

Pest management for the home apple orchard

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TABLE OF CONTENTS

- [Introduction](#)
- [Pest management schedule](#)
- [Diseases](#)
 - [Apple scab](#)
 - [Fire blight](#)
 - [Black rot of apple](#)
 - [Cedar-apple rust](#)
 - [Sooty blotch and flyspeck](#)
- [Insects](#)
 - [Apple maggot](#)
 - [Codling moth](#)
 - [Plum curculio](#)
 - [Multicolored Asian lady beetle](#)
- [Appendix: sources of IPM supplies](#)

INTRODUCTION

Minnesotans who grow apples at home have to combat many insect pests and diseases to produce a good crop. Many apple growers reduce their use of pesticides, while still harvesting quality fruit, through a set of practices known as Integrated Pest Management (IPM). IPM includes a combination of pest management techniques including monitoring for pest problems, removing diseased or infested plant material from the area, and many other cultural control techniques. Pesticide sprays are used in IPM only when necessary, and gardeners may choose from conventional or organic spray options.

In order for IPM to be effective, home apple growers must be able to recognize the common pests of apples and the damage they cause. They need to coordinate their pest management actions with weather, tree growth stages, and pest life cycles. If pesticides are necessary, always use them exactly as labeled, per federal law.

An IPM approach assumes that good care is being taken of the apple trees. Consult the University of Minnesota Extension publication [Growing apples in the home garden](#) for horticultural information. Good cultural practices—including site selection, variety and rootstock selection, proper planting, pruning, training, fruit thinning, irrigation, and harvest timing—all contribute to a satisfying harvest each year. In particular, well pruned trees allow for increased access to the tree canopy, making pest management tasks such as bagging fruit, monitoring diseases, placing traps, and applying pesticides easier and more successful.

PEST MANAGEMENT SCHEDULE

Depending on pest pressure in the planting, some sprays may not be necessary. Read about the specific pest to determine how to monitor for the pest, and to learn what level of pest infestation can be tolerated. The time interval between repeated sprays varies depending on the pesticide used. Refer to the pesticide label to determine when to reapply. If disease resistant apple varieties are planted, sprays for that disease can be skipped.

Table 1: Pest management schedule for apples

Time of action	Action or material	Pest
Dormant season (January – March)	Prune out diseased branches, remove mummy fruits	Fire blight Black rot
	Check apple storage containers and buildings for cocoons and remove any that are discovered	Codling moth
Silver tip ^a – ½” Green tip ^b (late April – early May)	Copper formulations *** <i>Only in trees with a history of fire blight infection</i> ***	Fire blight
1/2” Green tip ^b (late April – early May)	Captan or lime-sulfur Begin spray program; continue spraying at intervals specified on fungicide label ** <i>Unnecessary in scab resistant or immune varieties</i> **	Apple scab
Tight cluster ^c (early May)	Hang delta trap with lure to determine if codling moth is present	Codling moth
Warm, humid days during bloom (May)	<i>Bacillus subtilis</i> *** <i>Only in trees with a history of fire blight infection</i> ***	Fire blight
Bloom (May)	Monitor using paper plate in early morning for presence of plum curculio	Plum curculio
Petal fall ^d (May)	Malathion or bifenthrin or esfenvalerate *** <i>Only in trees with a history of plum curculio or codling moth</i> ***	Plum curculio Codling moth
7-10 days after petal fall (May)	Malathion or bifenthrin or esfenvalerate *** <i>Only in trees with a history of plum curculio or codling moth</i> ***	Plum curculio Codling moth
After thinning fruit (late June)	Bag each fruit OR hang red sphere traps	Apple maggot

End of primary scab season (late June)	Examine leaves for apple scab spots. If present on leaves, continue fungicide sprays into August.	Apple scab
Drop of fruitlets (late June)	Remove all fallen fruit from planting weekly throughout the season	Plum curculio Codling moth Apple maggot
Upon trapping 1-5 apple maggot flies (July - August)	Carbaryl or esfenvalerate or bifenthrin or spinosad (continue to monitor and spray when necessary)	Apple maggot
After harvest and leaf drop	Rake up and dispose of all fallen fruit and leaves	Apple scab Apple maggot Codling moth
<p>^a Silver tip---when buds are just beginning to swell</p> <p>^b ½ inch green tip---when buds have opened and ½ inch of green leaf tissue is visible</p> <p>^c Tight cluster---when flower buds are visible but still small and completely closed</p> <p>^d Petal fall---when most of the petals have fallen</p>		

DISEASES

APPLE SCAB

Venturia inaequalis

The most troublesome disease for apple growers in all parts of Minnesota is apple scab. Scab is caused by a fungus that infects both leaves and fruit. Scabby fruit are often unfit for eating, and continued infection of leaves weakens the tree.

Identification

Scab infections on leaves start as olive green to brown spots with an irregular or feathered edge. As leaf infections grow, they may merge together and assume a dark brown velvety appearance. Severely infected leaves may turn yellow and drop prematurely. Scab infections on young fruit start out as olive green to brown spots. As the lesions enlarge, they harden, and eventually become black, corky, inedible areas on the fruit. Severely infected fruit may be deformed and often crack open.

Important biology

Apple scab survives Minnesota's winters on infected leaves that have fallen to the ground. In spring, spores are ejected from last year's fallen leaves and create new infections on the young leaves and tiny fruitlets. Leaf spots quickly mature and produce new fungal spores. These spores spread to other leaves to create new infections throughout the growing season.

Abundant rainfall in May and early June is conducive to scab infection, and rainy summers allow the fungus to infect trees even more severely.

Many ornamental crab apple trees are susceptible to apple scab, so the disease can be spread to your fruit trees from nearby flowering crabs.

Management

Depending on where you live in Minnesota, scab control may be very difficult or relatively easy. Growers in drier parts of the state may not have to struggle as hard against scab. An isolated apple planting with no other apple or crab apple trees nearby will also be easier to keep scab-free. Inspecting your trees for scab lesions and keeping records of each year's infection severity is important in determining how intensively you need to manage scab.

Plant resistant varieties

The best way to deal with apple scab is to avoid it altogether by planting disease resistant varieties. Many varieties of apple trees are resistant or completely immune to apple scab. Susceptible and very susceptible trees will require fungicide sprays every year to control the apple scab fungus. Resistant trees will only require fungicide sprays in very wet years, where the apple scab fungus is nearby in other infected trees or in infected leaf litter. Good sanitation and cultural control practices will minimize the need for even these sprays. Immune trees do not require any fungicide sprays at any time, and will remain disease free all season long.



Apple scab infection on crab apple. Michelle Grabowski, UMN Extension

Sanitation

Rake all the fallen leaves from around your trees each autumn and remove them from the area. Infected leaves can be burned, buried or composted. Perfect sanitation in an apple planting could, in theory at least, control the disease. If there are other apple or crab apple trees in the vicinity of your planting, however, spores could become airborne and drift onto your property, starting the infection cycle again.

Pruning

The apple scab fungus needs moisture on the leaves to start a new infection. A well pruned tree with an open canopy will allow air to move through the tree and dry the leaves quickly. This will create an environment less favorable to the fungi and can help reduce the severity of apple scab in a tree. For proper pruning of apples see [*Growing apples in the home garden.*](#)



Apple scab leaf infections. M. Grabowski

Fungicide sprays

What fungicides should you use?

Materials available to home growers for scab control include captan, lime-sulfur, and powdered or wettable sulfur.

Applications of lime-sulfur closely following captan sprays can damage leaves and flower buds, so use caution when rotating these two materials.

All-purpose sprays, containing combinations of fungicides and insecticides, are also available. For scab sprays just after petal fall, when insecticide sprays may also be necessary, these chemical mixtures may be appropriate. If the goal of a spray is only to control apple scab, however, the insecticide portion of the spray is wasted. In addition, you may need to spray for scab while your trees are in bloom. Pollinators, including honeybees, bumblebees, solitary bees, and many other beneficial insects, will be killed by a spray that includes an insecticide, so never use an all-purpose fruit spray during bloom.

When should you start spraying?

To protect leaves and fruit from scab, most home apple growers need to spray fungicides in spring. Sprays should start at the growth stage known as "half-inch green tip," when the leaf buds have swollen and begun to open so that about half an inch of leaf tissue is visible.

How often should you spray?

Scheduling fungicide sprays for scab after the first application at half-inch green can involve a little guesswork. In warmer weather, leaves grow quickly, and newly-exposed tissue will be unprotected. In cooler weather, growth slows or stops.



Apple scab on fruit. T. Sutton.

Check fungicide labels for the recommended spray interval. Most labels offer a range of days to wait before spraying again. (E.g. seven to ten days after spraying, you will need to spray again). In plantings where there was a severe scab infection the previous year, use the shortest interval. In plantings where scab has not been a problem, a longer interval will probably give adequate protection. In addition if the weather is dry the longer interval is acceptable.

When can you stop spraying for scab?

In mid-June, examine the leaves on your trees for scab lesions. Be very thorough, checking upper and lower leaf surfaces, leaves on the interior and exterior of the canopy, leaves close to the ground and those higher in the tree. If you find no or very few apple scab leaf spots, you need not spray fungicide again. If you find scab lesions, or if there are unsprayed trees in your neighborhood with scab lesions, you should continue to spray, because the lesions on the leaves will release more scab spores all summer long.

If scab has been a problem in your apple planting, it may take a year or two to get it under control. If you continue with appropriately timed sprays that cover all leaf and fruit tissue, and practice excellent sanitation of fallen leaves, and if outside sources of fungal spores are few or distant, you should find in the second or third year that you only need to spray from half-inch green tip to mid-June.

Table 2: Susceptibility to apple scab of apple varieties grown in Minnesota

Very susceptible	Susceptible	Resistant	Immune
Cortland	Beacon	Honeycrisp™	Dayton
Honeygold	Fireside		Freedom
McIntosh	Haralson		Liberty
State Fair	Keepsake		McShay
Zestar!™	Paula Red		Pixie Crunch
	Sweet Sixteen		Pritine
	Wealthy		Redfree
	Chestnut Crab		William's Pride

FIRE BLIGHT

Erwinia amylovora

Fire blight is a bacterial disease of apple trees that can kill blossoms, new green shoots, branches, and sometimes entire trees. In Minnesota, fire blight is rarely a problem on blossoms due to cool temperatures during bloom. Infection of young green shoots occurs occasionally when warm wet weather coincides with new growth on susceptible varieties. If left untreated, infections can move into the main trunk and roots of the tree, resulting in death of the tree. However, several management strategies are available eradicate fire blight from infected trees before it becomes deadly.

Identification

Blossom blight

Infected flower blossoms first appear green gray, but quickly turn black and appear scorched. Blighted blossoms remain attached to the tree through the season and often into winter. Blossom blight is rare in Minnesota due to cool temperatures at bloom time.

Fruit infection

If fruit are infected through the flower or twig, they remain small and are often dark colored and shriveled. Fruit infected through insect or hail damage may have reddish brown to black spots.

Shoot blight

Young growing shoots that are infected turn green gray and bend over forming a 'shepherd's crook'. Infected leaves start out green gray, then turn brown around the edges and eventually turn completely brown and wilted. Blighted leaves remain attached to the tree throughout the season and into winter. If many branches of the tree have been infected, it may appear to have been scorched by fire, giving the disease its name.



Shepherd's crook caused by fire blight. G. Sundin.

Branch cankers

Infected branches and twigs are often darker in color and the bark may appear sunken and cracked. If the bark is cut away from the infected branch reddish brown discoloration can be seen on the inner wood. Branch cankers can be avoided by pruning out infections that occur on young shoots.

Bacterial ooze

On a warm wet day, cream or honey colored sticky droplets of liquid, known as bacterial ooze, arise from all infected plant parts, including fruit, flowers, leaves, and branches. Severely infected branches may release so much bacterial ooze, that liquid can be seen running down the tree.



Leaf and shoot dieback on a tree infected with fire blight. G. Sundin.

Important biology

Fire blight differs from other diseases of apple in that it is caused by bacteria, not fungi.

The fire blight bacteria infect plants within the Rosaceae family. In addition to apples and crab apples, this family includes mountain ash (*Sorbus*), Hawthorn (*Crataegus*), Serviceberry (*Amelanchier*), and brambles like raspberry and blackberry (*Rubus*). The fire blight bacteria survive Minnesota's winters inside infected branches. In the spring when the weather is wet and warm (above 60F), bacteria begin to multiply and ooze out of infected branches in a yellow white sticky liquid known as bacterial ooze.

Insects are attracted to this sweet, sticky ooze from infected tissue, either in your planting or nearby. Since the ooze contains bacterial cells, even if a microscopic amount sticks to an insect, the bacteria can be transferred to apple flowers that the insect later visits. Infection of flowers is called "blossom blight."

The bacteria can also be spread on moist air currents. Airborne fire blight bacteria can infect young green tissue, particularly after a storm has whipped the branches against each other, or after hail has injured soft tissue. This type of infection is called "shoot blight."

Regardless of if the infection starts in a flower or green shoot, it moves from these tissues into the branch. The infection will continue down the branch, killing attached leaves as it moves closer

to the main trunk. If the infection travels to the main trunk and the roots of the tree, the tree will die. Some cultivars of apple are able to wall off the infection and prevent the spread of the bacteria into the rest of the tree; others are susceptible to the infection and can be killed once the bacteria infect the trunk all the way around or enter the roots.

Cultural control

In the yard and garden, fire blight can easily be controlled with several cultural control practices if they are used in a timely manner.

Plant resistant varieties

Start out with a resistant variety of apple tree. It is important to know that most apple trees are two different plants grafted together. The scion is the top part of the tree. The variety name you see on the plant label typically describes the scion. The rootstock is the underground part of the tree. Ideally, both scion and rootstock would have resistance to fire blight.

Among rootstocks typically available to home growers, M7 is somewhat tolerant to fire blight, while M26 and M9 rootstocks are more susceptible. Newer rootstock cultivars have been selected specifically for fire blight resistance, but are not as widely available to home growers yet. Bud 9 is one example that has moderate to good fire blight tolerance. If you are planning a new planting, it may be worthwhile to seek out nurseries that offer trees on fire blight-resistant rootstocks.

Table 2: Fire blight susceptibility of apple varieties grown in Minnesota

Susceptible	Moderately susceptible	Moderately resistant	Resistant
Beacon	Cortland	Honeycrisp™	Haralson
Fireside	Keepsake	Zestar!™	Liberty
Honeygold	McIntosh		Red Baron
Paula Red	State Fair		SnowSweet
Wealthy	Sweet Sixteen		Chestnut Crab
	Centennial Crab		Dolgo Crab
	Whitney Crab		

Trees that are particularly lush and vigorous are very susceptible to fire blight because soft, succulent shoots are easily wounded and thus easily infected. Trees that exhibit more modest growth (12 inches or less per year) are not as susceptible. If you will be planting apple trees in rich soil, in a part of Minnesota that gets plenty of rain, or if your tree will be irrigated and fertilized as part of a lawn, choose a less vigorous rootstock. On sandy or poor soils, or in sites that are dry, a more vigorous rootstock will be necessary, but probably will not lead to the kind of lush green growth that invites fire blight. Consult the University of Minnesota Extension publication [*Growing apples in the home garden*](#) to choose a rootstock right for your area.

Maintain tree health through proper pruning and fertilizer use

Application of excessive nitrogen fertilizer can result in a flush of new growth that will be very susceptible to fire blight. To calculate the amount of nitrogen needed by the tree, submit a soil sample to the [University of Minnesota soil testing lab](#). Remember tree roots extend into the soil up to 2 times beyond the tree canopy. Lawn fertilizer applied to this area will also be taken up by the apple tree.

Bacteria thrive and multiply best in warm humid environments. Healthy trees should be pruned to maintain an open canopy that allows air to reach all leaves so that they dry quickly after rain or dew. For proper pruning of apples see [Growing apples in the home garden](#). In addition to proper pruning in the main canopy, all water sprouts, or suckers (small twigs growing directly from the main trunk) should be pruned off.

Pruning out infected branches

If fire blight is present in an apple tree, all infected branches must be removed and destroyed. This will stop the infection from moving further into the tree, and will prevent the bacteria from spreading to other trees. The best time of year to do this is in February or March, when the tree and the bacteria are dormant. Infected branches should be pruned back eight inches closer to the trunk than the apparent infection. Between cuts, disinfect pruning tools with a 10% bleach solution or an anti-bacterial cleaner such as Lysol or Listerine, to avoid spreading the disease. Burn cuttings or include them in your trash.

New shoots infected during the growing season can be removed following the same procedure. These cuts are best made during cool dry weather. Always remember to sterilize pruning tools between cuts!

In cases of serious infection, when the bacteria have entered the trunk of the tree, it's best to remove the tree entirely, including the stump. Infected tissue allowed to remain in the planting is a source of bacteria to infect the rest of your trees. Once the main trunk is infected, trees cannot be cured of the disease.



Fire blight canker. G. Sundin.

Pesticides

Pesticides are typically not necessary to control fire blight in Minnesota. In trees where fire blight has been a problem in past years, a dormant spray of a copper-containing product can be applied to reduce new infections. Copper should be sprayed in spring between silver tip (when buds are just beginning to swell) and ½ inch green tip (when buds have opened and ½ inch of green leaf tissue is visible). Spray coverage should be more than just a mist, leaving a visible residue on the branches. This coating will kill the fire blight bacteria as they emerge from branch cankers and stop them from starting new infections. Copper sprayed later in the spring can be very harmful to foliage and fruit, so do not spray copper after ½ inch green tip.

Although several sprays exist that can be used to stop the fire blight bacteria from starting a new infection, these sprays are unnecessary in trees that do not have a history of fire blight infection.

In Minnesota, sprays are only necessary where fire blight has been a problem in the past, susceptible cultivars are being grown and weather is wet and warm (above 60° F) during bloom. Sprays are only applied during blossom.

Serenade Garden Defense (*Bacillus subtilis*) is a biological control product containing an antibiotic producing bacteria. This product has been shown to reduce infections on apple blossoms if applied to healthy but at risk blossoms.

Streptomycin sulfate is an antibiotic that can prevent fire blight infections if it is sprayed on flowers or shoots before the bacteria infect. Although this product is available to gardeners, it is not recommended due to problems with the bacteria becoming resistant to the effect of the antibiotic if it is improperly used.

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BLACK ROT OF APPLE

Botryosphaeria obtusa

Black rot is occasionally a problem on Minnesota apple trees. This fungal disease results in leaf spot, fruit rot and cankers on branches. Trees that are not fully hardy in Minnesota, are infected with fire blight or are under stress due to environmental factors like drought are more susceptible to black rot infection than well maintained trees. Many cultural control practices will reduce the severity of this disease.

Identification

Fruit rot

Although infected fruit remains firm, rotten tissue with brown and black concentric rings can cover large areas of the fruit. Fungal spore producing structures, called pycnidia, can be seen as small black spots on older infections. Some fruit mummify and remain attached to the tree. Occasionally fruit are infected early in the season resulting in fruit that ripen weeks before the typical harvest date and are rotten at the core.

Leaf spots

Infected leaves develop "frog-eye leafspot:" circular lesions with purplish or reddish outer borders and light tan interiors.



Black rot canker. G. Sundin.



Branch canker. G. Sundin.

Branch cankers

Cankers appear as a sunken, reddish brown area on infected limbs often with rough looking or cracked bark. These cankers may not be readily apparent. If rotten fruit or frog-eye leafspot is present in a planting, inspect the trees for cankers.

Important biology

The fungus that causes black rot can infect dead tissue as well as living trunks, branches, leaves, and fruits. Branches or portions of the trunk that are dead or that have suffered winter injury or other damage are most likely to be infected.

Minnesota's severe cold often injures apple trees. Although the trees may not be killed outright, damaged tissue is susceptible to infection by black rot. Sunken black rot cankers may appear on the southwest side of young trees, where winter injury is common, or at crotches where branches join the main trunk, since these areas are typically the last to harden off in fall. Similarly, apple trees grown on sandy soils without supplemental irrigation, trees that are not irrigated during particularly dry spells, and trees grown in poorly drained soils, are all more susceptible to black rot. This is because both drought stress and the low oxygen of waterlogged soils lead to death and damage of the above-ground parts of trees. Fire blight, because it leads to dead wood easily infected by the black rot fungus, can make a planting more conducive to black rot infections.

Infected wood and mummified fruit are a source of infectious spores. The black rot fungi survive Minnesota winters in branch cankers and mummified fruit attached to the tree. In wet weather, spores are released and start new infections within the tree. Most new infections occur in spring. Leaf spots do not seriously affect the health of the tree unless many leaves turn yellow and fall off as a result of the infection (this is rare). In addition, leaf spots do not release fungal spores that start new infections on fruit or branches. Leaf spots are therefore of minor concern and management practices focus on reducing fruit and branch infections.

Management

Cultural control

To control this disease, remove dead material from the planting. Prune out dead or diseased branches, and pick all mummy fruits remaining on the trees, as these are sources of spores for future infections. All infected plant parts should be burned, buried, included



Black rot infection on fruit. UGA, Bugwood.org.



Branch dieback due to black rot cankers. G. Sundin.

it in household trash, or sent to a municipal composting site. Be sure to remove the stumps of any apple trees you cut down, as dead stumps can be a source of spores.

All winter pruning, of healthy or dead tissue, must be completed during freezing weather, as the fungus is not active until spring. Pruning cuts made in winter will have dried out and will not be susceptible to the disease by the time black rot spores are available to infect them.

Maintain tree health by reducing stress from environmental conditions and cultural practices. Choose an appropriate site for all new apple trees and plant only cultivars that are truly hardy for your area. Provide trees with adequate water. Keeping fire blight in check and removing any limbs or trees killed by fire blight can discourage black rot.

Fungicide sprays

Fungicide sprays are typically unnecessary for black rot management in Minnesota. Use fungicides only if the disease has persisted after cultural control practices have been implemented.

Captan and sulfur products are labeled for control of both scab and black rot, so a scab spray program including these chemicals may help prevent the frog-eye leafspot of black rot, as well as the infection of fruit. These sprays will not control or prevent infection of branches.

CEDAR-APPLE RUST

Gymnosporangium juniperi-virginianae

Cedar-apple rust is a fungal disease that spends half of its life cycle infecting apple or crab apple trees, and the other half infecting Eastern Red Cedar (*Juniperus virginiana*) or other species of juniper (*Juniperus sp.*). This disease can cause damage to leaves and fruit of very susceptible apple varieties, but is only a minor problem on resistant or partially resistant trees.

Identification

Cedar-apple rust causes leaf spots on apple and crab apple trees. Leaf spots are first yellow, then bright orange-red. Leaf spots often have a bright red border and may have small raised black dots in the center of the spot. These lesions grow through the leaf and develop small, brownish, spiky projections on the lower surface of the leaf. Very infrequently, fruit may exhibit a similar infection.

If there are red cedars or junipers in the yard or in nearby landscapes or wild areas, it may be useful to recognize that stage of the disease. Round brown galls up to two inches in diameter form on branches. These galls produce gelatinous, orange, horn-like projections during wet spring weather. While the galls may go unnoticed, the horns are bright orange and easily seen.



Cedar-apple rust gall on juniper before spore release. M. Grabowski.

Important biology

The cedar-apple rust fungus must alternately infect apple trees and red cedars or junipers and cannot survive without both host plants. The orange horns on red cedars or junipers produce spores in response to wet weather in the spring. These spores are carried on wind and can infect apple trees over a mile away. Galls on red cedars and juniper plants dry up and die in warm dry summer weather and no new infections on apple will occur until the following season. Apple leaf lesions produce spores that infect red cedars or junipers and start the cycle all over again.

Management

Planting resistant varieties is the best strategy for protecting backyard apple trees from cedar-apple rust. Among varieties commonly grown in Minnesota, only Beacon and Wealthy are very susceptible to cedar-apple rust. Most other varieties have some resistance to the disease. There are no effective fungicides available to gardeners to control this disease on fruit producing trees.

The majority of cedar-apple rust infections come from nearby red cedars. If the gelatinous orange tentacled galls are common on nearby cedars or junipers, it is possible scout for the round woody galls with orange horns in spring, and remove the growths to prevent the spread of spores.



Cedar-apple rust gall on juniper during spore release. L. Haugen, Bugwood.org.



Cedar-apple rust infection on apple leaf. M. Grabowski.

SOOTY BLOTCH AND FLYSPECK

Sooty blotch and flyspeck are sometimes called the "summer diseases" of apples, because the fungi that cause this problem typically appear in August or September. The damage these fungi cause is strictly cosmetic and does not affect the quality of the fruit.

Identification

Sooty blotch appears as grayish, greenish, brownish, or black smudges on the apple's surface. It can be rubbed or washed off the fruit fairly easily. Flyspeck looks like clusters of tiny black dots. Flyspeck cannot be easily cleaned off the fruit.

Important biology

Flyspeck and sooty blotch are caused by a complex of several different fungi. These fungi do not infect the live cells of the fruit and therefore do not cause fruit rot. The flyspeck and sooty blotch fungi only



Flyspeck and sooty blotch. Mark Gleason, ISU.

grow in the waxy cuticle on the fruit surface, resulting in minor blemishes. These fungi overwinter on the fruit, stems, leaves, and bark of many types of woody plants, including apples, pears, and raspberries. Spore development and germination are encouraged by warm, humid weather. Rain and wind spread the spores onto developing fruit. In Minnesota, flyspeck and sooty blotch occurs more commonly in the southern half of the state.

Control

Since these fungal infections do not affect fruit quality, and sooty blotch can easily be cleaned off the apples, the home grower need not take any action against them. However, pruning that allows good air circulation in the tree canopy will help minimize the severity of infection. Similarly, thinning fruit to only one per cluster allows good air circulation around each individual fruit. After a rain, if the fruit can dry off quickly enough, the spores may not be able to germinate and cause infection.

INSECTS

APPLE MAGGOT

Rhagoletis pomonella

The most important insect pest of Minnesota-grown apples is the apple maggot, sometimes called the "railroad worm." It is very common, infesting apples in all parts of the state. Heavily infested fruit is inedible and is suitable only for cider or animal feed. It is very important to manage this pest to protect your apples.

Identification

Fruit infested with apple maggot may be pitted and misshapen due to egg-laying. Each "sting" or hole created by the female fly as she lays an egg, forms a tiny spot or dimple. Inside the apple, small white larvae (maggots) feed on apple flesh, creating small tunnels which turn brown and rot. The adult fly is $\frac{1}{4}$ inch long, smaller than a common housefly, with characteristic dark markings on the clear wings, a conspicuous white spot where the thorax joins the abdomen, and three (male) or four (female) white stripes on the abdomen.

Important biology

Adult apple maggots begin to emerge from the soil starting about July 1, continuing through most of the summer. After emergence, apple maggot adults often leave and feed outside the orchard, in wooded or brushy areas, then return to lay eggs. They lay eggs just under the skin of apples with each female fly laying hundreds of eggs. Once eggs hatch, larvae feed for three to four weeks. When apples drop to the ground, the larvae enter the soil to pupate. Pupae overwinter underground, emerging as adults the following summer.



Apple maggot adult. University of Minnesota.



Apple maggot external injury. Dept. of Entomology, University of Minnesota.

Management

Sanitation

Sanitation can help reduce apple maggot populations. Frequently pick up and remove any apples that fall during the growing season and after harvest. Place these apples in the trash or send them to a municipal composting site. Do not compost them in your yard.

However, apple maggot flies can enter the planting from outside and you cannot rely on sanitation alone to prevent apple maggot infestations. There are three methods of managing apple maggots in Minnesota home plantings: bagging the fruit, trapping out, and monitoring and spraying.

Bagging

This method was developed in western Minnesota. After thinning the fruit, in early to mid-June, enclose each apple in a plastic sandwich bag, either a zipper closure bag or a plain bag closed with staples. Using a pair of scissors, snip the bottom corners off each bag, leaving a small opening for water to run out. At harvest, remove the bag. Although bagging fruit may take a few hours, the apples are protected from apple maggots for the rest of the season.

Bagging is easy to do if you have a small to medium-sized tree that can be managed from the ground or a short ladder. Or, if you have a tall tree, you may choose to bag only the fruits that are easy to reach, and let the apple maggots have the higher fruits.



Bagging apples to protect against apple maggot. Larry Zilliox.

Trap-out

The trap-out method uses sticky traps to capture apple maggot females that attempt to lay eggs on the fruit. Apple maggot traps are red spheres coated with tanglefoot, a sticky substance that adheres to almost any surface and permanently holds insects. The flies are attracted to the red color of the spheres, land on them, and are stuck.

You can use wooden or plastic spheres painted red, red plastic spheres designed and sold specifically for this purpose, or even store-bought large, red, fresh apples. Whichever type of trap you choose, the spheres or apples should be at least 3 inches in diameter and bright red.

Wooden spheres can be hung using an eye screw and a wire hook, while fresh apples may be skewered with a piece of stiff wire such as a coat hanger, and the excess wire bent into a hook. Although wooden balls and red plastic spheres sold as traps are convenient to hang, many people dislike cleaning them for storage, yet don't like the idea of throwing them away and purchasing new ones each year. Store-bought apples can be coated with tanglefoot and composted at the end of the season.

A variant of the red sphere is the Ladd trap, a red sphere/yellow rectangle combination that may be more effective in catching apple maggot flies. It may be worthwhile to use the Ladd trap,

although they are more difficult to clean. You may also choose to purchase scent lures to hang with your traps to increase their attractiveness to flies. The lures contain volatile chemicals that apple maggot flies perceive as the scent of apple fruit.

Hang one trap per 100 fruit (after thinning) in each tree. In small trees this will mean only one or two spheres. Make sure one trap is on the side of the tree facing any wooded or brushy area. A second trap should hang on the south side of the tree. In larger trees, you could have five or more traps distributed around the outside of the tree. If there are apple or hawthorn trees in wooded or landscaped areas nearby, you may want to hang traps in these trees as well, to further reduce apple maggot pressure.

Hang traps in the trees by the end of June, to catch the apple maggot flies as they first attempt to lay eggs. Remove any leaves or fruit touching the traps. Check all the traps weekly and, as needed, clean off the tanglefoot-coated insects, and/or apply more tanglefoot.

Monitor and spray

You can use a sticky red sphere trap as a way of monitoring apple maggot presence in your orchard, so that you can spray an insecticide at the right time to control the flies. In a small planting, you should hang one trap at eye level on the outside of the tree canopy, facing any wooded area nearby, or facing south. Many other insects will also get stuck, some of them small flies with similar wing markings, so learning to positively identify the apple maggot fly is very important.

Check the trap frequently. If you do not use a scent lure, spray for apple maggots as soon as you catch a single adult. If you hang a trap with a lure, wait until you have caught a total of five flies, whether they are all caught at once or one at a time.

Effective insecticides available for apple maggot control are esfenvalerate, carbaryl, and spinosad.

Check the pesticide label for the spray interval, typically given as a range of time, such as "7 to 10 days." Do not spray any more often than this. At the end of that interval, clean any insects off the trap, reapply tanglefoot if needed, and begin checking the traps every day or two as before. When the one-fly threshold (without lure) or five-fly threshold (with lure) is reached, spray again, and repeat the process of cleaning and checking traps. You will probably spray for apple maggot three or four times per season.

It's important to observe the pre-harvest interval, or the "days to harvest," i.e. the interval between pesticide application and harvest. Any fruit picked sooner than this should not be eaten and should be discarded. In some cases this interval could be as long as three weeks. Read the label of the particular insecticide you are using for this information. Fortunately, apple maggot adults are found in smaller numbers as the season progresses, and you should be able to stop spraying sometime in August.



Apple maggot internal injury. Dept. of Entomology, University of Minnesota.

Another option: kaolin clay

Kaolin clay, sold as "Surround at Home," can discourage apple maggot flies and other insects from laying eggs in apple plantings. It is applied in a visible layer to all surfaces of the tree, leaves, and fruit, and acts as a visual and physical repellent to insects. Apple maggot females are attracted to the red color of ripening apples, so a grayish-white apple is not attractive to them. Further, the sensation or chemical signal of the layer of clay particles is repellent to many insects, so that although they may land on the fruit, they immediately leave.

However, it's difficult to achieve and maintain the excellent coverage necessary in a climate like Minnesota's, where heavy rains can occur throughout the growing season. The clay washes off easily even in moderate rain. As fruits expand, coverage must be renewed frequently. A very well maintained coating of Surround can protect 90% of fruit from apple maggots, although effectiveness may be only as high as 30% of the apples. In addition, many home apple plantings are part of an ornamental landscape, and trees covered with the white clay are aesthetically unappealing.

See [Appendix: sources of IPM supplies](#), for information about where to buy trapping materials.

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CODLING MOTH

Cydia pomonella

Codling moth is an internal feeder, and infested fruit is not suitable for eating. Codling moth is common in southeastern and central Minnesota, particularly in places where commercial orchards are nearby, and less of a problem farther west and north. If you have never had a codling moth problem in your orchard, then you probably have a minimal population of this pest in your area. If codling moth is common in your area, however, it is very important to manage this pest.

Identification

The codling moth larva is large (up to ½" long), and has a pinkish body with a brownish head. Codling moth larvae often tunnel towards the apple cores and feed on the seeds before exiting the fruit. Crumbly golden-brown frass (excrement) is sometimes found at the hole where the larva exited the apple.

Important biology

There are two generations of codling moth in Minnesota. The first generation adults emerge from their overwintering sites in spring, just before bloom. Mated female moths lay up to 100 eggs on small, developing



Codling moth adult. Whitney Cranshaw, Colorado State University, Bugwood.org.



Codling moth larva. Clemson University, USDA Coop. Ext., slide set, Bugwood.org.

apples (usually only one egg per fruitlet). After hatching, the larvae chew an opening in the apple's skin. If they are protected by leaves, they may feed at the surface of the fruit before they tunnel into it.

When they have reached maturity, the larvae exit the fruit, drop to the ground, and crawl away to seek sheltered places to spin cocoons. Some larvae remain in this stage the rest of the summer and through the winter, pupating and emerging the following spring. Other larvae pupate immediately, and emerge as adult moths two to three weeks later, flying to the tree canopy to mate. A second generation that can start in late July or early August overwinters as mature larvae in cocoons in sheltered areas after they drop from the fruit. Typically, in home apple orchards, this second flight is not important.

Management

As with many other pests of apple, sanitation is important in keeping pest pressure low. But because codling moth adults can fly as far as a mile seeking an apple tree in which to mate and lay eggs, you probably will not be able to control this pest by sanitation alone if you live in an area where codling moths are common.

Sanitation

Home growers can reduce codling moth populations by maintaining superior sanitation in their plantings. Pick up and remove any fallen apples throughout the growing season and after harvest and place them in the trash.

Sometimes, harvested apples contain codling moth larvae. In storage, the larvae exit the fruit and seek a sheltered place in the storage area. If you store apples in a garage, barn, or other outbuilding, this structure may be a source of codling moth adults the next spring. Wooden apple crates, in particular, provide a good spot for the larvae to overwinter. Inspect your crates and the building in which you store the fruit for silken cocoons, and destroy the insects.



Codling moth external injury. Eugene E. Nelson, Bugwood.org.

Trapping codling moths

You can trap codling moth males entering your apple planting to determine if codling moths are present. Any number of different insects may find their way into the trap, so you should be able to identify the adult male codling moth. Codling moth adults are medium-sized (about 3/8" long) and light grayish brown. A distinctive band of shiny coppery scales at the rear edges of the males' wings makes them readily identifiable.

Codling moths are trapped using a tent-shaped plastic or waxed-paper trap, hung in a tree. The most common is the "delta" trap; also used are "wing" traps. The interior of the trap is coated with tanglefoot, and the trap is baited with a small rubbery lure that gives off synthetic female codling moth pheromones (attractant chemicals). Male moths seeking a mate detect the attractant pheromone, fly into the trap, and get stuck in the tanglefoot. See [Appendix: sources of IPM](#)

supplies, for information about where to buy trapping materials. The trap should be hung at about eye level on the outside of the tree canopy, in early May. Lures typically have a useful life of one or two months. When handling the lure, use a pair of tweezers dedicated to handling codling moth lures, or use disposable gloves. Otherwise, you may transfer attractant pheromone to surfaces other than the inside of the trap.

Check the trap weekly starting in mid-May, to determine if you have codling moths in your area. Clean out the moths and any other insects each time you check the trap.

If you don't catch any codling moth adults, there probably isn't a large enough population of this pest to require spraying. In most of Minnesota, the second flight of codling moth is not large enough to require a home grower to spray.

Insecticide sprays

However, if you do trap codling moths, be prepared to treat your apples soon after the first flight has begun. The best timing is to spray at petal fall, i.e. when most or all of the petals have fallen from the apple blossoms. Do not treat before this as the sprays will be ineffective and will also kill pollinating bees. Make a second spray, seven to ten days later (check the label for the exact interval).



Codling moth internal injury. Clemson University, USDA Coop. Ext., Bugwood.org.

Insecticides for codling moth control

Chemicals that control codling moth include esfenvalerate, and malathion. Sprays to control codling moth could coincide with fungicide sprays to control apple scab. In this case, you could mix insecticide and fungicide in the same tank, or use a pre-mixed all-purpose fruit spray that does not contain carbaryl.

PLUM CURCULIO

Conotrachelus nenuphar

Plum curculio is a common pest of many fruits throughout Minnesota, including plums, cherries, apricots and other soft fruits. It can damage apples, although the damage is often only superficial. If feeding and egg-laying damage are slight, due to a low population of these weevils, there may be no need to control plum curculio in home apple plantings. However, in some orchards, damage from plum curculio leads to a large percentage of fruit that is unattractive and sometimes inedible. Late-season plum curculio feeding may also open wounds that will later be exploited by multicolored Asian lady beetles.



Plum oviposition injury. Michigan State University.

Identification

Plum curculio adults are mottled brownish, blackish, and grayish weevils or "snout beetles." They have rough wing covers and a conspicuous curved beak or snout. They move into apple plantings around the time of bloom and lay eggs in apple fruitlets. "Stings" from egg-laying are the most common damage caused by plum curculio. The slit cut in the apple's skin by the female becomes a tan patch of apple skin with a distinctive shape. These scars can be ¼" wide or more, but are only superficial. The adults also feed on apple tissue. Early in the season, the damage is strictly superficial, not more than 1/8" deep, and typically heals over, leaving a scar in the fruit.



Plum curculio adult. Clemson University, USDA Coop. Ext., Bugwood.org.

Important biology

Plum curculio adult females lay eggs on apple fruitlets, but the larvae cannot grow and develop in the hard, expanding flesh. You will never find a live plum curculio larva in an apple at harvest, nor will you find extensive internal feeding damage caused by a curculio larva. However, plum curculio activity can cause premature fruit drop. If an apple drops early in the season, the flesh softens, and a curculio larva can finish its development. (The larvae often develop to maturity in soft fruits such as plums and cherries.)

Mature larvae leave the fruit, burrow into the soil and pupate, emerging as adults in August. These adults may feed on almost-ripe apples, causing puncture wounds. Later, they burrow into the soil or hide under leaf litter to overwinter, emerging in spring to mate, feed on immature fruit, and lay eggs.

Management

Effective non-chemical controls for plum curculio have not yet been developed. If this insect is more than a nuisance in your planting, you can try sanitation and shaking or beating the branches, but these methods probably won't be sufficient, and you will probably need to spray an insecticide.

Monitoring

You can check to see if plum curculios are present. Hold a white paper plate right under a branch, and shake or beat the branch to dislodge the plum curculios. Start looking for the adults before the flowers have opened, and check every few days. In the morning, when the insects are cold, they will fall onto the plate rather than flying away.

Sanitation

Host trees and shrubs near the apple planting, such as plum, cherry, or other berries may be the source of the curculio pressure. Removing these, if possible, could solve the problem. Remove fallen apples throughout the season and send out with trash or use as animal feed.

Shaking

To reduce plum curculio pressure somewhat, shake and beat the trunk and branches of the tree with a padded bat or stick to dislodge the insects. Cool mornings during bloom and petal fall are the best time to dislodge plum curculios, because if they are cold, they will simply fall out of the tree, rather than flying away. The ground beneath the tree should be covered with a sheet or tarp, and the insects that fall onto it can be removed from the planting and crushed. However, this would need to be done every morning for about a month, starting a week or so before bloom, to be effective.

Insecticide sprays

If you have had damage from plum curculio in previous years, spray an insecticide at petal fall, and again seven to ten days later. In many years, plum curculio adults enter the planting and begin laying eggs at about the same time as codling moths, so sprays for codling moth are likely to kill plum curculio adults. Esfenvalerate and malathion are effective against both pests. Esfenvalerate is highly toxic to bees, so do not to use it if there are any flowers open on your trees.

You could mix the insecticide with a fungicide you are using to control apple scab, or use a pre-mixed all-purpose fruit spray that does not contain carbaryl. (Although carbaryl is effective against plum curculio, it can cause all the fruit to drop if used within 30 days after full bloom.)

MULTICOLORED ASIAN LADY BEETLE

Harmonia axyridis

The multicolored Asian lady beetle is a relatively new pest of fruit in Minnesota. Growers may find ripe or nearly-ripe apples with fairly large cavities in them, and a number of lady beetles inside, eating the apple's flesh. This is the same lady beetle that sometimes invades houses or congregates on the sides of buildings. Information about this insect when it is associated with buildings can be found in the University of Minnesota Extension publication [Multicolored Asian lady beetles](#).



Multicolored Asian lady beetles infesting an apple. Eric Burkness, UMN.

Identification

The multicolored Asian lady beetle is a large lady beetle, up to 1/3" long. It may be yellowish-orange, bright orange, or darker reddish-orange. This lady beetle typically has nineteen spots, although this number is quite variable and individuals may have no spots and every combination of even numbers from two to eighteen. However, if you find lady beetles feeding in apples, you may be sure they are multicolored Asian lady beetles.

Important biology

There are many lady beetles in Minnesota, all of which are predators, eating soft-bodied insects, especially aphids. In this way, they are considered beneficial. Populations of multicolored Asian lady beetles are common in wooded areas, agriculture fields, and home gardens. As their preferred prey become scarce, these lady beetles fly to another food source, often fall-ripening fruit such as grapes, apples, and fall raspberries. These insects only infest apples that already have wounds, typically holes made by birds or other insects.

Management

The only management option for multicolored Asian lady beetles in apple plantings is sanitation. They only infest fruit that is already damaged, so picking up fallen apples and removing damaged apples still on the tree will help reduce the number of lady beetles in your apple planting. Insecticides are not a practical option.



Multicolored Asian lady beetles infesting an apple.

APPENDIX: SOURCES OF IPM SUPPLIES

Table 3: Pesticides for home apple growers

Chemical	Pests controlled	Trade name examples	Notes
Bactericides			
<i>Bacillus subtilis</i>	Fire blight	Serenade Garden Defense	Only during bloom or right after hail in spring
Copper	Fire blight	Many formulations, many brands	Can damage leaves, blossoms, fruit. Apply only before green tip.
Streptomycin sulfate	Fire blight	Bonide Fire Blight Spray	Not recommended
Fungicides			
Captan	Scab, black rot	Many brands	
Liquid lime-sulfur	Scab, black rot	Lilly Miller Polysul is labeled for spring use (most brands are only for dormant use).	Can burn plant tissue. Strong odor.
Wettable sulfur or sulfur dust	Scab, black rot	Many brands	Lime-sulfur is more effective. Can harm fruit finish and lower soil pH.
Insecticides			
Carbaryl	Apple maggot	Sevin and many other brands	Will cause fruit drop, so cannot be used until 30 days after full bloom. Very toxic to bees.
Esfenvalerate	Plum curculio, codling moth, apple maggot	Ortho Bug-B-Gon Max	Has a relatively long pre-harvest interval. Very toxic to bees.
Kaolin	Plum curculio, codling moth	Bonide	Not labeled for apple maggot
Spinosad	Apple maggot	Monterey Garden Insect Spray	
Fruit tree sprays (combinations of insecticide and fungicide)			
Captan, Carbaryl, Malathion	Scab, black rot, plum curculio, codling moth, apple maggot	Bonide	Will cause fruit drop if used within 30 days of bloom. Very toxic to bees.
Captan, Malathion	Scab, black rot, plum curculio, codling moth	Ferti-Lome	Very toxic to bees.

SOURCES OF TRAPS AND OTHER SUPPLIES

Ladd Research

83 Holly Court
Williston, VT 05495
800-451-3406

www.laddresearch.com

Ladd trap and apple maggot lure. Codling moth trap and lure. Tanglefoot.

Gardens Alive

5100 Schenley Place,
Lawrenceburg, Indiana 47025
513-354-1482

www.gardensalive.com

Surround at Home. Codling moth trap and lure. Ladd trap and apple maggot lure.

Biocontrol Network

5116 Williamsburg Rd.
Brentwood, TN 37027
800-441-2847

www.biconet.com

Codling moth trap and lure. Red sphere trap and apple maggot lure. Tanglefoot.

Gempler's

P.O. Box 44993
Madison, WI 53744-4993
800-382-8473

www.gemplers.com

Codling moth trap and lure. Red sphere trap and apple maggot lure. Tanglefoot.

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