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Diagnosing Plant Problems

Kentucky Master Gardener Manual Chapter 7

By James L. Green, former extension horticulture specialist, Oregon State University; Otis Maloy, retired extension plant pathologist, Washington State University; and Joseph Capizzi, extension entomologist emeritus, Oregon State University. Edited for Kentucky by John Hartman, extension plant pathologist (retired), and Lee Townsend, extension entomologist, University of Kentucky.

In this chapter:

To determine what factors have damaged a plant, you'll need to systematically and carefully observe the plant, its environment, and other plants in the area, then put all the pieces together to reconstruct the event(s) that produced the damage. You must make an accurate diagnosis before taking corrective action. Even if no corrective measures are available, it is good to know what the problem is and what its future development might be.

Factors causing plant damage can be grouped into two major categories:

- Living organisms such as pathogens (fungi, bacteria, viruses, and nematodes) and pests (insects, mites, mollusks, mammals, and birds)
- Nonliving factors such as mechanical damage (for example, breakage or abrasions), environmental conditions (such as extremes of temperature, light, moisture, or oxygen), and chemicals (such as herbicides or nutritional disorders)

Some pathogens, insects, and nonliving factors cause damage only if a plant is weakened by other primary factors. For example, borers generally attack only trees that already are suffering moisture or other physical stress.

It's frequently not enough to use symptoms alone for diagnosis, because completely different factors may cause similar symptoms on the same plant. In diagnosing plant damage, you can follow a series of deductive steps, gathering clues from the general situation down to an individual plant or plant part to determine the most probable cause of the damage.

The first step is to identify the plant and the problem. Then, attempt to distinguish between living and nonliving damaging factors based on observed damage patterns, development of patterns over time, and other diagnostic clues. Once you have limited the probable causes of the damage, you can obtain further information to confirm your diagnosis from reference books, plant pathologists, entomologists, horticulturists, and/or laboratory analyses.

These diagnostic steps are described in detail on the following pages.

Diagnostic Terms

General

Bacterium—A single-celled, microscopic organism having a cell wall but no chlorophyll. Reproduces by cell division.

Fungus—A plant organism that lacks chlorophyll, reproduces via spores, and usually has filamentous growth. Examples are molds, yeasts, and mushrooms.

Larva—Immature stage of an insect with complete metamorphosis that is specialized for feeding. A larva looks very different than the adult stage (for example, a caterpillar and a moth).

Host—A plant afflicted with a disease or insect pest.

Nematode—A microscopic roundworm, usually living in the soil. Many feed on plant roots and can be disease pathogens.

Nymph—Immature stage of an insect with gradual metamorphosis. It looks very much like the adult but is smaller. For instance, a grasshopper nymph looks like the adult but does not have wings.

Pathogen—Any organism that causes disease. Generally applied to bacteria, viruses, fungi, and nematodes.

Phytotoxic—Toxic to a plant (phyto = plant).

Sign—Direct evidence of a damaging factor (for example, a pest or pathogen itself, secretions, insect webbing, chemical residues, records of weather extremes or chemical applications).

Symptom—A change in a plant's growth or appearance in response to living or nonliving damaging factors.

Vector—A transmitter or carrier of disease.

Virus—An infectious agent too small to see with a compound microscope. Multiplies only in living cells.

Symptoms

Abscission—The dropping of leaves, flowers, or fruit by a plant.

Blight—Rapid, extensive discoloration, wilting, and death of plant tissue.

Blotch—A blot or spot (usually superficial and irregular in shape and size) on leaves, shoots, or fruit.

Canker—A dead place on the bark and cortex of twigs, stems, or trunks; often discolored and either raised or sunken.

Catfacing—Disfigurement or malformation of a fruit. Fruits typically affected include tomatoes and strawberries.

Chlorosis—An abnormal yellowish-white or gray color of plant parts resulting from incomplete destruction of chlorophyll.

Defoliation—The unnatural loss of a plant's leaves, generally to the detriment of the plant's health. Can be caused by high wind, excess heat, drought, frost, chemicals, insects, or disease.

Desiccation—Drying out of plant tissue.

Dieback—Progressive death of shoots, branches, or roots, generally starting at the tips.

Dwarfing—The underdevelopment of any plant organ.

Enation—Epidermal outgrowths on leaves or stems.

Epinasty—An abnormal downward-curving growth or movement of a leaf, leaf part, or stem.

Etiolation—Yellow, long, spindly growth resulting from insufficient light.

Fasciation—A distortion of a plant that results in thin, flattened, and sometimes curved shoots.

Flagging—Wilting and/or death of plant parts, usually starting from the tip(s) of one or a few branches or stems.

Gall—An abnormal, localized swelling on leaf, stem, or root tissue.

Mosaic—Nonuniform foliage coloration with a more or less distinct intermingling of normal green and light green or yellowish patches.

Mottle—An irregular pattern of light and dark areas.

Necrosis—Death of plant tissue.

Phyllody—A change from normal flower structures to leafy structures.

Rot—Decomposition and destruction of tissue.

Rugose—Wrinkled.

Russet—Yellowish-brown or reddish-brown scar tissue on a fruit's surface.

Scab—A crustlike disease lesion.

Stippling—Small, light green or chlorotic specks.

Water-soaked—Lesions that appear wet and dark and usually are sunken and/or translucent.

Wilt—Lack of turgor and drooping of leaves from lack of water.

Witches' broom—Abnormal brushlike development of many weak shoots.

Signs

Bacterial slime—A gooey or dried mass of bacterial cells that oozes out of plant tissues.

Conk—A fungal fruiting structure (such as shelf or bracket fungi) formed on rotting woody plants.

Cyst—The swollen, egg-containing female body of certain nematodes; can be seen on the outside of infected roots.

Frass—Sawdust-like material associated with insects chewing into plant tissues.

Fruiting body—A fungal structure that contains or bears spores.

Girdling—The cutting, removing, or clamping of bark all the way around a trunk or branch, sometimes caused by insect feeding.

Honeydew—A sticky substance excreted by aphids and some other insects.

Mine—Tunnel or cavity created by insects that feed within leaves or needles. Depending on the insect, it can appear as a winding serpentine mine or as an irregularly rounded blotch mine.

Mycelia—Masses of fungal threads (hyphae), which compose the vegetative body of a fungus.

Plant Identification and Appearance

First, determine whether a problem truly exists. It is essential to identify the plant (genus, species, and cultivar or variety) to know what it should look like. Use personal knowledge or plant reference books or consult experts.

If possible, compare the damaged plant with a healthy or normal plant of the same species and variety. Normal plant parts or seasonal changes sometimes are mistakenly assumed to be evidence of disease. For example:

- The 'Sunburst' honeylocust might seem to be suffering from a nutrient deficiency because of its chlorotic, yellowgreen leaf color. However, it was selected for this genetic characteristic, and the color is normal.
- The brown, sporeproducing bodies on the lower surface of fern leaves are a fern's normal propagative organs, not disease spores or insects.
- The small, brown, clublike tips that develop on arborvitae foliage in early spring are male flowers, not deformed shoots.
- Small galls on the roots of legumes such as beans and peas most likely are nitrogen-fixing nodules essential to normal development, not symptoms of root-knot nematode infection.
- The leaves of some plants, such as some rhododendron cultivars, are covered by conspicuous, fuzzy, epidermal hairs. They sometimes are thought to be evidence of disease, but they are a normal part of the leaf.
- Some plants have variegated foliage that may resemble symptoms of viral diseases.
- Premature leaf or needle drop by evergreen plants (for example, *Ficus benjamina*) frequently causes alarm. These plants normally retain their leaves or needles for three to six years and gradually lose the oldest ones during each growing season (Figure 1a). This normal leaf drop is obscured by the production of new leaves.

However, prolonged drought or other stress may cause the whole tree to temporarily turn yellow and may accelerate leaf loss, but that is not a reason for concern. The leaves that drop or turn yellow are the oldest ones, and their dropping protects the tree by reducing water loss.

If new leaves drop, however, there probably is a problem (Figure 1b). The cause may be a pathogen, insect, chemical deficiency, toxicity, or root problem.

In describing a plant abnormality, distinguish between symptoms and signs. Symptoms are changes in a plant's growth or appearance (for example, galls, blotches, or wilting) in response to living or nonliving damaging factors. Many factors produce the same symptoms, so symptoms do not produce a definitive diagnosis.

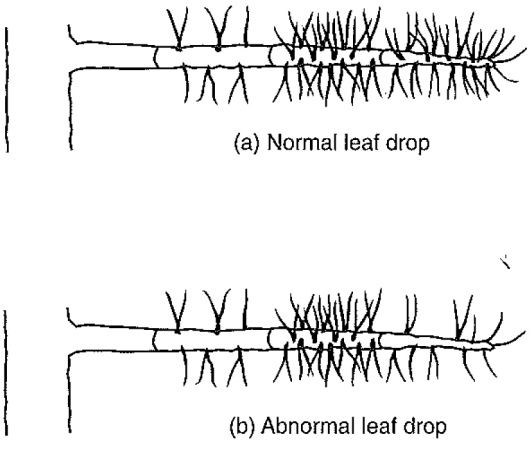


Figure 1. Normal versus abnormal needle or leaf drop from evergreens: (a) If drop is confined to older leaves, it is normal. (b) If newly produced leaves are lost, there is a problem.

Figure 2. If all or a major portion of a tree or shrub dies, suspect a root problem.

Figure 3. Nonuniform damage patterns on a tree canopy.

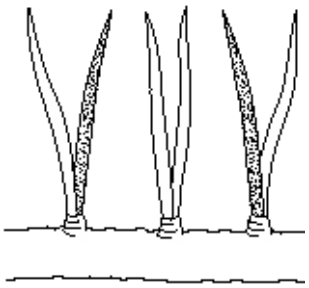


Figure 4. Random, scattered damage on conifer needles.

Signs are direct evidence of the damaging factor (for example, the pest or pathogen itself, secretions, chemical residues, or records of weather extremes). A combination of signs and symptoms is more likely to produce a definitive diagnosis than are symptoms alone.

Examine the entire plant. In defining a plant problem, it is essential to determine the true primary problem, because the plant part exhibiting obvious symptoms may not be the part experiencing damage. For example, some root problems cause foliage symptoms. In this case, the primary problem is damage to roots, not foliage.

In general, if the entire top of a plant or entire branches look abnormal, examine the plant downward to find the primary damage (Figure 2). Look for the factor causing the damage at the edge of the symptomatic area, and always examine the roots.

Damage Patterns

Patterns are excellent diagnostic clues and are where you start making the distinction between living and nonliving causes of plant damage.

Nonuniform or Random Damage (Living Factors)

With problems caused by living organisms such as pathogens or insects, there usually is no uniform pattern of damage. It may appear randomly on parts of a plant or on some plants in a group.

If scattered damage occurs in the plant canopy, suspect a problem in the foliage or aerial environment, not the roots (Figure 3). If scattered branches gradually decline and eventually die, suspect a canker pathogen, shoot blight, or borers. Verticillium wilt, on the other hand, is characteristically one-sided on a tree or shrub and can develop relatively quickly—in a month or so on some species (for example, some maples).

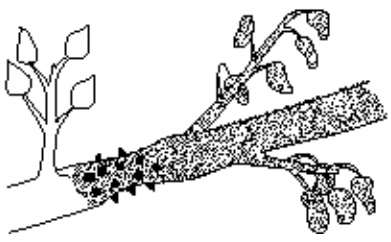


Figure 5. Shoot dieback caused by a fungal infection.

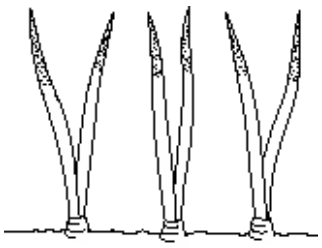


Figure 6. Uniform death of needle tips.

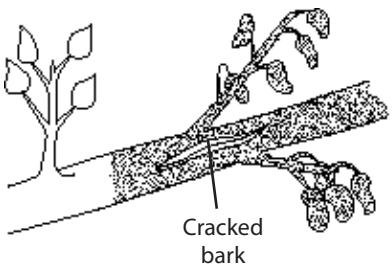


Figure 7. Shoot dieback caused by winter injury.

Similarly, living organisms usually damage leaves or needles in a random pattern (Figure 4). For example, conifer needles usually are affected over varying lengths and often appear straw yellow or light tan. Black fruiting fungal bodies may be present on diseased needles. Often, damage appears first on lower and inner parts of the canopy, where humidity is higher, and then progresses upward and outward.

With living damaging factors, there may not be a sharp line between affected and healthy tissues. Bacterial shoot blight is an exception, however. With this disease, the margin between affected and healthy tissue often is irregular and sunken. Bacterial shoot blight usually causes the shoot tip to wilt and bend over.

With fungal shoot dieback, there may be small, pinlike projections or bumps over the surface of dead bark (Figure 5). These structures are the spore-producing parts of the fungi. Note, however, that small, woody bumps normally radiate from all sides of spruce twigs where old needles were attached.

Uniform Damage (Nonliving Factors)

Damage patterns produced by nonliving factors, such as frost or toxic chemicals, generally are more regular. For example, they:

- May appear on all leaves of a certain age (for example, those forming the plant canopy when a toxic spray is applied)
- May affect all leaves with a certain exposure (such as those on the southwest side of a plant that are not shaded by other leaves)
- Likely will appear on more than one type or species of plant. Look for similar damage patterns on weeds, neighboring plants, etc.

Air pollutants frequently cause tip burn on conifers, as do certain soil-applied herbicides and excess fertilizer (Figure 6). Freezing may have a similar effect. All needles at a specific growth stage usually are affected, and usually each needle is affected to the same length. Affected tissue usually is reddish brown.

Damage caused by nonliving factors usually results in a sharp margin or edge between affected and healthy tissue. However, if bark and wood are cracked, suspect winter injury (Figure 7), in which dieback often is gradual rather than sudden.

Development of Damage over Time

Another clue for distinguishing between living and nonliving factors is what you see when you observe the pattern over time.

Sudden Decline (Nonliving Factors)

Sudden decline generally is caused by a nonliving factor such as a toxic chemical or extreme weather. All affected leaves might die immediately after a chemical application that is poisonous to plants. If branches die suddenly, especially if affected branches are concentrated on one side of the plant, suspect weather, animal damage, or chemical drift.

If a nonliving damaging factor is not removed, damage will intensify. For example, if a toxic chemical remains in the soil or air, plant damage within the contaminated area will continue to develop, but it won't spread to uncontaminated areas.

Sudden decline can be associated with living factors, such as when a plant is weakened by disease or insects and then subjected to an otherwise survivable stress (for example, Phytophthora root rot followed by a normal summer drought period).

Gradual Decline (Living Factors)

Gradual decline of an entire plant or a major portion of it usually is caused by a living factor (for example, Armillaria root rot, Verticillium wilt, or root weevils. However, it can also be the result of marginally survivable conditions such as nutrient-deficient soil.

Living organisms multiply and grow with time; therefore, they rarely afflict all of the host plant or plants at once. Damage generally appears first on one part of a plant and spreads. Likewise, it progresses from

Table 1. Symptoms and signs of fungal and bacterial leaf spots.

Abnormality	Fungal	Bacterial
Watersoaking	Not common	Common with rots of thick and succulent leaves and with initial appearance of angular leaf spots
Texture	Usually dry; may be papery	Some dry, some slimy to sticky; may be papery when dry
Odor	Usually none	Foul (putrid to earthy, acrid) odor usually associated with rots of fleshy plant parts
Pattern	Irregular to circular; may have concentric rings	Irregular to angular; often restricted by large veins
Disintegration	Uncommon	Common with rots
Color changes	Common: red, yellow, purple halos	Less common, but may have irregular, yellow halos
Pathogen structures	Common: mycelia, spores, spore structures	Wet or dried slime at edge of canker or leaf spot

plant to plant. For example, gradual shoot decline with retention of dead leaves usually indicates damage by a living factor.

Bacterial shoot blight and Phytophthora canker are exceptions to the gradual decline rule. They can cause rapid dieback.

Distinguishing among Living Causes of Damage

To identify the type of living factor that has damaged a plant, closely examine symptoms and signs. Symptoms are the modified appearance of the affected plant, such as necrotic tissues, chlorosis, cankers, galls, or leaf distortion. Signs are direct evidence of the actual organism. Examples are insects, fungal mycelia, spores, egg masses, insect frass, and mite webbing. Signs can be clues for identifying the specific organism that produced the damage. A combination of both symptoms and signs may be necessary for the initial distinction between disease and insect/mite damage.

Symptoms and Signs of Disease

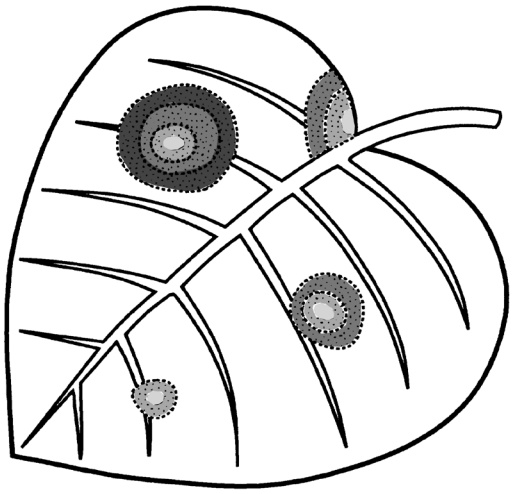
Differentiating between bacterial and fungal pathogens, especially those that cause leaf spots, is not always clear-cut, but certain symptoms are distinctive. Table 1 lists key distinguishing characteristics of fungal and bacterial leaf spots.

Fungal diseases

The presence of fungal mycelia and fruiting bodies are the best clue to a fungal disease. Fruiting bodies range in size from microscopic to those easily detectable with the naked eye. They are found within the leaf spot or stem rot area on an infected plant. Each type of fungus has its own characteristic structures, which are used by plant pathologists for identification.

Fungal leaf spots and stem rots are characterized by various symptoms: dry texture, concentric rings, and discoloration. Spots generally have distinct margins. They vary in size and usually are round and occasionally elongated (Figure 8).

Figure 8. Fungal leaf spots.



Concentric rings result as the mycelium grows outward from the point of initial infection (much like the crocheting of a doily). Leaf color ranges from tan (died first) in the center to darker brown (recently died) to very dark. The outer ring may have a light yellow, chlorotic edge where the infection is advancing. Margins of fungal leaf spots and stem rots can be brightly discolored.

Bacterial diseases

Bacteria enter plant tissues through wounds or natural openings in leaves, stems, roots, or fruit. Once they enter a plant, they reproduce rapidly and release enzymes and toxins that kill plant cells.

Bacterial galls

Crown gall bacteria genetically engineer their host plant to make galls and amino acids, thus giving the bacteria a place to live and the chemicals they need to grow and reproduce. The galls are characterized by hard, unspecialized plant cells. When young, galls resemble a head of cauliflower, but they harden with age.

Bacterial leaf spot

These bacteria usually enter through leaf stomata. A common symptom is a watersoaked appearance, which is usually revealed by holding an infected leaf to light. The tissue may become translucent, papery, and tan when dry.

Erwinia blight is an example of a bacterial disease that causes water-soaking. The water-soaked appearance occurs when bacteria dissolve the material holding plant cells together, thus destroying leaf or stem integrity. Some fungi also produce water-soaking, but usually not as extensively as Erwinia blight.

Initially, bacterial leaf spot symptoms are confined between leaf veins, resulting in discrete, angular spots with straight sides (Figure 9). Many bacterial leaf spots, such as Xanthomonas leaf spot on philodendron (also called red edge disease), expand until they reach a large leaf vein. The vein frequently inhibits the bacteria from spreading farther.

Bacterial leaf spot's color usually is uniform, though a chlorotic halo often surrounds a spot. Spots may enlarge and coalesce. In final stages, cracks may form in the plant tissue; disintegration follows. Some lesions may exude bacteria-filled fluid.

A few bacterial leaf blights, particularly on thick or spongy-textured leaves, are slimy and may have a rotten odor.

Vascular wilt

In some cases, bacteria plug a plant's water-conducting vascular tissue. The result is yellowing, wilting, browning, and death of leaves, stems, and roots.

Figure 9. Bacterial leaf spots.

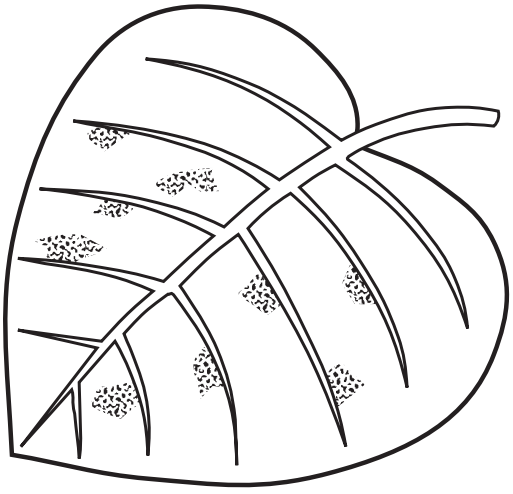
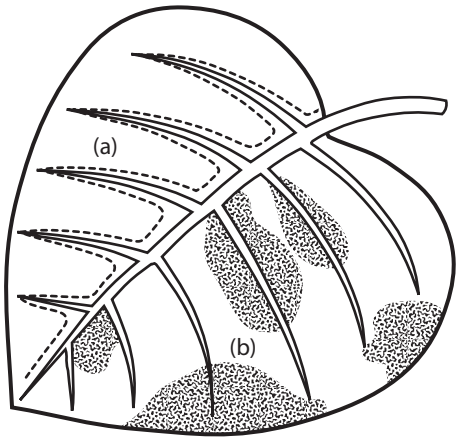


Figure 10. Typical signs of viral infection: (a) Vein banding (b) mosaic.



A Step-by-Step Method of Diagnosis

1. Determine that a real problem exists, then define it.

a. Identify the plant. Establish what a "normal" plant would look like at this time of year. Describe the abnormality (symptoms and signs).
b. Examine the entire plant and its community. Locate the primary problem and the plant part where initial damage occurred.

2. Look for patterns. Is the damage on more than one plant? On more than one plant species?

a. A non-uniform damage pattern (irregular or random pattern of damage) is indicative of living factors (pathogens, insects, mites, or other animals).
b. A uniform damage pattern (such as damage on all leaves of a certain age or all plants in an area) indicates nonliving factors (mechanical, physical, or chemical).

3. Outline development of damage over time.

a. Progressive spread of the damage on a plant or onto other plants indicates damage caused by living organisms.
b. Damage that does not spread to other parts of the affected plant or to other plants, and a clear line between damaged and undamaged tissues, indicate damage caused by nonliving factors.

4. Gather information to identify possible causes of damage.

a. Distinguish among living factors.
    1. Symptoms and signs of pathogens
    2. Symptoms and signs of insects, mites, and other animals
b. Distinguish among nonliving factors.
    1. Mechanical factors
    2. Physical factors
        a. Temperature extremes
        b. Light extremes
        c. Oxygen and moisture extremes
    3. Chemical factors
        a. Pesticide or pollutant phytotoxicities
        b. Nutritional disorders
c. Use references. You may need laboratory analyses to narrow the range of probable causes.

5. Synthesize information to determine probable causes.

Viral diseases

Viruses are submicroscopic entities that infect individual plant cells. They are obligate parasites, meaning that they can replicate only within a host's cell. As a virus proliferates, it moves on to infect other cells.

Because a virus commandeers its host cell to manufacture viruses identical to itself, the cell cannot function and grow normally. Chlorophyll production may stop, causing necrosis or the yellowing or blanching of chlorosis. In some cases, cells may grow and divide rapidly; in others, they may grow very slowly or stop dividing, causing distortion or stunting. The symptoms of most viral diseases fall into four categories:

Lack of chlorophyll in normally green organs—A common first symptom is vein clearing, in which veins look somewhat translucent or transparent but interveinal tissue remains green. In vein banding, a dark green, light green, or yellow band of tissue appears along the veins (Figure 10a). (When leaf veins remain green but tissue between veins becomes chlorotic, the cause may be deficiency of a nutrient such as iron.) Virus-infected foliage also may be mottled green and yellow, mosaic, ringed, or a rather uniform yellow (Figure 10b).

Stunting or other growth inhibition—As chlorophyll is lost, reduced photosynthesis leads to shorter internodes (spaces between nodes), smaller leaves and blossoms, and lower yield.

Distortions—Strangely formed leaves and flowers, witches' brooms, or rosettes result from non-uniform or uncontrolled growth.

Necrotic areas or lesions—Viruses require their host's survival for their own procreation, so they rarely cause death. Necrosis usually is confined to discrete areas of the plant.

These symptoms can be valuable clues for virus identification but are easily confused with symptoms of nutritional disorders, chemical injury, or damage caused by mites or insects. In addition, because of their extremely small size, viruses are not visible to the unaided eye. Virus particles are detectable only through an electron microscope or with special stains and a compound (high-magnification) microscope.

Viruses are transmitted from plant to plant by insects, mites, fungi, nematodes, rubbing, abrasion, grafting, or other mechanical means. They occasionally are transmitted in seed.

Nematodes

Nematodes are microscopic roundworms that damage plant tissues as they feed. Many feed on or in root tissues, but a few feed on foliage or other aboveground organs.

Root nematodes

Root-infesting nematodes damage root systems, causing aboveground symptoms—commonly moisture and nutrient stress and general stunting. Root-lesion nematodes (*Pratylenchus* spp.) and burrowing nematodes (*Radopholus similis*) destroy root tissues as they feed. Rootknot nematodes (*Meloidogyne* spp.) inject growth-regulating substances into root tissues, stimulating growth of large, tender cells that become permanent feeding sites. As root tissues grow around these sites, they form visible swollen galls or knots. Other root nematodes stunt growth, apparently by killing root meristems.

Shoot nematodes (Aphelenchoides spp.*)*

Shoot (foliar) nematodes feed inside leaves between major veins, causing chlorosis and necrosis. The tissue first collapses in wedge-shaped areas between the larger veins and then changes color. Injury most often is seen at the base of older foliage.

Symptoms and Signs of Insect Pests

Finding the insects feeding on a plant is the surest way to identify a problem. However, you may have to rely on other clues if the pest is no longer present. These clues include feeding location on the plant, type of feeding damage, time of year, and types of plants being damaged. The location and type of feeding damage are the most important clues in identifying an insect pest. Knowing an insect's life cycle (complete or simple metamorphosis) also is important when attempting to identify an insect or design a control program.

Feeding habits

General groups may be distinguished by their method of feeding. Beetles and caterpillars use chewing mouthparts to eat portions of leaves, while aphids and planthoppers remove plant sap with tubelike sucking mouthparts. Thrips rasp leaf and flower tissue; plant feeding mites remove the contents of cells, leaving a stippling pattern or tiny white spots on leaves. Use the following clues to find the cause of chewing/rasping damage:

- Caterpillars and some beetles consume entire leaves, leaving only the toughest veins.
- If distinct portions of the leaf are missing, the cause could be black vine weevil (the adults cut distinct notches from leaf margins); leaf cutter bees (circular holes cut from margins); or beetles, chafers, weevils, or grasshoppers (small, randomly scattered holes).
- Damaged (especially skeletonized) leaf surfaces may indicate slugs, leaf beetle larvae, pear slugs (pear sawfly larvae), elm leaf beetles, or thrips.
- Leaves tied with silken threads or rolled into tubes often harbor leafrollers or leaftiers (for example, omnivorous leaftiers).
- If there is a discolored or swollen area on a leaf, hold it up to the light to look for insects or frass in the damaged area. The culprit may be leafminers, which feed between upper and lower leaf surfaces (for example, boxwood, holly, birch, and elm leafminers).
- If petioles are weakened and leaves fall in early summer, suspect petiole and leaf stalk borers (for example, maple petiole borers), which burrow into petioles near leaf blades or bases. Cut open a petiole to look for a small moth or sawfly larva.
- If a twig's bark is girdled (cut, removed, or clamped all the way around), the culprit may be vine weevil or twig-girdling beetle.

- If a plant or specific branch is in general decline, examine it closely for frass, pitch, or holes in the bark. These signs are caused by borers, which feed under the bark in cambium tissue, solid wood, or xylem tissue. Examples are bark beetles, round and flatheaded borers, and clearwing borers.
- General decline of a plant along with chewed roots may indicate damage by root weevil larvae or white grubs.

Sap removal by sucking insects can cause wilting and occasionally damage to leaf veins. A few inject saliva or toxic substances that cause discoloration or distorted growth. Insects that secrete phytotoxic substances are called toxicgenic (toxin producing). The resulting plant damage is called phytotoxemia or toxemia.

Spotting or stippling occurs when chlorophyll is destroyed at the feeding site but toxins do not diffuse throughout the leaf. Aphids, leafhoppers, planthoppers, and spider mites bugs commonly cause this type of injury.

Severe toxemias develop when toxic saliva causes leaves to curl and pucker around an insect. Severe aphid infestations may cause this type of damage.

In some cases, toxic effects spread throughout the plant, resulting in reduced growth and chlorosis. This condition is known as systemic toxemia. Psyllid yellows of potatoes and tomatoes and infestations of scale insects or mealybugs may cause systemic toxemia.

Look for these clues when determining the cause of sucking damage:

- General (uniform) stippling, flecking, or chlorotic patterns on spruce needles usually are caused by spider mite damage. Lace bugs may be the cause on other plants.
- Random stipple patterns on leaves are caused by leafhoppers and mites.
- Leaf and stem distortion plus off-color foliage is the result of aphids (for example, rose aphids, black cherry aphids, or leaf curl plum aphids). It is often is confused with injury from growth-regulating chemicals.
- Galls (swellings on leaf or stem tissue) may be caused by various species of aphids, wasps, midges, and mites.
- Twigs that look like they've been split by a sharp instrument are the result of egg laying (oviposition) by sucking insects such as treehoppers and cicadas. Cicadas in particular often split a branch enough to kill its tip.
- General decline of an entire plant or plant part, as indicated by poor color, reduced growth, or dieback, may be the result of root, stem, or branch feeders such as scale insects or mealybugs.
- Accumulations of shiny honeydew and sooty mold indicate infestations of aphids or soft scales.
- Stunted tip growth of trees and shrubs may be due to armored scales.

Insect life cycles

Most insects develop from egg to adult through gradual (also called simple or incomplete) metamorphosis or complete metamorphosis. Gradual metamorphosis has three stages—egg, nymph, adult. Nymphs resemble adults and feed and behave much like them. Examples include grasshoppers and aphids.

Complete metamorphosis has four stages—egg, larva (specialized feeding stage), pupa, and adult. Examples include moths and beetles. Larvae look very different from the adult stage.

In both types of metamorphosis, the nymphs or larvae increase in size in distinct steps when they molt (shed their external skeleton). Discarded exoskeletons found near feeding sites on plants may be helpful in identifying the pest. All growth is completed before the adult stage.

Symptoms and Signs of Other Animal Damage

A variety of other living organisms can damage plants. For example:

Arachnids—Arachnids have eight legs (insects have six) and sucking mouthparts. Spider mites are an example. They have a simple life cycle and often cause leaf stippling, with damaged leaves then turning pale on the underside. Severe infestation causes leaf bronzing and death. Foliage may appear dirty, due to the presence of small, fine webbing mixed with eggs and frass on the underside of leaves. Eriophyid mites, on the other hand, cause distorted new growth, rolled leaf margins, and swollen veins. Symptoms of arachnid damage often are confused with damage from growth regulators.

Crustacea—Sowbugs and pillbugs usually feed on decaying vegetation. Unless populations are high, they are not considered damaging to live plants.

Mollusca—Slugs and snails feed on low-growing foliage and fruit growing in shaded, humid areas. They use rasping mouthparts to scratch and loosen soft tissue. Look for slime trails on foliage and the surrounding soil.

Miscellaneous animals—Millipedes (arthropods) feed on decaying plants. They have many small legs, are brownish or white in color, and vary in size from 1⁄2 to 2 inches long. They are not considered injurious to live plants.

Small mammals—Chewed bark and cambium tissue on small trees and shrubs most frequently is caused by mice, rabbits, squirrels, or possibly beavers. Look for teeth marks.

Large mammals—Cattle, goats, deer, and horses tear or cut branches.

Birds—Missing flower petals or punctured bark may be caused by yellowbellied sapsuckers. They make even rows of holes in tree trunks.

Distinguishing among Nonliving Causes of Damage

Uniform patterns of damage indicate that a nonliving factor is the probable cause. The three broad categories of nonliving factors include the following:

Mechanical factors—abrasion and bruising from construction or maintenance equipment, handling during transplanting, or lawn mowers.

Physical factors—environmental or weather changes such as temperature extremes, light, moisture, or wind.

Chemical factors—pesticide applications, aerial and soil pollutants, and nutritional disorders.

Additional clues, as discussed below, will help you determine which of these factors caused the damage.

Mechanical Factors

First, consider whether there has been recent excavation, construction, or paving on the site. Then examine the damaged plant. Close examination often reveals whether stems or roots were broken or girdled and whether leaves were bruised, punctured, or broken. For example, if stems break because a plant is dropped during transplanting, rapid wilting will occur above the break.

Physical (Environmental) Factors

Primary sources of diagnostic information for damage caused by physical factors are damage patterns and weather records.

Temperature extremes

Extremely hot or cold temperatures can damage plants. In both cases, recognizable damage patterns are likely to occur. Heat damage is most likely to occur in the early afternoon when the sun is in the southwest quadrant of the sky. Therefore, damage occurs primarily on outer, unshaded leaves on a plant's southwest side. Leaves shaded by other leaves or those on the northeast side may be undamaged. The most severe damage occurs on plant parts farthest from water-carrying roots, stems, and leaf veins.

Thus, leaves on the outer perimeter of the plant, leaf tips, and interveinal areas are most commonly damaged. This damage pattern is likely to occur uniformly over all plants in an area. Cold damage occurs on the least hardy plants and is most severe on the least hardy tissues of those plants. Plants vary in their hardiness (cold tolerance). By checking how low the temperature dropped and knowing the indicator plants for various USDA cold hardiness zones, you can begin to determine whether plant damage was caused by cold.

A plant gains cold hardiness gradually beginning at its terminal (tip) buds, and regains it gradually (also beginning at the tip buds), so the location of cold damage on a plant will tell you approximately when the damage occurred. Damage to buds occurs most often in late winter or early spring, while damage to lower plant parts may occur in the fall or early winter.

On a given structure (such as a leaf or bud), exposed, nonhardy tissues are damaged in a recognizable pattern. For example:

- Spring frost damage uniformly kills new, succulent growth. New growth emerging after the frost will be healthy.
- Frost cracks are lengthwise separations of bark and wood that generally occur on the southwest side of a trunk. They are the result of wide day/night temperature fluctuations in winter.
- The dividing cells on outer portions of leaves may freeze while still inside the bud. As a result, distorted or lacelike leaf blades develop.

Generally, root systems cannot survive at as low a temperature as can aboveground plant parts. Fortunately, soil temperatures in winter usually are warmer and more stable than air temperatures. Thus, cold damage to roots primarily is a concern with container-grown plants, where soil temperatures fluctuate more than in ground soil. Examine the root system to detect damage in container-grown plants. It generally occurs on the periphery of the root ball (near the container edge). Evidence includes black or spongy roots that lack new growth or new root hairs.

Aboveground symptoms of cold damage to roots generally do not become evident until shoots begin to grow in the spring. At that time, leaf expansion may be incomplete because of restricted water and nutrient uptake by the damaged root system. The result is smaller-than-normal leaves. As air temperature increases, water loss from shoots and leaves may exceed the roots' ability to take up water. As a result, the plant loses leaves or wilts, and it may die.

Light extremes

Plants can acclimate to various light conditions but need time to do so. They respond adversely to rapid light change. A sudden shift from low to high light destroys a plant's chlorophyll and leads to yellowing and necrosis. Rapid change from high to low light, on the other hand, results in reduced growth and leaf drop. Under low light, new leaves are larger, thinner, and darker green than normal, while flowering is reduced, delayed, or absent.

Oxygen and moisture extremes

Oxygen and moisture extremes primarily affect the root environment, where the quantities of oxygen and moisture are inversely related. That means a waterlogged (saturated) root environment lacks sufficient oxygen for root metabolism and growth. Consequently, less water and nutrients are taken up by plants.

Drought and waterlogging produce many of the same aboveground symptoms. The first symptoms to appear are wilting, chlorosis, and abscission (dropping) of older leaves. Under severe, continuing moisture stress, wilting and necrosis occurs on tips and interveinal regions of recently expanded leaves and new growth.

Chemical Toxicities

Patterns of chemical injury on individual plants differ, depending primarily on whether a chemical causes damage directly on contact or is absorbed and moves throughout the plant.

Direct-contact damage

Direct-contact damage can occur on both foliage and roots.

Shoot/foliage contact

Symptoms from shoot-contact chemicals occur over the general plant canopy. The injury does not spread with time or move to previously undamaged plants.

Injury is typified by chlorotic or necrotic spotting. Spots usually are uniformly and evenly distributed over the leaf surface and generally are the same size. Color usually is uniform across the spot, and the margin between affected and healthy tissue usually is sharp (Figure 11).

If a chemical is applied directly to aboveground parts, you may be able to see the application pattern. For example, the pattern of spray droplets may be visible or areas where spray accumulated along leaf edges may show the most damage. In the case of a toxic gas (volatile chemical), areas between leaf veins and along leaf margins—where water concentration is lowest—show damage first.

Examples of shoot/foliage contact chemicals are foliar-applied fertilizers; the agricultural herbicides paraquat, acifluorfen, and dinoseb; and herbicidal oils. (Very few, if any, contact herbicides are available to home gardeners.)

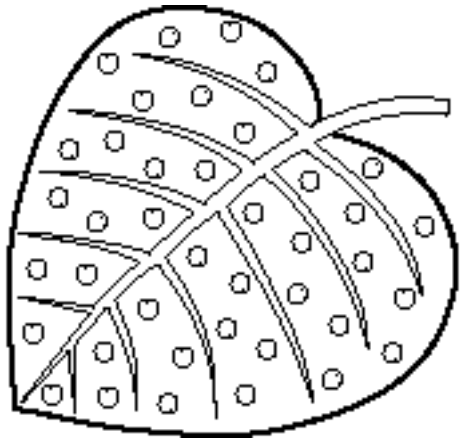
Root contact

Toxic contact chemicals in the root zone, including excess fertilizer, result in poor root development. Roots are injured and root tips may be killed.

Aboveground shoots may show water and nutrient stress symptoms—for example, reduced growth, wilting, or chlorosis—because the roots are unable to obtain water. In severe cases, wilting can occur even when the soil is wet. Lower leaves generally wilt first, followed by drying of leaf margins.

Herbicides that inhibit root growth include the agricultural herbicides dinitroanilines, DCPA (Dacthal), and diphenamid. Excess nitrogen fertilizer can have the same result.

Figure 11. Foliar chemical spray injury.



Keep in mind that many other factors also injure roots or inhibit their growth, including nematodes and other pathogens, soil compaction, cold weather, salinity, and nutritional deficiencies or excesses.

Translocated chemical damage

Some chemicals can move throughout a plant after being absorbed. The effects of these mobile chemicals depend on whether they are transported in the xylem or the phloem.

If transported solely in the xylem, the chemical moves upward through the plant, primarily causing symptoms in older foliage. Examples of xylem-transported chemicals include urea fertilizer and the agricultural herbicides triazine, alachlor, and metolachlor.

If transported in the phloem, a chemical may move in many directions from the point of absorption; for example, it may move from the shoots to the roots or vice versa. Symptoms caused by phloem-transported toxic chemicals occur primarily in the plant's new growth and meristematic regions. Affected young tissue is discolored or deformed, and injury may persist for several sets of new leaves. Examples of phloem-transported toxic chemicals include the common garden herbicides 2,4D, dicamba, and glyphosate.

Nutrient Deficiencies

Like the effects of toxic chemicals, the effects of nutrient deficiencies depend on whether the chemical is transported only in the xylem or also in the phloem.

Nutrients that are transported solely in the xylem are immobile in a plant once they have been moved upward from the roots. They cannot be moved through the phloem to new growth if a soil deficiency develops, so symptoms of these chemicals typically develop on new growth. Phloem-immobile chemicals include boron, calcium, iron, manganese, zinc, copper, molybdenum, and, in some plant species, sulfur.

In contrast, a phloem-mobile nutrient can be withdrawn from older leaves and moved to growing root and shoot tips if a soil deficiency develops, so that deficiencies of these nutrients will first be visible on older leaves. Nitrogen, phosphorus, potassium, magnesium, chlorine, and, in some plant species, sulfur, are phloem-mobile.

For More Information

Many other publications on specific insect and disease problems are listed in other chapters.

University of Kentucky Cooperative Extension publications

Timing Control Actions for Landscape Insect Pests Using Flowering Plants as Indicators. http://www.ca.uky.edu/entomology/entfacts/ent66.asp

Calendar for Common Kentucky Shade Tree and Woody Ornamental Pests. http://www.ca.uky.edu/entomology/entfacts/ef447.asp

Woody Plant Disease Control Guide for Kentucky (ID-88). http://www.ca.uky.edu/agc/pubs/id/id88/id88.pdf

Guide for Control of Annual and Perennial Flower and Ground Cover Diseases in the Landscape (ID-87). http://www.ca.uky.edu/agc/pubs/id/id87/id87.pdf

Other publications

Bennett, W.F., ed. Nutrient Deficiencies and Toxicities in Crop Plants (APS Press, St. Paul, MN, 1993). 202 pp.

Borror, D.J., and R.E. White. A Field Guide to the Insects of America North of Mexico (Houghton Mifflin Company, Boston, 1970).

Flint, M.L. Pests of the Garden and Small Farm: A Grower's Guide to Using Less Pesticide, Publication 3332 (University of California, Los Angeles, 1999).

Johnson, W.T., and H.H. Lyon. Insects That Feed on Trees and Shrubs, 2nd ed., rev. (Comstock Publishing Associates, Cornell University Press, Ithaca, NY, 1991).

The Ortho Problem Solver, 7th ed. (Chevron Chemical Co., San Francisco, 2008).

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Pirone, P.P. Tree Maintenance, 7th ed. (Oxford University Press, New York, 2000).

Sherf, A.F., and A.A. Macnab. Vegetable Diseases and Their Control, 2nd ed. (John Wiley & Sons, New York, 1986).

Sinclair, W.A., H.H. Lyon, and W.T Johnson. Diseases of Trees and Shrubs, 2nd ed. (Cornell University Press, Ithaca, NY, 2005).

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
General		
Poor fruit yield; fruit may be small and have poor taste	Uneven moisture	Water during dry periods.
	Poor soil fertility	Soil test; supply nutrients based on results.
Plants grow slowly; leaves light green.	Insufficient light	Thin plants; do not plant in shade.
	Cool weather	Growth will improve when weather warms.
	Poor soil fertility	Soil test; supply nutrients based on results.
	Improper pH	Soil test; adjust pH as needed.
	Excess water	Do not overwater; improve drainage.
Seedlings don't emerge	Dry soil	Water.
	Damping-off (fungal disease)	Use sterile pots and planting media; do not overwater; allow soil to dry slightly between waterings; treat seed with registered fungicide before planting.
	Incorrect planting depth	Plant at correct depth.
	Slow germination due to weather	Wait for appropriate weather conditions before planting.
	Root maggots	Use floating row cover; apply registered soil insecticide.
Wilted seedlings; seedlings fall over	Damping-off (fungal disease)	Use sterile pots and planting media; do not overwater; allow soil to dry slightly between waterings; treat seed with registered fungicide before planting.
	Cutworms	Use cutworm collars, biological control agent; apply registered soil insecticide.
	Root maggots, wireworms	Use floating row cover for seed maggots only; apply registered soil insecticide.
Chewed seedlings	Rodents, rabbits, or birds	Place fence around garden.
	Slugs	Use slug barrier or bait.
	Various insects	Identify insect; use appropriate nonchemical or chemical control.
Wilted plants; bottom leaves may turn yellow	Dry soil	Water.
	Root rot (fungal disease)	Use sterile pots and planting media; do not overwater; allow soil to dry slightly between waterings; treat seed with registered fungicide before planting.
	Vascular wilt (fungal disease, mainly affecting tomatoes, potatoes, eggplants, and peppers)	Plant resistant varieties; rotate.
	Root-knot nematodes, white grubs	Plant resistant varieties; rotate with nematodes that attack insects; remove diseased plants; fumigate soil.
	Various root-feeding nematodes	Submit soil sample for nematode analysis; plant resistant varieties; rotate; remove diseased plants; fumigate soil.
	Waterlogged soil	Improve drainage; do not overwater.
General leaf yellowing; no wilting	Nutrient deficiency	Soil test; supply nutrients based on results.
	Insufficient light	Thin plants; do not plant in shade.
Leaves stippled with tiny, white spots	Spider mites	Use predatory mites; apply insecticidal soap or registered miticide.
Leaf margins turn brown and shrivel	Dry soil	Water.
	Fertilizer burn	Test soil for soluble salts; do not overfertilize; flush soil with water.
	Potassium deficiency	Soil test; supply nutrients based on results.
	Cold injury	Do not plant too early.
Discrete, brown spots on leaves; some spots may coalesce	Fungal or bacterial leaf spot disease	See specific plant listings below.
	Chemical injury	Do not apply chemicals that are not registered for use on the plant; apply chemicals at recommended rates and in the right environmental conditions.
White, powdery growth on upper leaf surfaces	Powdery mildew (fungal disease)	Use resistant varieties; space plants adequately for better air circulation; control weeds; apply registered fungicide.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Leaves shredded or stripped from plant	Hail damage	—
	Rodents	Place fence around garden; use traps.
	Slugs	Use slug barrier or bait.
	Dead tissue drops out after fungal infection	Avoid wetting foliage; space plants adequately for better air circulation; apply registered fungicide before problem reaches this stage.
	Various insects	Identify insect; use appropriate nonchemical or chemical control.
Leaves with yellow and green mosaic or mottle pattern	Viral disease	Plant resistant varieties if available; plant certified, disease-free seeds or seedlings; control weeds; remove and destroy affected plants.
Leaves curled, puckered, or distorted	Herbicide injury (common on tomatoes and cucumbers)	Be careful when using herbicides.
	Viral disease	Plant resistant varieties if available; plant certified, disease-free seeds or seedlings; control weeds; remove and destroy affected plants.
	Aphids	Pick off, mash, or wash away insects; use biological control agent; treat plant (especially underside of leaves) with insecticidal soap or registered insecticide.
Tops turn yellow, brown, and die back; reddish-brown, orange, or black pustules appear on stems and leaves	Rust (fungal disease)	Plant resistant varieties; cut tops close to ground in fall and destroy; remove and destroy affected leaves; improve air circulation; avoid wetting foliage; apply registered fungicide.
Shoots wilt, turn yellow, then brown; vascular tissue in crown area is reddish-brown	Fusarium wilt (fungal disease)	Plant resistant varieties; destroy affected plants; rotate for 2 to 4 years; fumigate soil.
	Verticillium wilt (fungal disease)	
Asparagus		
Small spears; immature plants	Asparagus produces small spears for 2 or 3 years after planting.	
	Plants overharvested during previous year	Do not harvest late into the season: plants can't store enough food for following season.
	Poor fertility	Soil test; supply nutrients based on results.
	Poor drainage	Do not overwater; plant in well-drained area.
Spears crooked	Mechanical injury from windblown sand or mishandling	Be careful not to damage emerging spears when harvesting.
	Asparagus beetles, Japanese beetles	Beat foliage over a tray and discard the insects; apply registered insecticide.
Spears turn brown and soft	Frost injury	Protect spears with mulch.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris.
Leaves chewed; slime may be present on leaves; no evidence of insects.	Slugs (emerge at night and hide during the day)	Use slug barrier or bait.
Spears and leaves chewed or scarred	Asparagus, Japanese beetles	Beat foliage over a tray and discard the insects; apply registered insecticide.
Beans		
Skeletonized leaves	Mexican bean beetle larvae and adults	Apply registered insecticide.
Plants wilt/are stunted; leaves, may turn yellow	Dry soil	Water.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris.
	Root-knot nematodes	Rotate; remove diseased plants; fumigate soil.
	Poor fertility	Soil test; supply nutrients based on results.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Failure to set pods	High temperature causes blossoms to drop	Wait for cooler weather.
	Dry soil	Water.
	Wet soil causes lack of oxygen to roots	Do not overwater; plant in well-drained area.
	Mature pods left on vines cause seed production rather than pod set	Pick pods regularly.
Rust-colored powdery spots surrounded by yellow halos on leaves and stems	Rust (fungal disease)	Plant resistant varieties; remove plant debris and pods; remove and destroy affected leaves; apply registered fungicide.
Soft, watery spots or white, moldy growth on leaves, stems, and pods; plants wilt and die	White mold (fungal disease)	Rotate; remove plant debris; improve air circulation; use registered fungicide.
Water-soaked spots followed by irregular brown spots on underside of leaves	Halo blight (bacterial disease)	Delay planting until warm weather; plant disease-free seed; rotate; remove plant debris.
Mottled patterns on leaves; leaves often curl downward, may become chlorotic, soon die	Mosaic (viral disease)	Use resistant varieties; avoid planting beans near sweet, red, or crimson clover or gladioli, which may harbor the disease.
Leaves lose color; underside appears dusty and webbed	Spider mites	Use predatory mites, insecticidal soap, or registered miticide.
Young leaves curled, distorted, and yellow; clusters of tiny insects on leaves and stems	Aphids	Pick off, mash, or wash away insects; use biological control agent; apply insecticidal soap or registered insecticide.
Beets		
Small, circular spots with light centers and dark borders on leaves	Cercospora leaf spot (fungal disease)	Rotate; pick off and destroy affected leaves; thin planting; avoid wetting foliage.
Roots cracked; black areas on surface and inside of roots; plants stunted	Boron deficiency	Maintain soil pH between 6 and 7; soil test; supply boron based on results.
Deformed roots	Overcrowding	Thin beets early.
	Cloddy soil	Prepare soil properly.
Leaves with many small holes	Flea beetles	Use floating row cover or biological control agent; apply registered insecticide.
Irregular, tan blotches in leaves	Leafminers	Use floating row cover; remove and destroy infested leaves.
Carrots		
Inner leaves yellow; outer leaves reddish-purple; roots stunted and bitter	Aster yellows (phytoplasma disease)	Remove and destroy affected plants; control weeds; control leafhoppers with registered insecticide.
Root tops green	Roots exposed to sunlight	Cover exposed roots with soil or mulch.
Roots deformed	Overcrowding	Thin carrots early.
	Cloddy soil	Prepare soil properly.
	Root-knot nematodes	Submit soil sample for nematode analysis; rotate; remove diseased plants; fumigate soil.
	Excess nitrogen	Do not overfertilize.
Small maggots in roots	Carrot rust fly larvae	Rotate; plant resistant varieties; use floating row cover; apply registered insecticide.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Cole Crops (cabbage, broccoli, turnips, cauliflower, Brussels sprouts)		
Cabbage heads crack	Plant takes up excess water, causing head to burst	Harvest heads as soon as mature.
Poor heading	Overcrowding	Thin plants early.
	Dry soil	Water.
	High temperature	Wait for cooler weather.
	Poor soil fertility	Soil test; supply nutrients based on results.
	Club root (fungal disease)	Check roots for large swellings; rotate out of affected area for 7 years; lime soil to raise pH above 7.0.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris.
Discolored cauliflower heads	Exposure to sun	Tie leaves over heads early.
Plants wilt and turn yellow; roots have large swellings (not to be confused with smaller root knots caused by nematodes)	Club root (fungal disease)	Check roots for large swellings; rotate out of affected area for 7 years; lime soil to raise pH above 7.0.
Plants stunted and yellow (especially cabbage); roots not discolored	Dry soil	Water.
	Poor soil fertility	Soil test; supply nutrients based on results.
	Cabbage maggots	Use collars, floating row cover, or biological control agent; work in a soil insecticide at planting time.
Heads soft and rotted	Soft rot of broccoli (bacterial disease)	Grow broccoli varieties that shed water (conical head); provide good air circulation; avoid wetting heads.
Rough, brown, raised areas on underside of leaves	Oedema (physiological problem due to uneven water supply)	Water during dry periods; avoid overwatering in cool conditions.
Leaves riddled with shot holes	Flea beetles	Use floating row cover or biological control agent; apply registered insecticide.
Leaves chewed	Imported cabbage worm, cabbage looper, diamondback moth	Identify insect; use floating row cover or biological control agent; apply registered insecticide.
Some leaves curled, yellow; clusters of tiny gray or green insects	Aphids	Use floating row cover or biological control agent; apply insecticidal soap or registered insecticide.
Corn		
Stalks broken, pith tunnelled	European corn borer	Apply registered insecticide.
Ears not completely filled with kernels	Poor pollination	Plant in blocks of three or four short rows rather than single long one.
White (smooth) or black (powdery) galls on stalks, leaves, ears, or tassels	Smut (fungal disease)	Rotate; plant only 1 inch deep to encourage rapid germination; keep soil moist for first 4 weeks after germination; cut off galls before they turn black; remove plant debris.
Plants stunted; yellow and green striped mosaic pattern on leaves; older leaves pale yellow	Maize dwarf mosaic (viral disease)	Control weeds, especially wild grasses; control aphids; destroy affected plants.
Leaves reddish on margins	Phosphorus deficiency	Soil test; supply nutrients based on results; avoid planting in very cool soil.
Distorted leaves or stalks; leaves may fail to unfurl or stalk may be bent	Herbicide injury	Be careful when applying herbicides.
Caterpillars feeding on tips of ears	Corn earworms	Apply mineral oil or registered insecticide during silking to prevent infestation.
Young plants disappear	Cutworms	Use cutworm collars or biological control agent; apply registered insecticide.
	Birds	Use floating row cover or screen.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Cucurbits cucumbers, cantaloupes, pumpkins, squash, watermelons)		
No fruit produced	Poor pollination	Be patient—at first, male and female flowers not produced at the same time; bee activity may be low due to cool weather; protect bees when using insecticides.
Misshapen or bitter fruit	Poor pollination	Be patient; male and female flowers are not produced at the same time at first; bee activity may be low due to cool weather; protect bees when using insecticides.
	Dry soil	Water.
	Poor soil fertility	Soil test; supply nutrients based on results.
Water-soaked, sunken, brown, or black spot on end of fruit	Calcium deficiency, usually caused by uneven soil moisture during blossoming and poor supply of calcium to fruit during early development	Water during dry periods; supply calcium with foliar spray.
Wilted plants	Dry soil	Water.
	Bacterial wilt	Control cucumber beetles.
	Root rot (fungal disease)	Remove old plant debris; rotate; plant in well-drained area; do not overwater.
	Fusarium wilt (fungal disease)	Plant tolerant varieties if available; rotate.
Circular or irregular spots on leaves and/or fruit	Fungal or bacterial disease (any of several)	Plant resistant varieties; space plants properly; control moisture and humidity.
White, powdery growth on leaves; may be on both leaf surfaces	Powdery mildew (fungal disease)	Plant resistant varieties; rotate; provide air circulation; control weeds; apply registered fungicide.
Yellow and green mottle pattern on leaves	Viral disease	Control weeds before plants emerge; control insects; remove affected plants.
Leaves have strapped appearance: abnormally narrow with leaf veins stretched out at leaf margins so leaves appear feathery	Herbicide injury	Be careful when applying herbicides.
Holes chewed in leaves and stalks; yellow-green beetles with black stripes or spots	Cucumber beetles	Use floating row cover or biological control agent; apply registered insecticide.
Squash and pumpkin leaves wilt, eventually become black and crisp; dark gray 1/2-inch-long bugs present	Squash bugs	Hand pick and destroy; use floating row cover; apply registered insecticide.
Lettuce		
Bolting; may taste bitter	Weather too hot	Lettuce is a cool-season crop; plant early or late.
Sunken, water-soaked spots appear on lower leaves that turn brown and slimy; head turns brown	Rhizoctonia bottom rot (fungal disease)	Rotate; plant in well-drained area; remove plant debris.
	Sclerotinia (fungal disease)	Avoid crowding; plant in well-drained area; remove plant debris.
Stem and lower leaves rotted; dense, fuzzy, gray mold on affected areas	Botrytis gray mold (fungal disease)	Rotate; plant in well-drained area; remove plant debris.
Yellow or light green blotches on upper leaf surfaces; white, fuzzy mold on underside of blotches; spots eventually turn brown	Downy mildew (fungal disease)	Rotate; control weeds; apply registered fungicide.
Plants stunted, yellow; youngest leaves curled; head soft	Aster yellows (phytoplasma disease)	Remove and destroy affected plants; control weeds and insects.
	Mosaic virus	Remove and destroy affected plants; control weeds and insects.
	Nutrient deficiency	Soil test; supply nutrients based on results.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Leaf veins and area adjacent to veins turn light yellow, causing a "big vein" effect	Big vein (viroid disease)	Rotate; plant in well-drained area; remove and destroy affected plants.
Onions		
White flecks form on leaves and expand into elongated leaf lesions; white-to-purplish mold develops on spots during moist weather; bulb quality poor and often spongy	Downy mildew (fungal disease)	Rotate; plant in well-drained area; eradicate wild onions; avoid wetting foliage; apply registered fungicide.
Leaves yellow and die back from tips; bulbs soft and rotted	Fungal or bacterial bulb rot	Rotate; plant in well-drained area; remove plant debris; allow tops to die before harvesting; cure bulbs before storing; avoid bruising bulbs.
Tops stunted; roots yellow and eventually become pinkish	Pink root (fungal disease)	Rotate; plant in well-drained area; plant resistant varieties; fertilize and irrigate properly for optimal growth; remove plant debris.
Plants grow slowly, wilt, and die; white maggots inside bulb	Onion maggots	Use floating row cover; destroy infested onions; work registered insecticide into soil.
White streaks or blotches on leaves.	Onion thrips	Use floating row cover or biological control agent; apply insecticidal soap or registered insecticide.
Peas		
Plants stop producing pods; leaves turn yellow, then brown, and die.	Hot weather	Peas are cool-season vegetables; plant early in spring; plant heat-resistant varieties.
	Root rot (several fungi)	Rotate; plant in well-drained area; do not overwater; remove plant debris.
Plants stunted; lower leaves yellow; internal stem tissue brown	Fusarium wilt (fungal disease)	Rotate; plant resistant varieties; plant when soil temperature is below 65°F; remove plant debris.
White, powdery mold on upper, then lower, surface of leaves; leaves and pods may be distorted	Powdery mildew (fungal disease)	Rotate; plant resistant varieties; plant early; control weeds; remove plant debris.
Yellowish areas on leaves; blister-like ridges on underside of leaves and on pods	Pea enation mosaic (viral disease)	Plant resistant varieties; plant early before insect vectors are active; control weeds and insect vectors; remove and destroy affected plants.
Yellow and green mottle or mosaic pattern on leaves; plants stunted	Viral disease (any of several)	Plant resistant varieties; control weeds and insect vectors.
Peppers		
Wilted leaves, shiny with honeydew	Aphids	Apply registered insecticide.
Large, sunken, tan, water-soaked spot develops on blossom end of fruit; spot turns black,; mold may grow on surface.	Blossom-end rot, caused by calcium deficiency to developing fruits. Occurs when young fruits receive uneven moisture.	Apply calcium during soil preparation; mulch to conserve water; water during dry periods; use calcium foliar sprays.
Thin, wrinkled, tan areas develop on fruit and become white and papery	Sunscald	Provide shade if hot, sunny weather persists when heavy fruit crop is on plants.
Growth stunted; leaves turn yellow, roll inward, and die	Verticillium wilt (fungal disease)	Remove old crop debris; rotate, avoiding tomatoes and potatoes in rotation.
Plants stunted; leaves curled with yellow and green mottle; fruit misshapen with brown streaks, rings, or yellow, green, and red mottle	Viral disease (any of several)	Plant resistant varieties if available; control weeds and insect vectors; remove plant debris; wash hands often when working among plants; don't smoke around plants.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Plants wilt; lower leaves may turn yellow	Fungal or bacterial wilt disease	Rotate, avoiding tomatoes and potatoes in rotation; remove plant debris.
	Dry soil	Water.
	Waterlogged soil	Improve drainage; do not overwater.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris.
Hole in fruit near cap, pink caterpillar inside	European corn borer	Apply registered insecticide.
Potatoes		
Potato tubers are green	Exposure to sun	Mound soil up around plants; do not eat green parts of potatoes.
Plants wilt; bottom leaves may turn yellow	Dry soil	Water.
	Vascular wilt (fungal disease)	Rotate; remove plant debris.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris.
	Waterlogged soil	Improve drainage; do not overwater.
Brown, corky scabs or pits on tubers; plants do not wilt	Scab (fungal disease)	Use certified seed potatoes; use tolerant varieties; avoid using limestone or wood ashes where potatoes will be grown.
Tubers show irregular white or brown cavities when cut open	Hollow heart, caused by plants' growing rapidly	Do not overfertilize; maintain uniform soil moisture.
Tunnels bored just under the skin of tubers; small holes in leaves	Flea beetle adults and larvae	Watch for holes in leaves; use floating row cover or biological control agent; apply registered insecticide.
Leaves chewed; fat, red, humpbacked grubs or orange beetles with black stripes present	Colorado potato beetles	Hand pick beetles; use floating row cover or biological control agent; apply registered insecticide.
Radishes		
Purple-to-black spots develop on root surface; black discoloration extends inward in radial streaks; roots remain firm	Black root (fungal disease)	Plant in well-drained area; rotate; plant resistant varieties; do not overwater; remove plant debris.
Leaves riddled with tiny holes	Flea beetles	Use floating row cover or biological control agent; apply registered insecticide.
Roots infested with legless white worms	Cabbage maggots	Use floating row cover or biological control agent; apply registered insecticide.
Spinach		
Plants bolt	Hot weather and long days	Spinach is a cool-season crop; plant in early spring.
Pale yellow spots appear on upper leaf surfaces; grayish-purple mold develops on underside of spots; whole leaves may wither	Downy mildew (fungal disease)	Rotate; plant resistant varieties; remove infested plants.
Irregular, tan blotches or tunnels appear on leaves	Leafminers	Use floating row cover; remove and destroy infested leaves.
Tomatoes		
Dark brown, irregular spots with target rings, yellow halos develop on fruit; spots often are at stem end and are sunken	Early blight (fungal disease)	Rotate; plant resistant varieties; improve air circulation; avoid wetting leaves; remove plant debris; apply registered fungicide.

Table 2. A diagnostic key to vegetables.

Symptoms	Possible Causes	Controls
Dark brown, leathery spot on blossom end of fruit; mold may grow on spot	Blossom-end rot, caused by calcium deficiency to developing fruits. Occurs when fruits have uneven moisture supply during development	Apply calcium during soil preparation; mulch to conserve water; water during dry periods; use calcium foliar sprays.
Extreme malformation and scarring of fruit	Catfacing, caused by cool weather or herbicide injury during fruit formation	Protect young plants from cool temperatures; avoid using herbicides nearby.
Yellow-orange blotches that do not ripen at stem end of fruit, or white, papery spot on side of fruit facing sun	Sunscald	Prevent foliar diseases that cause leaf drop and expose fruits to sun; use cages to confine plants so they will shade themselves better.
Leaves distorted with "strapped" or feathery look (leaves narrower than normal, tips stretched out into thin projections, veins very close together)	Herbicide injury	Be careful when applying herbicides.
	Tobacco mosaic (viral disease) Note: It may be difficult to distinguish between herbicide injury and tobacco mosaic based on symptoms alone; however, during the spring lawn weed control season, strongly suspect herbicide injury. Leaves roll upward, feel leathery, but remain green; plants are not stunted.	Plant resistant varieties; wash hands and disinfect tools between plants; don't smoke around plants; remove plant debris.
	Excess water	Common physiological disorder after wet periods; do not overwater.
Young plants cut off at ground level	Cutworms	Use cutworm collars or biological control agent; apply registered insecticide.
Young plants have many tiny holes in leaves	Flea beetles	Healthy tomatoes tolerate a lot of flea beetle damage; if needed, use biological control agent or registered insecticide.
Tiny, white-winged insects on underside of leaves	Whiteflies	Use yellow sticky boards (smeared with grease) to attract and trap adults; apply insecticidal soap or registered insecticide.
White stippled areas in fruit	Stink bug feeding	Apply registered insecticides.

Note: This key is not a comprehensive list of plant symptoms, causes of damage, or controls. Refer to this chapter's general discussion of problem diagnosis and to other references for more information. Under controls, cultural, mechanical, and biological methods are listed first, chemical methods are listed last.

Table 3. A diagnostic key to tree fruits and nuts

Symptoms	Possible Causes	Controls
General		
Premature fruit drop	Natural thinning	Many trees produce more fruit than they need and thin themselves naturally.
	Spring frost	Frost often kills developing flower buds or fruits.
	Poor pollination	Tree may require another tree nearby for pollination; be careful not to kill bees when you use pesticides.
	Environmental stress	Drought, cold, and heat can cause fruit drop.
	Various diseases	See controls in Midwest Plant Disease Management Handbook.
	Various insects	Identify insects; see controls in Midwest Insect Management Handbook.

Table 3. A diagnostic key to tree fruits and nuts

Symptoms	Possible Causes	Controls
Few fruits on tree	Poor pollination	Tree may require another tree nearby for pollination; be careful not to kill bees when you use insecticides.
	Biennial bearing	Apples and pears naturally bear a heavy crop one year and few fruits the next year. Thin fruits to counteract this tendency.
	Improper pruning	Do not cut off fruit-bearing wood when pruning.
	Frost injury	—
Fruits too small	Failure to thin	Peaches, nectarines, and apples tend to produce many small fruits. Thin fruits to increase size of those remaining.
	Poor soil fertility	Soil test; supply nutrients based on results.
Gray-white, powdery growth on leaves; leaves and fruit may be distorted	Powdery mildew (fungal disease)	Improve air circulation; apply registered fungicide.
Black, sooty growth on leaves, stems, and/or fruit	Sooty mold (fungus that grows on honeydew substance secreted by aphids and other insects)	Identify insects; if aphids, hose down tree with a powerful spray of water; use biological control agent or registered insecticide.
Young leaves curled and distorted; clusters of insects on underside of leaves	Aphids	Encourage predators; hose down tree with a powerful spray of water to remove aphids; use biological control agent or registered insecticide.
Leaves with tiny, white spots, often dirty with webbing	Spider mites	Encourage predators; use predatory mites; apply registered miticide.
Apples and Pears		
Olive-brown, puckered spots on leaves and young fruit; fruit spots develop into brown, corky lesions; mature fruit is distorted	Scab (fungal disease)	Plant resistant varieties; rake and destroy fallen leaves; prune for better air circulation; avoid wetting leaves; apply registered fungicide.
Sunken, light brown circular spots on outside of apples, usually near blossom end; small, brown spots in edible part of fruit	Bitter pit (physiological disease)	Apply lime to soil; use calcium foliar sprays as fruit nears mature size.
Pink-white worms bore into fruit and feed near core	Codling moths	Use traps to monitor pest population; apply registered insecticide.
Apples have faint brown streaks in the flesh	Apple maggots	Use traps to monitor pest population; apply registered insecticide.
Shoots die back with tips bent over like a shepherd's crook	Fire blight	Prune out dead shoots and branches in winter.
Stone fruits (apricots, cherries, peaches, plums, and nectarines)		
Purple spots appear on upper surfaces of cherry leaves; leaves become shot-holed and turn yellow; fruit also may be affected	Cherry leaf spot (fungal disease)	Rake and destroy fallen leaves and fruits; apply registered fungicide.
Peach or nectarine leaves puckered, thickened, and curled from time they first appear in spring; leaves red or orange at first but turn yellow; shoots swollen and stunted	Peach leaf curl (fungal disease on peaches and nectarines)	Pick off and destroy affected leaves; fertilize the tree; apply registered dormant-season fungicide before buds begin to swell.
Blossoms and young twigs wilt and decay during bloom; sunken cankers with gummy ooze develop on twigs; circular, brown spots on fruit develop tufts of gray spores during moist weather	Brown rot (fungal disease common on all stone fruits)	Prune away badly affected twigs; follow stone fruit fungicidal spray program.
Cherry fruits infested with small, white worms	Cherry fruit flies	Use traps to monitor presence of adult flies; apply registered insecticide.

Table 3. A diagnostic key to tree fruits and nuts

Symptoms	Possible Causes	Controls
Walnuts		
White maggots feed in husks of nuts, causing nutshell staining and poor nut quality	Walnut husk flies	Use traps to monitor presence of adult flies; apply registered insecticide.
Reddish-brown spots on leaves followed by black, slimy spots on husks and in nuts	Walnut blight (bacterial disease)	Apply registered bactericide at early pre-bloom stage.

Note: This key is not a comprehensive list of plant symptoms, causes of damage, or controls. Refer to this chapter's general discussion of problem diagnosis and to other references for more information. Under controls, cultural, mechanical, and biological methods are listed first, chemical methods are listed last.

Table 4. A diagnostic key to berries and grapes.

Symptoms	Possible Causes	Controls
General		
Grayish-white moldy growth on leaves	Powdery mildew (fungal disease)	Provide better air circulation and drier conditions; control weeds; apply registered fungicide.
Plants wilt; leaves may turn yellow	Dry soil	Water.
	Waterlogged soil	Plant in well-drained area; do not overwater.
	Verticillium wilt (fungal disease)	Rotate; plant resistant varieties; fumigate soil.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris; apply registered fungicide.
Green and yellow mosaic or mottle pattern on leaves; plants may be stunted	Viral disease (any of several)	Purchase certified, virus-free plants; remove and destroy affected plants; control insects that spread virus.
Leaves rolled or tied together; small caterpillars feeding inside	Leafrollers, leaftiers	Use biological control agent or registered insecticide.
Blueberries		
Plants stunted and discolored	Soil pH too high	Blueberries require acid pH: soil test; acidify soil as needed.
	Nutrient deficiency	Soil test; supply nutrients based on results.
	Environmental stress (drought, soil insects, moles, poor cultural practices)	Identify problem; take corrective measures.
Berries turn reddish or tan as they ripen and become shriveled and hard; blossoms turn brown and wither; new leaves' centers are black	Mummyberry (fungal disease)	Use shallow cultivation to bury mummies and destroy spore cups; control weeds; apply registered fungicide.

Table 4. A diagnostic key to berries and grapes.

Symptoms	Possible Causes	Controls
Caneberries (blackberries, boysenberries, loganberries, raspberries)		
Plants wilt; leaves turn yellow at bottom of plant first; stems turn dark blue at base; internal stem tissue may be discolored	Verticillium wilt (fungal disease)	Rotate; use certified, disease-free plants, resistant varieties; plant in well-drained area; remove and destroy affected plants.
Plants wilt with symptoms as above, but stem discoloration is not evident	Dry soil	Water.
	Waterlogged soil	Plant in well-drained area; do not overwater.
	Verticillium wilt (fungal disease)	Rotate; use certified, disease-free plants, resistant varieties; plant in well-drained area; remove and destroy affected plants.
	Root rot (fungal disease)	Rotate; plant in well-drained area; do not overwater; remove plant debris; apply registered fungicide.
Ripening berries covered with tufts of gray, green, white, or black moldy growth	Fungal fruit rot (any of several)	Pick berries regularly and cool immediately; prune for better air circulation; avoid wetting leaves; control weeds; apply registered fungicide.
White or tan spots with purple borders on canes; canes die back	Anthracnose (fungal disease)	Prune out old canes immediately after harvest; thin out weak and unproductive canes; improve air circulation.
Grapes		
Whitish or gray fungus patches on leaves and later on fruit	Powdery mildew (fungal disease)	Train and prune for better air circulation; control suckers and weeds; apply registered fungicide.
Brown angular spots on leaves; fruits decayed and dried up	Black rot (fungal disease)	Remove fruit mummies from the vines in winter; apply registered fungicide in spring and summer.
Leaf resembles a fan; main veins drawn together and teeth along margins elongated; plants stunted	Fan leaf (viral disease)	Purchase certified, virus-free stock; do not replant in same location for 10 years unless soil is fumigated; remove and destroy affected plants.
	Herbicide injury	Be careful when applying herbicides.
Strawberries		
Gray, fuzzy mold on ripening fruit.	Botrytis (fungal disease)	Space plants for better air circulation; provide drier growing conditions; do not ovefertilize; remove and destroy affected fruits; apply registered fungicide.
Plants wilt; leaves may turn brown at margins; roots and crowns look discolored when cut open	Root rot (fungal disease)	Rotate; use disease-free plants; plant in well-drained area; do not overwater; remove plant debris.
Malformed berries; looks like several berries have grown together	Fasciation, a response to environmental conditions	Common in certain varieties—may be caused by insect activity.

Note: This key is not a comprehensive list of plant symptoms, causes of damage, or controls. Refer to this chapter's general discussion of problem diagnosis and to other references for more information. Under controls, cultural, mechanical, and biological methods are listed first, chemical methods are listed last.

Table 5. A diagnostic key to ornamental trees and shrubs.

Symptoms	Possible Causes	Controls
General		
Many small twigs broken off	Squirrel damage	Squirrels prune twigs for nest-building and sometimes prune more than they need.
	Wind breakage	—
Large areas of split bark; no decay evident	Frost cracks	Use tree wrap to protect bark from winter sun and temperature extremes.
	Sunscald	Thin-barked trees, such as young ones, split when exposed to intense sunlight; use tree wrap or block sun on bright days; avoid heavy fertilization in late summer and fall.
	Mechanical injury (such as lawn mower injury)	Remove grass from around base of trunk to avoid mowing too closely.
Large areas of split bark; decay evident in wood	Secondary decay of any of the wounds described above	Remove loose bark back to live cambium so the tree can heal itself.
	Fungal or bacterial canker	Prune away affected parts; apply registered fungicide.
Gray-white, powdery growth on leaves; leaves may be distorted	Powdery mildew (fungal disease)	Improve air circulation; control weeds; apply registered fungicide.
Black, sooty growth on leaves and/or stems	Sooty mold (fungus that grows on honeydew substance secreted by aphids and other insects).	Identify insects; if aphids, spray plant with a powerful stream of water to wash off insects and mold; apply insecticidal soap or registered insecticide.
Brown, dead areas on leaf margins	Leaf scorch, caused by insufficient transport of water to leaves	Scorch usually is caused by weather, but root rots or other root damage also can be involved. Bacterial leaf scorch is a major disease of some species. Water tree deeply during dry periods.
	Cold injury	—
	Chemical injury	Chemical injury to trees is not common, but does occur. Be careful when using herbicides.
Interveinal yellowing of leaves; no wilting	Nutrient or mineral deficiency	Soil test; supply nutrients based on results.
	Iron tied up in soil because of high soil pH	Soil test; acidify soil; supply iron if needed.
	Waterlogged soil results in poor transport of nutrients to leaves	Improve drainage; do not overwater.
Large, corky galls at base of tree and on roots	Crown gall (bacterial disease)	Treat preventively with biological control agent; minimize wounds when pruning; disinfect pruning equipment between trees; improve drainage; consult an arborist about pruning out galls. Trees may live for many years in spite of galls.
Brown, gray, green, or yellow, crusty, leaf-like growths on trunk and branches	Lichens	Lichens are a combination of algae and fungi; they grow in moist, shady areas and seldom cause damage.
Early leaf drop	Environmental stress such as drought, compacted soil, or transplant shock	Provide better growing conditions.
	Various insects or diseases	Look for signs of the causal agent; control as needed.

Table 5. A diagnostic key to ornamental trees and shrubs.

Symptoms	Possible Causes	Controls
General browning of conifer needles	Drought	Water deeply during dry weather.
	Transplant shock	Water regularly after transplanting.
	Girdled roots	Be sure main roots are not curled around themselves when transplanted; remove all strings and wraps before planting.
	Plant is root-bound	Cut container root ball in several places before transplanting.
	Dog urine injury	—
	Fungal disease	Check Midwest Plant Disease Management Handbook.
Yellow and green mottle or mosaic pattern on leaves; leaves may be distorted	Viral disease	No controls; may need to remove plant if virus spreads easily.
Sunken cankers on trunk or branches; plant may wilt or show poor growth	Fungal or bacterial canker	Prune away affected limb or bark areas.
Oozing sap on trunk	Insect borers	Check Midwest Insect Management Handbook.
	Mechanical injury	Prevent lawn mower or weed trimmer injury.
Leaves chewed or completely eaten	Various caterpillars, sawflies, leaf beetles, etc.	Identify pest; use biological control agent; apply registered insecticide while insects are young and before damage is extensive.
Scurfy, scalelike structures tightly attached to leaves, twigs, or branches	Various scale insects	Check Midwest Insect Management Handbook for types of scale that might be on the particular plant; use biological control agent; spray with dormant oil during winter to destroy eggs.
Young leaves puckered, curled, or distorted; clear, sticky substance on leaves; clusters of small insects on underside of leaves	Aphids	Check Midwest Insect Management Handbook; remove insects with powerful water spray; use biological control agent.
Leaves off-color with tiny white or yellow spots; may appear dirty due to fine webbing and collected dust	Spider mites	Check Midwest Insect Management Handbook; use predatory mites.
Birches		
Leaves sparse, especially at top of tree; swollen ridges in bark	Bronze birch borers	Apply a registered insecticide between late May and early June.
Leaves with pale blotches of varying size and shape	Birch leafminers	Treat with registered insecticide when first leaves are fully formed.
Dogwoods		
Large, brown, irregularly shaped blotches on leaves; dead leaves hang on through winter	Anthracnose (fungal disease)	Prune and destroy affected twigs; rake and burn fallen leaves; avoid wetting canopy; apply registered fungicide.
Native trees die, bark sloughs away	Collar rot (fungal disease)	Avoid damaging trunks with lawn mowers, etc.; remove loose bark; avoid wetting trunk.
Leaf petiole curls; leaf curls upward, sometimes discolors	Environmental stress	Dogwood leaves may curl from lawn herbicides, too much water, or many other stress conditions.
Junipers		
Entire plant dies	Root rot, probably Phytophthora	Remove plant debris; rotate; plant in well-drained area; do not overwater.
Twigs die	Juniper twig blight (fungal disease)	Prune and burn affected twigs; improve air circulation; avoid wounding twigs or wetting foliage; apply registered fungicide.

Table 5. A diagnostic key to ornamental trees and shrubs.

Symptoms	Possible Causes	Controls
Twigs webbed together tightly; affected twigs turn brown in warm weather	Juniper webworm	Apply registered insecticide in early spring.
Twigs appear clubby and gall-like; entire plant appears more compact than normal	Juniper tip midge	Apply registered insecticide.
Defoliation	Bagworms	Apply registered insecticide.
Maples		
Irregular, brown spots on leaves (on Norway maple, brown areas follow leaf veins); tree otherwise healthy	Anthracnose (fungal disease)	Rake and destroy fallen leaves; destroy cankered twigs; apply registered fungicide.
	Scorch, caused by hot, dry weather Note: Anthracnose can be confused with scorch if leaf spots have enlarged and run together. In early stages, it should be possible to distinguish between the two; scorch is mainly at leaf margins.	Water tree deeply.
Brown, dry areas on margins of leaves in late summer. Tree may decline	Scorch, caused by bacterial leaf scorch.	Water deeply to reduce disease impact. There is no cure for bacterial leaf scorch.
Leaves on tree suddenly wilt, may turn yellow and drop off; wilt may occur on one side of tree only; tree may die suddenly or decline over period of years; no external trunk or branch damage evident; some branches may have brown streaks in wood	Verticillium wilt (fungal disease)	Avoid heavy fertilizing, which produces soft, succulent growth; prune away dead branches; don't replant the site with a susceptible species; disinfect tools when pruning.
	Drought	Water deeply.
Small, red, green, or black globular growths on upper leaf surfaces	Gall mites	No control; harmless in most cases.
Oaks		
Brown, dry areas on leaf margins in late summer. Trees decline over several years.	Bacterial leaf scorch	Water trees as needed to reduce disease impact. There is no cure for bacterial leaf scorch.
Defoliation	Various caterpillars, some beetles	Stressed trees may benefit from application of a registered insecticide.
Galls: irregular growths on leaves or twigs	Various wasps, mites, gnats	No control needed
Pines		
Rough, elongated, swollen areas develop on trunks and branches; orange-colored spore masses burst through the cankered bark	White pine blister rust (fungal disease)	Prune away affected branches; rate planting sites for blister rust hazard; plant resistant varieties in high-hazard sites; don't plant near currants or gooseberries.
Rough, globular galls on trunk and branches covered with orange spores in late spring	Eastern gall rust (fungal disease)	Remove galls where practical.
Chlorotic spots appear on affected needles in fall and winter; far end of needle turns reddish-brown, while base remains green	Red band needle blight (fungal disease)	Prune out dead and dying branches; clean up plant debris under tree; provide good drainage and air circulation; control weeds.
During spring, last year's needles turn yellow, then brown, and drop; football-shaped fruiting bodies form on affected needles	Lophodermium needle cast (fungal disease)	Provide good air circulation; control weeds; clean up plant debris under tree; apply registered fungicide.
Holes in bark, sawdust on trunk or at base of tree	Various borers	Preventive insecticide applications. Promote tree health.
Needles at tips of twigs turn yellow, become deformed and stunted	Eriophyid mites	Apply registered insecticide.
Defoliation, often from top down	Various sawflies	Apply registered insecticide.

Table 5. A diagnostic key to ornamental trees and shrubs.

Symptoms	Possible Causes	Controls
Rhododendrons and Azaleas		
Fleshy, thick, white galls form on leaves and/or flowers	Azalea leaf and petal gall (fungal disease)	Pick off and destroy galls; apply registered fungicide.
General leaf yellowing on all or part of plant	Nutrient deficiency	Possible lack of nitrogen; review fertilizing program.
Chlorosis of newest leaves and terminal growth	Nutrient deficiency (possibly iron deficiency due to high soil pH)	Use sulfur to lower pH; use appropriate iron compounds to supply iron.
Chlorosis of second-year and older leaves.	Nutrient deficiency (possibly magnesium deficiency)	Soil test; supply magnesium based on results.
Leaf browning, especially on leaves exposed to wind or strong sunlight	Winter injury	Very common on rhododendrons in early spring.
	Scorch, caused by hot, dry weather	Supply water and/or shade.
	Phytophthora root rot	Rotate; plant in well-drained area; do not overwater; remove plant debris.
Leaves with yellow specks on upper surface; black, shiny spots underneath	Lace bugs	Remove by hand if population is low; apply registered insecticide.
Leaves notched	Root weevils	Use predators, baits, or beneficial nematodes; apply registered insecticide.
Roses		
Black, circular spots with feathery edges surrounded by yellow halo on leaves; leaves drop	Black spot (fungal disease)	Avoid wetting foliage; rake and destroy affected leaves; prune affected canes back to two buds; improve air circulation; apply registered fungicide.
Pustules containing orange or brown, powdery spore masses appear on lower leaf surfaces first and then upper leaf surfaces	Rust (fungal disease)	Remove and destroy affected leaves; remove plant debris; apply registered fungicide.
White, powdery fungal growth on young leaves; distortion is common.	Powdery mildew (fungal disease)	Improve air circulation; control weeds; remove plant debris; use registered fungicide.
Various patterns of yellow and green on leaves, including streaks, rings, vein-clearing (yellow veins), or blotches	Viral disease	Common on roses; these viral diseases generally enter through grafts and are not transmitted from plant to plant; buy healthy plants; maintain vigor by proper care of shrub.
	Nutrient deficiency	Soil test; supply nutrients based on results.
Spruce		
Needles turn yellow in late winter and brown as weather warms; drop off in late spring, leaving bare branches	Spruce aphids	Apply registered insecticide.
Older, inner needles of branches appear speckled with dull yellowish blotches; later, needles turn brown or purple from tips back and drop; rows of tiny, black specks on needles are visible with a magnifying glass	Rhizosphaera needle blight (fungal disease)	Space plants adequately for better air circulation; remove plant debris; avoid wetting foliage; do not prune when foliage is wet; apply registered fungicide.

Note: This key is not a comprehensive list of plant symptoms, causes of damage, or controls. Refer to this chapter's general discussion of problem diagnosis and to other references for more information. Under controls, cultural, mechanical, and biological methods are listed first, chemical methods are listed last. Most problems of ornamental trees and shrubs can be diagnosed from the list of general problems; only very common problems specific to certain plants are listed under specific plants.

Table 6. A diagnostic key to annual and perennial flowers.

Symptoms	Possible Causes	Controls
General		
Plants wilt; flowers may drop; leaves may turn yellow	Dry soil	Water.
	Waterlogged soil	Improve drainage; do not overwater.
	Transplant shock	Do not transplant during hot, sunny weather; water regularly after transplanting.
	Root, stem, or corm rot (fungal or bacterial disease)	Plant in well-drained area; do not overwater; destroy affected plants.
	Soil-inhabiting insect pests	Look for and identify problem insects; check Midwest Insect Management Handbook for controls.
Seedlings wilt; stems turn brown and soft and may be constricted at the soil line	Damping-off (fungal disease)	Plant in well-drained area; improve air circulation; allow soil to dry slightly between waterings; apply registered fungicide in early stages.
Plants fail to flower; foliage looks healthy	Wrong season	Plants have specific day-length requirements for flowering.
	Cool weather	Wait for warmer weather.
	Insufficient light	Do not plant sun-loving plants in shade.
	Too much nitrogen	Do not overfertilize; nitrogen stimulates foliage growth, sometimes at the expense of flower production.
	Immature plants	Biennials and young perennials often do not flower the first year.
Tall, "leggy" plant; stem and foliage pale or yellow	Insufficient light	Do not plant sun-loving plants in shade.
General yellowing of leaves; yellowing may be interveinal; plant may be stunted; no wilting	Nutrient deficiency	Soil test; supply nutrients based on results.
	Viral disease (any of several)	Check Midwest Plant Disease Management Handbook for specific crop susceptibility to viruses.
Grayish-white, powdery growth on leaves	Powdery mildew (fungal disease)	Plant resistant varieties; improve air circulation; control weeds; apply registered fungicide.
Pustules containing orange, yellow, or brown, powdery substance on leaves	Rust (fungal disease)	Plant resistant varieties if available; remove and destroy affected leaves; avoid wetting foliage; remove debris; apply registered fungicide.
Flowers wilt or fail to open; grayish mold appears on flowers in moist weather	Botrytis gray mold (fungal disease)	Remove and destroy affected flowers; improve air circulation; apply registered fungicide.
Yellow and green mottle or mosaic pattern on leaves	Viral disease (any of several)	Use resistant varieties; control insect vectors; remove and destroy affected plants.
Tiny, white dots (stippling) or white, interveinal areas on leaves	Spider mites	Use predatory mites; apply insecticidal soap or registered miticide.
Clusters of insects on stems or underside of leaves; leaves may be curled or distorted	Aphids	Pick off, mash, or wash away insects; encourage insect predators; apply insecticidal soap or registered insecticide.
Leaves chewed or completely eaten	Various insects	Check Midwest Insect Management Handbook for specific plant and controls.
	Slugs	Look for slime trails; use slug barrier or bait.
Light-colored tunnels or blotches in leaves	Leafminers	Remove and destroy affected leaves. Check Midwest Insect Management Handbook for specific plant and controls.
Tiny, white-winged insects on underside of leaves	Whiteflies	Use yellow sticky traps; apply insecticidal soap or registered insecticide.
White, cottony masses on leaves or stems	Mealybugs	Use biological control agent; apply registered insecticide.

Table 6. A diagnostic key to annual and perennial flowers.

Symptoms	Possible Causes	Controls
Chrysanthemums		
Flowers greenish instead of normal color; upper branches of flowering stem are yellowish and upright	Aster yellows (phytoplasma disease)	Control insect vectors; destroy affected plants.
Yellowing and wilting of foliage; leaves die from base of plant upward; discolored brown areas in stems	Verticillium wilt (fungal disease)	Use resistant varieties if available; obtain cuttings only from healthy plants; rotate; remove and destroy affected plants early.
Geraniums		
Corky, raised spots on lower leaf surfaces.	Oedema, a physiological problem associated with overwatering	Do not overwater.
Plants wilt; brown or black rotted area evident at base of stem; brown spots may be present on leaves.	Fungal or bacterial root or stem rot (any of several)	Plant in well-drained area; do not overwater; remove dead plants.
Iris		
Leaves turn yellow and wilt; if pulled gently, leaves detach from plant; soft, slimy, smelly rot at base of plant	Bacterial soft rot (bacterial disease)	Dispose of affected plants and rhizomes; divide plants frequently to avoid overcrowding; avoid wounding rhizomes; dry rhizomes in sun before replanting.
Small, brown spots with water-soaked edges; spots may run together; leaves may die	Leaf spot (fungal disease)	Improve air circulation; lime soil to raise pH above 6.0; remove and destroy affected plant parts; apply registered fungicide.
Marigolds		
Leaves yellow; plants wilt and die.	Fusarium wilt (fungal disease)	Improve soil drainage and air circulation; rotate; destroy affected plants; drench beds with registered fungicide.
	Wet, cold soils	Delay planting until conditions are right.
Leaves discolored and look dusty with tiny webbing.	Spider mites	Wash off foliage with water frequently; use predatory mites; apply insecticidal soap or registered miticide.
Leaves reddish, smaller than normal.	Lack of nutrients	Provide nitrogen fertilizer.
Narcissus (daffodils)		
Water-soaked areas that enlarge and wither on flower edges; later, small, elongated spots that turn brown on leaves; leaves may die	Fire (Botrytis) (fungal disease)	Rotate out of area for 2 years; improve air circulation; remove and destroy affected parts; apply registered fungicide.
Spots appear on top 2 to 3 inches of leaves as they emerge; leaves die	Leaf scorch (fungal disease)	Rotate to new planting site each year; apply registered fungicide.
Leaves have light green, grayish-green, or yellow stripes or mottles	Yellow stripe (viral disease)	Control insect vectors; remove and destroy affected plants.
Flowers smaller than normal; white streaks or blotches may appear	White break (viral disease)	Control insect vectors; remove and destroy affected plants.
Plants smaller than normal; fewer flowers than normal; plants die	Narcissus bulb flies	Dig and inspect bulbs at least every 2 years; discard those that are infested.
Peonies		
New shoots wilt and turn black; flowers, buds, leaves, and stems turn brown and leathery; gray, fuzzy mold may appear in wet weather	Botrytis blight (fungal disease)	Prune out affected parts; improve air circulation; remove plant debris; do not use mulch in spring when plants are emerging; apply registered fungicide.
	Frost damage	Provide cover.

Table 6. A diagnostic key to annual and perennial flowers.

Symptoms	Possible Causes	Controls
Tulips		
Stems are very short and flowers bloom at ground level	Warm spring and/or inadequate winter cooling	After digging bulbs, chill them in refrigerator before replanting.
Light or dark spots on leaves and flowers; spots enlarge to form large, gray blotches; fuzzy, brown or gray growth appears on spots during wet weather; leaves and stems distorted	Botrytis blight (fungal disease)	Rotate; improve air circulation; destroy affected plants; apply registered fungicide.
Flowers streaked, spotted, or mottled in an irregular pattern; leaves also may be streaked or mottled	Viral disease (any of several)	Many of the stripes in tulips are caused by viral diseases, but some may be desirable; either destroy the affected plants or put them far enough away from others to prevent spread of disease; control insect vectors.
	Thrips (tiny insects that feed on emerging flowers)	Use biological control agent, insecticidal soap, or registered insecticide.
Zinnias		
Off-color lesions near base of plant followed by white, cottony growth on stems; plant wilts and dies	Stem rot (fungal disease)	Space plants for better air circulation; remove and destroy affected plants; apply registered fungicide.
Plants wilt; no sign of root rots or stem disorders	Dry soil	Supply moisture.
	Soil too wet	Improve drainage; do not overwater.

Note: This key is not a comprehensive list of plant symptoms, causes of damage, or controls. Refer to this chapter's general discussion of problem diagnosis and to other references for more information. Under controls, cultural, mechanical, and biological methods are listed first, chemical methods are listed last. Most problems of annual and perennial flowers can be diagnosed from the list of general problems; only very common problems specific to certain plants are listed under specific plants.

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