Organic Apple Production

IN IOWA

IOWA STATE UNIVERSITY
Extension and Outreach

The best system for organic apple production in the Midwest uses apple cultivars that are resistant to apple scab plus integrated approaches—including mechanical, cultural, and biological control methods—to manage destructive insects.

Because commercial production of organic apples is relatively new in the Midwest, most information for growers comes from New York and California (see References).

Get the most from your ORGANIC ORCHARD

MAXIMIZE PROFITS with timely harvests.

PRACTICE GOOD SANITATION by picking up and/or destroying all fallen or rotten apples.

AVOID PROBLEMS with E. coli and other human diseases by only using apples picked off trees.

CONSIDER USING chickens and guinea hens to clean orchard floors of infested apples.

BE EXTREMELY AGGRESSIVE in managing disease and insect problems to reduce damage and crop loss. To be effective, the producer must continuously monitor for insect or disease problems and develop a timely management plan.

SEEK ADVICE and help from professionals, such as extension specialists.

VISIT WITH OWNERS of neighboring conventional orchards and assure them that you will use sound and proven sustainable practices to manage insects and diseases so as not to negatively impact their orchards.

Marketing Opportunities

Midwest organic apple growers have two likely markets for their produce—the large natural food grocery chains and/or local consumers.

Selling to the national chain stores is challenging because their buyers expect organic apples to be cosmetically similar to conventionally produced apples. The high humidity that is typical in the Midwest often meansgrowers do not need the irrigation systems required by growers in other parts of the country. However, the humidity also can encourage problems with disease, weeds, and insects. When disease-resistant cultivars are planted and careful management techniques are used, an organic apple grower can effectively produce marketable, aesthetically appealing fruit for national grocery chains.

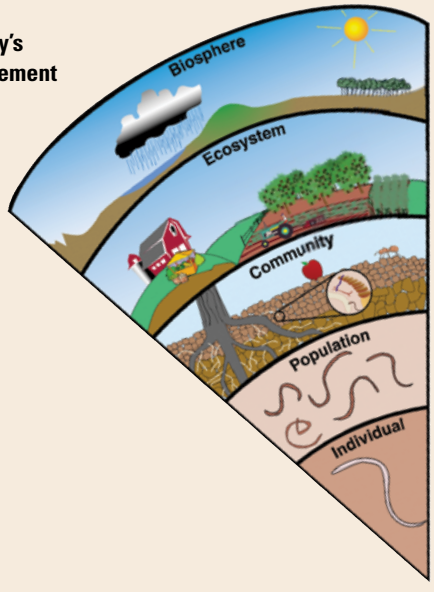
The second opportunity for Midwest organic apple growers is to market their produce directly to consumers who prefer small-scale, locally produced, synthetic chemical-free and third-party verified, organically-raised food.

Growers can take advantage of this niche market through on-farm sales, participation at farmers' markets and sales to local grocery stores (see "Using Organic Agriculture and Sustainable Crops and Livestock in the Local Food System" PM 1995).

By carefully developing this market, growers can maintain an adequate profit margin while personally connecting with consumers.

An additional strategy for organic growers is to expand their marketing to include "value-added" products—such as cider, preserves, pies, and other prepared goods. On-farm processing requires special equipment and compliance with health regulations (see References). Alternatively, a grower can work with other orchard owners who have processing capabilities.

Michigan State University's Fruit Ecology and Management Manual discusses the importance of viewing the orchard as an entire eco-system (see References).



PLUM CURCULIO

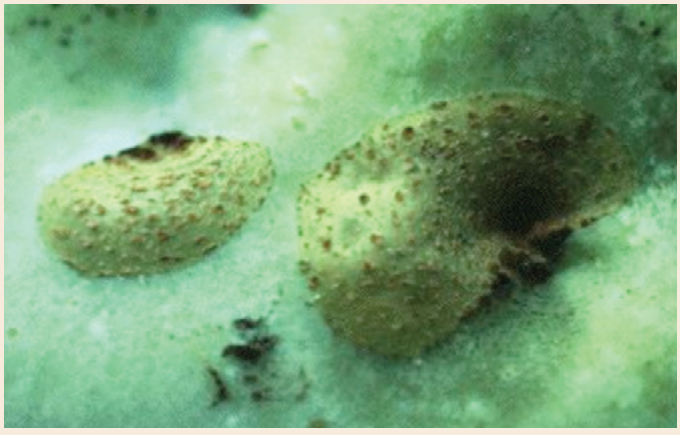
The most devastating apple insect pest is the plum curculio, a small, brown, snout-nosed weevil native to most apple production areas in the eastern U.S. This beetle injures fruit in multiple ways:

- Scarring caused by surface feeding and egg depositing
- Internal damage caused by burrowing larvae
- Premature fruit drop
- Punctured fruit caused by adults feeding in late summer and fall

Avoiding this pest is difficult because the adult weevil over winters in woodlots, fencerows, and hedges. If your orchard is near a maple woodlot, planting one or two rows of conifers along the woodlot edge will discourage plum curculios from entering in the fall. Abandoned orchards and neighboring fruit trees—including crabapple, wild apples, pears, plums, cherries, peaches, and apricots—also can harbor plum curculio beetles.

The weevils move into the orchard during bloom to feed on young flowers. After mating, the female adult beetle bores a small hole into the skin of the developing fruit, deposits a single egg, and then makes a crescent cut below the hole to protect the egg from being crushed by the rapidly expanding fruit tissue. The female lays an average of 150 to 200 eggs, which hatch 2 to 12 days later. The grubs (larvae) tunnel into the fruit's central seed cavity where feeding commences until development is completed in about three weeks.

Plum curculio adult weevil



Cresent-shaped markings of the plum curculio

The larvae generate and release pectin enzymes that trigger the host fruit to drop prematurely. The grubs then chew through the fallen fruit and enter the soil to pupate. A combination of several cultural control methods can be useful in reducing damage.

Visual observation of the adults and their egg deposition marks is the best way to detect beetle activity. It is important to check the perimeter apple trees at bloom. "Trap trees" of plum trees can be used for early detection because the crescent signature appears earlier on plums than apples. Additionally, USDA Agricultural Research Service scientists have developed pheromone traps that attract adult beetles and allow a grower to capture the insects when they first arrive in the orchard.

Infested fruit typically drop before the larvae complete their feeding. Prompt gathering and disposal of the dropped apples before the larvae exit the apple to enter the soil can reduce the number of emerging adults. Boiling, burning, or soaking in oil should destroy the larvae in the dropped apples. Infestation may be greater in the outside two or three rows of trees than in the rest of the orchard. Not all dropped apples are caused by plum curculio. Other causes are heavy fruit set and poor pollination.

"Tree jarring" limbs with a padded board can knock adults from a tree to a waiting tarp placed below. This should be done in the early morning while it is still cool to prevent beetles from flying away. Captured beetles must be destroyed immediately. For significant control to be achieved by this method the trees should be jarred every morning for four to six weeks beginning at blossoming.

During the cocoon stage or pupal period a mechanical disking of the top inch of soil where pupation occurs can be an effective control. Disking should begin about three weeks after the infested fruit starts to drop. This should be done on weekly intervals for several weeks. Do not start too early. If the cocoon is broken before pupation occurs, the larvae make another cocoon.

Parasitic wasps are likely to be attracted by a diverse array of ground vegetation with small flowers. Flowers should blossom after apple trees to avoid attracting bees that attack plum curculio larvae.

Mixing poultry feed with the soil under the trees can encourage free-ranging fowl (such as chickens, ducks and geese) to scratch for larvae and adult weevils. Mobile chicken coops also could be moved along the edge of the orchard. Hogs also have been employed to consume fallen infested apples.

CODLING MOTH

Coddling moth larva and damage

The codling moth is present throughout North America. In the warmer parts of the Midwest, there may be two or three generations per season. Several acceptable cultural and biological control methods are available.

Mating disruption is considered mandatory in organic apple orchards. Females release pheromones that signal their location to males during the mating period. Codling moth's mating cycle can be disrupted by releasing mass quantities of pheromones into the orchard through dispenser strips tied on trees or through "puffer" systems. Since treeless spaces and taller trees interrupt pheromone spread, for best results, trees should be evenly spaced and of equal heights. Mating can occur in the air above the dispensers so the ties should be placed as high in the trees as possible. An aerosol dispenser, nicknamed the "puffer," uses a timer to periodically spray specific amounts of pheromone at the recommended rate per acre into the orchard. When codling moth populations are high, an organic grower can combine mating disruption with black light traps. Both male and female moths are attracted to black light.

***Bacillus thuringiensis* (Bt)**, a naturally occurring bacterium, can be used with limited results against codling moth. Dipel™ is an example of a product formulated with this bacterium. Other organic insecticides used against codling moth include a spinosad fungus, Entrust™, and codling moth granulosis virus (CMGV), commonly sold as Cyd-X™.

Adult *Trichogramma* wasps feed on insect eggs, nectar, pollen, and honeydew. Border plantings of good nectar and pollen food sources—such as alfalfa, sorghum, sunflower, corn, clovers, and wildflowers—will increase wasp parasitism of codling moth eggs.

Codling moth larvae can be intercepted as they descend the trunk to pupate by wrapping the trunks with corrugated cardboard. The cardboard provides an artificial pupation site and should be removed and destroyed about a month after the first larvae have moved down to pupate.

Kaolin particle film
(Surround™) was introduced in 1999 for use against apple pests. Surround™ is a liquid spray that dries to leave

a protective powdery film on the surfaces of leaves, stems and fruit. Tiny particles of the clay become attached to an insect as they come in contact with the film, acting as an irritant. The film-coated plants and fruit are unsuitable for insect feeding and egg laying. The film is white and highly reflective–making the tree unrecognizable to certain insects as a host.

Surround™ is reported to be an effective deterrent against plum curculio, codling moth, leafrollers, leafhoppers, mites, stink bugs, and apple maggot. Other reported effects include reduction of heat stress, fruit drop and sunburn, improvement of color, and greater return bloom in certain cultivars. Iowa State University trials in 2000 produced a 50 percent reduction in codling moth damage with the use of kaolin particle film (see References). Since these trials, organic apple growers are relying more on CMGV and spinosad for more effective codling moth management.

Woodpiles, boxes, and bins can be a major source of re-infestation of codling moth and should be routinely cleaned and kept away from the orchard.

MITES, APHIDS, SCALE, LEAFHOPPERS

These so-called minor pests primarily feed on apple stems and foliage. They can be tolerated in much higher numbers than direct fruit pests until their occurrence is high enough to seriously weaken the tree, resulting in reduced quality and quantity of fruit or even tree death.

Beneficial organisms—such as aphid midges *(Aphidoletes aphidimyza)*, pink spotted lady beetles (*Coleomegilla maculata*), green lacewings (*Chrysoperla* spp.), predatory mites (*Galendromus occidentalis, Galendromus pyri, Neoseiulus fallacies, Zetzellia mali*), and spined soldier bugs (*Podisus maculiventris*)—generally keep minor pests below damage-inducing thresholds. The natural bacteria, *Bacillus thuringiensis* (*Bt*), can be used for any leaf-eating caterpillars on the trees. If mites or scale insects are present (not normally a problem in Iowa), horticultural oils (vegetable-based) can be used. Oils should not be used in conjunction with sulfur or within 30 days of sulfur applications. A combination of the two can cause leaf burning. Organic growers who rely on frequent sprays of non-selective botanicals like pyrethrum may be inducing minor pest problems.

Apples can be protected with Fuji bags – paper bags individually placed around each apple to prevent insect attack.

BORERS

Several species of borers also may be pests in apple tree cultivation. Trees that are stressed by drought or disease are much more susceptible to borers. Borer development takes one to two years to complete.

A primary control method is to remove serviceberry trees (the preferred hosts of the round head borer) from close proximity to the orchard. Flatheaded and roundheaded borers emerge from late April through early May and start laying eggs beneath the bark scales of the fruit tree. A favorite egg-laying location is the graft union of a tree. When the larvae hatch they burrow under the bark to feed on the cambium tissue. Trees with good vigor are able to drown invading larvae with sap.

The dogwood borer feeds primarily on burr knot tissue on clonal rootstocks. These clusters develop on the above ground portion of some rootstocks. To prevent dogwood borer attack, plant so that the graft or bud union is within an inch of the soil. This should inhibit development of burr knots. Dogwood borer damage is generally less damaging than that caused by the flatheaded or roundheaded types.

For all species of borers use a wrap or paint to cover the bottom 12 to 14 inches of the trunk. The wrap material can be window screen, metal, fiberglass, or nylon secured at the top with a twist tie that should be loosened once a year. This will help prevent entry, but is not as effective on roundhead borers because they attack near ground level.

All types of borer larvae can be removed from the trunk with a jackknife or piece of wire. Routine checks during the spring and summer will help identify signs of borer damage—such as frass mixed with sawdust at the pest entry hole. By September, the borer may have burrowed beyond the range of manual removal.

Apple maggot adult flies (larvae attack fruit)

APPLE MAGGOT

Apple maggot can be a serious pest in certain years in Iowa. The apple maggot remains in a pupal stage underground throughout the winter and, in June or July, flies will emerge from a few inches below the soil surface. Female flies lay eggs and once they hatch, tiny larvae begin to tunnel through the fruit. Apples will rot internally once bacteria develop from larval tunneling, causing apples to drop from the tree in severe cases. Adult flies can be trapped by placing one red sphere covered with a sticky coating per tree. The flies also are susceptible to pyrethrum and diatomaceous earth sprays.

Tips on Spraying

Growers should **follow label** rates and application recommendations for all spray treatments.

Conventional spray equipment with some form of agitation is ideal for use in commercial organic apple orchards. Full coverage of the material on the foliage, branches and trunk is important. A fan-type sprayer that blows the leaves around works well for this purpose.

A **spray program** for plum curculio and first-generation codling moth should start at first petal fall and continue for 6 to 8 weeks or until the infestation is over. Spraying should be done every 5 to 7 days to achieve a high level of suppression.

Using **white Surround™ film** may increase photosynthesis by keeping the tree cooler longer on hot days. Studies show that trees sprayed six to eight weeks after petal fall had increased yields and red color. Fruit trees in hot areas benefit from marked reduction in sunburn. If spraying is discontinued after eight weeks, little or no residue will remain at harvest because of rain and wind. Residue left on the fruit at harvest might be considered unsightly, but is not a problem for processing. Although the residue is not harmful, if a full season spraying program is used to suppress apple maggot or other late season pests a scrubber/washer will need to be used to remove any dust remaining on the fruit at harvest for the fresh market. A Michigan State University study reported increased return bloom where Surround™ had been used the previous year (see References). Combining Surround™ with other available cultural pest controls is key to an effective program for producing high quality fruit.

Pruning and trellising apple trees helps open air spaces within the canopy, which aids in disease management.

Apple scab management is best achieved by planting resistant varieties.

Managing Diseases

APPLE SCAB

The most serious apple disease worldwide is apple scab. The seriousness of infections depends on a combination of factors: rain, longevity of leaf wetness, and temperature. Spores germinate and cause infection when leaves have been wet for 48 hours at temperatures from 32° to 40°F. However, germination occurs after only nine wet hours when temperatures are 58° to 76°F.

If primary infections are not controlled they can erupt into secondary infections later in the season. Secondary infections weaken the tree and blemish and deform the apples. During wet periods, secondary infections develop when summer spores germinate in lesions on leaf and bud tissues and spread throughout the tree. The warmer the weather, the more quickly summer spores developfollowing a primary infection.

Planting scab-resistant varieties is the best long-term strategy for the organic grower; examples include Jonafree, Redfree, Liberty, Freedom, Dayton, William's Pride, Gold Rush, Enterprise, Priscilla, Nova Easygro, and WineCrisp.

On susceptible varieties, timely sprays of sulfur, lime-sulfur, or Bordeaux mixture (copper sulfate plus lime) are effective against scab spores if applied before the spores have a chance to germinate. Trees must be sprayed before, during, and after every rain from the time of bud break until all the spores are discharged. These fungicides can be harmful to foliage or blossoms so label instructions must be followed. If primary infections are prevented, it may not be necessary to spray during the rest of the season. Otherwise, spraying will have to continue through the season.

The scab fungus over-winters on fallen apple leaves. By raking and destroying (burying, burning, or composting) the fallen leaves, a grower can control and for the most part eliminate the primary scab inocula. Animals (hogs and sheep) also can be used for cleaning the orchard floor of infected apples. However, for the best results, a grower should establish an orchard with scab-resistant fruit trees.

FIRE BLIGHT

This disease is caused by the bacterium *Erwinia amylovra*. Warm, wet conditions are conducive to bacteria production. Wind, rain, bees, aphids, and other insects spread bacteria throughout the orchard. Large numbers of new infections can occur within minutes after rain or heavy dew.

Infections gain entry to the tree through blossoms or lush new growth then spread internally through the stems working towards the roots. Affected branches appear as if scorched, wither, and turn a brownish black. Resistant varieties are rarely invaded beyond young wood (Empire, Liberty, and Priscilla varieties are moderately resistant).

Once infected, the only treatment is to remove infected limbs to minimize damage. Cutting damaged branches during the growing season should be done only high in the tree when the central tree stem is threatened and the job can be completed quickly. Make cuts only into two year old or older wood and at least four to five inches short of the next healthy branch union.

An unfortunate characteristic of this bacterium is its ability to be present in healthy tissues far ahead of visible symptoms. These are not visible because high levels of reserve carbohydrates in living bark tissues deny bacteria water and limit development of symptoms. If healthy looking branches are cut, the natural defense provided by the reserve carbohydrates is breached and cankers will form around the site of infection. Bacteria will remain at the canker site through the off-season and will survive to infect more trees the following year.

For prevention, cankers that form around the cut can be removed during the regular dormant pruning season during the winter. All blighted twigs, branches, and cankers should be cut out about five inches below the last point of visible infection burn. After each cut, the shears should be dipped in a strong bleach solution (1 part bleach to 4 parts water) to avoid transmitting the disease from shears to branch. Because fire blight favors young succulent tissues, cultural practices that favor moderate growth (such as low fertilization and limited pruning) are recommended. Streptomycin is an antibiotic produced by cultured fungi, and has been the most common commercial control since the 1950s. Organic growers should check with their certifier to identify organically acceptable mixes of streptomycin. Application is made just before rain or heavy dew is expected during early bloom, when the average temperature is 60°F or higher. If rainy conditions persist, repeat spraying within four days. Unnecessary overuse of streptomycin could induce resistance in the pathogen population. Streptomycin should never be used when burned branch tips are present. Copper formulations, such as Bordeaux mix, sprayed at green tip stage provide some protection from infection. For best results, copper formulations should be applied to the entire orchard. Streptomycin sprays should not be used in combination with copper sprays.

Powdery mildew

Primarily a foliar disease, powdery mildew can affect the fruit if the infection is severe. For example, infections that curl, distort, and discolor leaves reduce photosynthesis and affect overall tree health. Mildew can be controlled with sulfur compounds, such as elemental sulfur and lime-sulfur, or Bordeaux mixture.

Cedar apple rust

The responsible fungus moves between Eastern red cedars (junipers, not true Midwest cedars) and apple trees; it spends part of its life on an Eastern red cedar. Incidence can be reduced by eliminating junipers within a given area; however, spores can travel up to three miles, making eradication impossible. If spray controls are used, the grower should time sulfur fungicide sprays to coincide with the springtime appearance of orange gelatinous "horns" on the galls on the cedar. This bizarre-looking fruiting stage releases spores that infect the apple trees.

Summer rots

When summers are warm and humid, black rot, bitter rot, and white rot can be problematic. Cultural practices that can help suppress these organisms include pruning out diseased wood, removing fruit mummies, pruning for light penetration and air circulation, and avoiding poorly drained sites when planting new orchards.

Managing Weeds

Mulching and mowing are primary methods for weed management in an organic orchard. Mulches can be wood chips, bark, paper, plastic, or straw. Research has demonstrated the durability and protectiveness of bark and wood chips over other choices. Some orchardists use a Weed Badger™ to cultivate around trees but damage to roots and trees can occur if care is not used.

Periodic mowing along with planting a cover crop of grass with some legumes (e.g., clovers) for beneficial insect attraction is recommended over fallow ground.

Organic fruit operations may include animals to maintain vegetation once trees or vines are of an adequate size

Conclusion

The organic apple orchardist can build an economically and ecologically sustainable business, but potential pitfalls related to disease and insect management require attention to infection periods and timely applications of organic-compliant treatments. Despite the increase in large-scale organic apple production and the abundance of organic apples from Washington state and New Zealand, most organic consumers prefer locally produced fruits and vegetables, which will help secure markets for Iowa organic apples.

No endorsement of products or firms is intended, nor is criticism implied of those not mentioned.

LEOPOLD CENTER

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For complete reports on all organic ag projects, visit *extension.agron.iastate.edu/organicag*

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p.7 Field photograph by J. Reganold, Washington State University

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