions.

Soil compaction

In compacted soil, the soil particles are pressed closer together leading to reduced pore space and limited flow of water and air. This leads to reduced root health as described above in the section about wet soils. Trees and shrubs exhibit branch dieback and reduced vigor. Soil can be compacted by foot traffic or construction in urban settings. In rural settings, livestock traffic can lead to compacted soils. Clay soils are more prone to compaction than sandy soils. Wet soils are also more prone to compaction. Soil compaction is a primary cause of tree failure on new construction sites or following home renovations involving heavy equipment. During construction, heavy equipment should be kept away from tree and shrubs, at least out to the drip line.

Adding soil to a site

Most tree and shrub roots grow in the upper 18 inches of the soil profile and are sensitive to changes in the soil grade or depth. When a layer of soil is added around a tree or shrub, air flow is decreased resulting in anaerobic (low-oxygen) conditions. Water movement downward to the root zone may be decreased, causing reduced soil moisture, or the water table may rise contributing to anaerobic conditions.

New roots do not develop well in the added layer of topsoil. The damaged roots are less effective at obtaining water and nutrients. Affected trees and shrubs may die within a few months, or they may decline slowly over a period of years. Symptoms include leaf yellowing, production of abnormally small leaves, premature fall coloration, poor leaf emergence, a thin crown, cankers, or epicormic branching or suckers along the trunk or main branches. In later stages, wood decay and the associated decay fungi may develop. Another indication that soil fill may have occurred is lack of a root flare. A normal tree that has been planted correctly is wider or flared at the base as it goes into the soil (Photo 4a). A tree that has had soil filled in around it may lack a root flare (Photo 4b).

Removing soil from a site

With a majority of the root system in the top 18 inches, removal of soil from this area can result in significant damage to the tree or shrub by removal of the fine feeder roots that are required to uptake water and nutrients. The remaining fine feeder roots are closer to the surface and are subject to damage from drying, freezing, or overheating. Symptoms are similar to those caused by the addition of soil (described above): small yellow leaves, epicormic sprouts, branch dieback, decline, or eventual death.

Fertility and pH

Plants require certain nutrients for growth and development. Those nutrients come from the soil and from fertilizers (manufactured products as well as manures or composts) that are added to the soil. Fertility excesses and deficiencies are damaging, and some fertility problems can be mistaken for diseases. Some soils have high or low pH, influencing the availability of essential nutrients. For example, high pH (greater than 7.0) renders iron less available to some plants, causing yellowing known as iron chlorosis (see below). High soil pH is a common problem in western Kansas. A soil test can provide information on pH and nutrients as well as recommendations on how to remedy potential problems. Contact information for the Kansas State University Soil Testing Lab is provided on Page 20 (Diagnosing problems).

Iron chlorosis

Iron deficiency results in yellow (chlorotic) leaves with the leaf veins remaining green (Photo 5). Under severe iron chlorosis, leaves develop brown irregular spots. Trees under chronic iron deficiency may exhibit poor growth and branch dieback. Iron becomes less available as soil pH increases (greater than 7.0), and many areas of Kansas have high pH soils. Pin oak, sweetgum, and soft maple as well as many other trees and shrubs also are susceptible to iron chlorosis. Avoid planting trees and shrubs sensitive to iron chlorosis in high pH soils. An iron deficiency can be corrected in some cases with foliar sprays or trunk injections of iron-containing compounds, or by soil amendments containing iron sulfate; however, these procedures are laborious and some soils are hard to adjust, such as calcareous soils. A soil test can provide information on pH and nutrients as well as recommendations on how to remedy potential problems. Contact information for the Kansas State University Soil Testing Lab is provided on Page 20 (Diagnosing problems).

Girdling damage

Girdling roots

Roots tightly wrapped around the main trunk or other roots cause constriction, reducing the flow of water and nutrients in the xylem and phloem. Large branches on the same side as the girdled roots lose vigor and may eventually die. If a large lateral root girdles a significant portion of the trunk, the plant will become progressively more stressed over a number of years. The main leader may die back. Girdling roots are sometimes visible at the base of the tree (Photo 6a). Underground girdling roots are more difficult to detect, but if root flares are lacking or the trunk is flattened or concave on one side (Photo 4b), an underground girdling root may be present. Improper planting and poor production practices are the primary causes of girdling roots. Young trees that have grown too long in containers tend to have overgrown root systems that spiral along the walls of the container. If the roots are not trimmed or straightened during planting, root girdling can become a problem. Trees planted along city streets are particularly prone to the development of girdling roots. In some cases, a tree-care professional can alleviate the problem by removing a section of the root. Regular watering and fertilizing may be needed to improve plant vigor.

Other girdling injury

In addition to girdling roots, described above, girdling can be caused by wires (for example, from wire baskets around the root ball), rope, string, vines, and other materials that are wrapped around trunks, roots, or branches (Photo 6b). The flow of water and nutrients is reduced by constriction, leading to reduced vigor and dieback.

Chemical damage

Herbicide injury

Herbicides applied to lawns, gardens, roadsides, crop fields, or other sites may cause damage to trees and shrubs if improperly used. Soil sterilants used along driveways, fencerows, and ditches can be absorbed by tree or shrub roots many feet away from the trunk, resulting in extensive damage. Trees and shrubs also can be injured by airborne herbicide drift. Symptoms of herbicide injury include yellowing or distortion of leaves, scorching of leaves, and branch dieback. Herbicides can cause gradual decline or rapid death. Following directions on the pesticide label can avoid most herbicide injury. Avoid excessive use of herbicides near trees and shrubs. If herbicide injury is suspected, determine which herbicide was applied, the application rate, and when the herbicide was applied, noting that some herbicides have an extended period of residual activity.

Salt injury

Injury to trees and shrubs from deicing salts is common in urban areas, particularly along sidewalks and roadways (Photo 7). Salt injury to roots occurs when deicing salts are washed into the root zone by precipitation, which leads to branch dieback, wilting, leaf yellowing, and leaf scorch. Salt injury also can occur on branches from direct contact of deicing salts, with twig dieback as a common symptom.

Gas leak

Natural gas leaks from an underground line are not directly toxic to trees and shrubs, but may negatively modify the growing environment of the soil by displacing oxygen. Multiple plant species may be affected in the vicinity of a leak. The soil may have a black color or an off-smelling odor indicating the presence of anaerobic conditions. Gas companies can use gas-detection meters to confirm the presence of a leak. An affected tree or shrub may not recover from a gas-related root injury. Soil aeration using an auger or compressed air may improve the condition of the soil before planting a replacement tree. Gas leak injury is rare but may be something to consider when evaluating tree decline.

Mechanical damage

Storm injury

High winds, heavy snow loads, hail, and ice storms can cause physical damage to trees and shrubs (Photo 8). The wounded areas are susceptible to infection by decay and canker-causing fungi. Trees and shrubs weakened by wood decay are particularly prone to branch damage or tipping over. Proper pruning after storm injury helps prevent decay. Trees may require inspection and evaluation by a professional after storm damage for defects. Some trees or shrubs may require removal to reduce risk.

Lightning

Lightning may strike a tree resulting in a dead strip of bark extending the length of the trunk, split or shattered bark (Photo 9), or major structural damage. In contrast, some strikes may run the length of the tree and kill the root system resulting in a slow death with no obvious immediate damage. Tall trees, trees growing alone in open areas, trees growing in moist soils, or trees growing along lakes and ponds are more susceptible to lightning strikes. Trees may exhibit immediate damage or may take some time to show signs of decline. A tree-care professional should evaluate severely damaged trees.

Equipment damage

Lawn mowers, weed trimmers, improper pruning techniques, and vehicle impact can damage trees and shrubs. These wounds are potential infection sites for wood decay fungi. Depending on the amount of damage, the plant may decline quickly or slowly over many years. Using mulch (Photo 3a) reduces the potential for injury from lawn mowers and weed trimmers by reducing equipment use next to the trunk. Mulch should not be placed directly against the trunk.

Excavation and construction damage

During construction, tree and shrub roots are often severed while excavating or trenching for utility lines, driveways, sidewalks, building foundations, and other structures (Photo 10). Damage levels depend on the extent of root breakage or removal. Loss of major roots leads to reduced water and nutrient uptake as well as a dieback of the major branches on the side of the root removal. Wounded roots are more susceptible to soil-borne pathogens. Depending on the amount of damage, trees may decline quickly or slowly over many years. If there is significant root damage, the tree may need to be evaluated by a professional for potential removal to prevent complete tree failure.

Animal damage

Animals cause physical injury to trees and shrubs by weakening the plant and providing entry sites for plant pathogens. In some years, squirrels chew strips of bark off twigs and small branches, leading to branch dieback. They

also can clip the ends of branches. Deer feed on young branches and stems, removing the growing point, which leads to unattractive, bushy growth. Male deer rub antlers on trees and shrubs, breaking branches and damaging bark. Sapsuckers/woodpeckers cause damage by creating holes when they feed on insects just below the bark. Rabbits and voles feed on the base of young, thin-barked trees and shrubs, causing girdling. Trunk protection or cages may be required. There are also animal repellents available that can be sprayed on plants for short-term protection.

Diseases

Plant pathogens that penetrate and colonize plant tissue cause many tree and shrub problems. Many tree and shrub diseases lead to only minor aesthetic damage, with little harm to the plant's overall health. Some diseases cause temporary or permanent damage to a plant's vigor, whereas a few diseases are capable of killing trees or shrubs.

The most common tree and shrub pathogens in Kansas are fungi. Fungi can cause leaf spots, wilting, cankers, root rots, and many other symptoms. Most fungi produce spores that can be spread by wind, rain, or in soil to start new infections. Many fungi produce their spores in reproductive fruiting structures. Some fungi also produce special structures for survival during winter or for long periods in the soil.

Along with fungi, other microbial organisms, including bacteria, nematodes (microscopic worms), and viruses are capable of causing plant diseases. Bacteria thrive in wet conditions. They can cause many diseases with diverse symptoms including leaf spots, cankers, and galls. Viruses spread plant to plant in different ways including by insects and on sap on infested pruning tools. The main nematode problem on trees and shrubs in Kansas is the pinewood nematode, which causes pine wilt.

Tree and shrub diseases can be divided into different categories. Several common categories of plant diseases are described below, with general comments on biology, symptoms, and management: (1) foliar diseases such as leaf spots and anthracnose, powdery mildew, and rusts; (2) wilts; (3) cankers and branch dieback/twig blight; (4) crown gall; (5) wood decay; (6) root rot; (7) wetwood; and (8) viruses. Comments on specific diseases are provided in the table following this introductory chapter, starting on Page 22.

Foliar diseases

Leaf spots and needle blights

Leaf spots are localized infections on broadleaf foliage or needles. In Kansas, fungi cause most leaf spots. Common examples of fungal leaf spots include ash leaf spot (Photos 11a – 11b), apple scab (Photo 12), Septoria leaf spot of dogwood (Photo 13a), cherry leaf spot (Photo 13b), black spot of rose (Photo 14), and Dothistroma needle blight of pine (Photo 15a). Bacterial leaf spots of trees and shrubs are rare in Kansas. Leaf spots seldom cause extensive damage to deciduous trees, especially if the spotting occurs late in the season when the tree or shrub has produced and stored adequate carbohydrates. Since conifers retain their needles and use them for photosynthesis for several years, the loss of needles is more damaging.

Fungi that cause leaf spots usually produce spores that are spread by wind or rain splash. Most leaf-spot causing organisms survive on infected plant debris and require moisture on the leaf surface for a number of hours to infect the host. Therefore, cultural practices such as sanitation (removing infected debris, raking leaves in fall) and providing good air movement (such as thinning an overly crowded windbreak) reduce the incidence of these diseases. Avoid wetting the foliage with overhead watering. When establishing new plantings, plan ahead to avoid crowded conditions. Occasionally, fungicide sprays may be useful to protect trees and shrubs from severe infection. Resistant varieties are available for some leaf spotting diseases.

Anthracnose diseases

Anthracnose is a general term used to describe a group of plant diseases caused by various fungi that infect leaves and twigs in spring. Anthracnose fungi survive the winter in infected twigs and fallen leaves. They cause new infections during wet spring weather. In Kansas, anthracnose is most common on sycamore, ash, elm, maple, oak, and walnut. The anthracnose fungi are host specific, meaning that (for example) the fungus that causes anthracnose on oak is different from the one that causes anthracnose on maple. Symptoms include irregular foliar blighting and spotting, often along the major veins (Photos 16a, 16b, 93, 107, and 108), and/or premature leaf shedding. Sycamore anthracnose sometimes also causes twig blighting (Photo 17). Repeated killing of young twigs results in abnormal branching and gives the tree a ragged appearance. Anthracnose diseases can be

confused with herbicide injury, environmental scorch, or frost injury, especially during spring weather fluctuations.

Although anthracnose diseases are unsightly, they do not kill or weaken the plant. In particular, large, mature trees tend to recover rapidly if properly maintained. The arrival of warm, dry summer weather after spring rains speeds the recovery process as the tree produces more foliage. Fungicides are rarely needed. Fungicides are available to prevent anthracnose, but they must be applied during the critical infection period in the spring. The typical recommended timing to initiate foliar applications is at or just before bud break. Fungicide applications later in the season have minimal effect. Some fungicide injection products are available for certain anthracnose diseases. The cultural practices described above for general leaf spots also can reduce anthracnose.

Powdery mildew

Powdery mildews are common foliar diseases that appear as a white, powdery growth on the surface of leaves. The fungus may be visible as small, discrete colonies (Photo 18a) or it may grow on large portions of the leaf surface (Photo 18b). The fungus absorbs nutrients from the leaf, reducing the plant's carbohydrates, and the fungal colonies may be considered unsightly. Powdery mildews rarely cause significant damage to trees and shrubs in Kansas. If infection is severe, the reduced carbohydrates can result in a weakened plant that may be more susceptible to winter injury. Powdery mildews are caused by many different, but related, species of fungi. For example, powdery mildew on rose (Photo 18a) is caused by a different fungal species than powdery mildew of lilac (Photo 18b). Ash, barberry, oak, and many other trees and shrubs also are susceptible to various powdery mildews.

Rusts, including cedar apple rust, hawthorn rust, and quince rust

Rusts are named for the orange, rust-colored spores and fruiting structures that they produce. Like powdery mildews, rusts are fairly specific to the plants they infect. For example, the fungus that causes ash rust (Photos 19a and 19b) is different from the rust that infects rose (Photos 21a – 21b). Some rust fungi alternate between two hosts, such as cedar-apple rust. Cedar apple rust, hawthorn rust, and quince rust are common in Kansas and are described below. Other related species have been reported on rosaceous hosts in other states but have not been detected in Kansas.

Cedar apple rust is caused by the fungus *Gymnosporangium juniperi-virginianae*. The fungus produces several life stages that alternate between apple (and related species) and junipers. Some junipers are called Eastern red cedar, hence the name "cedar" apple rust. On juniper, the disease develops as hard, brown galls ½ to 1 inch in diameter. During wet weather in spring, the galls produce orange horn-like tentacles that are about ¾ to 1 inch long (Photo 22). The horns produce a spore type that infects the other (apple, crabapple, etc) host. The galls are productive for only 1 year, though the dead galls may persist on the tree. On apple, leaves develop yellow-orange spots on the upper leaf surface (Photo 23a) and tube-like projections on the lower surface (Photo 23b), which produce another spore type that infects juniper, completing the cycle. The disease does not reduce the health of infected junipers but can cause major defoliation of susceptible crabapples (and relatives), reducing photosynthesis and weakening the tree. Resistant varieties of some types of apple and crabapple are available.

Hawthorn rust is similar to cedar apple rust and is caused by the fungus *Gymnosporangium globosum*. Like cedar apple rust, it infects junipers, but the alternate hosts include hawthorn, apple, crabapple, serviceberry, quince, and pear. On juniper, the disease produces galls and orange horn-like structures (Photo 24), but they are smaller, ¼ to ½ inch in diameter, than cedar apple rust galls and they persist for multiple years. Foliar symptoms of hawthorn rust on the apple hosts are similar to cedar apple rust, with yellow-orange spots on the upper leaf surface and tube-like structures on the lower surface (Photos 23a – 23b). Like cedar apple rust, hawthorn does not seriously affect junipers but can cause serious defoliation of the apple hosts.

Quince rust is the third common rust from this group in Kansas, and it is caused by the fungus *Gymnosporangium clavipes*. On juniper, quince rust does not produce galls with horn-like projections. Instead, it causes swelling of twigs, with spores produced in orange cushions that are swollen and slimy when wet (Photo 25) and crust-like when dry (Photo 26). On juniper twigs, the disease can be active and produce spores for 4 to 6 years, and affected twigs eventually die. Furthermore, unlike cedar apple rust and hawthorn rust, quince rust tends to occur on twigs (Photo 27a), thorns, and fruits (Photo 27b) of hawthorn.

Wilt diseases

Wilt pathogens colonize the water-conducting vessels in plants. The most common and serious wilt diseases of trees in Kansas are Dutch elm disease, Verticillium wilt, oak wilt, and pine wilt.

Dutch elm disease

Dutch elm disease is caused by the fungi *Ophiostoma novo-ulmi* and *Ophiostoma ulmi.*

Symptoms include yellowing, browning, and wilting of leaves on a branch or several branches, leading to a "flagging" effect (Photo 29), which often becomes apparent during the first summer heat. Infected trees may die within a few weeks or survive for a year or more. Affected branches develop a brown streaking of the sapwood just beneath the bark layer (Photo 30). The fungus is spread from tree to tree by elm bark beetles and also can move between trees through root grafts.

Prevention, scouting, and sanitation are critical for managing this disease. Early detection of the disease is important. Trees showing more than 5 to 10 percent crown symptoms seldom can be saved and should be removed immediately. Root grafts between healthy and diseased elms should be disrupted by mechanical trenching before the diseased tree is removed to prevent spread through roots. All diseased elm wood should be burned or buried immediately. The wood should not be stored for firewood use unless the bark is removed. Systemic fungicide injections may be used to prevent infection or to treat high-value trees already infected, but only if disease is detected early, when fewer than 5 percent of the crown exhibits symptoms. Fungicides are not a substitute for sanitation, and they are not always effective. There are new varieties of elms available with resistance to Dutch elm disease, and these should be considered in new plantings.

Verticillium wilt

Verticillium wilt, caused by the soilborne fungi *Verticillium dahliae* and *Verticillium albo-atrum*, primarily occurs in late spring. Common hosts include catalpa, redbud, smoketree, maples, and elm, but many more species also are susceptible. The fungus infects through roots, therefore it is important to avoid wounding the roots or root collars.

Affected plants exhibit rapid wilting and drying of leaves in a portion of the tree (Photo 31) or throughout the entire crown. In addition, leaves may turn yellow. Branch dieback also can occur. Vascular discoloration (brown streaking) may be visible when viewing cross sections of cut branches (Photo 32) or when bark is removed. Symptoms generally progress from lower parts of the tree upward. Infected trees and shrubs can suddenly die, but they sometimes survive several years or more with slow decline over time.

Water any trees showing symptoms of Verticillium wilt unless there is sufficient soil moisture. Dead branches should be pruned. If a site is known to have a history of Verticillium wilt, select a nonsusceptible plant when replanting, such as conifers, hackberry, dogwood, hawthorn, honeylocust, sycamore, sweetgum, or crabapple.

Oak wilt

Oak wilt, caused by *Bretziella fagacearum* (syn. *Ceratocystis fagacearum*), is an occasional problem on red oak in northeast Kansas and along the Kansas/Missouri border. Red oaks are more susceptible than white oaks to oak wilt. Infected trees develop symptoms in late spring starting with a half leaf scorch, premature shedding of individual branches followed by a progressive wilt and decline. Brown streaks are present in the sapwood underneath the bark of flagging branches (Photos 105, 106a, and 106b). Tree decline generally occurs within one season.

Oak wilt is spread by sap beetles (aka picnic beetles) and from tree to tree through root grafts of infected oak trees. Other problems that can be confused with oak wilt include environmental stress, poor site factors, Hypoxylon canker, and bur oak blight. Testing to confirm oak wilt can be done at the K-State Plant Disease Diagnostic Laboratory. Infected trees should be removed and root grafts broken. Healthy oaks near infected can be injected with a fungicide to protect against spread of the disease. Wood from the infected tree should not be moved out of the area as it can carry the disease to new locations. Wood held for firewood should be tarped. Avoid wounding or pruning of oak trees during April, May, and June.

Pine wilt

Pine wilt is a one of the leading causes of the decline and death of pine trees in landscape and windbreak plantings in eastern and central Kansas. The disease is caused by the pinewood nematode, *Bursaphelenchus xylophilus*, but also requires the presence of longhorn (pine sawyer) beetles (Photo 77) in the genus *Monochamus* (Cerambycidae). Synchronized life cycles of both pests ensure that dispersal-stage juvenile nematodes are transmitted to healthy trees during maturation feeding

by adult beetles, which can occur throughout the spring and summer months in Kansas. Trees killed by pine wilt serve as sites of beetle oviposition (egg-laying), further ensuring that the nematode and the pine sawyer beetle are mutually present when the next generation of adult beetles emerge.

Tree mortality results from disruption of the water conducting system. Needles of infected branches rapidly turn brown but remain attached, while the branches become dry and brittle due to the lack of sap. Symptoms, which may initially appear on individual branches, progress throughout the tree within a few weeks to months (Photo 33).

Trees often develop a blue discoloration inside the wood due to the growth of a "blue stain fungus" associated with the disease. The fungus does not cause pine wilt but rather invades the tree after the pine wilt disease has already progressed significantly. Disease incidence and severity differs among pine species, with the most susceptible species being Scots pine. Other susceptible species in Kansas include Austrian, Mugo, eastern white pine, and southwestern white pine.

Sanitation is an essential component of pine wilt management. Infected trees should be cut to ground level and the wood chipped or burned before April 1. Preventative tree injections with a labeled nematicide are a management option for valuable trees. Biennial injections have been shown to provide protection against the establishment of pinewood nematode and the development of pine wilt. Injections are expensive, however, and require the services of trained professional arborists.

Cankers

Cankers are caused by fungi and bacteria that infect tissue under the bark. Canker symptoms include sunken, cracked, or discolored bark, such as occurs with Thyronectria canker of honeylocust (Photo 34). Fungal fruiting structures may be visible on the bark, such as Endothia (Photo 35) and Hypoxylon canker (Biscogniauxia canker) (Photo 36) of oak. In canker diseases, the wood in the affected area is brown and dead, visible when the bark is removed (Photo 37). Fire blight is a bacterial disease of crabapple, pear, and related species that can cause branch cankers.

Canker diseases are most common in trees and shrubs stressed by winter injury, drought, freeze/thaw cycles, hail, insect boring wounds, or pruning wounds. Several canker fungi are known to survive latently in plant tissue, without causing symptoms, and then colonize rapidly when the tree or shrub is stressed.

The risk of cankers can be reduced through proper care, including appropriate watering, pruning (while minimizing wounds), fertilization, protection from winter injury, and other general practices. Some cankers can be managed by pruning out affected branches. Fungicides are not effective against cankers.

Crown gall

Crown gall is caused by a soilborne bacterial species, *Agrobacterium tumefaciens*. Galls normally develop near the soil line, although in some species, galls occasionally develop higher on the stem or on branches. The galls first appear whitish or creamy colored but later turn dark and woody (Photo 38). Galls disrupt the normal flow of nutrients and water, reducing plant growth. In Kansas, euonymus, rose, cottonwood, willow, apple, peach, and cherry are commonly affected, but many other species also are susceptible to crown gall.

Once the disease occurs, there are no curative treatments. The best means of managing crown gall is to prevent the introduction of the pathogen. Carefully inspect all plants for galls before purchasing or planting. Any plants with galls should be discarded immediately. The crown gall bacterium attacks susceptible tissues through wounds, so minimize injury to tree roots during planting and cultivation. The bacterium can survive many years in the soil. Do not replant with susceptible species in sites where crown gall has been a problem.

Wood decay

Wood decay reduces the strength of branches, trunks, and roots, which poses a risk to structures, cars, or people, especially during windy weather or ice storms. Trees and shrubs with decayed roots are prone to falling due to loss of root anchoring strength.

Wood decay is the progressive deterioration of the cell wall substances (lignin and cellulose) of wood, caused primarily by fungi that produce enzymes capable of degrading those substances. Wood decay organisms colonize through wounds, branch stubs, and other compromised sites. Trees and shrubs have natural defense mechanisms that may "wall-off" (compartmentalize) the decay process to a certain portion of the plant, but this barrier may be breached with additional wounding

or injury. Once the decay process has been initiated, it is difficult to control.

Decay is often invisible from the outside except where wounds or injuries have removed the bark. In those areas, symptoms of wood decay include soft, spongy, discolored, or crumbling wood (Photo 39). The presence of conks or mushrooms, the reproductive structures (fruiting structures) of wood-rotting fungi, also can indicate decay (Photos 40 and 88) as well as other types of macroscopic (visible to the naked eye) fungal growth (Photos 41a – 41b). It is common, however, for decay to occur without any fungal growths visible. Other symptoms of decay include hollow cavities, cracks, swellings in the trunk or branches, or general decline.

There are no "cures" for wood decay. Wood decay can be prevented by avoiding wounding. Pruning cuts should be made when branches are small to minimize wound size. Additional resources are available for details on appropriate pruning techniques.

Routinely inspect trees and shrubs for indications of decay. A trained tree-care professional should evaluate trees with conks, mushrooms, or other symptoms of decay. A certified arborist should remove trees that pose a risk to people, structures, or vehicles.

Phytophthora and Pythium diseases

Phytophthora root rot is a "water mold" (fungus-like organism) that affects trees and shrubs in the landscape, especially in sites with poor drainage. *Pythium* is another water mold that sometimes occurs in the landscape but is more common in nurseries and flower beds. Affected roots do not effectively acquire water and nutrients, which leads to wilt stress, nutrient deficiency, branch dieback, and general plant decline. The roots may be dark or mushy, with a lack of small feeder roots. To reduce problems with *Phytophthora* and *Pythium* root rots, avoid planting in sites with poor drainage, improve drainage in existing sites, and avoid excessive watering.

Phytophthora ramorum

Phytophthora ramorum is an emerging disease on the West Coast, primarily California, Oregon, and Washington. It has the potential to move from nursery production systems to landscapes and native oak forests. This disease is not known to occur in Kansas landscapes but could become introduced. *Phytophthora ramorum* is a water mold disease that causes a disease complex known as **sudden oak death** on oaks and **ramorum blight** on nursery plants. Ramorum blight is associated with more than 100 nursery plant hosts and causes symptoms of a foliar blight. Sudden oak death produces reddish, bleeding trunk canker, leaf scorch and tree decline on coastal oaks in the pacific northwest. Conditions that would favor *P. ramorum* would be moderate temperatures and above average rainfall. Testing for *P. ramorum* can be done at the K-State Plant Disease Diagnostic Laboratory.

Wetwood

Wetwood also is called bacterial wetwood, bacterial slime, or slime flux. Symptoms of wetwood include the dripping or oozing of liquid or slime from cracks or wounds, which leaves a stain on the bark (Photo 42). Wetwood is common in elm, cottonwood, maple, mulberry, oak, willow, and sycamore. In general, wetwood does not pose any significant threat to landscape trees. Numerous species of bacteria have been associated with wetwood. Alcoholic flux is another condition in which microbes ferment sap. This process produces gas and alcohol, which develop into foamy exudates (Photo 43). Alcoholic flux is common on sweetgum, willow, elm, and oak, especially when trees are stressed.

Viruses

Viruses can be spread by insects, sap transfer on infested tools, and grafting. They are not common in trees and shrubs, but there are several that occur in Kansas, especially on roses, including **rose mosaic virus** (Photo 44a – 44b). Viruses cause a variety of symptoms including ringspots, mottling/mosaic coloration, and line patterns. Viruses also can cause distorted growth, such as the witches brooms and excessive thorniness associated with **rose rosette** (Photos 45a – 45b). Viruses are systemic in plants, meaning the plant is infected for life. There is no cure for viruses. Infected plants should be removed and destroyed immediately to prevent further spread.

Insect and mite pests

Most insect pests associated with forest and urban ecosystems cause relatively minor damage to established trees unless populations reach outbreak proportions, in which case, there may be acute (short-term) or chronic (long-term) damage to trees and shrubs. It is important to understand the factors responsible for insect pest populations causing tree damage. First, abiotic (nonliving) factors such as weather (storms), over-crowding (competition), improper pruning, soil compaction, nutrient deficiencies, moisture availability, and aging may result in stress. Those factors are described in the section on abiotic disorders. Any type and/or level of stress results in trees and shrubs being more susceptible to various insect and mite pests. Trees not experiencing stress are able to defend themselves primarily through the production of chemicals such as oleoresin (a mixture of monoterpenes and resin acids), which provides defense against adult bark beetles.

Endemic insect and mite pests are commonly native to an area or have been established for some time, and are widely distributed. They are mainly a concern when extreme environmental conditions persist such as high temperatures and lack of moisture, resulting in trees experiencing stress, which compromises their ability to defend themselves. Population fluctuations or cyclic patterns may occur from year-to-year, depending on environmental conditions and the abundance of beneficial organisms, such as, parasitoids, predators, and pathogens, which may naturally regulate insect and mite pest populations. Extreme weather, harvesting, and forest fires can also reduce populations of these insect and mite pests by causing either direct mortality (death) or eliminating essential food sources or habitats.

Exotic insect pests have been inadvertently or accidentally introduced into the United States from other countries and invade new ecosystems in the absence of their typical natural enemies (e.g., parasitoids and predators). They can migrate within a short period of time. Some exotics may be specialists (attacking one type or genus of tree) or generalist, in which case, they may attack many kinds of trees. With no prior exposure to such insects, trees and shrubs may lack natural defenses, thus increasing their susceptibility. The major exotic insects that are a potential threat to forest and/or urban ecosystems of Kansas are the emerald ash borer (*Agrilus planipennis*) and the Asian longhorned beetle (*Anoplophora glabripennis*).

Insect feeding behavior

Insect pests differ in their ability to damage trees and shrubs, which is associated with their feeding behaviors. The typical feeding behaviors of insect pests of forest and urban ecosystems are chewing, piercing-sucking, and boring. The following sections list and describe the potential insect and mite pests of forest and urban ecosystems in Kansas based on their feeding behavior.

Chewing insects

Chewing insects such as beetles, caterpillars, grasshoppers, and sawflies physically remove plant tissue including leaves, twigs, and flowers. Wood-boring beetles are a special type of chewing insect and are discussed in a separate section. Below are descriptions of some of the common chewing insects.

Beetles

Adult beetles typically have a hardened, outer-covering that protects the forewings. Larvae are usually soft-bodied and may vary in color depending on the beetle species. The adults feed on aboveground plant parts (e.g., leaves and stems) whereas, depending on the beetle species, larvae feed on belowground plant parts (e.g., roots) or aboveground plant parts (e.g., leaves and stems).

Elm leaf beetle (*Pyrrhalta luteola*) adults are ¼ of an inch long, and yellow to dull-green, with a black stripe on each wing cover extending the entire length of the abdomen. There are distinct black spots on the head and thorax (Photo 46a). Larvae are ½ of an inch long and yellow with two lines of black spots on the back (Photo 46b). Apply contact insecticides at the first appearance of adults and larvae, which may be feeding simultaneously. Thorough coverage of both the upper and under sides of leaves is important.

European elm flea weevil (*Orchestes alni*) adults are ⅛ inch long and red-brown with black markings (Photo 47a). Adults possess thickened hind legs adapted for jumping. The adults are active in May, and after mating, females lay eggs near large leaf veins. Legless, cream-colored larvae emerge from eggs. The larvae tunnel into elm leaves while feeding; creating serpentine tunnels within the main portions of the leaf and blotched tunnels near leaf tips. The larvae eventually pupate in the tunnel and adults emerge from May through June. Adults feed on the leaf underside, creating small pinhead-sized holes

(Photo 47b). Adults are active through August and then search for sheltered habitats such as loose bark or leaf litter to overwinter. European elm flea weevil overwinters as an adult near previously infested elm trees. There is one generation per year. The European elm flea weevil attacks all species of elms.

Japanese beetle (*Popillia japonica*) adults are ⅜ to ½ inch long, metallic green with coppery-brown wing covers. There are white tufts of hair at the end of the abdomen (Photo 48). Adults are present and active for 30 to 45 days, feeding continuously on leaves and flowers. They feed, primarily between leaf veins, resulting in leaves appearing lace-like or skeletonized. Adults also chew holes in flower buds and feed on the petals of open flowers. Japanese beetle adults tend to congregate in large numbers on plants. Damage can be severe if beetles reach high numbers. In those cases, apply contact insecticides when adults are active. It is important to note that multiple applications will be required.

Black vine weevil (*Otiorhynchus sulcatus*) adults are ⅜ of an inch in length, black, and the body is covered with patches of fine yellow hairs (Photo 49). Adults have a short, snout-shaped mouth, which is used to create characteristic notches on plant leaves during feeding (Photo 50). These notches are typically, but not always, located on leaf margins. Black vine weevil adults cannot fly. Adults are typically active at night and hide in debris or under plant containers during the day. Adults feed on leaves and primarily affect the aesthetic appearance of plants. The larva (Photo 51), which feeds on roots, is the life stage that can cause plant damage. As such, insecticides can be applied to the soil to prevent larval damage.

Caterpillars

Caterpillars are the larvae of butterflies and moths (order Lepidoptera). They have soft bodies, hardened head capsules, and several pairs of fleshy legs called prolegs.

Bagworm (*Thyridopteryx ephemeraeformis*) creates a small silken bag or case, covered with material from the host plant. Young caterpillars are ⅛ to ¼ of an inch long (Photo 52). Caterpillars emerge from eggs over a month-long period. Older or mature caterpillars and their bags are 1 to 2 inches long (Photo 53). Females never develop into adult moths because they lack eyes, wings, legs, and antennae. Females remain inside the bag, producing eggs before dying. Males, however, transition into black moths with clear wings that are 1 inches long, and emerge from the bottom of the bag, dispersing to mate. Bagworms feed on a wide range of evergreen and deciduous trees and shrubs including arborvitae, cedar, white pine, elm, honeylocust, maple, oak, and poplar. Bagworms can cause substantial damage if they reach high numbers. Contact or stomach poison insecticides can be used to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.

Eastern tent caterpillar (*Malacosoma americanum*) builds nests that are initially 1 to 2 inches in length and width, and located in the crotches of twigs of various trees in the Roseacae family including hawthorn, cherry, plum, and crabapple (Photo 54). Full-grown caterpillars are 2 inches or more in length, with a black head. The body is black with a white stripe extending down the back and a series of bright blue spots between yellow lines (Photo 55). Adult moths are 1 inch long and red-brown with two white stripes or wavy bands extending across each forewing. Physically remove or disrupt the nest early in the spring to avoid having to apply a contact or stomach poison insecticide.

Fall webworm (*Hyphantria cunea*) caterpillars are yellow-green or brown with black spots. Mature caterpillars are 1 to 1½ inches long, with orange-yellow or black tubercles on the body. They have tufts of long, gray, silken hairs on the body (Photo 56). The head capsule varies from red to black. Caterpillars build large, protective nests that are typically found on the ends of branches. Caterpillars do not leave the nests when feeding (Photo 57). Adult moths are 2 inches long, with the forewings containing brown spots, and small red-orange markings at the base of the front legs (Photo 58). Fall webworm caterpillars feed on birch, cherry, elm, hickory, walnut, willow, and other various shade trees and shrubs. Prune out localized nests and dispose of immediately. Use a rake to disrupt the nests, which allows birds to feed on the caterpillars.

Mimosa webworm (*Homadaula anisocentra*) caterpillars are approximately ½ inch long when full-grown, green to dark brown, with white stripes extending the length of the body. Caterpillars rapidly move backward when disturbed. The caterpillars web leaves together on the ends of branches. Webbing typically starts at the tops of trees. Caterpillars feed on leaves at the ends of branches. Heavily infested trees appear brown or scorched. Caterpillars eventually leave trees using a silken strand before pupating. Mimosa webworm pupates in bark crevices or the pupae attach to structures such as buildings. Selective pruning quickly removes isolated or localized infestations of mimosa webworm. Contact or stomach poison

insecticides must be applied early in the season before leaves are webbed together.

Grasshoppers

Adult grasshoppers (order Orthoptera) are generally 1 to 2 inches long (Photo 59). They vary in color from brown, red, yellow, to green depending on the species. Grasshoppers have modified, long hind legs that are adapted for jumping. Grasshoppers tend to feed during the daytime creating ragged holes in plant leaves (Photo 59). Many species of grasshoppers attack a variety of tree and shrub species. In most cases, the feeding damage associated with grasshoppers is aesthetic. Grasshoppers are difficult to manage with insecticides due to their migratory behavior and the adults possess a hardened, waxy cuticle that reduces insecticide penetration.

Sawflies

Sawflies (order Hymenoptera) resemble caterpillars; however, sawfly larvae have prolegs (small fleshy stubs) on every abdominal segment whereas caterpillars lack prolegs on some segments In addition, caterpillar larvae have hairs or crochets on their feet, which are absent on sawfly larvae.

European pine sawfly *(Neodiprion sertifer)* adults resemble wasps. The female is orange, whereas the male is black. Both are 5⁄16 of an inch long. Full-grown larvae are approximately ¾ to 1 inch in length, gray-green with a black head and legs. A single, light-colored stripe extends down the back with two light green stripes and one dark green or black stripe located on each side of the body (Photo 60). Larvae feed in groups on previous years' needles and may consume all the needles on a single branch. The larvae will feed on different pine species including mugo, Scotch, red, jack, and Austrian pine. Contact insecticides can be applied when larvae are present in early spring. In addition, larvae can be removed by hand and placed into a container of soapy water.

Rose sawfly (*Endelomyia aethiops*) females make slits along the edges of rose leaves using their saw-like ovipositor (egg-laying device) and insert eggs. Larvae that emerge from eggs resemble a slug. Larvae are approximately ½ of an inch long when full grown and yellow-green with an orange head (Photo 61a). Rose slug larvae feed on the underside of leaves resulting in a skeletonized appearance (Photo 61b). The larvae eventually fall onto the soil surface to pupate. Rose slugs overwinter as pupae in earthen cells created by the larvae. There is usually one generation per year.

Piercing-sucking insects and mites

Insects such as aphids, leafhoppers, and scales feed in the vascular tissues of plants including the xylem (water-conducting tissues) and/or phloem (food-conducting tissues) withdrawing plant fluids with their stylet-like mouthparts. Plants fed upon by piercing-sucking insects may exhibit symptoms such as stunting, leaf yellowing or chlorosis, wilting, and distortion of new growth. Certain mite species also have piercing-sucking mouthparts but do not feed in the xylem or phloem. Instead, they feed in the palisade or spongy mesophyll cells removing the green pigment (chlorophyll) from plant leaves.

Aphids

Aphids, in general, are 1⁄25 to ⅛ of an inch long, soft-bodied, pear-shaped, with two tubes called cornicles protruding from the back of the abdomen (Photo 62). The color of aphids varies, depending on the host plant fed upon and aphid species, from brown, green, red, yellow, orange, or black. Aphids use their piercing-sucking mouthparts to remove plant fluids from terminal growth and leaf undersides, which may cause leaf curling or distortion. During the feeding process, aphids produce honeydew, which is a clear sticky liquid that serves as a growing medium for black sooty mold. Ants may be present because ants feed on the honeydew excreted by aphids, move aphids from plant-to-plant, and protect them from natural enemies (e.g., parasitoids and predators). Contact or systemic insecticides may be used to manage aphid populations. In addition, high-pressure water sprays can quickly remove aphids from trees and shrubs.

Leafhoppers

Leafhoppers are approximately ⅛ of an inch long, slender, and wedge-shaped (Photo 63a). They are commonly yellow to light green although this varies depending on the species. The wings are held roof-like over the body. Leafhoppers use their piercing-sucking mouthparts to withdraw plant fluids causing "stippling" of plant leaves (Photo 63b), which is similar to the damage caused by twospotted spider mite feeding. Feeding by leafhoppers may also result in leaf distortion, chlorosis, plant stunting, curling of leaves, leaf yellowing, and leaf browning or necrosis. In addition, certain leafhopper species can vector diseases such as aster yellows. Leafhoppers are difficult to manage with contact insecticides because they are highly mobile.

Lace bug

Adults possess lacy, clear, shiny wings that are held flat over the body (Photo 64). Adults are ⅛ to ¼ of an inch long, and tend to move sideways when disturbed. Females can lay between 20 to 50 eggs during their lifespan on the underside of leaves. Eggs are black with a long, cylindrical shape, similar to a wine flask. Nymphs that emerge from eggs are shiny, black with spines located on the periphery of the body (Photo 65). Lace bugs feed on leaf undersides using their piercing-sucking mouthparts, to withdraw plant fluids from individual leaf cells, causing the upper leaf surface to appear light yellow or mottled, stippled and/or bleached (Photo 66). The damage is similar to that caused by the twospotted spider mite and leafhoppers; however, lace bugs leave black, tar-spot-like droplets of excrement on leaf undersides whereas both the twospotted spider mite and leafhoppers do not. Lace bugs, in general, will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be applied; however, thorough coverage of the leaf undersides is important. Applying insecticides may not be practical for large plants.

Scales

Scale insects can be divided into two groups: soft or bark scales and hard or armored scales. Soft scales are convex, and oval or globular in shape, and produce a waxy covering. Hard scales appear circular or rounded in shape, and produce a hardened covering. Another way to distinguish between the two scale groups is that soft scales produce honeydew, a clear sticky liquid, and hard scales do not.

Pine needle scale (*Chionaspis pinifoliae*) females are elongated, approximately 1⁄16 to ⅛ of an inch long and white with a yellow portion attached, which tapers to one end. First and second instar nymphs (crawlers) are narrow and yellow. Males are a small, rectangular in shape with a white covering. Pine needle scale overwinters as red eggs located underneath mature female scales. Nymphs (crawlers) are flat and yellow. Contact insecticides should be applied as soon as nymphs (crawlers) are active.

Obscure scale (*Melanaspis obscura*) is ⅛ of an inch long and dull gray to black (Photo 67), which allows them to blend in with the bark of host trees such as oaks. Nymphs (crawlers) are typically active from July through September. Obscure scale primarily attacks oaks, but can be found on willow, maple, crabapple, and hickory. Contact insecticides must be applied as soon as nymphs (crawlers) are active. Maintain proper plant health by providing sufficient water and applying mulch around the base of plants. Obscure scale can be removed from the trunk by scraping them off with a stiff-bristled brush.

Pine tortoise scale (*Toumeyella parvicornis*) adults are approximately ⅛ to ¼ of an inch in diameter and hemispherical in shape. Females are red to light brown, with dark-brown to black markings (Photo 68). Males are somewhat flattened, smaller, and white in color. Pine tortoise scale produces copious amounts of honeydew, which is a clear, sticky liquid. Nymphs (crawlers) may be active from mid-June through early July. Contact insecticides should be applied when nymphs (crawlers) are active.

Oak kermes scale (*Kermes pubescens*) adults are ⅛ to ¼ of an inch in length and are lightly mottled brown (Photo 69). They are primarily located at the base of small twigs. Old female scales may be black and globular in shape with hard-shelled coverings that resemble certain oak galls. Nymphs (crawlers) are similar in appearance to other scale nymphs (crawlers). In general, oak kermes scale will not kill plants, but heavy infestations may affect aesthetic appearance. Prune out heavily infested branches or twigs. Contact insecticides should be applied when nymphs (crawlers) are active.

European elm scale (*Gossyparia spuria*) adults are ¼ to ⅜ of an inch long, oval in shape with the body periphery encircled by a white waxy substance (Photo 70). They are commonly located on branches or twigs and where branches connect. The nymphs (crawlers), which are present in late June, are yellow and located in cracks and crevices in the bark. European elm scale feeds on American and other native elms. Prune out localized infestations. Contact insecticides including horticultural oils can be applied when nymphs (crawlers) are active during the season.

Euonymus scale (*Unaspis euonymi*) adult female covers are dark brown, convex, and oyster shell-shaped. They are ⅛ to ¼ of an inch in length. Male covers are white and smaller than females (Photo 71). Nymphs, which are orange, resemble small yellow spots moving around on stems and leaves. The females are typically located on the stems; whereas males are present on the underside of plant leaves. Euonymus scale overwinters as a mated female on plant stems. Euonymus scale feeds on evergreen euonymus, holly, privet, and pachysandra. Prune out heavily-infested branches and dispose of immediately. Apply a contact insecticide such as horticultural oil when nymphs (crawlers) are active during the season.

European fruit lecanium scale (*Parthenolecanium corni*) adults are ⅛ to ½ of an inch long. Females are hemispherical in shape and light to dark brown with mottling patterns on the body. Shape and color varies depending on the plant host fed upon. Females expand in size producing several hundred eggs in May and June. Eggs are laid underneath the female covering. After eggs are laid, the female body desiccates, becomes brittle, and turns brown (Photo 72). Nymphs (crawlers) emerge from beneath the female covering in June and July, migrate to leaves and start feeding. Nymphs (crawlers) feed during the growing season. In late summer, before leaves fall, second-instar nymphs (crawlers), which are ¼ of an inch long and yellow-brown, return to twigs and overwinter. There is usually one generation per year.

Mites

Twospotted spider mite (*Tetranychus urticae*) adults are about 1/16 of an inch long, oval-shaped, and green-yellow to red-orange, and have two dark spots on both sides of the abdomen (Photo 73). The larvae and nymphs are pale-yellow to yellow-green. Twospotted spider mite feeds on the underside of leaves. Damaged leaves have small white to yellow speckles (Photo 74), which is typically referred to as "stippling." Heavily infested leaves are yellow to bronze, turn brown, desiccate, and eventually fall off plants. Webbing may be present on the underside of leaves and plant stems when populations are excessive. Multiple applications of a contact pesticide (with miticidal activity) may be required throughout the season. In addition, thorough coverage of all plant parts is important. A high-pressure water spray removes all life stages (eggs, larvae, nymphs, and adults) from plants.

Spruce spider mite (*Oligonychus ununguis*) adults are oval-shaped and approximately 1/60 of an inch long. They are black, tan, or red, whereas nymphs vary in color from light gray to green. Spruce spider mite adults and nymphs feed primarily on conifers including arborvitae, Douglas fir, hemlock, juniper, and spruce, causing stippling and/or bleaching of affected needles or foliage. Spruce spider mite overwinters in the egg stage. A high-pressure water spray removes all life stages (eggs, larvae, nymphs, and adults) of the mite. Miticides can be applied; however, thorough coverage of all plant parts is important. A dormant oil applied in winter kills overwintering eggs on the bark and needles.

Wood-boring insects

Wood-boring insects typically attack stressed trees and shrubs. Females lay eggs on the bark and larvae emerge from eggs and tunnel into plants and feed within the vascular tissues such as the cambium, phloem, or sapwood (xylem). Larval activity disrupts the flow of water and nutrients in plants. Most beetle and caterpillar borers attack stressed plants. It is important to note that wood-boring beetles (e.g., flat-headed borers) pack their tunneled galleries with sawdust-like frass, whereas wood-boring caterpillars (e.g., clear-wing) expel sawdust from cracks in the bark that accumulates at the base of infested plants. Systemic insecticides can be applied preventatively as a soil drench or directly injected into a tree or shrub for management of wood-boring beetle larvae but not wood-boring caterpillars. Avoid plant stress by implementing appropriate cultural practices such as watering, fertility, pruning, and mulching.

Beetles

Cottonwood borer (*Plectrodera scalator*) adults are 1 to 1¼ inches long, and have a shiny black and white body with checkered markings (Photo 75). The antennae are similar in length to the body and are black. Cottonwood borer attacks cottonwood, poplar, and willow. Larvae are located inside infested trees (Photo 76). Adults can be seen tunneling into the tree at the soil line. The life cycle requires 2 years to complete.

Smaller European elm bark beetle (*Scolytus multistriatus*) adults are ⅛ of an inch long and brown to black. A noticeable spine is present on the underside of the abdomen and the wing covers are rounded. Larvae, which are white, are located in the inner bark in feeding galleries. The beetle is one of the primary vectors of Dutch elm disease (*Ophiostoma* spp.). European elm bark beetle attacks American, Siberian, and Chinese elms.

Pine sawyer beetle (*Monochamus* spp.) adults are ½ to ¾ of an inch long with the antennae longer than the body. Adults are mottled gray and brown (Photo 77). Larvae are creamy white and 1¼ to 2 inches in length when full-grown. They are located inside infested trees feeding on the inner bark, cambium, and outer sapwood creating galleries that are filled with frass. The beetles are the vector of pine wilt disease, which is described in the disease section.

Walnut twig beetle (*Pityophthorus juglandis*) adults are approximately 1/16 of an inch long, and red-brown (Photo 78). Adults possess four to six concentric ridges on the upper surface of the shieldlike covering behind and over the head. The larvae, which are located inside infested trees feeding within the phloem, are white and C-shaped. The walnut twig beetle vectors the fungus associated

with thousand cankers (*Geosmithia morbida*), which can kill established black walnut trees. It should be noted, however, that the walnut twig beetle and the thousand cankers fungus have not been reported in Kansas.

Emerald ash borer (*Agrilus planipennis*) adults are approximately ½ of an inch long, metallic-green, and shaped like a bullet (Photo 79). The emerald ash borer creates ⅛ of an inch wide, D-shaped holes in the bark (Photo 80). The larvae, which are located just beneath the bark, are tapeworm-like with bell-shaped segments (Photo 81). There is a distinct protrusion on the end of the abdomen of mature larvae. Emerald ash borer attacks green, white, blue, and black ash trees.

Asian longhorned beetle (*Anoplophora glabripennis*) adults are 1 to 1½ inches long, and shiny black with white spots on the abdomen (Photo 82). The antennae, which contain alternating white and black bands, are as long as the body of females and twice the body length of males. These bands can help distinguish the Asian longhorned beetle from the cottonwood borer, which has solid black antennae. Larvae are stout, round, legless, and white to pale-yellow. Mature larvae are 1½ to 2 inches long. Asian longhorned beetle attacks maple, elm, birch, willow, and poplar. This beetle has not been detected in Kansas but is an important insect to be aware of due to its potential for damage.

Caterpillars

Ash/lilac borer (*Podosesia syringae*) adults, which are typically active in mid- to late April, are brown, clear-wing moths with a 1¼-inch wingspan (Photo 83). Females lay eggs on ash trees, and cream-colored larvae emerge that are about 1½ inches long when full-grown, with brown heads (Photo 84). Larvae cause plant damage by creating tunnels and feeding within the bark. Larvae may tunnel farther into the wood and feed within the sapwood and heartwood. Ash/lilac borer feeds near the base of plant stems, creating swollen areas or cracks at the base of plants and where major branches attach to the trunk. Evidence of larval feeding is the presence of light-colored sawdust below infested trees or shrubs. In addition, pupal cases may be visible protruding from trees (Photo 85). It is important to maintain plant health through proper watering, fertilization, pruning, and mulching. A contact insecticide may be applied to the bark in early spring to kill adults that emerge from trees or shrubs and larvae that emerge from eggs.

Plant galls

Many trees and shrubs are subject to attack by gall-forming organisms. Insects, mites, nematodes, bacteria, fungi, and viruses can cause galls. Gall-forming insects and mites include beetles, wasps, moths, midges, sawflies, thrips, scales, adelgids, aphids, psyllids, twig borers, and eriophyid mites. The primary trees and shrubs susceptible to gall-forming insects in Kansas are oak, poplar/cottonwood, and willow. Oaks, in particular, are susceptible to a wide variety of gall-forming insects.

A gall is an abnormal plant swelling caused by a gall-forming insect (or mite), which lives part of its life in the gall, feeding inside the gall on the surrounding content of plant cells. These plant cells are abundant in carbohydrates, protein, and fats. As an insect feeds, it injects growth-reducing chemicals causing plant cells to abandon their normal growth pattern. This results in the formation of enlarged cells that divide until an abundance of reorganized tissue envelops the insect. Galls may occur on any plant part including roots, stems (Photo 86), leaves (Photo 87), petioles, fruits, seeds, and terminal growth. Galls can be used to identify the insects or mites causing the galls based on shape and the plant species. Galls provide protection from environmental conditions (e.g., temperature, rainfall, and sunlight) and natural enemies (e.g., parasitoids and predators).

Gall abundance depends on availability of susceptible trees and shrubs. Many galls, in general, are formed on rapidly growing terminal growth or young trees. In some cases, tree growth rate may determine susceptibility, as faster-growing trees tend to be more susceptible to gall-forming insects than slower-growing trees. This may be due to the number of active growing points for colonization as faster-growing trees have more buds available.

Galls, in general, are not a problem as they do not cause a reduction in plant vigor and do not kill the plant. Galls are unsightly and may detract from the appearance of the plant. There is nothing that can be done to alleviate problems with galls other than using plants that are not susceptible to gall-forming insects or mites. The best way to manage galls is to prune them out, without destroying the aesthetic appearance of the plant. In most cases, especially for gall-forming wasps, pruning must be performed before adults emerge in early spring; however, this practice may not be practical for trees heavily infested with galls. The use of pesticides is not effective in managing gall-making insect or mite populations because the insects or mites are well protected.

There are several galls that occur in Kansas on an annual basis. Examples of some common galls include: hackberry nipple gall maker, ash flower gall, and oak vein pocket gall.

Hackberry nipple gall maker (*Pachypsylla celtidis-mamma*) adults, which are called psyllids or jumping plant lice, resemble miniature cicadas and are about 3⁄16 of an inch long. Adults emerge from leaf litter in spring, mate, and females lay eggs in newly emerging leaves. Nymphs emerge from eggs and feed on leaves, subsequently producing galls. Galls are about 3⁄16 of an inch wide and ¼ of an inch tall, and located on leaf undersides (Photo 87). Nymphs remain in the galls during summer with adults emerging in September. Adults overwinter in bark crevices.

Ash flower gall is caused by an eriophyid mite (*Eriophyes fraxiniflora*). Mites overwinter on ash trees near buds and feed on the male flowers when they active in the spring. Feeding causes proliferation of the bud tissue, which results in the formation of clusters of ½ to 1 inch wide, round green galls with roughened, irregular surfaces (Photo 117). Since only the male flowers are affected, the gall-forming mite does not affect tree health.

Oak vein pocket gall is caused by a gall-midge (*Macrodiplosis quercusoruca*). Galls are elongated, pocket-like swellings on the lateral veins and mid-rib of pin oak leaves (Photo 118). Adults are ⅛ of an inch long and resemble small mosquitoes. Female midges lay eggs in newly unfolded leaves. Small larvae or maggots emerge from eggs and migrate to the lateral mid-veins and begin feeding. After a few days, leaf tissue surrounds each larva. The full-grown larva is white and less than ⅛ of an inch long. Development is complete by mid-spring to early summer. Larvae eventually emerge from the gall, fall to the ground, and overwinter or enter diapause (a physiological state of arrested development) until next spring. There is one generation per year.

General pest management and plant health strategies

Appropriate cultural practices can promote overall tree and shrub health and help prevent disease epidemics and insect and mite pest outbreaks.

Use the right plant in the right place. Select species and varieties adapted to your location. Plants that are not adapted to a site's microclimate, soils, or other site factors are more susceptible to stress as well as diseases and insects. Conduct a thorough site evaluation before selecting plant materials, considering sunlight exposure, slope, soil type, soil pH, drainage, and other characteristics.

Purchase healthy plant material. Plant pathogens and insects may be introduced on contaminated plants or infested soil. Carefully inspect plants for any problems before purchasing and installing them at a site.

Provide proper watering. Too much or too little water can cause stress and increase susceptibility of trees and shrubs more prone to certain diseases and insects. Frequent overhead watering from sprinklers leads to prolonged periods of leaf wetness, which can promote many diseases. Soaker hoses or drip irrigation are less conducive to foliar diseases. Avoid saturating the root zone to prevent root health problems and root rot diseases. The soil should be moist but not overly wet. Waterlogged soils can lead to root damage, root diseases, and plant decline.

Provide proper fertility. Similar to watering, too much or too little fertilizer can predispose trees and shrubs to diseases and insects. Determine the appropriate fertilizer requirements, including considerations associated with the age of the tree or shrub. Submitting soil for a nutrient analysis may help identify particular fertility practices to implement.

Plant resistant cultivars when available. For some diseases, there are plant cultivars (varieties) that have natural resistance. These cultivars may still develop a low level of disease, but it will be much reduced compared to susceptible cultivars.

Remove and destroy infested plant refuse. Many plant pathogens survive on dead plant material. Removing plant debris reduces the amount of disease inoculum (pathogen spore and other survival and dispersal structures) for infection the following season.

Prune out infected branches. For some diseases, pruning out the affected plant parts can help reduce disease spread. In some cases, such as fire blight, pruning tools should be disinfected between cuts. Pruned branches should be removed from the site and, in some cases, destroyed (chipped, burned, or buried).

Control weeds. Weeds and grass compete with young or recently transplanted trees for nutrients and water. Keep the soil beneath the tree crown free of weeds and grass. Mulching to a 2- to 4-inch depth beneath the crown helps control weeds and benefit recently transplanted trees and shrubs. Avoid placing mulch directly in contact with the trunk.

Use pesticides judiciously. Most tree and shrub diseases and insect pest infestations do not require any pesticides. In some cases, pesticides may be appropriate, such as sites with chronic, destructive problems that reduce plant health year after year. Accurate identification of the problem, proper timing, and application method are critical for control. See the section below for more information on pesticide use.

Pesticide use for disease, insect, and mite management

Most tree and shrub diseases, as well as insect and mite pests, do not require any pesticide applications. Many diseases and insect and mite pests require no management at all because they do not reach damaging levels. If management is necessary, the cultural practices described throughout this guide should be initiated. For example, consider planting a resistant variety or a nonhost. If cultural practices do not reduce disease, insect, or mite pest populations to nondamaging levels, then the use of pesticides may be warranted. Fungicides, bactericides, insecticides, and miticides are applied to manage fungi, bacteria, insects, and mites, respectively. Pesticides should be applied following all label directions regarding uses, rates, timing, application equipment, personal protective equipment, and storage. Accurate diagnosis and knowledge of the biology and life cycle of the pest or disease is essential in selecting an appropriate pesticide to maximize efficacy and reduce effects on nontarget organisms.

Pesticides vary in their mode of action, or their ability to move in or on plant tissue, which is important when selecting a pesticide. Contact pesticides kill pests by direct contact. Therefore, thorough coverage is important as plant parts that are not covered and new tissues that emerge after application will not be protected.

Some pesticides are systemic, meaning they penetrate the plant tissue and are translocated within the plant. Some systemic pesticides move upward in the plant (acropetal movement), whereas others move both up (acropetal movement) and down (basipetal movement) in the plant. Locally systemic pesticides penetrate the plant only at the site of application, with little translocation within the plant. Some local systemics have translaminar properties, meaning they move from one leaf surface to another, which can be useful when thorough coverage is difficult to achieve. Keep this in mind with root diseases as these pesticides may need to be watered or drenched into the root zone to reach the area where the pathogen is active. Even with systemic pesticides, thorough coverage of all plant parts will increase efficacy.

Pesticides for disease management

With respect to disease management, there are several other factors to consider regarding the use of pesticides. Contact materials are effective only when used in a preventative manner. They must be applied before the pathogen arrives and penetrates (colonizes) the plant tissue. In contrast, systemic materials have a certain level of postinfection activity, meaning sometimes they can reduce pathogen growth even after the pathogen has begun to colonize the plant. However, even systemic products are most effective when used preventively or early in the disease development. The product labels will provide information on optimal timing of application.

There are several classes of systemic fungicides, each with a unique mode of action. That is, the different classes affect a specific physiological process in the cells of the target fungus, such as certain proteins involved in cell membrane production, cell division, or energy production (respiration). Contact materials tend to have multiple modes of action, meaning they affect numerous physiological processes in the cells of the target fungi. Details on these modes of action are beyond the scope of this publication, but other resources can be used to learn more about these concepts.

Pesticides for insect and mite pest management

Successful management of insect and mite pests with pesticides (in this case, insecticides and miticides) involves implementing appropriate procedures including proper coverage, timing of application, and frequency of application. There are two primary groups of pesticides associated with management of insect and mite pest populations: contact and systemic. Contact pesticides kill an insect or mite pest by direct contact or when an insect or mite pest walks or crawls over a treated surface. The active ingredient enters the feet and moves to the site of action. Systemic pesticides, which are primarily applied as a drench or granule to the soil, involve the active ingredient being taken up by the roots and then translocated or distributed throughout the plant into locations (e.g., leaves) where insects feed. Stomach poisons are another group of pesticides; the insect pest feeds on a treated surface and ingests the insecticide, which is then absorbed through the stomach lining. It is always recommended to read the pesticide label before making any application.

There are a number of pesticides that may be used to manage insect and mite populations with distinct modes of action. The mode of action is how a pesticide affects the metabolic or physiological processes of an insect or mite pest. Many pesticides have a site-specific mode of action that negatively influences some component of the central nervous system or disrupts the production of energy of the target pest. Other pesticides, including insecticidal soaps and horticultural oils, have a broad mode of activity and either desiccate or smother the target insect or mite pest.

Diagnosing problems

If a tree or shrub problem arises, it is critical to make an accurate diagnosis before taking action. An incorrect diagnosis may lead to incorrect management practices including inappropriate use of pesticides.

Some tree and shrub problems are relatively easy to identify; others, such as root diseases and vascular wilts, are much more difficult to diagnose without considerable experience. It is important to have as much information as possible about the plant and site before making a diagnosis. Some factors to consider include:

What is the species of the affected plant? Correct identification of the plant species is critical. Many diseases and pests are specific to certain plant hosts, so this information makes it possible to focus on problems most common on that species. It is also helpful to determine the cultivar/variety. If multiple species are affected, an abiotic problem may be more likely.

What is the overall condition of the site? Make observations on soil type, potential drainage problems, sun/shade exposure, watering practices, recent construction, and other site factors.

What has been the recent weather? Drought, excessive moisture, heat, cold, and wind can all affect tree and shrub health. Wet weather triggers some diseases, such as leaf spots, whereas hot, dry weather causes other problems.

What cultural practices have been conducted at the site? Determine the watering practice, fertilization, pruning, and other tree/shrub management practices that have been implemented. These factors play an important role in disease, insect, and mite pressure as well as abiotic stresses.

What is the distribution of the problem? Determine if the problem is uniform, clumped, or random. Determine if there are any physical structures or soil differences that may contribute to the problem. In general, diseases, insects, and mites tend to cause clumped and random patterns, whereas abiotic factors tend to cause uniform patterns of damage.

What part of the plant is affected? Often, diagnosis is based entirely on leaf symptoms when the primary symptom(s) and actual cause of the problem may be associated with the roots or trunk. Check the entire plant for any evidence of injury. Specifically, look for leaf spots, wilting, rotting roots, cankers, mechanical wounds, etc.

Once detailed information on the cultural conditions, pattern of the problem, and specific symptoms has been obtained, a diagnosis may be attempted. Compare the information gathered with photographs and descriptions of problems in extension bulletins, books, and websites. If the diagnosis is still uncertain, get assistance from your local K-State Research and Extension office. You may also contact the following laboratories at Kansas State University:

K-State Plant Disease Diagnostic Laboratory
4032 Throckmorton Plant Sciences Center
1712 Claflin Road
Manhattan, KS 66506
Phone: (785) 532-6176
email: clinic@ksu.edu
Website: *www.plantpath.k-state.edu/extension/plant-disease-diagnostic-lab/*

K-State Insect Digital Diagnostic Services
Website: *entomology.k-state.edu/outreach-and-services/diagnostician/*
email: *gotbugs@ksu.edu*

K-State Agronomy Soil Testing Laboratory
2308 Throckmorton Plant Sciences Center
1712 Claflin Road
Manhattan, KS 66506
Phone: (785) 532-7897
Website: *www.agronomy.k-state.edu/outreach-and-services/soil-testing-lab/*

K-State Herbarium (Plant/Weed Identification)
Herbarium Division of Biology — Ackert Hall
Kansas State University
Manhattan, KS 66506
Phone: (785) 532-6619
email: herbarium@ksu.edu
Website: *www.k-state.edu/herbarium/*

Supplemental resources

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Tree and shrub problems in Kansas

Tips on using this table: This table is arranged by host species (tree or shrub species) in alphabetical order by the common name. The information is meant to be a quick guide, or starting point for determining potential causes of tree and shrub problems, primarily in the ***landscape***. Other resources are available for more detailed information for nurseries or other production facilities — contact the K-State Plant Disease Diagnostic Lab or the authors of this publication for information.

Host	*Problems*	*Identification/Symptoms*	*Comments*
Almond flowering/ornamental – see Cherry			
Amelanchier – see Serviceberry			
Arborvitae *Thuja occidentalis* and *Thuja orientalis*	**Diseases**		
	Kabatina tip blight *Kabatina juniperi*	Upper 2 to 6 inches of branch tips turn red or yellow, usually in late winter/early spring (Photos 99a – 99b). Affected tips dry out and drop off in late spring/early summer. Primarily a cosmetic problem. Occasional.	Space plants appropriately to allow airflow; avoid wounding plants; avoid overhead watering that wets the foliage; prune out and remove/destroy affected branch tips.
	Seiridium canker *Seiridium cuppressi* (see Pages 2 and 9)	Branches and stems develop long, flat cankers, sometimes with bleeding. Entire trees, sections of trees, or individual branches may turn dull green then brown in late spring or early summer. Most severe on exposed sites.	Winter injury and other abiotic issues make trees more susceptible to the canker. Prune out cankered branches and destroy them. Provide adequate water.
	Insects and Mites		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial damage if not managed. Contact or stomach poison insecticides may be used to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.
	Spruce spider mite *Oligonychus ununguis* (see Page 15)	Adults are oval-shaped and approximately ⅑₀ of an inch long. Adults are black, tan, or red whereas nymphs are light gray to green. Feeding causes needles to become mottled in appearance, and then yellow and eventually bronze. Damaged needles may fall off prematurely. Heavy infestations may cause branch dieback.	A high-pressure water spray will remove all life stages (eggs, larvae, nymphs, and adults). Miticides may be applied; however, thorough coverage of all plant parts is important. A dormant oil spray applied in winter will kill overwintering eggs located on the bark and needles.

Host	Problems	Identification/Symptoms	Comments
Arborvitae, cont.	**Environmental, Cultural, and Other Problems**		
	Fall needle drop	Interior needles turn brown and drop in fall, especially in drought years. Natural physiological process.	Provide adequate water.
	Winter injury/ winter kill (see Page 2)	Branch dieback.	Can predispose plants to Seiridium canker (see above).
Arizona cypress *Cupressus arizonica*	**Diseases**		
	Seiridium canker *Seiridium cupressi* (see Page 9)	Branches and stems develop long, flat cankers, sometimes with bleeding. Entire trees, sections of trees, or individual branches may turn dull green then brown in late spring or early summer (Photo 120). Most severe on exposed sites.	Winter injury and other abiotic issues make trees more susceptible to the canker. See general discussion of cankers and winter injury in introduction. Prune out cankered branches and destroy them. Provide adequate water.
Ash *Fraxinus* spp.	**Diseases**		
	Anthracnose *Discula fraxinea* also called *Gnomoniella fraxini* (see Page 6)	Irregular, brown blotches or spots develop on leaves, commonly associated with leaf veins or margins. Premature leaf shedding. Twig and shoot blight phases may occur with minor twig shedding. Disease more prevalent in late spring/early summer during wet weather.	Rarely damaging, primarily cosmetic, no management needed.
	Ash leaf spot *Mycosphaerella fraxinicola* (see Page 6)	Brown leaf spots, usually ¼ to ½ of an inch in diameter, with yellow margins develop in late summer. Leaf spots coalesce and severely affected leaves drop prematurely. In wet years, disease may appear in early- to mid-summer (Photos 11a – 11b).	Rarely damaging, primarily cosmetic, no management needed. If a series of wet years occurs, with early symptoms and repeated early defoliation, tree health may be affected. Rake up and destroy affected leaves.
	Ash rust *Puccinia sparganioides* (see Page 7)	Bright orange raised bumps form on leaves, becoming twisted, distorted, or swollen (Photos 19a – 19b).	Rarely damaging, primarily cosmetic, no management necessary.
	Mycosphaerella leaf spot – see Ash leaf spot		

Host	Problems	Identification/Symptoms	Comments
Ash, cont.	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.
	Wood decay Heart rot *Perenniporia fraxinophila* and others (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted. (Photos 39 – 40, and 88).	Fungus enters through wounds and branch stubs, therefore prevent wounds to trees and prune properly. There is no control once the fungus has colonized the wood. Trees with indications of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.
	Insects and Mites		
	Ash flower gall *Eriophyes fraxiniflora* (eriophyid mite) (see Page 17)	Clusters of ½ to 1 inch, round, green galls that are roughened with irregular surfaces are present throughout the tree canopy. (Photo 117)	The galls are not harmful to ash trees.
	Ash/lilac borer *Podosesia syringae* (see Page 16)	Adults are brown, clearwing moths with a 1¼-inch wingspan. Larvae tunnel and feed within trees causing isolated branch dieback. Pupal cases may be noticed protruding from infested trees. Light-colored sawdust may be present at the base of infested trees (Photos 83 – 85).	Maintain plant health through proper watering, fertilization, pruning, and mulching. A contact insecticide can be applied to the bark in early spring to kill adults that emerge from trees and larvae that emerge from eggs laid by females.
	Eastern ash bark beetle *Hylesinus aculeatus*	Larvae feed under the bark creating tunnels that can cause isolated branch dieback. Adults emerge from branches and feed on green wood but cause minimal damage.	Maintain plant health by implementing cultural practices such as proper watering, fertilization, pruning, and mulching.

Host	Problems	Identification/Symptoms	Comments
Ash, cont.	Emerald ash borer *Agrilus planipennis* (see Page 16)	Adults are approximately ½ of an inch long, metallic-green, and shaped like a bullet. Larvae feed under the bark, causing branch dieback and bark splitting. Look for D-shaped holes in the bark (Photos 79 – 81).	Maintain plant health by implementing cultural practices such as proper watering, fertilization, pruning, and mulching. Contact your local K-State Research and Extension agent for current information on distribution and if insecticides should be applied.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
Azalea – see Rhododendron			
Bald cypress *Taxodium distichum*	**Insects and Mites**		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long whereas mature (older) caterpillars are 1 to 2 inches in length. Caterpillars create small bags or cases covered with material from the host plant (Photos 52 – 53). Feeding causes the browning of leaves.	Can cause substantial damage if not managed. Contact or stomach poison insecticides can be applied to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.
	European fruit lecanium scale *Parthenolecanium corni* (see Page 15)	Scales are ⅛ to ½ of an inch long. Females are hemispherical in shape and light to dark brown with mottling patterns on the body. Mature scales are hemispherical in shape, light to dark brown, and possess distinct molting patterns on the body (Photo 72). During feeding, scales produce honeydew, which is a sticky liquid that attracts ants.	Will not kill plants, but heavy infestations can reduce aesthetic appearance. Insecticides must be applied when nymphs (crawlers) are active, which is usually June and July. Thorough coverage of all plant parts is important to effectively manage nymphal populations.
	Environmental, Cultural, and Other Problems		
	Iron chlorosis (see Page 4)	Yellowing of foliage (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.

Host	Problems	Identification/Symptoms	Comments
Barberry *Berberis*	**Diseases**		
	Powdery mildew (see Page 7)	White, powdery fungal colonies develop on leaf surfaces (Photos 18a – 18b). More common on golden barberry, rare on red barberry. Leaf shedding can occur.	Rarely damaging, primarily cosmetic, no management necessary.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy condition (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Root decline (wet feet) (see Page 3)	Dieback, branch decline, dark colored roots.	Plant into well-drained soils.
Basswood – see Linden			
Birch *Betula* spp. **White birch** *Betula papyrifera* **River birch** *Betula nigra*	**Diseases**		
	Leaf spot various fungi including Septoria (see Page 6)	Small brown leaf spots. Leaf yellowing and shedding. Primarily occurs on river birch during wet summers.	Rarely damaging, primarily cosmetic, no management needed.
	Insects and Mites		
	Bronze birch borer *Agrilus anxius*	Adults are ⅜ to ½ of an inch long, elongated, and metallic-bronze. Larvae cause branch swelling and bleeding, followed by dieback. Infested trees typically have ridged or swollen bark where larvae have fed. Look for D-shaped holes in the bark. Primarily occurs on white birch.	Maintain plant health through proper watering, fertilization, pruning, and mulching. A contact insecticide may be applied to the bark in spring to kill adults that emerge from trees and larvae that emerge from eggs. A systemic insecticide can be applied to the soil in early spring as plants are leafing-out.

Host	Problems	Identification/Symptoms	Comments
Birch, cont.	Fall webworm *Hyphantria cunea* (see Page 12)	Adult moths are 2 inches long, with the forewings containing spots, and small red-orange markings at the base of the front legs. Caterpillars are yellow-green or brown with black spots. Mature caterpillars are 1 to 1½ inches long, with orange-yellow or black tubercles on the body. They have tufts of long, gray, silken hairs on the body. Caterpillars create nests on the ends of tree branches and feed within the nests (Photos 56 – 58).	Prune out localized nests and dispose of immediately. Use a rake to disrupt nests, which will allow birds to feed on the caterpillars.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture. White birch is not adapted to the Kansas climate and is prone to scorch and other environmental stresses.
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green. (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
Black locust *Robinia pseudoacacia*	**Diseases**		
	Wood decay Heart rot *Phellinus robiniae* and others (see Page 9)	The fungus causes a white rot of the heartwood leading to spongy yellow tissue. Large, brown to black bracket-shaped conks form on the bark (Photos 39 – 41, and 88). The disease is often associated with locust borer injury. Common in old trees.	Fungus enters through wounds and branch stubs, therefore prevent wounds to trees and prune properly. There is no control once the fungus has colonized the wood. Trees with indications of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.
Boxwood *Buxus*	**Diseases**		
	Boxwood blight *Calonectria pseudonaviculata* also called *Cylindrocladium buxicola*	Black and brown leaf spots and premature shedding. Black stem lesions followed by stem blighting. Favored by cool, wet conditions, such as cool, moist spring weather.	Not currently established on Kansas landscapes but could become introduced on infected nursery stock. Inspect all nursery stock. Do not plant suspect materials. Report potential cases of boxwood blight to K-State Plant Disease Diagnostic Laboratory.

Host	Problems	Identification/Symptoms	Comments
Boxwood, cont.	Macrophoma leaf blight *Hyponectria buxi*	Raised black pepper speck fruiting bodies on dead leaves. Occurs on plants weakened by stress.	Prune out dead stems. Provide overall good plant care
	Volutella blight *Pseudonectria buxi* also called *Volutella buxi*	Leaves and stems turn tan and die. Fungus produces peach colored cushions (sporodochia) on the undersides of leaves. Favored by cool/wet weather.	Prune out dead stems. Provide overall good plant care
	Insects and Mites		
	Boxwood leafminer *Monarthropalpus flavus*	Larvae are yellow-white to green and create mines or tunnels between the upper and lower parts of leaves, causing irregular blisters to form on leaf undersides. Adults are orange-yellow to red and resemble mosquitoes or gnats. Adults do not feed on plants.	Remove leaves infested with larvae. Insecticides should be applied when adults are present and when new growth emerges.
	Twospotted spider mite *Tetranychus urticae* (see page 15)	Adults are about 1/16 of an inch long, oval-shaped, and green-yellow to red-orange, and have two dark spots on both sides of the abdomen (Photo 73). The larvae and nymphs are pale-yellow to yellow-green. Twospotted spider mite feeds on leaf undersides causing leaves to appear light yellow (bleached) in color. Leaves may also be white or have yellow stippling (Photo 74). Heavily infested leaves may turn brown and fall off plants.	A high-pressure water spray applied to leaf undersides will dislodge all life stages (eggs, larvae, nymphs, and adults) of the twospotted spider mite. Miticides can be used; however, miticides must be applied frequently and all plant parts must be thoroughly covered, especially leaf undersides, with the spray solution.
	Environmental, Cultural, and Other Problems		
	Winter desiccation (see Page 2)	Browning of leaf margins during dry, windy weather.	Provide adequate water. Use mulch to help retain soil moisture.
	Winter injury/ winter kill (see Page 2)	Sections or whole plants die back due to low winter temperatures.	Common in Kansas. Prune out dead stems. Provide overall good plant care
Burning bush – see Euonymus			

Host	Problems	Identification/Symptoms	Comments
Catalpa	**Diseases**		
Catalpa spp.	Leaf spot various fungi (see Page 6)	Discrete spots or irregular white blotches develop on leaves. Usually late in season.	Rarely damaging, primarily cosmetic, no management needed.
	Powdery mildew (see page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.
	Insects and Mites		
	Catalpa sphinx *Ceratomia catalpae*	Caterpillars have a black "horn" that protrudes from the end of the abdomen. Caterpillars feed on leaves and can completely defoliate a tree.	Although the caterpillars can cause defoliation, management may not be warranted because mature trees can produce new leaves. However, contact insecticides can be used to manage extensive caterpillar infestations.
	Environmental, Cultural, and Other Problems		
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
Cedar – see Juniper			

Host	Problems	Identification/Symptoms	Comments
Cherry, peach, almond, plum **Flowering, ornamental** *Prunus* For trees grown for fruit production, contact your local extension office for information.	**Diseases**		
	Bacterial leaf spot *Xanthomonas arboricola* pv. *pruni* (see Page 6)	Small, dark leaf spots develop, eventually turning dry and falling out to produce a tattered, shothole pattern. Favored by wet conditions. Fruit spotting may also occur.	Rarely damaging, primarily cosmetic, no management needed.
	Black knot *Apiosporina morbosa* also called *Dibotryon morbosum*	Corky, swollen growths develop on twigs, branches, or trunks. Young knots are greenish and soft, old knots are hard and blackened (Photo 89). Affected limbs can die back.	Inspect trees each winter and prune out symptomatic branches 6 to 8 inches below the visible knot, and remove and discard or burn the wood.
	Brown rot *Monilinia fructicola*	The fungus causes blighted shoots and flowers. Fruit rot and develop a brown, fuzzy fungal growth then dry into "mummies."	Prune and destroy infected twigs. Remove mummy fruit from tree and the ground below tree.
	Canker *Cytospora* spp. (see Page 9)	Bark may be sunken, cracked, or discolored. Fungal fruiting structures may be present. Tissue under the affected bark is dead. Tree may produce abundant gummy resin (gummosis). Damage is commonly associated with winter injury.	Prune out affected limbs and remove or destroy the wood. Maintain overall plant health with proper pruning, fertilization, and watering.
	Cherry leaf spot *Blumeriella jaapii* (see Page 6)	Small, purple-brown spots develop on leaves (Photo 13b). Leaves may turn yellow and fall prematurely. Little impact on flowering trees. Most common in wet years.	Rarely damaging, primarily cosmetic, no management needed. If infection is severe, rake up and remove fallen infected leaves.
	Crown gall *Agrobacterium tumefaciens* (see Page 9)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Do not simply prune out galls. Do not replant with a susceptible host.
	Peach leaf curl *Taphrina deformans*	Leaves are curled, puckered, thickened, and distorted with a greenish or reddish color (Photo 90). Infected leaves fall off the tree.	If defoliation is severe, maintain overall tree vigor with appropriate watering and fertilization. Applying fungicides before spring bud swell can reduce disease.

Host	Problems	Identification/Symptoms	Comments
Cherry, peach, almond, plum cont.	Plum pocket *Taphrina communis*	Fruits become enlarged, hollow, and distorted.	Little damage to tree, no management needed.
	Insects and Mites		
	Eastern tent caterpillar *Malacosoma americanum* (see Page 12)	Full-grown caterpillars are approximately 2 inches or more in length, with a black head. The body is black with a white stripe extending down the back and a series of bright blue spots between yellow lines. Create nests in the crotches of twigs. Caterpillars feed on newly emerging leaves in spring (Photos 54 – 55).	Remove or disrupt nests in early spring, which will reduce the need to apply an insecticide.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Common on peach. Provide adequate water. Use mulches to help retain soil moisture.
	Sunscald Southwest winter injury (see Page 3)	Sunken, discolored cracked wood on the south or southwest side of the tree.	Common in Kansas. Prune affected sections back to healthy wood in the spring and provide adequate watering.
Cotoneaster *Cotoneaster*	**Diseases**		
	Fire blight *Erwinia amylovora*	Sudden browning and wilting of branch spurs (Photos 92a – 92b) or new shoot growth. Tips of blighted shoots curl, giving appearance of a "shepherd's crook" (Photo 91). Inner bark tissue turns water soaked with red-to-black discoloration. Cankers form on affected branches. Favored by wet spring weather at bloom.	Prune out affected branches at least 12 to 18 inches below visible damage. Sanitize tools between cuts. See further discussion of fire blight under crabapple.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.

Host	Problems	Identification/Symptoms	Comments
Cotoneaster, cont.	**Insects and Mites**		
	Lace bug *Corythucha cydoniae* (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
Cottonwood – see Poplar			
Crabapple *Malus* For trees grown for fruit production, contact your local extension office for information.	**Diseases**		
	Cankers *Botryosphaeria* spp. and other fungi (see Page 9)	Cankers develop on trees damaged or weakened from sunscald, drought, insect injury, or chronic leaf spot diseases with repeat defoliation (see rust and scab). Sunken or discolored bark tissue and branch dieback are common symptoms.	Prune out affected branches. Maintain overall plant health with proper pruning, fertilization, and watering.
	Cedar apple rust *Gymnosporangium juniperi-virginianae* (see Page 7)	Most common rust disease on crabapple. Yellow-orange spots develop on leaves (Photo 23a). Tube-like structures develop on leaf undersides (Photo 23b). Defoliation can occur. Occasional raised orange spotting on fruit.	Plant resistant varieties. Preventative fungicides may be useful in cases with chronic, severe defoliation.

Host	Problems	Identification/Symptoms	Comments
Crabapple, cont.	Fire blight *Erwinia amylovora*	Sudden browning and wilting of branch spurs (Photos 92a – 92b) or new shoot growth. Tips of blighted shoots curl, giving appearance of a "shepherd's crook" (Photo 91). Inner bark tissue turns water soaked with red-to-black discoloration. Cankers form on affected branches. Favored by wet spring weather at bloom.	Prune out affected branches, in winter if possible, at least 12 to 18 inches below visible damage. Disinfect pruning tools in 10 percent solution of household bleach or 70 percent alcohol between each cut. Oil pruning tools afterwards to prevent corrosion. Avoid over-fertilization. Avoid pruning in spring/summer especially in wet weather.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b). Leaves may be crinkled or deformed.	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Scab *Venturia inaequalis* (see Page 6)	Olive-green spots, which later turn brown, develop on upper and lower leaf surfaces in the spring (Photo 12). Fruit lesions are rough or scaly, and appear dark green when wet. Numerous leaf infections will cause yellowing and premature defoliation which results in a loss of tree vigor.	The best means of control is the use of resistant cultivars. The disease may be partially controlled on susceptible varieties by removing leaf debris in the fall. In cases of chronic, severe infection, spring fungicides may be beneficial to tree health.
	Wood decay *Xylaria* and others (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted. (Photos 39 – 40, and 88). *Xylaria* fruiting structures are finger-shaped, black, charcoal-like projections, which develop at the base of the tree.	Fungus enters wounds and branch stubs —prevent tree wounds and prune properly. There is no control once the fungus has colonized the wood. Trees with signs of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.
	Insects and Mites		
	Eastern tent caterpillar *Malacosoma americanum* (see Page 12)	Full-grown caterpillars are approximately 2 inches or more in length, with a black head. The body is black with a white stripe extending down the back and a series of bright blue spots between yellow lines. Create nests in the crotches of twigs. Caterpillars feed on newly emerging leaves in spring (Photos 54 – 55).	Remove or disrupt nests in early spring, which will reduce the need to apply an insecticide.

Host	Problems	Identification/Symptoms	Comments
Crabapple, cont.	Fall webworm *Hyphantria cunea* (see Page 12)	Adult moths are 2 inches long, with the forewings containing spots, and small red-orange markings at the base of the front legs. Caterpillars are yellow-green or brown with black spots. Mature caterpillars are 1 to 1½ inches long, with orange-yellow or black tubercles on the body. They have tufts of long, gray, silken hairs on the body. Caterpillars create nests on the ends of tree branches and feed within the nests (Photos 56 – 58).	Prune out localized nests and dispose of immediately. Use a rake to disrupt nests, which will allow birds to feed on the caterpillars.
	Japanese beetle *Popillia japonica* (see Page 12)	Adults are ⅜ to ½ of an inch long, metallic-green with coppery-brown wing covers. There are tufts of white hair on the end of the abdomen (Photo 48). Feeding by adults causes leaves to appear lace-like or skeletonized.	Removing adult beetles by hand may be effective for situations associated with small trees and low infestations. However, contact insecticides may be required to prevent damage to plants.
Dogwood *Cornus*	**Diseases**		
	Leaf spot *Septoria* spp. (see Page 6)	Small, angular, brown, gray, or purple lesions with whitish center. (Photo 13a). Usually appears in the mid- to late season. Red twig dogwood is most susceptible.	Management not necessary. Raking and removing fallen leaves may reduce disease somewhat in following year.
Douglas fir *Pseudotsuga menziesii*	**Environmental, Cultural, and Other Problems**		
	Environmental scorch (see Page 2)	Needles turn brown, starting at tips. Occurs during dry, windy weather in all seasons.	Provide adequate water. Use mulches to help retain soil moisture.
Elm *Ulmus*	**Diseases**		
	Anthracnose – see black spot		
	Bacterial wetwood several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photo 42).	Rarely damaging, primarily cosmetic, management not necessary.

Host	Problems	Identification/Symptoms	Comments
Elm, cont.	Black spot *Stegophora ulmea* also called elm anthracnose (see Page 6)	Symptoms generally appear in mid to late summer. On American elm, small, black irregular lesions or blotches form on the upper surface of the leaves.(Photo 93). On Siberian elm, leaf spots are gray. Heavily infected leaves turn yellow and drop from the tree. Petioles and new twigs can also be infected. Defoliation may be extensive during wet summers.	Rarely damaging, primarily cosmetic, no management needed.
	Cankers *Botryosphaeria, Nectria, Dothiorella* and others (see Page 9)	Common on Siberian and lace-bark elms following drought or winter injury. Dark, sunken lesions or depressions form on twigs and branches. Branch dieback and overall tree decline may occur.	Maintain overall plant health with proper pruning, fertilization, and watering. If cankers develop, prune out and remove or destroy affected wood.
	Dutch elm disease *Ophiostoma novo-ulmi* and *Ophiostoma ulmi* (see Page 8)	Yellowing, browning, and wilting of leaves, often on scattered branches causing "flagging" (Photo 29). Discoloration (brown streaking) may be visible in vascular tissue when cut branches are viewed in cross section or bark is removed (Photo 30). Entire tree may die in a few weeks or up to a year or more.	Remove and destroy infected trees, destroying root grafts with neighboring elms beforehand. If disease is detected early (less than 5 percent canopy symptoms), pruning affected branches may prevent spread within the tree. Wood should not be saved for firewood.
	Leaf curl *Taphrina ulmi*	Light-green blisters develop on the upper surface of leaves in early spring. Later, the lesions turn brown. Infection is restricted to the period when new leaves are emerging in the spring.	Rarely damaging, primarily cosmetic, no management needed.
	Sooty mold	Black moldy growth on the surface of leaves and succulent stems (Photo 28). The sooty mold fungi are not parasitic to the plant, they are saprophytes living on insect (ex: aphid, scale) honeydew.	Sooty mold does not cause serious injury and control of the fungus is not necessary; however, the presence of sooty mold can be an indication of heavy insect activity.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.

Host	Problems	Identification/Symptoms	Comments
Elm, cont.	Wood decay *Pleurotus ostreatus*, *Phellinus* spp., *Ganoderma* spp., and others (See Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted. (Photos 39 – 40, and 88).	Avoid wounding the base of the tree. No control is available once infection has occurred. Trees that are a structural risk should be removed.
	Insects and Mites		
	Elm leaf beetle *Pyrrhalta luteola* (see Page 11)	Adults are approximately ¼ of an inch long, yellow to dull-green, with a black stripe on each wing cover extending the length of the abdomen (Photo 46a). Feeding by adults causes shot holes between leaf veins whereas the larvae feed on the leaf undersides resulting in skeletonization of leaves (Photo 46b). Damaged leaves eventually turn brown and dry up.	Apply contact insecticides at the first appearance of adults and larvae, which may be found feeding simultaneously. Thorough coverage of the upper and under sides of leaves is important.
	European elm flea weevil *Orchestes alni*	Adults are approximately ⅛ of an inch long and red-brown with black markings (Photo 47a). Adults have a short, snout-shaped mouth. Larvae create serpentine or blotched mines within the main portions of the leaf and leaf tips. Adults create small pinhead sized holes ("shot holes") in leaves (Photo 47b).	European elm flea weevil adults and larvae will not kill an existing elm tree. If need be, apply a contact insecticide when adults are present.
	European elm scale *Gossyparia spuria* (see Page 14)	Adults are ¼ to ⅜ of an inch long, oval-shaped with a brown shell encircled by a white waxy substance. Can produce copious amounts of honeydew, a sticky liquid (Photo 70).	Prune out localized infestations of European elm scale. Contact insecticides or horticultural oils can be applied when nymphs (crawlers) are active during the season.
	Twig girdler *Oncideres cingulata*	Small branches or twigs that fall on the ground have a V-shaped groove from the outside inward and ragged center.	Collect and destroy fallen branches or twigs from September through May.
	Environmental, Cultural, and Other Problems		
	Squirrel damage (see Page 5)	Squirrels chew bark strips off causing branch dieback. Can be severe in occasional years.	No management.

Host	Problems	Identification/Symptoms	Comments
Euonymus *Euonymus*	**Diseases**		
	Crown gall *Agrobacterium tumefaciens* (see Page 9)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Pruning out galls is not effective. Do not replant with a susceptible host.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Insects and Mites		
	Euonymus scale *Unaspis euonymi* (see Page 14)	Adult females are ⅛ to ¼ of an inch long, with a dark brown covering, and are shaped like the shell of an oyster. Males are white and elongated. The upper surface of leaves may appear yellow or mottled. The underside of leaves may be covered with both white (male) and brown (female) scales (Photo 71).	Prune out heavily infested branches and dispose of immediately. Apply a contact insecticide or horticultural oil when nymphs (crawlers) are active during the season.
	Twospotted spider mite *Tetranychus urticae* (see Page 15)	Twospotted spider mite adults are about 1/16 of an inch long, oval-shaped, and green-yellow to red-orange, and have two dark spots on both sides of the abdomen (Photo 73). The larvae and nymphs are pale-yellow to yellow-green. Twospotted spider mites feed on leaf undersides causing leaves to appear light yellow (bleached) in color. Leaves may also be white or have yellow stippling (Photo 74). Heavily infested leaves may turn brown and fall off plants.	A high-pressure water spray applied to leaf undersides will dislodge all life stages (eggs, larvae, nymphs, and adults) of the twospotted spider mite. Miticides can be used; however, miticides must be applied frequently and all plant parts must be thoroughly covered, especially leaf undersides, with the spray solution.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions. Can occur in summer or winter (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.

Host	Problems	Identification/Symptoms	Comments
Euonymus, cont.	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
	Winter injury/ winter kill (see Page 2)	Branches die back, sometimes to the ground. In spring, new leaves may emerge but wilt rapidly and die due to damage to branches.	Prune out dead branches. Provide adequate water.
Firethorn – see Pyracantha			
Forsythia *Forsythia*	**Diseases**		
	Leaf spot various fungi (see Page 6)	Round, brown spots (lesions) develop on foliage.	Rarely damaging, primarily cosmetic, no management needed.
	Phomopsis twig gall associated with *Phomopsis*, but true causation not well understood	Small (1 to 2 inches in diameter), lumpy, rough, woody galls on aerial branches (Photo 94). Occasionally causes branch dieback.	Rarely damaging. Primarily cosmetic. Maintain overall plant vigor with proper watering, fertilization, etc. Avoid wounding plants. Prune out affected branches during dry weather at least 6 to 8 inches below gall.
	Insects and Mites		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial damage if not managed. Contact or stomach poison insecticides can be applied to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.
Goldenrain tree *Koelreuteria*	**Diseases**		
	Nectria canker *Nectria cinnabarina* (see Page 9)	Dieback on one or more branches. Dead branches are light tan and dotted with black to red fruiting structures of the fungus. Infection is associated with winter injury.	Maintain overall plant health with proper pruning, fertilization, and watering. Remove cankered branches in late winter.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering and fertilization. Do not replant a susceptible species into a site with history of Verticillium wilt.

Host	Problems	Identification/Symptoms	Comments
Hackberry *Celtis occidentalis*	**Diseases**		
	Twig blight *Botryosphaeria*	Dieback of small twigs and medium-sized branches. Associated with stress.	Minor damage, no management needed.
	Witches broom an interaction of powdery mildew, *Podosphaera phytoptophila,* and an eriophyid mite, *Aceria celtis*	Affected branches develop abnormal swelling and a proliferation of lateral shoots. Brooms most visible during winter. Bud scales may be loose. Mites and powdery mildew cleistothecia may be visible in dissected buds viewed under magnification.	Does not damage tree health. Cut off affected branches.
	Wood decay *Ganoderma*, *Phellinus*, and others (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. The disease causes decline and death of the tree. The fungus causes a white, spongy rot of the roots and root collar. In the advanced stages of Ganoderma root rot, the fungus produces amber to reddish-brown, hoof-shaped conks at the base of the tree (Photos 39 – 40, and 88).	Avoid mechanical wounds to the base of the tree. No control is available once infection has occurred. Trees that are a structural risk should be removed.
	Insects and Mites		
	Hackberry nipple gall maker *Pachypsylla celtidismamma* (see Page 17)	Galls, which are primarily present on leaf undersides, are approximately ¼ of an inch in diameter and ¼ of an inch high (Photo 87). The galls are evident on hackberry trees during summer and are created by a psyllid or jumping plant lice.	There is no management strategy for hackberry nipple gall maker. In addition, the galls do not affect plant health.
	Environmental, Cultural, and Other Problems		
	Hackberry decline	Pale foliage, thin crown, poor growth, overall tree decline. Thought to be caused by poor site conditions and stressful environmental conditions.	Promote overall tree health with appropriate water, fertilizer, pruning, etc.
	Island chlorosis	Blocky/angular bright yellow blotches that are bordered by veins (Photo 119). Thought to be caused by a virus, but cause is undetermined.	Not damaging, primarily cosmetic. No management needed.

Host	Problems	Identification/Symptoms	Comments
Hackberry, cont.	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green. (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
	Squirrel damage (see Page 5)	Squirrels chew bark strips off causing twig and branch dieback. Can be severe in occasional years.	No management needed.
Hawthorn *Crataegus*	**Diseases**		
	Fire blight *Erwinia amylovora*	Sudden browning and wilting of branch spurs (Photos 92a – 92b) or new shoot growth. Tips of blighted shoots curl, giving appearance of a "shepherd's crook" (Photo 91). Inner bark tissue turns water soaked with red-to-black discoloration. Cankers form on affected branches. Favored by wet spring weather at bloom.	Prune out affected branches at least 12 to 18 inches below visible damage. Sanitize tools between cuts. See further discussion of fire blight under crabapple.
	Leaf spot *Diplocarpon mespili* also called *Entomosporium mespili* (see Page 6)	Red to black angular spots develop on leaves. Leaves may turn yellow. Extensive leaf spotting will cause early defoliation. Succulent twigs can also become infected. Most common in wet, cool years.	Rarely damaging, primarily cosmetic, no management necessary. In sites with severe disease, rake and discard or destroy dead leaves each fall.
	Hawthorn rust *Gymnosporangium globosum* (see Page 7)	Yellow-orange spots develop on leaves (Photo 23a). Tube-like structures develop on leaf undersides (Photo 23b). Leaves may turn yellow and drop prematurely.	Plant resistant varieties. Preventative fungicides may be useful in cases with chronic, severe defoliation.
	Quince rust *Gymnosporangium clavipes* (see Page 7)	Small, pinkish-white tube-like structures protrude from fruit (Photo 27b). Orange powder-like spores may dislodge from tubes when touched. Swelling and distortion of thorns, petioles, and succulent stems and twigs (Photo 27a). Affected shoots and twigs eventually exhibit dieback.	See comments in table under crabapple.

Host	Problems	Identification/Symptoms	Comments
Hawthorn, cont.	**Insects and Mites**		
	Lace bug *Corythucha cydoniae* (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important.
Hickory and pecan *Carya* For further information on commercial pecan production, contact your local extension office.	**Diseases**		
	Crown gall *Agrobacterium tumefaciens* (see Page 9)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Do not simply prune out galls. Do not replant with a susceptible host.
	Leaf spot, anthracnose various fungi (see Page 6)	Round, brown spots (lesions) develop on foliage.	Rarely damaging, primarily cosmetic, no management needed.
	Pecan scab *Fusicladium effusum* also called *Cladisporium caryigenum* and *C. effusum*	The disease causes rough, green to black spots on leaves and nuts of pecan. The disease is occasional in Kansas.	Rarely damaging on landscape trees, no management needed.

Host	Problems	Identification/Symptoms	Comments
Hickory and pecan, cont.	**Insects and Mites**		
	Fall webworm *Hyphantria cunea* (see Page 12)	Adult moths are 2 inches long, with the forewings containing spots, and small red-orange markings at the base of the front legs. Caterpillars are yellow-green or brown with black spots. Mature caterpillars are 1 to 1½ inches long, with orange-yellow or black tubercles on the body. They have tufts of long, gray, silken hairs on the body. Caterpillars create nests on the ends of tree branches and feed within the nests (Photos 56 – 58).	Prune out localized nests and dispose of immediately. Use a rake to disrupt nests, which will allow birds to feed on the caterpillars.
	Walnut caterpillar *Datana integerrima*	Mature (older) caterpillars are black with white-gray hairs. Young caterpillars skeletonize individual leaves and older caterpillars consume the entire leaf. Extensive feeding can result in complete defoliation, which can cause severe injury or tree death.	Remove young caterpillars by hand. Contact or stomach poison insecticides can be applied when caterpillars are initially present. Once damage is noticeable, it is too late to apply an insecticide.
Holly *Ilex*	**Diseases**		
	Canker and twig dieback various fungi (see Page 9)	Lesions form on branches and cause dieback.	Prune out infected branches. Maintain shrub health with proper pruning, fertilization, and watering.
	Insects and Mites		
	Native holly leafminer *Phytomyza ilicicola*	Larvae are yellow and create serpentine and/or blotched mines in leaves. Leaves may fall prematurely during winter or early spring.	Remove leaves infested with larvae. Insecticides should be applied with new plant growth emerges.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Spine spot	Small, gray spots with purple halos are caused by spines on leaf edges puncturing adjacent leaves.	Primarily cosmetic, not damaging to plant, no management needed.

Host	Problems	Identification/Symptoms	Comments
Honeylocust *Gleditsia triacanthos*	**Diseases**		
	Canker *Nectria/ Thyronectria* (see Page 9)	Branch dieback, reduced foliage and premature defoliation. Sunken, dark-red cankers form in branch crotches or at pruning wounds (Photo 34). Young trees may die rapidly while mature trees may remain in a weakened state for many years. Common in trees stressed by drought or over-watering.	Maintain tree health with proper pruning, fertilization, and watering. Avoid mechanical wounds to the trunk. Prune out all cankered branches to 1 foot below visible damage. Some cultivars are more susceptible than others.
	Honeylocust knot Suspected to be caused by a bacterium and/or herbicide damage, but causation not fully understood.	Small, swollen galls at branch nodes. Shoot blighting may also occur.	In many cases this condition does not affect tree vigor, just causes unattractive knots. In cases with shoot blighting, affected branches can be pruned out. Sanitize tools between cuts using 70 percent alcohol or 10 percent bleach (dip tools in oil afterwards to prevent corrosion). Avoid planting nursery stock with symptoms.
	Leaf spot *Linospora gleditsiae* (see Page 6)	Numerous small black spots clustered in a group. Some leaf yellowing and shedding.	Rarely damaging, primarily cosmetic, no management needed.
	Wood decay Root rot *Ganoderma* spp. and others (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted. (Photos 39 – 40, and 88). *Ganoderma* produces reddish-brown conks (fruiting structures) on roots and the lower trunk.	Fungus enters through wounds, therefore prevent wounds to trees during planting and maintenance. There is no control once the fungus has colonized the wood. Trees with indications of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.
	Insects and Mites		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial damage if not managed. Contact or stomach poison insecticides may be used to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.

Host	Problems	Identification/Symptoms	Comments
Honeylocust, cont.	Mimosa webworm *Homadaula anisocentra*	Caterpillars are approximately ½ of an inch long when full-grown, green to dark brown, with white stripes extending the length of the body. Larvae, which are ½ of an inch long, and green in color, web leaves together on the ends of branches (Photo 95). Heavily infested trees appear brown or scorched.	Contact or stomach poison insecticides need to be applied when caterpillars are initially present. Once damage is noticeable, it is too late to apply an insecticide.
Honeysuckle *Lonicera* ***Note:*** Bush honeysuckles (Amur honeysuckle — *Lonicera maackii* and Bella honeysuckle — *Lonicera* × *bella*) are problematic invasive weeds and should not be planted.	**Diseases**		
	Leaf blight *Insolibasidium deformans*	This disease first appears on newly-developing leaves in the spring. Affected leaves turn tan then become dry and brittle. Leaves often twist or curl and drop prematurely. A white, powdery mass of the fungus forms on the lower surface of the leaf, in contrast to powdery mildew, which is primarily on the upper surface.	Rarely damaging. If disease occurs, rake and discard diseased leaves in the fall.
	Powdery mildew (see Page 7)	Leaf yellowing and minor leaf shedding. Most common in humid conditions. Unlike other powdery mildews, fungal growth is rarely visible on leaves.	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Insects and Mites		
	Honeysuckle witches-broom aphid *Hyadaphis tataricae* (see Page 13)	New growth is stunted with distinct clusters ("witches broom") on the ends of branches. Plants appear red-streaked, and leaves are curled and smaller than normal (Photo 96).	Use resistant varieties of honeysuckle. Systemic insecticides can be applied in spring when new leaves are expanding and before newly hatched aphids feeding. Once damage is noticeable, it is too late to start any type of control strategy.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.

Host	Problems	Identification/Symptoms	Comments
Horse chestnut	**Diseases**		
Aesculus	Leaf blotch *Phyllosticta paviae* also called *Guignardia aesculi* (see Page 6)	Large, brown, irregular blotches on leaves, sometimes limited by veins. Blotches often have a yellow border. Dark fruiting bodies may be visible. Affected leaves may become shriveled or distorted. Severe infections cause premature defoliation. Most common in wet weather.	Generally occurs late in summer. Rarely damaging. No management needed.
	Rust *Puccinia andropogonis*	Orange spots and pustules develop on foliage. Primarily in wet years.	Rarely damaging, primarily cosmetic. No management needed.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
Hydrangea	**Diseases**		
Hydrangea	Bacterial leaf spot *Xanthomonas campestris* (see Page 6)	Blocky, angular leaf spots, bordered by veins, are initially water-soaked then turn brown. Leaf spots may have yellow halo (Photo 97).	Rarely damaging, primarily cosmetic. Most common in very wet years. Avoid overhead watering. Improve airflow to promote drying. Avoid working on plants when they are wet. If practical, remove diseased leaves and discard.
	Botrytis bud blight/gray mold *Botrytis cinerea*	Petals develop spotting. Buds and flowers discolor and die rapidly. Gray, fuzzy fungal growth may be visible. The fungus primarily invades senescing, wounded, or overly succulent tissue.	Most common in humid spring conditions. Avoid overhead watering. Improve airflow to promote drying. Avoid excessive fertilization.
	Cercospora leaf spot *Cercospora* spp. (see Page 6)	Round, purplish-brown lesions develop on leaves.	Rarely damaging, primarily cosmetic. Most common in very wet years. Avoid overhead watering. Improve airflow to promote drying. Avoid working on plants when they are wet. If practical, remove diseased leaves and discard.

Host	Problems	Identification/Symptoms	Comments
Hydrangea, cont.	**Environmental, Cultural, and Other Problems**		
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green. (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
Juniper *Juniper* Upright forms include: **Eastern red cedar** *Juniperus virginiana* **Rocky Mountain Juniper** *Juniperus scopulorum* Shrub and groundcover junipers: Various *Juniperus* species	**Diseases**		
	Botryosphaeria canker *Botryosphaeria stevensii* (see Page 9)	Rocky Mountain juniper is highly susceptible, less common on eastern red cedar. Branch dieback and mortality (Photo 98). Branch cankers are elliptical, flattened and often covered with resin. Cankers are difficult to detect unless the outer bark is removed. Branch cankers are frequently at the lower part of the branch, near the trunk. Common in eastern Kansas. Favored by wet weather.	Prune out diseased branches. Remove tree if more than one-half of the crown is affected. Do not plant Rocky Mountain juniper in eastern Kansas. Do not replant Rocky Mountain juniper in plantings where the disease is present.
	Cedar-apple rust *Gymnosporangium juniperi-virginianae* (see Page 7)	Brown galls, ½ to 1 inch in diameter, develop on young shoots. In spring (usually April or May), gelatinous orange "horns" up to ¾ to 1 inch long, protrude from galls, producing spores (Photo 22). Galls survive 1 year.	Rarely damaging to juniper. No management needed.
	Cercospora needle blight *Pseudocercospora juniperi*	Lower, inner needles turn reddish-brown and drop in late summer or fall (Photo 102). If disease occurs for several years defoliation can become severe and kill plants. Most common in wet years. Potentially serious on Rocky Mountain juniper in eastern half of Kansas.	Select resistant varieties. Do not plant Rocky Mountain juniper in eastern Kansas. Space plants appropriately to allow airflow.
	Hawthorn rust *Gymnosporangium globosum* (see Page 7)	Brown galls, ¼ to ½ inch in diameter, develop on young shoots. In spring (usually April or May), gelatinous orange "horns" up to ¼ to ½ of an inch long, protrude from galls, producing spores (Photo 24). Galls survive several years.	Rarely damaging to juniper. No management needed.

Host	Problems	Identification/Symptoms	Comments
Juniper, cont.	Kabatina tip blight *Kabatina juniperi*	Infection period is in fall. Symptoms appear in spring, with upper 2 to 6 inches of branch tips turning red or yellow. Gray lesions develop at base of affected shoots. Affected tips dry out and drop off in late spring/early summer (Photos 99a – 99b).	Space plants appropriately to allow air flow; avoid wounding plants; avoid watering that wets the foliage; prune out affected branch tips. Symptoms disappear when affected tips fall off on their own.
	Phomopsis tip blight *Phomopsis juniperovora*	Extremely rare. Occurs occasionally in nursery production and sites with overhead watering. Upper 4 to 6 inches of branch tips turn brown then gray, usually from late spring through early fall. Affected tips dry out and drop off (Photo 100a). Fungal structures may be visible (Photo 100b).	Space plants appropriately to allow air flow; avoid wounding plants; avoid watering that wets the foliage; prune out affected branch tips. Symptoms disappear when affected tips fall off on their own.
	Quince rust *Gymnosporangium clavipes*	Swollen twigs and branches. Cushion-like gelatinous orange slime develops during wet spring weather (usually April or May), producing spores (Photo 25). Infections can produce spores for several years. Cushions become crusty when dry (Photo 26).	Affected branches may die back to healthy point. Overall, little damage to tree. No management needed.
	Root rot/root decline (see Pages 3 and 10)	Branch dieback, general decline. Most common in low-growing shrub junipers. Can be caused be wet soils. Infection by *Phytophthora* also occurs under wet conditions and causes similar symptoms.	Avoid planting in areas with poor drainage.
	Seiridium canker *Seiridium cupressi* (see Pages 2 and 9)	Branches and stems develop long, flat cankers, sometimes with bleeding. Entire trees, sections of trees, or individual branches may turn dull green then brown in late spring or early summer. Most severe on exposed sites. Not common on juniper.	Winter injury and other abiotic issues make trees more susceptible to the canker. Prune out and remove cankered branches. Provide adequate water.

Host	Problems	Identification/Symptoms	Comments
Juniper, cont.	**Insects and Mites**		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial damage if not dealt with. Contact or stomach poison insecticides may be used to deal with early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.
	Environmental, Cultural, and Other Problems		
	Bronzing due to male pollen cones Normal growth process	Small male cones develop in late winter/early spring which can give the tree a temporary bronze "off" color	No action needed. Part of normal tree growth.
	Drought stress (see Page 2)	Dieback in sections or entire tree due to prolongued dry conditions. Young plantings are at increased risk.	Provide adequate water. Prune out dead branches.
	Salt injury (see Page 5)	Browning of foliage, tip dieback (Photo 7).	Junipers along roads and sidewalks are sensitive to deicing salts.
	Winter desiccation (see Page 2)	Branches turn dull-green, then brown in March and April. Scorch. Foliage can also turn a dull green during winter months but does not die, leading to a temporary winter browning. Very common.	Provide adequate water.
	Winter injury/ winter kill (see Page 2)	Branch tip scorch and branch dieback. Very common.	Provide adequate water. Prune out dead twigs and branches.
Lilac *Syringa*	**Diseases**		
	Bacterial shoot blight *Pseudomonas syringae*	Affected leaves and shoots first appear water-soaked but quickly darken and shrivel as if scorched by fire. Succulent growth is more susceptible. Occasional in wet springs.	Prune out infected shoots 10 to 12 inches below visible symptoms and discard or destroy pruned materials. Disinfect pruning shears after each cut. Avoid pruning during wet weather. Some lilac cultivars have reduced susceptibility to bacterial shoot blight.

Host	Problems	Identification/Symptoms	Comments
Lilac, cont.	Leaf spot *Cercospora* and *Pseudocercospora* (see Page 6)	Small, brown blocky lesions can lead to whole leaf scorch and heavy defoliation. It is especially severe in wet years.	Multiple wet years can significantly weaken the planting. Improving airflow and avoiding overhead watering may reduce disease risk. Raking/removing diseased fallen leaves may reduce disease risk the following year.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photo 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Ramorum blight also called sudden oak death *Phytophthora ramorum* (see Page 10)	Large necrotic (brown) blotches on foliage. Shoot dieback. Blackening of leaf stems and succulent shoots. Defoliation. Most likely under wet conditions.	**Not known to occur in Kansas landscapes.** Could be introduced on nursery stock. Avoid purchasing and planting suspect material. Contact K-State Plant Disease Diagnostic Laboratory to report suspect plants.
	Insects and Mites		
	Ash/lilac borer *Podosesia syringae* (see Page 16)	Adults are brown, clearwing moths with a 1¼-inch wingspan. Larvae cause plant injury by tunneling and feeding within trees, resulting in isolated branch dieback. Pupal cases may be noticed protruding from infested trees. Light-colored sawdust may be present at the base of infested trees (Photos 83 – 85).	Maintain plant health through proper watering, fertilization, pruning, and mulching. A contact insecticide may be applied to the bark in early spring to kill adults that emerge from trees and larvae that emerge from eggs.
	Oystershell scale *Lepidosaphes ulmi*	Adult female covers are approximately ⅛ of an inch long, gray to brown, and shaped like the shell of an oyster. Branches or twigs can be completely encrusted with oystershell scales. Scale feeding can cause twig and branch dieback.	Prune out heavily infested branches or twigs. Contact insecticides may be used; however, applications are most effective when nymphs (crawlers) are present. Use double-sided sticky tape wrapped around branches to assess when nymphs are active.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.

Host	Problems	Identification/Symptoms	Comments
Linden	**Insects and Mites**		
Tilia	Japanese beetle *Popillia japonica* (see Page 12)	Adults are ⅜ to ½ of an inch long, metallic-green with coppery-brown wing covers. There are tufts of white hair on the end of the abdomen (Photo 48). Feeding by adults causes leaves to appear lace-like or skeletonized. Feeding damage starts at the top of trees.	Apply contact insecticides when adults are active. Multiple applications will be required.
	Lace bug *Corythucha cydoniae* (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions. Most common in late summer (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
London plane tree – see Sycamore			
Magnolia	**Environmental, Cultural, and Other Problems**		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Winter injury/ winter kill (see Page 2)	Low temperatures and/or fluctuating winter temperatures can result in partial or whole plant death.	Prune out dead limbs and provide adequate water.

Host	Problems	Identification/Symptoms	Comments
Maple *Acer*	**Diseases**		
	Anthracnose *Discula* and *Gloeosporium* spp. (see Page 6)	Reddish to black spots or blotches form on leaves in the spring, particularly during wet, cool weather. Typically, the spots are formed along the veins. Severe infection may cause premature leaf shedding.	Rarely damaging, primarily cosmetic, no management needed.
	Bacterial wetwood Several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photo 42).	Rarely damaging, primarily cosmetic, management not necessary.
	Leaf blister *Taphrina* spp.	Light-green blisters develop on the leaves. The blisters eventually turn brown. Hard maples are more susceptible.	Rarely damaging, primarily cosmetic, no management needed.
	Leaf spot Tar spot *Rhytisma acerinum* Purple Eyespot *Phyllosticta* spp. (see Page 6)	Tar spot (Photo 103) occurs during warm, wet summer weather. Purple eye spot occurs in fall during cool, wet weather.	Rarely damaging, primarily cosmetic, no management needed.
	Wood decay Root rot *Armillaria mellea, Ganoderma lucidum,* and others (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted (Photos 39 – 41, and 88).	Fungus enters through wounds and branch stubs, therefore prevent wounds to trees and prune properly. There is no control once the fungus has colonized the wood. Trees with indications of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.

Host	Problems	Identification/Symptoms	Comments
Maple, cont.	**Insects and Mites**		
	Woolly alder aphid *Prociphilus tessellatus*	Aphids form large colonies on leaf undersides and are covered with a white, fluffy wax. Aphids feed on plant fluids causing leaves to curl inward. During feeding, aphids produce honeydew, a clear sticky liquid that attracts ants.	A high-pressure water spray applied to leaf undersides will dislodge aphids from plants. Insecticides may not be effective in managing aphids because the curled leaves provide protection from exposure to insecticide sprays.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
	Sunscald Southwest winter injury (see Page 3)	Sunken, discolored cracked wood on the south or southwest side of the tree.	Prune out dead limbs and provide adequate water.
	Winter injury/ winter kill (see Page 2)	Branch tip scorch and branch dieback. Low winter temperatures may result in sections of the tree that fail to leaf out in the spring or a whole tree die back. Sprouts may develop at the base of the dead tree.	Prune out dead limbs and provide adequate water.
Mulberry *Morus rubra*	**Diseases**		
	Bacterial wetwood several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photo 42).	Rarely damaging, primarily cosmetic, management not necessary.
	Leaf spot *Cercospora* spp. (see Page 6)	Reddish brown spots on leaves. Occurs during wet weather.	Rarely damaging, primarily cosmetic, no management needed.

Host	Problems	Identification/Symptoms	Comments
Mulberry, cont.	Popcorn disease *Ciboria carunculoides*	The fruit is replaced by hard fungal structures resembling popcorn seeds.	This disease does not cause permanent damage and control is not necessary.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Environmental, Cultural, and Other Problems		
	Twig dieback Various fungi, including *Botryosphaeria* (see Page 9)	This canker problem is associated with weak pathogens attacking freeze-damaged twigs.	Keep trees vigorous by proper fertilization and watering. Prune out dead twigs in late winter or early spring.
Oak *Quercus*	**Diseases**		
	Anthracnose *Apiognomonia errabunda* (see Page 6)	Irregular brown dead areas on the leaves along the veins. Affected leaves appear scorched starting from the tip. Defoliation may be light to heavy and some twig dieback may occur. The disease is favored by wet, cool spring weather. Anthracnose is most serious on white oaks (Photos 107 – 108).	Rarely damaging, primarily cosmetic, no management needed.
	Bacterial wetwood several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photo 42).	Rarely damaging, primarily cosmetic, management not necessary.
	Botryosphaeria canker *Botryosphaeria quercuum* (see Page 9)	Shoot die back on red oak trees. Black fruiting bodies may be present.	Botryosphaeria is found under stress conditions and is frequently associated with drought stress or scale damage.

Host	Problems	Identification/Symptoms	Comments
Oak, cont.	Bur oak blight *Tubakia iowensis*	Affects bur oaks. Necrosis develops along veins. Leaves may develop a scorched appearance starting from the tip. Black fruiting structures may be visible on petioles. Infected trees retain some infected leaves and petioles (Photo 104b).	Can be damaging on bur oaks mid-to-late season in very wet years, causing tree decline if tree is affected over multiple years. Promoting overall tree vigor may reduce stress. Can look similar to anthracnose but occurs later in the season.
	Endothia canker *Endothia gyrosa* (see Page 9)	Sunken areas in bark on trunks or branches. Orange, red, or brown fungal fruiting structures may be present (Photo 35). Branch dieback/decline. Associated with stress.	Maintain overall plant health with proper pruning, fertilization, and watering. Prune out cankered or dead limbs.
	Hypoxylon canker/ Biscogniauxia canker *Hypoxylon/ Biscogniauxia* (see Page 9)	The fungus colonizes weakened, declining trees, especially in drought years. Early decline symptoms include yellowing and wilting of leaves on upper branches. Branch dieback occurs and eventually outer bark is sloughed off. When the bark is gone, a crust of fungal material (stroma) is exposed. The color of this mass changes from brown to silver to black (Photo 36).	Maintain overall plant health with proper pruning, fertilization and watering. There is no control for this disease once it becomes established in the tree. Remove dead tree to the ground, leaving no stump, and burn the wood immediately.
	Leaf blister *Taphrina caerulescens*	The disease first appears as light green blisters on the leaves. Blisters may enlarge and affected leaf tissue turns brown. Leaf blister only occurs during wet, cool springs.	Rarely damaging, primarily cosmetic, no management needed. Most common in wet years.

Host	Problems	Identification/Symptoms	Comments
Oak, cont.	Oak wilt *Bretziella fagacearum* also called *Ceratocystis fagacearum*	Red oak group much more susceptible than white oak group. Early symptoms are wilting leaves on individual branches in the upper portion of the tree in late May or June. Individual leaves bronze from the margins inward and the tip downwards to the petiole Half leaf scorch is common. Wilting progresses down the tree. If the bark on affected branches is pulled back, brown streaks are evident in the sapwood. Branch samples containing streaks should be submitted to the diagnostic lab for confirmation of the disease. Infected trees die in 1 to 2 years (Photos 105 – 106).	Currently occurs in eastern quarter to third of Kansas. Prune when trees are dormant. Avoid pruning from March through July. Diseased trees should be removed and destroyed, but root grafts should be disrupted first to prevent spread. Wood should not be saved for firewood.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b). Particularly common on English oak.	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Sooty mold fungi	Black moldy growth on the leaf surface (Photo 28). The fungi growing on the leaves are not parasitic to the plant, they are saprophytes living on insect (ex: aphid, scale) honeydew.	Sooty mold does not cause serious injury and control of the fungus is not necessary; however, the presence of sooty mold can be an indication of heavy insect activity.
	Tubakia leaf spot *Tubakia/Actinopelte* (see Page 6)	Small dark spots on leaves between the veins. Some spots may have a light brown center. Spots may also coalesce and form large irregular patches (Photo 104a). Pin oak is more susceptible than other oaks.	Rarely damaging, primarily cosmetic, no management needed. Most common in wet years.
	Wood decay Root rot Various fungi *Armillaria mellea* (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted. (Photos 39 – 41, and 88). *Armillaria* produces black fungal shoestring-like growth (rhizomorphs). In the fall yellow to tan (orange) mushrooms are seen at the base of the tree.	Fungus enters through wounds and branch stubs, therefore prevent wounds to trees and prune properly. There is no control once the fungus has colonized the wood. Do not replant in sites where *Armillaria* was present. Trees with indications of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.

Host	Problems	Identification/Symptoms	Comments
	Insects and Mites		
Oak, cont.	Galls Various species (see Pages 16 – 17)	Several insect and mite species cause galls on oak leaves and twigs. Oak bullet gall causes spherical growths on twigs (Photo 86). Oak vein pocket gall causes elongated swelling on lateral veins and mid-ribs of leaves (Photo 118).	Rarely damages plants, primarily aesthetic. No management strategy is needed.
	European fruit lecanium scale *Parthenolecanium corni* (see Page 15)	Mature scales are hemispherical in shape, light to dark brown (Photo 72) with distinct mottling patterns on the body. Scale nymphs (crawlers) and adults feed on leaves and branches. Extensive infestations can cause branch dieback. Produce honeydew, which is a clear sticky liquid that attracts ants.	In general, will not kill plants but extensive infestations may reduce aesthetic appearance. Prune out heavily infested branches or twigs. Contact insecticides must be applied when nymphs (crawlers) are active.
	Oak kermes scale *Kermes pubescens* (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Scales are usually present on the ends of branches at the base of small twigs, causing branch dieback. Scales resemble oak galls and produce honeydew, a sticky liquid that attracts ants (Photo 69).	In general, will not kill plants but heavy infestations may reduce aesthetic appearance. Prune out heavily infested branches or twigs. Insecticides may be used but must be applied when nymphs (crawlers) are active.
	Oak lace bug *Corythucha arcuata* (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important.
	Oak twig girdler *Oncideres cingulata* (longhorned beetle)	Small branches or twigs that fall on the ground have a V-shaped groove from the outside inward and ragged center. There is a smooth cut near the bark.	Collect and destroy fallen branches or twigs from September through May.

Host	Problems	Identification/Symptoms	Comments
Oak, cont.	Obscure scale *Melanaspis obscura* (see Page 14)	Female adults are approximately ⅛ of an inch long and dull gray to black. They blend in with the bark of host trees such as oaks (Photo 67). Heavy infestations may encrust the entire trunk and branches of plants. Leaves may appear yellow in color.	Contact insecticides must be applied when nymphs (crawlers) are active. Maintain proper plant health by providing adequate watering and mulch around the base of plants. Remove scales from the trunk by scraping with a brush.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5). Pin oak is particularly susceptible.	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
	Winter injury/ winter kill (see Page 2)	Twig and branch dieback. Can predispose trees to Nectria canker (see above).	Prune out dead limbs and provide adequate watering.
Osage orange	**Environmental, Cultural, and Other Problems**		
	Early fall freeze	Significant limb dieback. Large sections of the tree fail to green up in the spring.	Damage occurs when low temperatures occur before fall dormancy. Prune out dead limbs.
Peach, flowering/ornamental – see Cherry			
Pear flowering/ ornamental, including Bradford and Callery pear For trees grown for fruit production, contact your local extension office for information.	**Diseases**		
	Bacterial shoot blights Fire blight *Erwinia amylovora* Pseudomonas blight *Pseudomonas syringae*	Infection begins at flowering. Blighting of new leaves and shoots during wet weather in May and June; affected leaves turn black at the margins or along the veins, then entire leaves turn black (Photos 91 – 92). A shepherd's crook is characteristic for fire blight. Botryosphaeria canker often develops subsequently.	Prune out diseased shoots during hot, dry periods, cutting at least 6 to 8 inches below visible blighting. Avoid excessive fertilization.

Host	Problems	Identification/Symptoms	Comments
Pear, cont. Ornamental pear species may be considered problematic invasive weeds.	Rust *Gymnosporangium* (see Page 7)	Yellow-orange spots develop on leaves (Photo 22). Tube-like structures develop on leaf undersides and on fruits of ornamental pear varieties (Photo 23b). Defoliation can occur in severe cases.	Plant resistant varieties. Preventative fungicides may be useful in cases with chronic, severe defoliation.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b). Can be confused with bacterial shoot blights, which occur during wet spring weather.	Provide adequate water. Use mulches to help retain soil moisture.
Pecan – see Hickory			
Photinia	**Diseases**		
	Leaf spot *Diplocarpon mespili* also called *Entomosporium mespili* (see Page 6)	Symptoms start as small red dots, developing into ¼-inch leaf spots with purplish borders. Black dots (fruiting structures) maybe be visible. Severe infections can lead to defoliation.	Rarely damaging, management not needed. Disease most susceptible in succulent tissue so avoid summer pruning and excessive fertility.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Insects and Mites		
	Lace bug *Corythucha* spp. (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important.

Host	Problems	Identification/Symptoms	Comments
Photinia, cont.	**Environmental, Cultural, and Other Problems**		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
Pieris	**Diseases**		
	Ramorum blight also called sudden oak death *Phytophthora ramorum* (see Page 10)	Large necrotic (brown) blotches on foliage. Shoot dieback. Blackening of leaf stems and succulent shoots. Defoliation. Most likely to occur in wet spring conditions.	**Not known to occur in Kansas landscapes.** Could be introduced on nursery stock. Avoid purchasing and planting suspect material. Contact K-State Plant Disease Diagnostic Laboratory to report suspect plants.
Pine *Pinus*	**Diseases**		
	Brown spot *Lecanosticta acicola* also called *Mycosphaerella dearnessii*	Infection occurs primarily in wet weather in spring and early summer. Needle spotting and partial needle scorch in summer. Needle browning and needle drop in fall/winter. Most prevalent on lower, interior foliage. Most common on Scots pine, especially when grown in Christmas tree plantations. Also can occur on ponderosa pine.	Promote good air circulation with adequate tree spacing, pruning, and weed management around trees in plantations. In cases of severe, chronic disease, spring fungicides may be beneficial. Contact your local extension office for information.
	Dothistroma needle blight/ needle cast *Dothistroma septosporum*	Scattered yellow or tan spots appear on interior needles in late summer or early fall. Spots often enlarge into red bands that encircle the needles. Needles then turn yellow from the band to the tip. Black fruiting bodies are formed in the band during late winter or early spring and summer (Photo 15a). Extensive needle drop in interior needles, leaving only the current season's growth (Photos 110a – 110b). Chronic disease in successive years can leave the interior lower third of the tree bare of needles. Needle blight is a serious disease on Austrian and ponderosa pine. Mugo pine is also susceptible but Scots pine is considered resistant.	Most common in crowded plantings. Provide adequate spacing for improved airflow. Raking up fallen diseased needles may reduce disease pressure. Spring fungicides may beneficial in sites with chronic, severe disease. Contact your local extension office for information.

Host	Problems	Identification/Symptoms	Comments
Pine, cont.	Pine wilt Pinewood nematode *Bursaphelenchus xylophilus* (see Pages 8 – 9)	Foliage turns gray-green then brown with individual branches dying back Affected trees usually die within a few months (Photo 33). Infection often occurs in early summer with symptoms and tree death appearing in late summer to early fall.	Nematode is spread to new trees by the pine sawyer beetle. Remove and destroy infected trees by chipping or burning by April 1 of the following year to prevent further spread by sawyer beetle adults. Injections may reduce disease risk if used preventively. Contact your local extension office for information.
	Tip blight *Diplodia sapinea* also called *Sphaeropsis sapinea*	Infections occur during rainy spring weather. Symptoms first appear in late May or early June. New candles (shoots) fail to elongate and turn yellow or tan (Photo 109a). Small droplets of resin often form on stunted needles. Needles normally remain attached to the branch. In late summer, small black fruiting bodies develop at the base of infected needles and on cone scales (Photo 109b). Austrian, ponderosa, Scots and Mugo pine are all susceptible. The fungus can also develop a canker infection in older wood, especially in wounded or drought-stressed trees. Cankers on the branches or trunk produce abundant resin.	Maintain overall plant health with appropriate watering, fertilizing, etc. Promote airflow with appropriate tree spacing. If disease becomes established in a tree, spring fungicide applications starting at candle elongation may reduce disease. May need to be applied for several years in a row.
	Insects and Mites		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial damage if not dealt with. Contact or stomach poison insecticides may be used to deal with early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.

Host	Problems	Identification/Symptoms	Comments
Pine, cont.	European pine sawfly *Neodiprion sertifer* (see Page 13)	Full-grown larvae are ¾ to 1 inch long, gray-green with a black head. A light-colored stripe extends down the back and two light-green stripes and one dark-green or black stripe is located on each side of the body (Photo 60). Larvae feed in groups on previous year's needles before new growth expands. The larvae consume the needles on a branch causing the needles to become brown.	Contact insecticides may be used as soon as larvae are present in early spring. Larvae can also be removed by hand and placed into a container of soapy water.
	Nantucket pine tip moth *Rhyacionia frustrana*	Adult moths have orange markings on the forewings (Photo 111a). Young caterpillars are approximately 1/16 of an inch long, cream-colored with a black head. Older caterpillars are about ⅜ of an inch long and yellow to orange (Photo 111b). The larval or caterpillar stages, which are orange, mine the shoots and buds of young pine trees. The terminal growth or tips may be deformed, distorted, or killed outright.	Insecticides should be applied in the spring; however, thorough coverage of all plant parts is important, especially the terminal growth of pine trees.
	Pine needle scale *Chionaspis pinifoliae* (see Page 14)	Adult females are 1/16 to ⅛ of an inch long, elongated, and white with a yellow portion attached that tapers to one end. Can completely cover needles causing chlorosis and premature needle drop. In addition, heavy infestations can reduce the aesthetic appearance of plants.	Contact insecticides should be applied as soon as nymphs (crawlers) are active. Thorough coverage of all plant parts, including leaves and stems, and leaf undersides is important.
	Pine tortoise scale *Toumeyella parvicornis* (see Page 14)	Adults are ⅛ to ¼ of an inch in diameter and hemispherical in shape. Females are red to light brown, with dark-brown to black markings. Males are flattened, smaller than the females, and white. Nymphs (crawlers) are red (Photo 68). During feeding, scales produce honeydew, which is a sticky clear liquid that attracts ants.	Insecticides must be applied when the nymphs (crawlers) are active, which is from mid-June through early July. Thorough coverage of all plant parts is important, especially the interior canopy and lower branches of pine trees.

Host	Problems	Identification/Symptoms	Comments
Pine, cont.	**Environmental, Cultural, and Other Problems**		
	Drought stress (see Page 2)	Tree decline and branch dieback. Most common in Scots and white pine.	Easily confused with pine wilt.
	Environmental scorch Needle scorch (see Page 2)	Needles die from the tip back while the base remains green (Photo 2). Occurs during periods of dry, windy weather in both summer (hot temperatures) and winter (cold temperatures).	Provide adequate water.
	Iron chlorosis (see Page 4)	Yellowing of needles. Primarily on eastern white pine.	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
	Natural needle drop	Two- to four-year needles on the inside of the tree turn yellow, then brown, and drop off in the fall (Photo 101). Needle shed is more prevalent with stress caused by heat and drought.	This phenomenon is a natural occurrence in pines.
	Wet soil (see Page 3)	General tree decline, branch dieback.	Avoid planting pines in wet sites.
	Winter injury/ winter kill (see Page 2)	Damage can occur on outer portion of the branch, whole branches and occasionally the tree tops.	Buds may still be viable so wait until late May to assess recovery potential.
Plane tree – see Sycamore			
Plum, flowering/ornamental — see Cherry			
Poplar *Populus* and related trees including: **Eastern cottonwood** *Populus deltoides* **Willows** *Salix*	**Diseases**		
	Bacterial wetwood and slime flux several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photos 42 – 43).	Rarely damaging, primarily cosmetic, management not necessary.

Host	Problems	Identification/Symptoms	Comments
Poplar, cont.	Canker *Leucostoma, Valsa, Cytospora* (see Page 9)	Brown sunken cankers on twigs and branches. Cankers may enlarge and girdle the branch. Fungal spores ooze out of pycnidia (fungal fruiting structures) in red, threadlike masses. Most common in trees with stress or injuries. Frequently follow ice storms or freeze damage.	Maintain overall plant health with proper pruning, fertilization and watering. If cankers develop, prune out and remove or destroy affected wood.
	Crown gall *Agrobacterium tumefaciens* (see Page 9)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Do not simply prune out galls. Do not replant with a susceptible host.
	Leaf spot *Marssonina, Septoria,* and others (see Page 6)	Small dark spots on leaves. Septoria spots often develop a gray center. These leaf spots occur during wet summer weather and generally do not cause serious damage. Minor leaf shedding may occur.	Rarely damaging, primarily cosmetic, management not needed.
	Rust *Melampsora* spp. (see Pages 6 – 7)	Yellow-orange powdery spots on the underside of leaves develop from June through September. Occurs primarily during wet summers. Minor leaf shedding may occur.	Rarely damaging, primarily cosmetic, management not needed.
	Insects and Mites		
	Cottonwood borer *Plectrodera scalator* (see Page 15)	Adults are 1 to 1¼ inches long, shiny black and white, with checkered markings on the body. Larvae damage the root crown and buttress roots, resulting in the girdling of plants. Adults feed on the bark and leaf petioles. Heavy infestations of adults may result in defoliation of plants (Photos 75 – 76).	Maintain proper plant health by providing adequate watering and mulch around the base of plants. Prune out infested branches. Look for round-shaped exit holes in the bark.
	Environmental, Cultural, and Other Problems		
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.

Host	Problems	Identification/Symptoms	Comments
Privet *Ligustrum*	**Diseases**		
	Anthracnose and twig blight *Colletotrichum gleosporioides* and *Glomerella cingulata* (see Page 6)	Leaf spots on foliage. Cankers develop on twigs causing dieback. The bark and wood of diseased areas turn brown. Pink fungal fruiting structures form in the dead bark.	Prune and remove infected twigs.
	Leaf spot *Cercospora* and others (see Page 6)	Leaves develop small, circular spots. Severe leaf spotting may cause premature defoliation.	Rarely damaging, primarily cosmetic, no management needed.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
Pyracantha (firethorn) *Pyracantha*	**Diseases**		
	Fire blight *Erwinia amylovora*	Sudden browning and wilting of branch spurs (Photos 92a – 92b) or new shoot growth. Tips of blighted shoots curl, giving appearance of a "shepherd's crook" (Photo 91). Inner bark tissue turns water soaked with red-to-black discoloration. Cankers form on affected branches. Favored by wet spring weather at bloom.	Prune out affected branches at least 12 to 18 inches below visible damage. Sanitize tools between cuts. See further discussion of fire blight under crabapple.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.

Host	Problems	Identification/Symptoms	Comments
Quince flowering/ ornamental *Cydonia*	**Diseases**		
	Crown gall *Agrobacterium tumefaciens* (see Page 8)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Do not simply prune out galls. Do not replant with a susceptible host.
	Fire blight *Erwinia amylovora*	Sudden browning and wilting of branch spurs (Photos 92a – 92b) or new shoot growth. Tips of blighted shoots curl, giving appearance of a "shepherd's crook" (Photo 91). Inner bark tissue turns water soaked with red-to-black discoloration. Cankers form on affected branches. Favored by wet spring weather at bloom.	Prune out affected branches at least 12 to 18 inches below visible damage. Sanitize tools between cuts. See further discussion of fire blight under crabapple.
	Leaf spot various fungi including *Cercospora* (see Page 6)	Small round brown spots develop on foliage. Leaf yellowing and shedding. Favored by wet conditions.	Rarely damaging, primarily cosmetic, no management needed.
	Insects and Mites		
	Lace bug *Corythucha* spp. (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important.

Host	Problems	Identification/Symptoms	Comments
Redbud *Cercis canadensis*	**Diseases**		
	Leaf spot *Cercospora* and others (see Page 6)	Small reddish brown leaf spots with irregular margins. Occurs during wet years, primarily late in the growing season.	Rarely damaging, primarily cosmetic, no management needed.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.
	Wood decay Various fungi (see Page 9)	Decayed, rotted wood (crumbly, spongy, discolored). Mushrooms or conks may be present. Symptoms of decay may not be visible until extensive structural damage to the tree has resulted. Bracket-shaped conks or mushrooms indicate the presence of decay (Photos 39 – 40, and 88).	Fungus enters wounds and branch stubs —prevent tree wounds and prune properly. There is no control once the fungus has colonized the wood. Trees with signs of decay should be evaluated by a tree-care professional. Trees that are a structural risk should be removed by a certified arborist.
	Insects and Mites		
	Redbud leaffolder *Fascista cercerisella*	Young caterpillars are approximately ¼ of an inch long, initially white, and then become light green. Older caterpillars are about ½ of an inch long with alternating bands of white and black on the body. Larvae have alternating black and white bands, and reside in the folded leaves. Leaves fold over with distinct thickened white webbing located within the folds (Photos 112a – 112b).	In general, damage will not kill plants, although the aesthetic appearance can be affected. Contact insecticides will only be effective when applied early before leaves fold-over.
	Environmental, Cultural, and Other Problems		
	Bark shedding Normal physiological process	Small patches of bark shed along the trunk. Tends to occur on mature trees.	Is normal part of plant growth. Does not impact tree vigor.

Host	Problems	Identification/Symptoms	Comments
Redbud, cont.	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Herbicide injury (see Page 5)	Cupping or distortion of leaves, often caused by drift of phenoxy herbicides.	Primarily cosmetic, not damaging.
Rhododendron *Rhododendron* ***Note:*** Rhododendron is not adapted to the Kansas climate.	**Diseases**		
	Cankers *Botryosphaeria, Phomopsis,* and others (see Page 9)	Leaves on individual branches droop and turn brown. Stem tissue turns dark brown. Branch dieback.	Maintain overall plant health with proper pruning, fertilization, and watering. If cankers develop, prune out and remove or destroy affected wood.
	Leaf gall *Exobasidium vaccinii*	Pale green or white fleshy, distorted galls on foliage. Rare. Favored by wet conditions.	Hand removal or pruning of galled tissue may reduce disease.
	Leaf spot various fungi (see Page 6)	Round, brown spots (lesions) develop on foliage.	Rarely damaging, primarily cosmetic, no management needed.
	Ramorum blight also called sudden oak death *Phytophthora ramorum* (see Page 10)	Large necrotic (brown) blotches on foliage. Shoot dieback. Blackening of leaf stems and succulent shoots. Defoliation. Most likely to occur during wet conditions.	**Not known to occur in Kansas landscapes.** Could be introduced on nursery stock. Avoid purchasing and planting suspect material. Contact K-State Plant Disease Diagnostic Laboratory to report suspect plants.
	Root rot *Phytophthora* spp. (see Pages 3 and 10)	Common in nurseries but less common in landscapes. Affected plants wilt and leaves drop. Roots and stems may develop a reddish-brown discoloration.	Inspect all nursery stock before purchasing. Avoid planting in sites with poor drainage. Improve drainage in problem areas.

Host	Problems	Identification/Symptoms	Comments
Rhododendron, cont.	**Insects and Mites**		
	Black vine weevil *Otiorhynchus sulcatus* (see Page 12)	Adults are approximately ⅜ of an inch long, black, and the body is covered with patches of fine yellow hairs. Adults have a short, snout-shaped mouth. Adults are active at night, feeding on leaf margins, which creates small notches around the leaf edges (Photos 49 – 50). Heavy infestations can completely defoliate plants. Larvae (Photo 51) feed on plant roots and may girdle plants at the crown resulting in wilting and possibly plant death.	Adult feeding primarily affects the aesthetic appearance of plants. The larva can cause substantial plant damage. Insecticides can be applied to soil to prevent larval damage.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Winter injury/ winter kill (see Page 2)	Branch and twig dieback.	Prune out dead branches.
Rose *Rosa*	**Diseases**		
	Black spot *Diplocarpon rosae* (see Page 6)	Leaves develop roughly circular, black spots with feathery margins. Multiple spots will cause yellowing of the leaf and defoliation. Most common in wet conditions. Can also infect canes (Photo 14).	Choose a variety with reduced susceptibility. Rake and remove (do not compost) fallen affected leaves. Avoid overhead watering and improve airflow to promote drying. Prune out infected canes. Fungicides may be beneficial in sites with chronic, severe disease. Contact your local extension office for information.
	Botrytis blight/ gray mold *Botrytis cinerea*	Spotting and browning of petals. Petals shed. Grayish brown fuzzy fungal growth may be present. Most common in wet, humid conditions. In very wet years may cause bud blight.	Primarily cosmetic. Disease development ceases during hot, dry weather. Improve air flow.

Host	Problems	Identification/Symptoms	Comments
Rose, cont.	Cane canker Several fungi (see Page 9)	Small spots or lesions form on canes, often at a pruning cut. These lesions may expand rapidly and kill the cane.	Prune out all cankered canes several inches below the margin of the discolored area. Maintain overall plant health with proper pruning, fertilization and watering.
	Crown gall *Agrobacterium tumefaciens* (see Page 9)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Do not simply prune out galls. Do not replant with a susceptible host.
	Downy mildew *Peronospora sparsa*	Leaves develop irregular or angular spots that are brown, purple, or red. Severe defoliation can occur. In cool, humid (humidity greater than 85 percent) conditions fuzzy sporulation may be visible on the undersides of leaves. Rare in landscape due to typical hot, dry Kansas weather.	In nursery or greenhouse production use ventilation and watering practices that reduce humidity and leaf wetness. Avoid introducing infected plants to the greenhouse, nursery, or landscape. Remove and destroy affected leaves.
	Leaf spot *Rosisphaerella rosicola* and *Cercospora rosicola* (see Page 6)	Leaves develop purple-brown lesions with gray or tan centers.	Rake up and remove infected leaves.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Rose mosaic caused by several viruses, often in combination (see Page 10)	Leaves develop a yellowing, mottling, variegation, or ringlike patterns (Photos 44a – 44b). Diseased plants normally are not killed but they have reduced vigor and may be more prone to winterkill. Symptoms are most prominent on new growth in spring and may not be visible in late summer or early fall. The virus is spread by propagation practices.	There is no control for this disease once the plant is infected. Purchase virus-free plants. Do not purchase or plant roses with evidence of viral infection. Do not propagate from diseased plants. Remove and destroy affected plants.

Host	Problems	Identification/Symptoms	Comments
Rose, cont.	Rose rosette virus (see Page 10)	Very serious on multiflora rose (an invasive weed) but will attack all rose types. Diseased plants often have a red or purple cast and develop large witch's brooms of the canes. Excessive thorniness. Infected plants often die within 5 years. Spread by an eriophyid mite (Photos 45a – 45b).	There is no control for this disease once the plant is infected. The disease can spread quickly in a planting. Promptly remove and destroy all diseased plants.
	Rust *Phragmidium* spp. (see Page 7)	Yellow-orange spots develop on upper leaf surfaces (Photo 21a). Leaves develop powdery, orange pustules on the lower surfaces (Photo 21b). Pustules may turn black with development of another spore type in late summer/fall. Defoliation may occur and can be severe.	Remove infected leaves. Avoid overhead watering. If disease is chronic and severe, fungicides may be beneficial.
	Insects and Mites		
	Japanese beetle *Popillia japonica* (see Page 12)	Adults are ⅜ to ½ of an inch long, metallic-green with coppery-brown wing covers. There are tufts of white hair on the end of the abdomen (Photo 48). Feeding by adults causes leaves to appear lace-like or skeletonized.	Removing adult beetles may be effective for situations associated with small plants and low infestations. However, applying contact insecticides may be required to prevent substantial plant damage.
	Twospotted spider mite *Tetranychus urticae* (see Page 15)	Adults are approximately 1/16 of an inch long, oval-shaped, green-yellow to red-orange, with two dark spots on both sides of the abdomen (Photo 73). Larvae and nymphs are pale-yellow to yellow-green. Twospotted spider mite feeds on the leaf undersides causing leaves to appear light yellow (bleached) to bronze in color. Leaves may also be white or have yellow stippling (Photo 74). Heavily infested leaves may turn brown and fall off plants.	A high-pressure water spray applied to the leaf underside will quickly remove all life stages. Miticides may be used; however, they must be applied frequently enough and all plant parts must be thoroughly covered, especially leaf undersides, with the spray solution.

Host	Problems	Identification/Symptoms	Comments
Rose, cont.	Rose aphid *Macrosiphum rosae* (see Page 13)	Rose aphids are approximately ⅛ of an inch long, pear shaped, and vary in color from green to pink to red. There are two tubes, called cornicles, which protrude out from the end of the abdomen. Aphids are noticeable feeding in large groups on leaves, stems, and developing buds (Photo 113). Feeding causes leaves to curl upward and deforms flower buds. Aphids produce honeydew, a sticky liquid.	A high-pressure water spray applied to locations where aphids are feeding will quickly remove aphids from plants. Contact and systemic insecticides may be effective in managing aphid populations if applied early in the growing season; before aphid populations are extensive.
	Rose sawfly *Endelomyia aethiops* (see Page 13)	Full-grown larvae are approximately ½ of an inch long, yellow-green, with an orange head (Photo 61a). Leaves fed upon by larvae have a skeletonized appearance (Photo 61b).	Apply a contact insecticide when larvae first appear. The insecticide *Bacillus thuringiensis* subsp. *kurstaki* will not kill sawfly larvae.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
	Winter injury/ winter kill (see Page 2)	Branch and twig dieback.	Prune out dead branches.
Russian olive *Elaeagnus angustifolia* ***Note:*** Russian olive can become invasive in pastures.	**Diseases**		
	Leaf spot *Septoria argyraea* (see Page 6)	Round to oval leaf spots with a gray center and dark margin. Fungal fruiting bodies (pycnidia) appear as small black dots in the center of the spot.	Rarely damaging, primarily cosmetic, no management needed.

Host	Problems	Identification/Symptoms	Comments
Russian olive, cont.	Stem canker *Phomopsis, Tubercularia,* and *Botryosphaeria* (see Page 9)	Oval to elongate dark sunken cankers on branches. Infected bark remains smooth but cracks may form at the margin of the canker. Fruiting bodies develop in the dead bark and appear as raised pustules. Branch dieback and tree death.	Remove and discard or destroy diseased branches. Cut branches at least 6 inches below any cankers when the wood is dry. Maintain overall plant health with proper pruning, fertilization, and watering.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.
Serviceberry *Amelanchier*	**Diseases**		
	Fire blight *Erwinia amylovora*	Sudden browning and wilting of branch spurs (Photos 92a – 92b) or new shoot growth. Tips of blighted shoots curl, giving appearance of a "shepherd's crook" (Photo 91). Inner bark tissue turns water soaked with red-to-black discoloration. Cankers form on affected branches. Favored by wet spring weather at bloom.	Prune out affected branches at least 12 to 18 inches below visible damage. Sanitize tools between cuts. See further discussion of fire blight under crabapple.
	Leaf spot various fungi (see Page 6)	Round, brown spots (lesions) develop on foliage. Most common in wet years.	Rarely damaging, primarily cosmetic, no management needed.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces. (Photos 18a – 18b)	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
Smoketree *Cotinus*	**Diseases**		
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain overall plant health with appropriate watering, fertilization, etc. Do not replant a susceptible species into a site with history of Verticillium wilt.

Host	Problems	Identification/Symptoms	Comments
Smoketree, cont.	**Environmental, Cultural, and Other Problems**		
	Winter injury/ winter kill (see Page 2)	Freeze injury can lead to whole tree death or vertical cracks that run the length of the trunk and/or major limbs.	Prune out dead limbs and provide adequate water.
Spirea *Spirea*	**Diseases**		
	Crown gall *Agrobacterium tumefaciens* (see Page 9)	Large woody galls develop, usually on root collars or roots (Photo 38). Galls start out light colored and darken with age. Galls reduce plant vigor and eventually can kill the plant. Causal bacterium persists long-term in soil at the site.	Avoid planting infected materials. Inspect before purchasing/planting. Remove and destroy entire infected plants. Do not simply prune out galls. Do not replant with a susceptible host.
	Leaf spot various fungi (see Page 6)	Round, brown spots (lesions) develop on foliage. Leaf yellowing and minor shedding.	Rarely damaging, primarily cosmetic, no management needed.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Insects and Mites		
	Spirea aphid *Aphis spiraecola* (see Page 13)	Spirea aphids are approximately ⅛ of an inch long, pear-shaped, and light green. There are two tubes, called cornicles, which protrude out from the end of the abdomen. Aphids congregate on terminal growth and can cause leaf curling and stunted plant growth. Aphids produce honeydew, a sticky liquid.	A high-pressure water spray applied to locations where aphids are feeding will quickly remove aphids from plants. Contact and systemic insecticides may be effective in managing aphid populations if applied early in the growing season; before aphid populations are extensive.
	Environmental, Cultural, and Other Problems		
	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green. Common. (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.

Host	Problems	Identification/Symptoms	Comments
Spruce *Picea* spp.	**Diseases**		
	Canker *Cytospora kunzei* (see Page 9)	Cankers on branches are covered with white patches of pitch. Small black fruiting bodies may be present in diseased bark. Scattered branch dieback.	Occasionally is found on drought-stressed or winter-injured trees. Remove infected branches but do not prune during wet weather. Maintain overall plant health with proper pruning, fertilization, and watering.
	Needlecasts *Rhizosphaera kalkhoffii* and *Stigmina lautii*	Interior (1- and 2-year-old) needles on lower branches turn purplish-brown in summer and usually drop by late fall. Black spots in lines/rows may be visible on needles in late fall or early spring (Photo 15b, Photo 115). Starts in lower tree and works upward over several years (Photo 114). Most common in wet years. Most common in eastern half of Kansas.	Improve airflow by avoiding overcrowded plantings. For *Rhizosphaera*, application of fungicides in spring, when needles are half-elongated and again when needles are fully elongated, may reduce disease. No materials currently specifically labeled for *Stigmina*.
	Insects and Mites		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial plant damage if not dealt with. Contact or stomach poison insecticides may be used to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.
	Spruce spider mite *Oligonychus ununguis* (see Page 15)	Adults are oval-shaped and approximately ⅑₀ of an inch long. Adults are black, tan, or red whereas nymphs are light gray to green. Feeding causes needles to become mottled in appearance, and then yellow, and eventually bronze. Damaged needles may fall off prematurely. Heavy infestations may cause branch dieback.	A high-pressure water spray will remove all life stages (eggs, larvae, nymphs, and adults). Miticides may be applied; however, thorough coverage of all plant parts is important. A dormant oil spray applied in winter will kill overwintering eggs located on the bark and needles.

Host	Problems	Identification/Symptoms	Comments
Spruce, cont.	**Environmental, Cultural, and Other Problems**		
	Environmental stress (see Page 2)	Very common. Needles turn brown to purple, sometimes including current year's growth. Needle drop and branch dieback. Scorched needles will shed and whole tree may die, especially after prolonged periods of drought conditions.	Caused by stress from growing in less than ideal conditions. Spruce are not well adapted to Kansas growing conditions. Provide tree with adequate watering and fertilization. Plant in protected location.
Sumac *Rhus*	**Diseases**		
	Fusarium wilt *Fusarium oxysporum* f. sp. *rhois*	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing cross-section of cut branches or when bark is removed.	Maintain overall plant health with appropriate watering, fertilization, etc.
	Verticillium wilt *Verticillium dahliae* and *Verticillium albo-atrum* (see Page 8)	Wilting, yellowing, decline, dieback. Vascular discoloration (brown streaking) may be visible when viewing the cross-section of cut branches or when bark is removed (Photos 31 – 32).	Maintain plant health with appropriate watering and fertilization. Do not replant a susceptible species into a site with history of Verticillium wilt.
Sweetgum *Liquidambar styraciflua*	**Diseases**		
	Bacterial wetwood several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photo 42).	Rarely damaging, primarily cosmetic, management not necessary.
	Canker various fungi (see Page 9)	Branch dieback. Tissue under bark is dead/brown.	Maintain overall plant health with proper pruning, fertilization, and watering.
	Leaf spot various fungi (see Page 6)	Round, brown spots (lesions) develop on foliage. Primarily in late summer during wet years.	Rarely damaging, primarily cosmetic, no management needed.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.

Host	Problems	Identification/Symptoms	Comments
Sweetgum, cont.	Iron chlorosis (see Page 4)	Yellowing of leaf tissue between veins; veins remain green (Photo 5).	Avoid planting susceptible species in high pH soils. In severe cases provide iron with injections.
Sycamore and London Plane *Platanus*	Anthracnose *Apiognomonia veneta* also called *Gnomonia platani* and *Discula platani* (see Page 6)	Brown irregular areas along veins. Young leaves turn brown and fall off. Twigs may be killed (Photos 16 – 17). Infection occurs in cool weather just as buds open. London plane is less susceptible than sycamore.	Rarely damaging, primarily cosmetic, no management needed. Trees usually produce new foliage and recover with the onset of warmer, drier summer weather.
	Bacterial wetwood Several bacterial species (see Page 10)	Liquid oozes from wounds and cracks and runs down bark, leaving discolored streaks on branches or trunk (Photo 42).	Rarely damaging, primarily cosmetic, management not necessary.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b). London Plane is more susceptible than sycamore.	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Insects and Mites		
	Sycamore lace bug *Corythucha ciliata* (see Page 14)	Adults are ⅛ to ¼ of an inch long and have lacy, clear, shiny wings held flat over the body. Nymphs are black with spines located on the periphery of the body. Black eggs and nymphs, and lacy-appearing adults may be present on leaf undersides. Damage appears as light-yellow mottling or stippling on the upper leaf surface (Photos 64 – 66).	In general, lace bugs will not cause severe plant damage, although extensive populations may reduce aesthetic appearance. Contact insecticides may be used; however, thorough coverage of leaf undersides is important. However, this may not be practical for large plants.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
	Shedding bark	Loose plates of bark slough off the limbs and trunk in early summer.	Cosmetic. Management not necessary.

Host	Problems	Identification/Symptoms	Comments
Viburnum	**Diseases**		
Viburnum	Canker *Botryosphaeria*, others (see Page 9)	Branch dieback. Wood under bark is brown/dry. Most common on stressed plants.	Maintain overall plant health with proper pruning, fertilization, and watering. If cankers develop, prune out and remove or destroy affected wood.
	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Ramorum blight also called sudden oak death *Phytophthora ramorum* (see Page 10)	Large necrotic (brown) blotches on foliage. Shoot dieback. Blackening of leaf stems and succulent shoots. Defoliation. Most likely to occur during wet conditions.	**Not known to occur in Kansas landscapes.** Could be introduced on nursery stock. Avoid purchasing and planting suspect material. Contact K-State Plant Disease Diagnostic Laboratory to report suspect plants.
Walnut	**Diseases**		
Juglans	Anthracnose *Ophiognomonia leptostyla* also called *Marssonina juglandis* and *Gnomonia leptostyla* (see Page 6)	Irregular brown or black spots on leaflets, sometimes with yellow margins. Premature defoliation. Brown to black sunken spots on nut hulls.	Rarely damaging, primarily cosmetic, management not needed.
	Fusarium canker *Fusarium solani* (see Page 9)	Branch dieback. Long, dark areas of dead tissue under bark.	Occurs primarily after harsh winters.
	Leaf spot various fungi including *Cylindrosporium* sp. (see Page 6)	Small brown spots and minor shedding occur during wet conditions.	Rarely damaging, management not necessary.

Host	Problems	Identification/Symptoms	Comments
Walnut, cont.	Powdery mildew (see Page 7)	White, powdery fungal growth develops on leaf surfaces (Photos 18a – 18b).	Rarely damaging, primarily cosmetic, no management necessary. Improving airflow may reduce severity.
	Thousand cankers disease *Geosmithia morbida* (see Page 9)	Associated with walnut twig beetle (*Pityophthorus juglandis*) (Photo 78). Branch dieback, overall tree decline, small black cankers (Photo 37) and beetle galleries visible under bark. Beetle exit holes are tiny but may be visible in bark. Exit holes are easier to see in younger branches with smoother bark.	**Not known to occur in Kansas but spread into Kansas is possible.** Contact your local extension office for information.
	Insects and Mites		
	Fall webworm *Hyphantria cunea* (see Page 12)	Adult moths are 2 inches long, with the forewings containing spots, and small red-orange markings at the base of the front legs. Caterpillars are yellow-green or brown with black spots. Mature caterpillars are 1 to 1½ inches long, with orange-yellow or black tubercles on the body. They have tufts of long, gray, silken hairs on the body. Caterpillars create nests on the ends of tree branches and feed within the nests (Photos 56 – 58).	Prune out localized nests and dispose of immediately. Use a rake to disrupt nests, which will allow birds to feed on the caterpillars.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.
Willow *(Salix)* – see Poplar			
Yew *Taxus*	**Diseases**		
	Root decline (wet soils) (see Page 3)	Branch dieback, plant decline (Photo 116).	Avoid planting into poorly drained soils.

Host	Problems	Identification/Symptoms	Comments
Yew, cont.	Root rot *Phytophthora* spp. (see Pages 3 and 10)	Branch dieback, plant decline. Most common in sites with poor drainage.	Avoid planting into poorly drained soils.
	Insects and Mites		
	Bagworm *Thyridopteryx ephemeraeformis* (see Page 12)	Young caterpillars are ⅛ to ¼ of an inch long, whereas mature caterpillars are 1 to 2 inches long. Caterpillars create bags or cases covered with material from host plant (Photos 52 – 53). Feeding causes browning of foliage.	Can cause substantial damage if not managed appropriately. Contact or stomach poison insecticides may be used to manage early infestations. Removing female bags by hand in the winter may be effective in reducing caterpillar populations the following season.
	Black vine weevil *Otiorhynchus sulcatus* (see Page 12)	Adults are approximately ⅜ of an inch long, black, and the body is covered with patches of fine yellow hairs. Adults have a short, snout-shaped mouth. Adults are active at night, feeding on leaf margins, which creates small notches around the leaf edges (Photos 49 – 50). Heavy infestations can completely defoliate plants. Larvae (Photo 51) feed on plant roots and may girdle plants at the crown resulting in wilting and possibly plant death.	Adult feeding primarily affects the aesthetic appearance of plants. The larva can cause substantial plant damage. Insecticides can be applied to the soil to prevent larval damage.
	Environmental, Cultural, and Other Problems		
	Environmental scorch (see Page 2)	Shoot tips turn brown and dry during dry windy weather. Can occur in summer or winter.	Provide adequate water.
	Winter injury/ winter kill (see Page 2)	Sections or whole plants die back due to low winter temperatures.	Common in Kansas. Prune out dead stems. Provide good plant care
Zelkova *Zelkova*	Environmental scorch (see Page 2)	Leaf margins and/or entire leaves turn brown and dry (scorched) during dry, windy conditions (Photos 1a – 1b).	Provide adequate water. Use mulches to help retain soil moisture.


Photos 61a and 61b. *Rose sawfly larvae (a) and feeding damage (b).*

Photo 62. *Aphids are soft-bodied and pear shaped with two tubes called cornicles protruding from the back of the abdomen.*


Photos 63a and 63b. *Adult leafhopper (a). Leafhopper feeding damage (b).*

Photo 64. *Lace bug adult.*

Photo 65. *Lace bug nymphs.*

Photo 66. *Lace bug feeding damage on oak leaf.*

Photo 67. *Obscure scale.*

Photo 68. *Pine tortoise scale females and nymphs (crawlers).*

Photo 69. *Oak kermes scale.*

Photo 70. *European elm scale.*

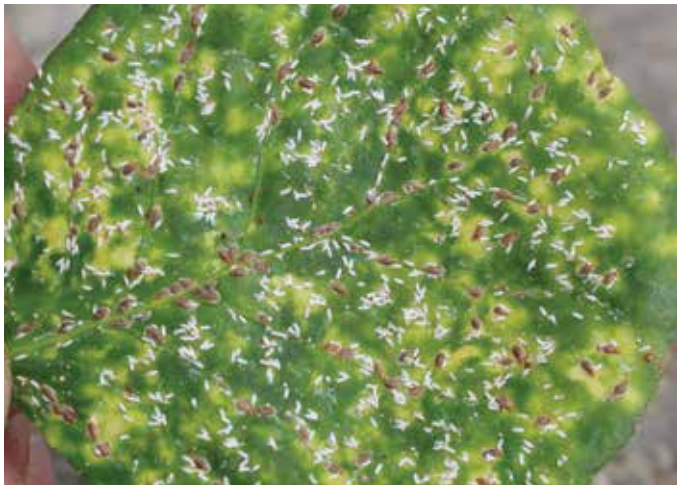

Photo 71. *Euonymus scale females (brown) and males (white).*

Photo 72. *Lecanium scales on bald cypress.*

Photo 73. *Twospotted spider mite adult.*

Photo 74. *Twospotted spider mite feeding damage.*

Photo 75. *Cottonwood borer adult.*

Photo 76. *Cottonwood borer larva.*

Photo 77. *Pine sawyer beetle adult.*

Photo 78. *Walnut twig beetle adult (actual size 1/16 inch).*

Photo 79. *Emerald ash borer adult.*

Photo 80. *Emerald ash borer adult emergence hole.*

Photo 81. *Emerald ash borer larvae.*

Photo 82. *Asian longhorned beetle adult.*

Photo 83. *Ash/lilac borer adult.*

Photo 84. *Ash/lilac borer larva.*

Photo 85. *Ash/lilac borer pupae.*

Photo 86. *Oak bullet gall.*

Photo 87. *Hackberry nipple gall maker.*

Photo 88. *Mushrooms and conks are indicators of decay. Shown here: ash heart rot caused by Perenniporia fraxinophila.*

Photo 89. *Black knot of cherry, plum, and other stone fruit causes black swellings on branches.*

Photo 90. *Peach leaf curl causes distortions and discoloration.*

Photo 91. *Fire blight may cause shoot tips to curl, causing a "shepherd's crook" symptom in wet spring weather. Can be confused with summer scorch.*

Photos 92a and 92b. *Fire blight infected shoots (a) and branch spurs eventually turn brown or black (b). Can be confused with summer scorch.*

Photo 93. *Black spot on elm (also called elm anthracnose) causes irregular, blotchy lesions on the upper leaf surface.*

Photo 94. *Brown, woody Phomopsis gall on forsythia.*

Photo 95. *Mimosa webworm.*

Photo 96. *Honeysuckle witches-broom aphid damage.*

Photo 97. *Bacterial leaf spot of hydrangea. Spots are brown with a blocky, angular shape.*

Photo 98. *Botryosphaeria canker causes branch dieback in Rocky Mountain Juniper.*

Photos 99a and 99b. *Kabatina tip blight on juniper (a) and closeup showing fungal fruiting structures (b).*

Photos 100a and 100b. *Phomopsis tip blight on juniper causing browning and dieback (a). Close-up of Phomopsis to show fungal fruiting structures (b).*

Photo 101. *Natural needle drop in pine.*

Photo 102. *Cercospora needle blight can cause needle drop in lower part of tree. Primarily in Rocky Mountain Juniper.*

Photo 103. *Tar spot of maple.*

Photos 104a and 104b. *Leaf spot of oak caused by Tubakia (a) and Bur oak blight (b).*

Photo 105. *Partial leaf scorch caused by oak wilt. Can be confused with environmental scorch.*

Photos 106a and 106b. *Oak wilt causes dark streaking in the vascular tissue visible in longitudinal views (a) and cross sections (b).*

Photo 107. *Oak anthracnose.*

Photo 108. *Oak anthracnose causes browning along the veins.*

Photos 109a and 109b. *Pine tip blight stunts needles and shoots (a). Pine tip blight fungal fruiting structures on cones (b).*

Photos 110a and 110b. *Dothistroma needle blight causes shedding of internal needles (a). Needle spotting and browning caused by Dothistroma (b). See also photo 15a for needle close-up.*

Photos 111a and 111b. *Nantucket pine tip moth adult (a) and larva (b).*

Photos 112a and 112b. *Redbud leaffolder larva (a) and damage (b).*

Photo 113. *Rose aphids.*

Photo 114. *Rhizosphaera needle cast causes shedding of lower, interior needles. See also 15b.*

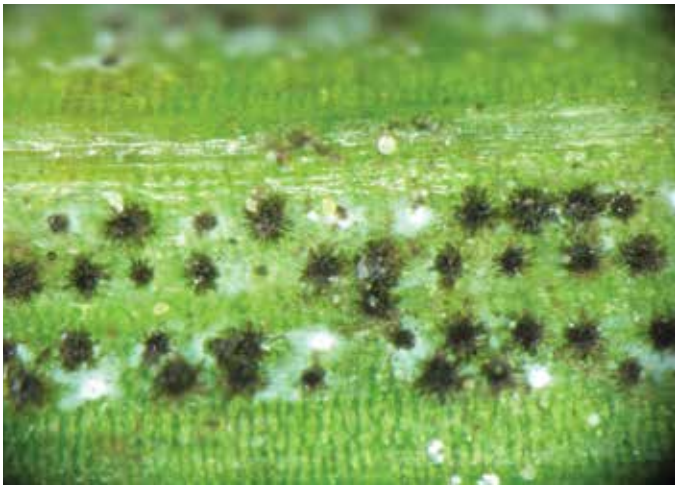

Photo 115. *Fruiting structures of Stigmina needle cast on spruce (compare to 15b).*

Photo 116. *Wet soil causes decline and dieback in yew.*

Photo 117. *Ash flower gall.*

Photo 118. *Oak vein pocket gall.*

Photo 119. *Hackberry island chlorosis causes yellow-green blocky lesions.*

Photo 120. *Seiridium canker causes die back on Arizona cypress.*

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