

A pple pest management for home gardeners

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Apple trees are popular in yards and gardens throughout Wisconsin. However, the moist, temperate climate of Wisconsin favors a number of disease and insect pests that must be managed in order to produce high-quality fruit. Managing pests will also make trees more tolerant of drought and cold and thereby prolong tree life.

This bulletin outlines basic principles of pest management. While this is not a guide to organic fruit production, where possible we have included strategies that do not rely on pesticides (chemicals that kill pests). Pesticides are often used by commer-

cial apple growers because many of the non-chemical pest management methods are impractical for a large orchard. Home gardens, however, usually contain only a few trees, and non-chemical methods should form the backbone of pest management. Limiting pesticide use in the home garden is desirable for the health of people, animals, and the beneficial microbes and insects, which far outnumber the pests. Successful pest management using few or no pesticide sprays depends on understanding the pests' life cycles and weather conditions that favor their survival and growth. Further information on growing apples can be found in the publications listed on page 12.

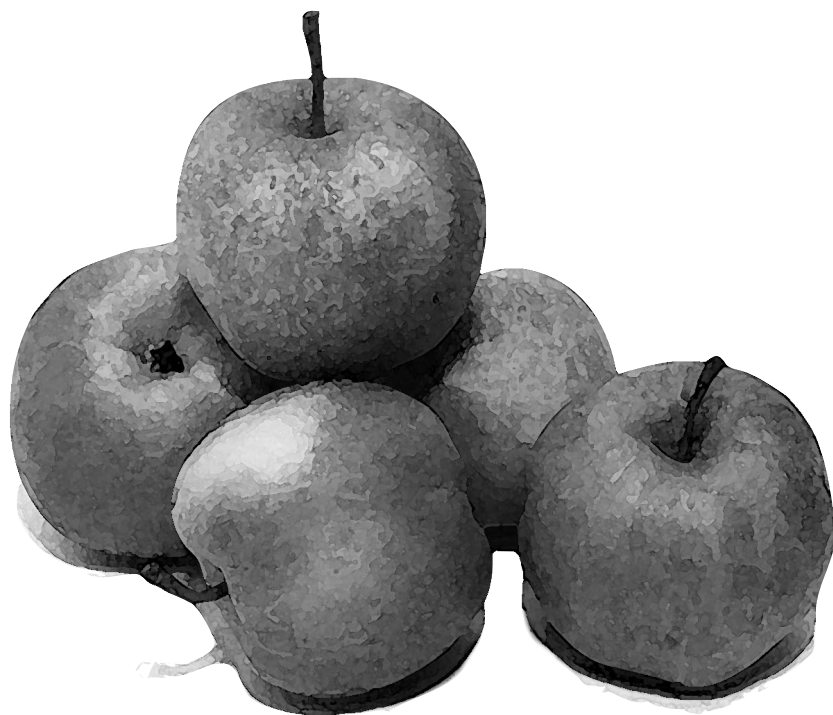
General pest management strategies

Most people think about pest management when they find wormy or scabby apples at harvest. Unfortunately, this is too late to manage the pests that have already damaged the fruit. Pest management is a season-long endeavor that should begin even before apple trees are planted. Choosing a suitable planting site, fertilizing as needed, and training and pruning will help trees resist, or at least tolerate, the onslaught of pests. Some general approaches to pest management are described below. Most commercial apple growers enjoy their greatest success when they use a combination of these methods in an integrated pest management (IPM) program. IPM is also successful in the home garden and yard.

Disease-resistant varieties

The cheapest, safest, and simplest way to manage pest problems is to avoid them. The most serious diseases of apple can be avoided by planting disease-resistant varieties purchased from a reputable nursery. In Wisconsin the need for fungicides (pesticides used to control diseases caused by fungi) can be eliminated completely in most years by planting apple varieties resistant to apple scab. See Extension publication *Apple Cultivars for Wisconsin* (A2105) for information on the relative resistance of apple varieties to diseases.

While no apple cultivars specifically resistant to insects have been



Is organic apple production for you?

It's difficult to get a high yield of undamaged apples using truly organic methods. Even commercial organic orchards may experience losses of 25% or more, and they rely on relatively labor-intensive methods. In some cases, frequent applications of approved organic fungicides and insecticides are needed. If you are willing to use conventional insecticides, you can usually harvest a reasonably good crop with relatively few insecticide applications. In fact, in Wisconsin, it's likely that you can produce better-quality fruit with fewer applications using synthetic pesticides rather than approved organic pesticides. This is especially true if growing varieties that are susceptible to apple scab.

developed, some varieties are more tolerant than others to certain types of pests. For example, apple maggot tends to be more of a problem on early-maturing summer varieties rather than on varieties that mature later in the year.

Intervention

Intervention includes trapping insects to prevent them from damaging fruit (trapping is described in the insect section). Intervention also includes removing or eliminating alternate hosts and reservoirs for pests. For example, raspberry and blackberry canes can harbor the fungi that cause flyspeck and sooty blotch on apple fruit. Juniper is the alternate host for rust diseases of apple. Wild plum is an important host for plum curculio, which also attacks apples. Obviously, it is not always possible or

desirable to destroy other plants for the sake of a few apple trees!

Sanitation

Many disease and insect pests reproduce or spend the winter on dropped fruit or dead leaves and branches. Therefore, it is a good practice to remove fallen fruit and leaves and dead or broken branches. Insects that infest fruit complete their life cycle after the fruits have fallen to the ground; such fruit should be picked up and destroyed as soon as possible to remove the insects before they complete their life cycle.

Pesticides

Pesticides can be applied either preventatively (i.e., before pests or damage are expected) or curatively (i.e., after pests have just reached the level at which they start to cause damage). The preventative approach

is relatively easy because you don't have to take the time to monitor and identify pests. However, this method can be expensive and wasteful because sprays are applied at weekly or bi-weekly intervals, regardless of whether or not pests are present. The curative approach is kinder to the environment, especially beneficial insects and microbes, but it requires monitoring pest numbers and the weather, and understanding pests' life cycles. For optimal tree health and your personal safety, always follow instructions on the product label.

Diseases

Several different species of fungi, bacteria, water molds, and viruses cause diseases of apple trees. Fungi cause most of the diseases found on apple trees in home gardens. An important exception is fire blight, which is caused by a bacterium. Diseases caused by viruses are usually not a problem on apple trees in Wisconsin and can be avoided by purchasing high-quality stock from reputable nurseries.

The life cycles of fungi, water molds, bacteria, and viruses are very different, as are the approaches to disease management. Knowing which type of pathogen you're dealing with is necessary to adopt suitable management strategies. Many apple diseases also occur on crabapple, pear, and related ornamental trees; these plants will be continuing sources of inoculum if you don't manage their diseases as well. Some of the more common diseases and their management are described briefly below. For more information, refer to bulletins and web sites listed at the end of this publication. Your county Extension office can assist you in diagnosing diseases and other pests.

■ Apple scab

Apple scab is by far the most common disease of apple and crabapple trees in home gardens and yards. Fruit with scab have unsightly brown to black lesions and, in severe cases, deep cracks. Pear trees also get scab, but the pear scab pathogen does not infect apple. Planting scab-resistant varieties is the best way for the home gardener to manage scab. Otherwise it is nearly impossible to produce blemish-free apples without applying fungicides.

The scab fungus overwinters in fallen leaves. In the spring, fungal spores are ejected from leaves on the ground. Thus, raking leaves in the fall and again in the spring as soon as the snow melts will help reduce the disease. Apple leaves are susceptible to infection as soon as buds show green tissue in early spring. Infection can occur at temperatures as low as 40°F if trees remain wet for several hours. Thousands of new spores are produced within a single scab lesion, and each spore is capable of starting a new infection. Therefore, if early-season infections are not prevented, scab will be a problem all season long, resulting in early defoliation and unattractive fruit. A tree with severe scab will be prone to cold injury in the subsequent winter and might not produce fruit the following year.

Management. If you have varieties that are susceptible to scab, the first fungicide spray should be applied when buds show 1/4 to 1/2 inch of green tissue, especially if the weather is rainy or foggy, or rain is predicted. (If the spray has had time to dry following application, a moderate rain will not wash it off.) Most fruit tree fungicides found in garden centers are “protectants,” meaning they should be applied before infection.

Fungicides should be applied every 7 to 14 days through petal fall, unless the weather is exceptionally dry. If there are no scab lesions showing on leaves and young fruit by 4 weeks after petal fall, then no more sprays will be needed to control this disease. However, if scab has developed, additional sprays will be necessary to prevent fruit infections. Most fruit tree fungicides are formulated specifically with scab in mind.

■ Fire blight

Fire blight can be deadly to apple trees and related plants. In highly susceptible varieties, the disease is almost impossible to control after it has become established and the weather is warm and wet.

Fire blight is caused by a bacterium that infects plants through flowers and soft, succulent shoots and then spreads internally throughout the tree.

Management. Apple varieties and rootstocks differ greatly in their level of resistance to fire blight. If the rootstock becomes infected, the tree is likely to die. Therefore, you should especially avoid susceptible varieties grafted to susceptible rootstocks. Excessive nitrogen fertilization also should be avoided, as this promotes lush new growth, which is highly susceptible to fire blight.

If fire blight infections are few, they can be pruned out during the growing season by cutting at least 10 inches (more is better) below visible symptoms. If there are too many infections to remove, it's best to postpone pruning until winter when the bacterium is not active.

Chemicals have been inconsistent in controlling fire blight. Copper compounds (e.g., Bordeaux mixture) may help kill bacteria that ooze from cankers in the spring. The antibiotic

streptomycin protects flowers from infection but does not control fire blight after symptoms have developed.

For more information about this disease, see Extension publication *Apple, Pear, and Related Trees Disorder: Fire Blight* (A1616).

■ Flyspeck and sooty blotch

Flyspeck and sooty blotch appear in late summer as clusters of black dots (flyspeck) and black, sooty smudges (sooty blotch) on fruit. The diseases affect yellow and red apple varieties similarly, but are much more noticeable on lighter-colored apples. The fungi remain in the peel and do not affect the taste or texture of the fruit. The fungi that cause flyspeck and sooty blotch overwinter on many woody plants, especially raspberry and blackberry canes. Dead or weakened apple wood (e.g., fire blight cankers) can also serve as a reservoir for the fungi. Spores are spread by wind and rain during the summer. Disease development is favored by extended rainy periods, especially when evening temperatures are warm (65° to 70°F) and humid.

Management. To the extent possible, remove any undesirable woody plants, since these are potential reservoirs for the fungi. Prune trees to promote air circulation and drying of fruit and foliage.

■ Powdery mildew

Powdery mildew is a common disease that can occur on almost all yard and garden plants. Unlike scab, however, powdery mildew is not a major problem on apple every year in Wisconsin. The fungus that causes powdery mildew on apple is different from the species that infect other plants such as lilacs and roses.

Management. Although the powdery mildew fungal spores do not require rain to germinate and

infect, infection is favored by humid conditions following rain. Therefore, to promote air circulation and reduce relative humidity within the tree canopy, prune trees in late winter. Many of the scab-resistant varieties are also fairly tolerant of powdery mildew. The fungus overwinters in apple buds and survives best during mild winters and on apple trees growing near heated buildings. The powdery mildew fungus becomes active when shoot growth starts in the spring, and this is when chemical control is most effective.

■ **Phytophthora root and crown rot**

Phytophthora root and crown rots are caused by various species of the water mold *Phytophthora*. Several species of *Phytophthora* are common in Wisconsin soils, but they only cause problems for apple trees if the soil and/or base of the tree remain wet for several days at a time. Such conditions are more common in fall or spring, and this is when *Phytophthora* is most active. *Phytophthora* can cause root rot or cankers on the trunk at or just below the soil line (known as the

“crown”). Leaves on affected trees are generally

small and pale during early summer and turn reddish in late summer. Because apple trees can regenerate roots, a tree can recover from root infection if soils are moist but not saturated. Trees with crown rot may survive for a few years, but they generally do not recover.

Management. Prevention is the best way to manage this disease. It is critical to choose a well-drained site where water does not pool after heavy rains. Planting in light, sandy soil is ideal. If soil is heavy, choose relatively resistant rootstocks such as M.9, Mark, Bud.118, Bud.9, and the Geneva (“G”) series; avoid highly susceptible rootstocks such as MM.106 and M.26. Heavy mulching keeps soil wet and should be avoided if drainage is less than ideal. Plastic trunk guards should be loosened or removed during prolonged wet periods. The area surrounding the trunk should be kept free of tall grass and weeds that will retain moisture.

Managing *Phytophthora* diseases of apple with chemicals is usually ineffective, and the products available for this purpose generally are not carried by garden centers.

■ **Rust diseases (cedar apple rust, quince rust, hawthorn rust)**

Rust diseases of apple are caused by several related species of fungi. The rust fungi depend on various species of juniper (especially *Juniperus virginiana*, the eastern red cedar) to complete their life cycles. In the spring, fungal spores are carried up to a few miles from junipers to apple trees. Obviously, eliminating all juniper trees in the vicinity of your apple trees is not practical.

Management. Several apple varieties are highly resistant to cedar apple rust and should be used if eastern red cedars are abundant in the

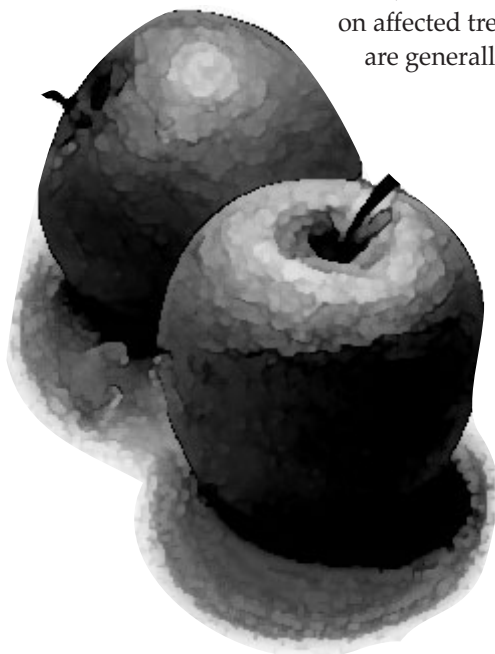
area. Unlike apple scab, rust lesions on apple do not produce spores that can re-infect apple; only spores from junipers will infect apple leaves and fruit. If fungicide sprays are used, they should be applied every 10 to 14 days, especially if rain is anticipated, starting when apple flower bud clusters are separated (open cluster stage) through about a month after petal fall.

Insects and mites

Over 50 types of insects and mites are known to damage apple trees and fruit, but a much smaller number routinely cause sufficient damage to be of concern to home orchardists. Different types of pests can attack the root system, the trunk and branches, the leaves, and the fruit. Those pests that directly attack the fruit are of biggest concern in home apple production. There are four or five very common pests that directly attack apple fruit, sometimes making the fruit totally unusable. It is difficult to control some of these pests without at least some insecticide use. Apple insects are so common that it is impossible to grow fruit without some losses unless control methods are used.

How much control is needed?

For many people, a few bushels of quality fruit are sufficient, especially if they don’t have a way to store them. If these are your expectations, you will be able to grow apples with minimal insect control. On the other hand, if you wish to produce a large crop of high-quality fruit, your insect control program will need to be more rigorous. People also have differing views on the use of pesticides. While many are comfortable with the margin of safety required by federal agencies, which is reflected in the label directions, others are more cautious and would prefer to use fewer



pesticides. Some people are comfortable with “organic” pesticides whereas others would prefer to use no pesticides at all.

We’ve organized the control discussion for each pest to reflect the different options available, from a conventional insecticide-use program to options that are less dependent on such products. Keep in mind that for some major pests, “least toxic” options may be fairly ineffective or completely unavailable. Also be aware that organic insecticides are not nontoxic; indeed, pyrethrum, an approved organic insecticide, is actually more hazardous to humans than is malathion, a commonly used synthetic insecticide. Further, because many organic insecticides break down very rapidly after they are sprayed, they often have to be used more frequently than synthetic insecticides to achieve the same level of control.

You should be able to get a high percentage of good quality fruit with only two to four insecticide applications per year, especially if you are willing to use conventional insecticides that generally provide up to 2 weeks of protection. The critical spray periods are at petal fall and 2 to 3 weeks after, and then from mid-July to mid-August. For more detailed spray timing, refer to the table.

Insect monitoring. One way to achieve good insect control with minimal use of pesticides is to examine the trees regularly to evaluate levels of pest activity. For example, very small developing fruit should be examined every 3 to 4 days for about 2 to 3 weeks after flowering to look for crescent-shaped slits caused by plum curculio. This damage is readily seen. If an unacceptable number of fruit are being damaged, control should begin immediately.

One method of monitoring when certain insects are present is to use insect traps. (A list of suppliers is provided at the end of this publication.) For moths such as leafrollers, codling moth, and leafminers, use sticky traps baited with a synthetic version of the insect’s mating pheromone. These traps catch only males, not the egg-laying females, and therefore are not effective for control. However, by knowing when the insects are flying, you’ll know when eggs are being laid and when insecticides should be used. If you keep track of the numbers of insects trapped from year to year, you’ll also know whether a particular pest is more abundant than normal. Apple maggot traps are red sticky spheres that mimic a ripe apple; they are baited with an odor similar to ripe fruit. Unlike sticky traps, this type of trap can be used both to monitor and control apple maggots.

The most serious fruit pests of apple occur throughout the entire growing season, from the time the fruit start to develop until harvest. Plum curculio and leafroller damage can begin a day or two after petal fall; codling moth starts about 5 to 10 days later, with a second generation in summer; and apple maggot damage can be seen from early July into September. It’s important to know which of these insects are causing problems—only then will you be able to develop a control program that is most effective but with the least input. Your county Extension office will be able to help you diagnose insect injury.

Fruit-damaging insects

The most troublesome insects for home apple growers are those that directly attack the apple fruit. Following are brief summaries of the biology, damage, and control of the

most commonly encountered apple pests. More detailed information on these and other insects is found in the bulletin *Growing Apples in Wisconsin* (A3565).

■ Apple maggot

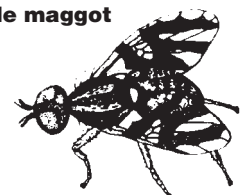
The adult apple maggot is a fly that lays its eggs under the skin of ripening apples. The eggs hatch into tiny maggots (called railroad worms) that tunnel through the fruit, leaving discolored trails. As the fruit starts to decompose, it falls from the tree. Apples that are infested at harvest may appear sound, but will rot in storage. There is one generation per year, but the egg-laying period is lengthy, from early July to late August or even early September. Early-maturing varieties tend to be more readily attacked than late-maturing varieties.

Management. Apple maggot is probably the most serious insect problem affecting Wisconsin home apple production. The apple maggot fly is a strong flier that disperses readily to find new plantings to infest. If left uncontrolled, a substantial proportion of fruit will often be attacked. Hawthorn fruits are the natural host of apple maggots and may serve as a reservoir of apple maggots; wild and untended apple trees also serve as reservoirs.

Low toxicity control program.

Apple maggot is the only apple pest that can be controlled fairly effectively by trapping. Female flies are attracted

apple maggot



to baited, sticky red spheres. Hang traps in trees about 5 feet above the ground by the first of July. Maintain traps through early September by replenishing the lure (check package instructions for timing), and by cleaning the traps and reapplying sticky material if they become coated with insects, leaves, or dirt. For best control, use one trap per 50 to 100 fruit.

Intermediate to conventional insecticide program. Approved organic insecticides are relatively ineffective against this pest because they break down rapidly after spraying and the adult flies are strong fliers capable of rapidly reinfesting trees from other areas. Conventional insecticides remain active for about 2 weeks after spraying and therefore provide longer control with fewer applications.

Apple maggot traps can be used for monitoring as well as control. For monitoring, only a couple of traps are needed for a small home orchard. Place traps in trees in late June and inspect twice weekly for apple maggot flies. For optimal control, apply a spray as soon as the first fly is caught. Conventional insecticides need to be applied only at 2-week intervals, regardless of whether or not additional flies are caught in the traps. Continue spraying every 2 weeks as new flies are trapped. If you prefer not to use traps, spray during the first week in July and repeat at 2- to 3-week intervals until the end of August. Generally, relatively good results can be obtained with a series of three applications about 3 weeks apart, in early July, late July, and mid-August.

■ Caterpillars—leafrollers and green fruitworms

There are several types of caterpillars (moth larvae), all of which cause similar damage. Most injury occurs soon after fruit set, when the larvae feed on the fruit surface, removing the skin and underlying flesh. The damage usually heals, leaving a brown, corky, surface scar, but with the remainder of the affected fruit sound and usable. These insects also feed on foliage, especially before, during, and shortly after the blossom period, but foliage feeding is usually not extensive enough to hurt the tree, or to reduce fruit quality or yield.

Management. Caterpillars are frequently attacked by beneficial natural enemies, including many types of predatory and parasitic insects. Therefore, although there usually are some caterpillars present, generally the numbers are fairly low and damage is less than 5 to 10%. In severe outbreaks, however, damage may be much greater. Because the injury is only on the fruit surface and the wound usually is self-healing, the damage is easily cut away when the harvested fruit are being prepared for use. Therefore, many home apple growers may choose to ignore this damage and not do anything to control these insects.

Low toxicity control program. Do nothing and accept that some fruit will be damaged, but that these apples can be used for sauce or baking. However, keep an eye on the amount of damage from year to year; if populations build it may be necessary to treat.



caterpillar

Intermediate insecticide program. Sprays containing the living bacterium *Bacillus thuringiensis* (Bt) are effective for controlling leafrollers and fruitworms, and are considered safe and acceptable for organic production. Several brands are available; check with your local garden center. Spray residues are very short-lived and applications must be applied once before bloom, once during bloom (Bt does not harm pollinators), and once or twice immediately at the end of the blossom period.

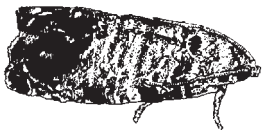
Conventional insecticide program. Conventional insecticides effectively control these insects; refer to the table. The most important control time is just after bloom (at petal fall); delays will result in some fruit scarring. *Conventional insecticides must not be used during bloom to protect pollinators.* Occasionally a second generation of leafrollers hatches in midsummer; these can also be controlled with conventional insecticides.

■ Codling moth

This is the proverbial “worm in the apple.” The damage is easily recognized by the rotted core with a single straight tunnel to the outside, where the insect piles its waste material. The larva is often pinkish in color and grows to about 2/3 inch long. There are usually two generations per year, the first when fruit are young and the second in mid- to late summer. Infested fruit begin to rot internally and often fall from the tree before ripening.

Management. This is a very common insect and one of the most serious pests of apple. It is not unusual to see nearly the entire crop infested in areas where the population is high and no controls have been applied.

Low toxicity control program. There are no good options for low input control. This is a very common pest but tends to be more of a problem in some areas than in others. Codling moth females are relatively weak fliers, and if your fruit trees are isolated from sources of infestation you may be able to successfully produce sound fruit for many years.



codling moth

“Windfall” fruit that drop from the tree early are often infested with insects, usually either codling moth or apple maggot. These should be picked up as soon as they fall and discarded, destroyed, or deeply buried. If burying, cover apples with at least 12 inches of soil. Leaving fruit on the ground or putting them whole onto a compost pile will allow insects to complete their life cycle, resulting in further infestation.

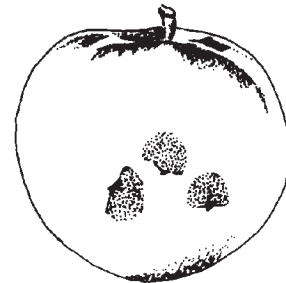
However, it is likely that they will eventually become infested. Be sure to pick up and destroy fallen fruit.

Intermediate insecticide program. Conventional insecticides are the best option for controlling codling moth; see the table. If the level of infestation in your area is moderate to low, and you are willing to tolerate some fruit loss, two to four insecticide applications per year (one for each generation) may be sufficient. However, these need to be properly timed.

Because the insects spend only a very brief time on the outside of the fruit, a protective layer of residual insecticide must be present on the fruit when the eggs hatch. The first egg-laying period starts around the end of flowering and continues for 2 to 3 weeks. If you wish to make only a single application, it should be timed for about 5 to 10 days after the end of bloom. You will get better control of the first generation with two applications, the first made at about 7 days after petal fall and the second about 2 weeks later. It is difficult to say exactly when egg laying for the second generation will occur because of yearly differences in temperatures. For precise timing of sprays for both generations, use pheromone monitoring traps, as described in the insect monitoring section.

Conventional insecticide program. For maximum fruit protection, spray at petal fall and again at about 2-week intervals for a total of three sprays for the first generation. If necessary, make two to three additional applications for second generation in mid- to late summer.

plum curculio and damage



■ Plum curculio

Plum curculio adults are a type of weevil. Adult weevils overwinter in protected locations, such as under firewood, piles of brush, fallen leaves in woodlots, or in overgrown fencerows. They move into apple trees during the blossom period and for 2 to 3 weeks after petal fall.

Female weevils take a few small nibbles out of very young fruit and then cut a small ($\frac{3}{16}$ inch) crescent-shaped slit into the surface of the fruit to lay eggs. As the damaged fruits grow, the affected areas become lumpy and misshapen. Frequently the eggs do not successfully hatch in apples, so the grub-like larval stage may not be present. There is only one generation per year, with damage occurring usually within the first 3 weeks after bloom.

Management. Plum curculio is a native insect that is best adapted for feeding on stone fruits and tends to be more of a problem in areas where wild plum and wild cherry grow. In some areas, plum curculio is very abundant and, if not controlled, can damage a high percentage of the crop. When low to moderate populations are present, the damage is primarily cosmetic and may be tolerable. Conventional insecticides readily

control plum curculio; other methods are less effective. If possible, remove wild or abandoned host plants from the area to reduce overall population levels.

Low toxicity control program. You can jar plum curculio adults from trees by tapping limbs with a padded stick or pipe. First place a sheet under the portion of tree being tapped, and then pick up the insects when they fall to the sheet. This needs to be done two to three times per week for about a month starting during the blossom period. This approach is more practical and effective on small trees (young or dwarf) than on large trees.

Alternatively, many plum curculios approach a tree by walking across the ground rather than flying. Chickens readily eat these insects, and a fair level of control can be achieved by confining chickens to forage under the trees from the blossom period until about 3 weeks after petal fall. Do not allow chickens into areas that have been treated with pesticides; read the pesticide labels regarding such precautions.

Rotenone is an approved organic insecticide that is somewhat effective against plum curculio. It breaks down rapidly in the environment and needs to be applied at least weekly during the egg-laying period.

Intermediate to conventional insecticide program. Conventional insecticides readily control plum curculio. Generally two applications are sufficient, the first at petal fall and the second about 10 to 14 days later. In areas of very high numbers, three applications may be necessary at 10-day intervals. Refer to the table. To use the least possible amount of insecticide, monitor young fruit twice weekly starting a few days after petal fall, and do not treat until you see egg-laying scars.

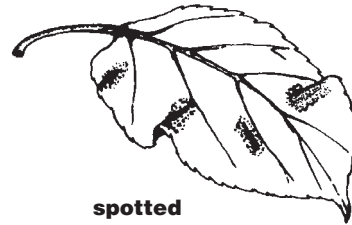
Plant-damaging insects attack leaves, stems, or branches. Usually there is no need to control for these pests, but occasional intervention may be needed.



aphid



spider mite



spotted tentiform leafminer



San Jose scale

Plant-damaging insects

■ **Aphids**

Various types of aphids feed on apple foliage. Some produce a white, cottony, waxy material that is easily seen. Others cause leaves to twist and curl. Even though the damage appears dramatic, it usually is of minor consequence to tree health or fruit quality. Aphids have many natural enemies (predators, parasitic wasps, and fungal diseases) that keep them in check. Large populations can be controlled with insecticidal soaps or conventional insecticides.

■ **Scale insects**

A few types of scale insects attack apple trees. The most common is San Jose scale. These are very tiny insects, up to 1/16 of an inch in diameter and covered with a grayish hard waxy "scale." They usually feed on branches, but may also feed on leaves and fruit. On green or yellow fruit there is a red halo surrounding each insect. Scales are sap-sucking insects and large numbers can severely stress trees, even to the point of killing branches. San Jose scale can be controlled before flowers open using dormant oil sprays or by using conventional insecticides 1 to 3 weeks after petal fall. Thorough coverage of trunk and branches is essential.

■ **Spider mites**

Spider mites are very tiny creatures, only about 1/50 of an inch in size, and are usually dark reddish-brown in color. They feed on the leaves by sucking out sap and other leaf components, including the green chlorophyll. Usually spider mites are under good biological control from tiny predatory mites, as well as common predators such as lady beetles and lacewings. In addition, heavy rains wash many off of trees, and high humidity slows their feeding and reproduction. Occasionally they occur in large enough numbers to cause the leaves to turn bronze-colored; this affects the overall health of the tree and may reduce fruit size or quality. On small trees, many can be washed off with a forceful stream of water. Insecticidal soaps and summer spray oils are somewhat effective. If populations are high in late summer, thousands of deep red overwintering eggs may be laid around the tips of the stems; these are readily visible with a magnifying glass. These can be controlled with a dormant oil spray applied before flowers open in the spring.

■ Spotted tentiform leafminer

Spotted tentiform leafminer is a tiny caterpillar that feeds within the leaf, causing a speckled, blister-like leaf mine about $\frac{3}{4}$ inch long. These are common insects and a few mines can be found on almost every apple tree. Low population levels do not hurt the trees or fruit. The insect is usually heavily parasitized by tiny stingless wasps, and only occasionally are enough present to cause damage in home orchards. The beneficial wasps are killed by conventional insecticides, and leafminer outbreaks may be a sign of too much insecticide use. By reducing unnecessary insecticide usage, the natural balance will eventually be regained.

Leafminers overwinter in fallen leaves. Raking and burning the leaves in the fall will kill a substantial portion of the overwintering population. If leaf mining becomes severe, insecticides containing permethrin or bifenthrin are effective controls if properly timed early in the insect's life cycle. Once the mines are visible on the upper leaf surface, chemical control is not effective. Petal fall is an important time to control. These products are broad-spectrum insecticides which will be harmful to beneficial insects.

Weeds

Weeds and other vegetation are not typically thought of as pests, but they may reduce yields and fruit quality by competing for light, water, and nutrients. They may also harbor insect and disease pests. Grasses are particularly competitive. Many grasses have expansive and finely divided roots that intercept moisture and nutrients before they reach tree roots. Further, mowing or trimming close to trees can injure the trunks, especially on young trees. To limit weed competition and to protect trunks from

insect, disease, and physical damage, keep a vegetation-free area that has a 2- to 3-foot radius around each tree.

Mechanical control

Mechanical control of vegetation includes cultivation and mulches. Shallow cultivation every few weeks with a sharp hoe or shovel will eliminate young seedlings and older weeds. Be careful not to damage the trunk or roots growing near the surface. Don't use a rototiller near trees, as this will harm them. Perennial weeds are the most difficult to manage using cultivation.

A mulch of wood chips, shredded bark, sawdust, straw, or other organic material can be used to inhibit weed growth. However, organic mulches should be kept to a minimum if the soil is heavy or poorly drained. Decorative stones or gravel are also effective, but will not offer complete weed control. Do not mound mulches up against the trunk. Instead, spread them in a "donut" fashion, keeping the deepest area several inches from the trunk. Mulches need to be renewed each year to remain effective. Killing existing vegetation with a non-residual herbicide before applying mulches will give better results.

Some weed barrier fabrics are also effective, but should be covered with an organic mulch to prevent sunlight damage to the fabric.

Chemical control

Herbicides can be used to kill weeds growing under apple trees. Check the label to ensure that they are registered for use on specific plants before applying. For controlling weeds that are already growing, apply glyphosate. Glyphosate kills actively growing annual and perennial weeds. It is a nonselective, non-residual herbicide that will kill desirable plants as readily as weeds. It is selective only through selective appli-

cation. For the most benefit to apple trees, apply glyphosate in the spring or early summer. Before spraying, thoroughly protect trunks of young trees with plastic wrap or aluminum foil. Remove and discard the wrap once the spray has dried. Glyphosate must be used according to label directions. No residual herbicides are recommended for home orchards.

Use of chemical pesticides

While weeds are controlled by applying herbicides to the ground, disease and insect pests are generally controlled by applying fungicides and insecticides directly to trees. The timing of sprays, relative to tree growth, is as important as the type of spray used. The following table lists the most appropriate chemicals and when to apply them. Garden centers vary in the products they carry. Therefore, rather than recommending specific products, we suggest you check product labels for active ingredients and then use the product as directed on the label. Many general-purpose fruit tree sprays, sometimes called "home orchard" sprays, contain a fungicide such as captan plus one or more insecticides (for example, malathion or carbaryl). While convenient, these sprays may result in excessive insecticide use that can kill beneficial insects along with the pests.

The recommendations in the table should be similar to those on product labels. However, if you find any differences, follow the directions on the product label. It is illegal and potentially dangerous to use pesticides in a manner inconsistent with the product label. Check labels and read the comments and footnotes in the table for important information about possible toxicity to plants and incompatibility of certain chemicals.

About this table

The insect control recommendations in the following table relate to a more conventional insecticide program that will maximize protection from insect injury. If you live in an area with low insect pressure, or if you simply prefer to use fewer pesticides, refer to the management recommendations for each of the pests.

Spray timing

The date at which apple trees reach various developmental stages depends on the variety and weather. During a warm spring, trees move quickly from one stage to the next; during a cool spring, trees may remain at a given stage for several days. For example, an extra scab spray may be needed between “open cluster” and “full bloom” if this period lasts longer than 10 days, especially if there is rain. Sprays are generally not needed at intervals shorter than 7 days.

Spray schedule for apple trees

When to spray	Pest	Material	Comments
Dormant —before any green shows	aphids, scale insects, spider mites	dormant oil or lime sulfur	<ul style="list-style-type: none"> Thorough coverage of stems, branches, and trunk is necessary for scale control.
Green tip —when 1/4 to 1/2 inch of green shows	scab	captan or ferbam or mancozeb or myclobutanil or copper ^a or sulfur ^b	<ul style="list-style-type: none"> Leaf damage can result if captan is used within 10 days of an oil application. Ferbam and mancozeb are known as EBDC fungicides. See product labels for limitations when using EBDCs. Copper can damage leaves and fruit and should not be used later than green tip. See footnotes on copper and sulfur.
	fire blight	copper ^a	
Tight to open cluster —when flower buds are visible	scab	same as GREEN TIP except no copper	<ul style="list-style-type: none"> See footnote on sulfur. An extra application may be needed if flower buds take more than 10 days to develop from open cluster to full bloom. Ferbam and mancozeb are known as EBDC fungicides. See product labels for limitations when using EBDCs.
	powdery mildew	sulfur ^b or myclobutanil or thiophanate-methyl	
	rust	ferbam or mancozeb or myclobutanil	
Full bloom	scab	same as GREEN TIP except no copper	<ul style="list-style-type: none"> Streptomycin should only be applied if temperatures are above 60°F and rain, heavy dew, or fog prevail. Do not apply streptomycin after bloom. Although some labels permit copper application during bloom to control fire blight, copper can injure blossom and fruit tissue.
	powdery mildew, rust	same as TIGHT TO OPEN CLUSTER	
	fire blight	streptomycin	
To protect pollinating insects, do not use insecticides during bloom.			

Spray schedule for apple trees *(continued)*

When to spray	Pest	Material	Comments
Petal fall —when more than 75% of flower petals have dropped	scab	same as green tip except no copper	<ul style="list-style-type: none"> ■ Carbaryl and permethrin have been associated with outbreaks of spider mites when used frequently on fruit trees.
	powdery mildew, rust	same as TIGHT TO OPEN CLUSTER	<ul style="list-style-type: none"> ■ Permethrin cannot be used after petal fall.
	aphids, caterpillars, codling moth, plum curculio	bifenthrin or carbaryl ^c or esfenvalerate or malathion or permethrin	
First cover —7 to 10 days after petal fall	scab	captan or sulfur ^b	<ul style="list-style-type: none"> ■ To prevent residues on fruit and to stay within product limitations, do not use mancozeb or ferbam after petal fall.
	powdery mildew	same as TIGHT TO OPEN CLUSTER	
	rust	myclobutanil	
	codling moth, plum curculio, San Jose scale	bifenthrin or malathion	
Additional covers —as needed, at 10- to 14-day intervals during the summer	scab	captan or sulfur ^b	<ul style="list-style-type: none"> ■ If scab lesions are not visible 4 weeks after petal fall, no additional scab sprays will be needed.
	flyspeck, sooty blotch	captan or sulfur ^b or thiophanate-methyl	<ul style="list-style-type: none"> ■ Sulfur is only partially effective against flyspeck and sooty blotch. Sanitation and pruning during winter are critical. ■ Sprays for apple maggot should start no earlier than the first week of July.
	aphids, apple maggot, codling moth, leafrollers	carbaryl ^c or bifenthrin or malathion	<ul style="list-style-type: none"> ■ Carbaryl has been associated with outbreaks of spider mites when used frequently on fruit trees.

^a Copper is an active ingredient in many products. Bordeaux mixture (copper sulfate + hydrated lime) can damage fruit if applied later than green tip. Also, copper and lime are incompatible with certain other pesticides (e.g., captan), so check labels for these warnings.

^b Sulfur should not be used on days when temperatures are expected to exceed 85°F as damage to foliage and fruit is possible.

^c Carbaryl can cause fruit to fall from the tree if applied within 3 to 4 weeks after bloom, until fruit is approximately 1 inch in diameter.

Additional information

For related information on growing apple trees, the following publications are available from your county Extension office or from the publications web site of University of Wisconsin-Extension Cooperative Extension: cecommerce.uwex.edu

Publications

■ **General Information**

- Apple Cultivars for Wisconsin* (A2105)
- Fruit Crop Pollination* (A3742-E)
- Growing Apples in Wisconsin* (A3565)
- Home Fruit Cultivars for Northern Wisconsin* (A2488)
- Home Fruit Cultivars for Southern Wisconsin* (A2582)
- Rootstocks for Fruit Trees in Wisconsin* (A3561)
- Training and Pruning Apple Trees* (A1959)
- Walnut and Butternut Toxicity* (A3182)
- When Are Apples Ripe?* (A3743-E)

■ **Disease and insect pests**

- Apple Disorder: Sooty Blotch and Flyspeck* (A3173)
- Apple, Flowering Crab, Hawthorn, Juniper Disorder: Cedar-Rust Complex* (A2598)

- Apple, Pear, and Related Trees Disorder: Fire Blight* (A1616)
- Common Tree Fruit Pests* (NCR063)
- Diseases of Tree Fruits in the East* (NCR045)
- Eastern Tent Caterpillar* (A2933)
- Tree Fruits: Insect and Disease Management for Backyard Fruit Growers In the Midwest* (AIDEA3)
- Watercore of Apple* (A3280)

Web sites

The following sites have useful information and photographs of apple pests and diseases. Note that biological information and controls that are listed on these sites may be substantially different from those recommended in Wisconsin.

- Cornell University—
nysipm.cornell.edu/factsheets/treefruit
- Penn State University—
ssfruit.cas.psu.edu/PomeFruits.htm
- Virginia Polytechnic Institute and State University—
ento.vt.edu/Fruitfiles/VirginiaAppleSite.html

- West Virginia University—
caf.wvu.edu/kearneysville/wvufarm1.html
- North Carolina State University:
ipm.ncsu.edu/apple/contents.html

Sources of pest management equipment and supplies

- Great Lakes IPM—
greatlakesipm.com
800-235-0285
- Gempler's—
gemplers.com
800-382-8473

University of Wisconsin-Extension does not advocate these sources over other sources of pest management supplies.

References to pesticide products in this publication are for your convenience and are not an endorsement of one product over other similar products. You are responsible for using pesticides according to the manufacturer's current label directions. Follow directions exactly to protect the environment and people from pesticide exposure. Failure to do so violates the law.



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