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Cherries: Organic Production

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Published March 2014

IP463

This publication focuses on organic pest and disease control and other topics relevant to organic production of both tart and sweet cherries. It introduces the Canadian bush cherry and discusses climatic considerations for cherry production. Information on marketing is included, as are further resources and sources of trees and pest-control materials.

Carmine Jewel bush cherry. Photo: Bob Bors, University of Saskatchewan

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The National Sustainable Agriculture Information Service, ATTRA *(www.attra.ncat.org)*, was developed and is managed by the National Center for Appropriate Technology (NCAT). The project is funded through a cooperative agreement with the United States Department of Agriculture's Rural Business-Cooperative Service. Visit the NCAT website (*www.ncat.org*) for more information on our other sustainable agriculture and energy projects.

Introduction

Commercial organic cherry production presents many challenges. The cherry fruit fly, bacterial canker, phytophthora root rot, leaf spot, fruit cracking, late frosts, and brown rot of the blossom and fruit are all serious obstacles to the orchardist hoping to make a profit with cherries, particularly for the organic grower. Yet, despite these and other hurdles, organic cherry production is a profitable option for U.S. growers in much of the Northwest, and in the East, light can be seen at the end of the (high) tunnel.

Sweet and tart cherries belong to different species, and the differences between these species drive management choices. Compared to tart cherries (*Prunus cerasus*), sweet cherries *(P. avium)* are taller (30 to 40 feet unpruned on standard rootstocks), produce larger fruits, are somewhat more susceptible to diseases, require cross-pollination, are less cold hardy, and are usually hand-harvested for the fresh market.

Tart cherries are short (18 to 20 feet unpruned on standard rootstocks), are cold hardy, have fruit more resistant to cracking and brown rot (relative to sweet cherries), are self-pollinating, and most are machine harvested for the processing market.

A third and new type of cherry, the Canadian bush cherry (see photo above), resulting from controlled crosses between *P. cerasus* and *P. fruticosa* (the Mongolian bush cherry), seems to be poised for successful

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commercial production in Canada and, probably, the United States. Breeding advances in Canada have resulted in a bush that yields large amounts of sweet-tart cherries (18 to 22 brix), is cold hardy to minus 40°F, disease resistant, and suited to mechanical harvest with blueberry harvesters.

Recent advances in developing dependable, dwarfing rootstocks for cherries benefit conventional and organic growers alike, but may greatly increase the viability of organic operations, especially in the East, because the smaller size will enable them to be grown inside high tunnels (plastic-covered hoop houses). This protected growing condition reduces problems associated with rainfall and fluctuating temperatures (see box "Trees in Tunnels" on page 3). Some of the dwarfing rootstocks are also more genetically resistant to bacterial canker and root rots than the standard types currently used.

Many considerations and practices are the same for both organic and conventional cherry growers. Cherries prefer a deep sandy or sandy loam soil with a slightly acid to neutral pH. A pH of 6.2 to 6.8 is often cited as ideal. Pruning and training will be approximately the same for all kinds of culture. Information on these topics is available from sources such as the Cooperative Extension Service, state cherry production councils, orcharding texts, and trade magazines. This publication focuses primarily on organic pest and disease control and other topics relevant to organic production.

Organic approaches to managing fertility, weed control, and orchard-floor vegetation apply across tree-fruit crops (e.g., apples, peaches, pears, cherries, and plums). For general information on organic orchard practices, see ATTRA's *Tree Fruits: Organic Production Overview.*

Climatic Considerations

As with most other tree fruits, the climate in the western United States is more amenable to production of organic cherries than is the more humid climate of the East. The problems mentioned in the Introduction are present both East and West, but the higher rainfall and humidity in the East tend to magnify those problems. In fact, fruit cracking from rain—purely a physiological problem and not a disease in itself—plagues all eastern growers, organic or otherwise, and greatly favors commercial sweet cherry production in the West, where most production relies on controlled irrigation, not rainfall. There is some commercial sweet cherry production in the Northeast, but its scale is dwarfed by the production of the West; additionally, northeastern growers have relatively few cultivars to choose from due to the propensity of cultivars like Bing to crack in the rain.

In contrast, because tart cherries are not as susceptible to fruit cracking or brown rot as are sweets, they can be grown profitably in areas outside the arid West. In fact, tart cherry production is centered around the Great Lakes states, with Michigan being the biggest producer.

Another climatic consideration is the chilling requirement. Cherries require a winter chilling period in order to break dormancy successfully and bloom. For most sweet cherries, the chilling requirement is more than 1,000 hours; for tart cherries the requirement is roughly 800 hours. This is one of several reasons why cherry production is not practical in warm, southern climates. There are a few cultivars with low chilling requirements, but they are not the important commercial cultivars. These low-chill cultivars can be problematic in areas with fluctuating wintertime temperatures, like the mid-South, where they quickly meet their chilling requirements and begin to bloom any time the weather is warm for a week or more, only to have the blossoms nipped by the inevitable return to cold.

Another factor related to temperature is hardiness of the wood. Winter damage usually takes the form of longitudinal cracks in the southwest-facing parts of trunks. This is because the angle of the winter sun warms up the southwest aspect and predisposes that warmed tissue to subsequent freeze damage when nighttime temperatures drop. Such damage is a problem in itself, but the more serious problem occurs when the wound is colonized by the opportunistic bacteria that cause bacterial canker (more under Major Diseases). Tart cherries are somewhat less likely to suffer winter damage to trunks and branches, but the threat of winter damage cannot be ignored by tart cherry growers. The usual preventive treatment for both sweet and tart cherries is to paint the trunks with whitewash or white latex paint (though latex paint is not permissible for organic growers), which reflects the sun's heat. Another tactic is to make sure that a low branch or branches emanate from the southwest face of the trunk, thereby shading the trunk from the winter sun.

Outside of the type of winter damage described above, there is simple cold-hardiness of the whole tree to be considered. In general, sweet cherries are the least hardy, usually being designated as hardy to minus 20°F (USDA Zone 5). Tart cherries are rated as hardy to minus 30°F (Zone 4), and the Canadian bush cherries are hardy to minus 40°F (Zones 2 and 3).

The final climatic consideration is heat, which, for the most part, simply aggravates disease problems. The humid South, for instance, is very conducive to the spread and infection of brown rot. Sweet cherries are quite susceptible to brown rot and bacterial canker and, as a result, are very difficult to grow successfully in the South, though the southern Appalachians are a tad more hospitable to cherries. The tart cherries, again, are more resistant to brown rot and can be grown organically in much of the South, but they are still quite susceptible to powdery mildew and leaf spot, diseases made worse by the heat and humidity. More information on these diseases and their organic control is presented in the Major Diseases section.

Trees in Tunnels—Unnatural, Perhaps, but Organic!

Cherry trees in a high tunnel. Note the small, yellow-lidded bumblebee box between trees two and three, counting from the left. Photo: Gregory Lang, Michigan State University

The introduction of the plastic-covered high tunnel to farms and orchards might be the key to small-scale commercial organic production of many fruit crops that have previously proven difficult to grow organically, especially in the East. Use of high tunnels began as a way to extend the season of vegetables and strawberries under the protection of plastic. Growers and researchers soon realized that brambles, grapes, and even fruit trees could benefit from the disease protection high tunnels afford. In addition to providing disease protection, high tunnels can greatly reduce cherry fruit cracking that often follows rains near the harvest period (Lang et al., 2007).

The main benefit high tunnels offer the organic cherry grower is the ability to exclude and otherwise inhibit disease propagules. Splashing, blowing rain is the main vehicle for spreading most fruit diseases. Moreover, most fungal diseases of leaves or fruit require free water on the plant surface for the conidia or spores to germinate and infect the plant. Thus, where rain can be excluded, diseases like brown rot can be practically eliminated. Even if an errant *Monilinia* spore (causal organism of brown rot) blew in, there wouldn't be water on the fruit to allow the spore to germinate and penetrate the fruit.

Growers and researchers are growing cherries and other members of the genus Prunus, all susceptible to brown rot, successfully in tunnels. Dr. Gregory Lang, Michigan State University tree fruit specialist, points out that though fruit cracking, brown rot of fruit, and bacterial canker are greatly reduced in tunnels, they are not eliminated (www.cherries.msu.edu/pdf/OrchardShow09G-Lang.pdf). Water and humidity management are issues still being addressed. Pollination is managed with purchased bumblebee colonies (see photo).

Dr. Curt Rom, University of Arkansas tree fruit researcher and high-tunnel enthusiast, says most key insect pests do not come into the high tunnels. But, warns Rom, the high tunnel is not a silver bullet (2013). Some insects still get in and may enjoy relative freedom from their natural enemies. Consequently, populations of insects such as mites, whiteflies, and aphids can explode.

At least one disease, powdery mildew, which does not require free water to germinate and spread, thrives in the high relative humidity usually found in high tunnels. Fortunately, there are effective organic controls for these problems. Organic controls for brown rot aren't nearly as reliable, so growing under cover is an appealing alternative for organic growers in areas of high rainfall.

For more information on high tunnels, call ATTRA at 800-346-9140.

Site

Like the flowers of most other temperate-zone fruit trees, cherry blossoms are susceptible to late spring frosts, so the planting site should be higher than the surrounding area to allow colder, heavier air to drain out of the orchard during bloom.

Because bacterial canker is such a devastating disease on cherries and because the bacteria usually find their first foothold in the cracks and crevices of winter-damaged trunks, it is important to avoid sites with south or southwest-facing slopes. These tend to heat up too quickly, predisposing the tree to winter damage, as described earlier. Bacterial canker is discussed further in the Major Diseases section.

A New Type of Cherry: The Canadian Bush Cherry

Botanists hypothesize that the original tart cherry (*P. cerasus*) was the result of chance, prehistoric hybridization of the sweet cherry (*P. avium*) and the Mongolian bush cherry (*P. fruticosa*). Mimicking nature, Canadian plant breeders (beginning with Les Kerr in the 1930s) deliberately crossed the tart cherry back to the presumed ancestral parent, the Mongolian bush cherry, resulting in naturally dwarfed (on their own roots; not grafted), super cold-hardy, disease-resistant trees that are amenable to machine harvest and produce high yields of cherries considerably sweeter than the common tart cherry (Bors and Matthews, 2004).

A bowl of one of the selections from the University of Saskatchewan breeding program. Photo: Bob Bors, University of Saskatchewan

Beginning in 1974, Rick Sawatzky of the University of Saskatchewan took these initial hybrids and began a long "one-man breeding program" (Bors and Matthews, 2004). In 1999, the University of Saskatchewan released the first Canadian bush cherry, SK Carmine Jewel. As of this date, five more selections—Romeo, Valentine, Crimson Passion, Juliet, and Cupid, together known as the Romance Series—have been released.

Besides the improvements over the conventional tart cherry already mentioned, these cherries have darker juice which is generally considered a "plus" for the processing industry. However, compared to the industry-standard tart cherry, Montmorency, the bush cherries are sweeter (18 to 22 brix; compare to 12 to 16 brix for Montmorency), which makes them attractive as a dessert cherry eaten fresh like a sweet cherry.

They are rated cold hardy down to minus 40°F, and will grow in clay and/or alkaline soils. Mature height is from four to eight feet, making them well-suited for high-density plantings and for harvest by mechanical blueberry pickers. They will yield their first crop within three years of planting, and like the conventional tart cherry, they are self-fertile (do not require cross-pollination).

Yield data is still being compiled, but early indications are encouraging. By year five, bushes are yielding about 4.5 pounds of fruit per bush, and by year nine, 11 to 22 pounds per bush (Bors and Matthews, 2004). Yields per acre will be largely determined by plant density. Recommended within-row plant spacing is six feet. Rows can be as close as 12 feet from one another if the intention is to harvest by hand. For machine harvest, rows should be 17 to 20 feet apart.

The Canadian researchers are optimistic about the prospects for organic production of bush cherries, at least in Canada, where they have been remarkably little bothered by pests and diseases (Bors and Matthews, 2004). Mammals and birds have been the most serious pests to date.

For more information, access the University of Saskatchewan's two-page dwarf tart cherry guide at www.fruit.usask.ca/articles/cherry_guide.pdf or order the comprehensive 88-page hard copy

Rootstocks and Organic Production

Like most other commercial tree fruits, cherry trees are really two trees in one; i.e., a top, or scion, is grafted onto a rootstock. (The Canadian bush cherries, propagated on their own roots, are an exception to this generalization; see section on bush cherries.) Horticulturists have used the same two seedling rootstocks, Mazzard (a *P. avium* seedling) and Mahaleb (the St. Lucie cherry, *P. mahaleb*) for literally centuries. In fact, it is believed that Mazzard seedlings were first used as sweet cherry rootstocks more than 2,400 years ago by early Greek and Roman horticulturists, and Mahaleb was chosen by French gardeners in the 1700s for its slight dwarfing effect on scions grafted to it (Long and Kaiser, 2010). Though presumably better than past alternatives, these rootstocks are subject to many problems and are at least partly responsible for the saying "Cherry trees love to die" (Robinson et al., 2007).

Plant-parasitic nematodes, phytophthora root rot, bacterial canker, viruses, intolerance to heavy soils, graft incompatibility with some scions, and trees that are too tall and too slow to come into bearing are among the problems that have plagued the old rootstocks and prompted contemporary researchers to seek better choices: choices which are finally becoming available, such as the Swiss Gisela series and the Russian Krymsk series. However, this is a relatively new area of research and specific recommendations for different areas and situations are still being worked out. For instance, as good as rootstock Gisela 5 looks in Europe, it has not proven equally good in the United States, at least where it's been tried.

Contemporary advances in developing better cherry rootstocks have particular significance for organic growers. A smaller fruit tree is easier to spray for disease and pest control, whether the spray materials are organic or otherwise. Another advantage of smaller trees is that they can be grown under cover, thereby helping tremendously in suppressing disease (see "Trees in Tunnels" on page 3). But beyond size control, genetic resistance to bacterial canker, phytophthora root rot, armillaria (oak root rot), and plant-parasitic nematodes are of particular value to organic growers because of the limited choice of organically approved pesticides. In particular, genetic resistance can reduce the need for chemical fumigants that are sometimes employed to prevent problems with persistent soil diseases when cherries are planted after cherries or other stone fruit.

Rootstock choice significantly affects how susceptible a cultivar is to bacterial canker. Observations in Oregon found that

(Continued on page 6)

Table 1. Some Characteristics of Cherry Rootstocks

Information for this table was compiled from research conducted in different parts of the country under varying conditions; accordingly, the information should be used as a general guide rather than as an absolute determiner. Contact local or regional cherry specialists before making any large financial investment in cherry cultivars or rootstocks.

Rootstock	Size (% of Mazzard)	Tolerance to heavy soils	Bacterial canker	Phytophthora	Armillaria	Viruses
Colt	80-100	mod. tolerant	m.r.	r	m.s.	m.r.
F.12/1	110		m.r.			
Gisela 6	90	tolerant	v.s.	m.r.		m.r.
Gisela 12	75	tolerant		m.s.		m.r.
Krymsk 5	80	mod	s			
Krymsk 6	70	mod				s
Maheleb	80	not tolerant	m.r.	s	s	m.r.
Maxma 14	100	tolerant	s			m.r.
Mazzard	100	not tolerant	s	s	m.r.	m.r.
MXM 2	100+	not tolerant		m.r.	s	m.r.
MXM 60	90	tolerant	m.s.	m.r.	m.r.	m.r.
Performer	70	tolerant	m.r.			

Key: Mod=moderately; r=resistant; m.r.=moderately resistant; s=susceptible; m.s.=moderately susceptible; v.s.=very susceptible; blank=no data found

Sources: Long and Kaiser, 2010; Lang, 2013; Robinson et al., 2007; Spotts et al., 2010

Rootstocks and Organic Production ... ***Continued from page 5***

"death of trees on Mazzard was 30% but was 77% when trees were on Gisela 6 rootstock. While no Bing on Colt rootstock died, mortality of Bing on Gisela 6 was 90% in one study. Trees on Gisela rootstocks have shown increased susceptibility in field observations. Bing on Krymsk 5 had smaller heading cut cankers than trees on Mazzard or Gisela 6, and 43% of trees died on Krymsk 5 compared with 50% on Mazzard" (Spotts et al., 2010).

Though not immune to bacterial canker, Colt and Performer rootstocks are at least moderately resistant. Of the old rootstocks, Mahaleb is more resistant than Mazzard. Since spread of bacterial canker is favored by splashing rain and freeze damage, in areas prone to these events, such as much of the Northeast, canker-resistant rootstocks should be chosen as understocks. The *P. avium* clone F.12/1 is also resistant and is employed in the relatively rainy Willamette Valley production area by budding the scion high on the trunk or even on the first branches where splashing rain is less likely to reach the scion (Long and Kaiser, 2010). Western Oregon growers prefer F.12/1 to Mazzard due to its resistance to bacterial canker. The F.12/1 stock forms the trunk from the branch union down, and the scion is budded onto each lateral branch. The bacterial-resistant stock slows the progression of canker infection that develops on the branches and hinders the infection from proceeding to the trunk (Long, 2009).

Phytophthora root rot is another serious disease, especially in heavy or poorly drained soils. In university trials in New England, tree losses due to phytophthora were as follows: Mazzard—18%, Mahaleb—8%, Gisela 5—1.4%, Gisela 6—1.6%, and Gisela 12—4.0% (Robinson et al., 2007). Find more on phytophthora below in the Major Diseases section.

Armillaria (also known as oak root rot) can be a problem in sandy soils, especially where stone fruits have been grown previously, and may threaten the very survival of tart cherry production in Michigan (Lang, 2013). Trials have been established in Michigan that might reveal resistance to armillaria, but it is too early for results. Among older rootstocks, Mazzard is somewhat resistant. See more under Major Diseases.

For more information on rootstocks, see the Pacific Northwest Extension publication *Sweet Cherry Rootstocks for the Pacific Northwest,* written by Lynn Long and Clive Kaiser, which can be found at http://extension.oregonstate.edu/wasco/rootstocks.

of *Dwarf Sour Cherries: A Guide for Commercial Production* from www.usask.ca/bookstore.

For sources of plants, go to The University of Saskatchewan's list of Licensed Propagators (www.fruit.usask.ca/propagators.html), which includes Canadian nurseries authorized to ship to the United States as well as some American nurseries (for example, Henry Fields and Gurney's) licensed to propagate and sell within the United States.

Major Insect Pests

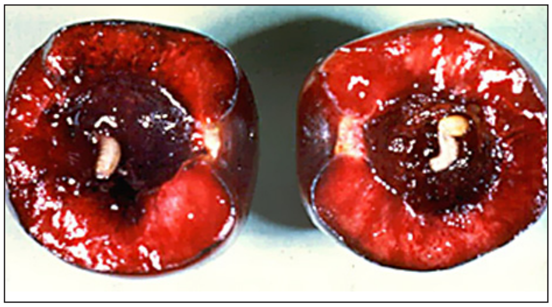
Cherry Fruit Fly

The most serious insect pests of cherry are the cherry fruit fly and western cherry fruit fly (also known as black cherry fruit fly), *Rhagoletis cingulata* and *R. fausta,* respectively. For practical purposes, the two species can be considered together because life cycles and controls are essentially identical, though the western cherry fruit fly emerges from the soil 10 to 14 days earlier than the cherry fruit fly. In places like Michigan and New York, where both species overlap, there is a correspondingly longer period necessary to monitor and control.

Failure to adequately control these pests can cause severe crop loss due to the presence of fruit fly larvae (maggots) in the cherries at harvest. Both federal (USDA) regulations and consumers demand a zero tolerance for maggots in fruit at harvest, and this has forced growers into intensive spray-control programs to achieve perfect control. Commercial growers begin spraying when first fly emergence is detected on infested sentinel trees, or when temperature-driven phenology models (Jones et al.,1991) indicate emergence has commenced in a given region.

This zero-tolerance policy also precludes many alternative methods of control for commercial growers. For instance, beneficial nematodes applied to the soil under cherry trees provided 80 to 88% control of fruit fly pupae in European trials (Koppler et al., 2005), but the surviving pupae would become adults that could each lay 50 to 200 eggs. Though inadequate for commercial production, beneficial nematodes might provide sufficient control for the home grower.

Cherry fruit flies spend roughly 10 months of the year as pupae in the soil under the cherry trees, emerging as adults beginning in late May and continuing into July, depending on species and soil temperatures. Adults feed and mate but do not begin laying eggs for about 10 days; this



Western cherry fruit fly larvae in cherry. Photo: Courtesy Agriculture & Agri-Food Canada

period provides a window of opportunity for control. To monitor the emergence of the flies into the orchard, some sources suggest hanging yellow, sticky traps in the trees (see Further Resources for sources of the traps), but at least one source (Jones et al., 1991) claims such traps can indicate emergence too late and that only temperature-driven phenology models can be trusted. Fortunately, in states with significant commercial cherry production, Cooperative Extension Service specialists offer such phenological data and provide pest-management alerts to growers. Contact your county Cooperative Extension Service to link to the cherry or cherry-pest-management specialists in your state.

After the 10-day feeding and mating period, flies begin to lay their eggs just under the skin of the fruit. Eggs hatch in five to seven days, and the maggots (larvae) feed on the pulp of the cherry. When fully grown, the larvae exit the fruit, drop to the ground, and begin their 10-month pupation in the soil.

Spinosad, derived from a naturally occurring bacteria, is quite effective at controlling the fruit fly, and it is approved for use as an organic pesticide in cherry production. It has been used in combination with bait, as well as applied as a foliar insecticide. The bait-plus-spinosad product (GF-120NF) is an attractant that is lethal to flies that feed on it while "grazing" on the tree. This bait is "squirted" and spattered on the trees weekly at 20 fluid ounces per acre diluted in about 1.5 to two gallons of water per acre (it should NOT be applied with an air-blast sprayer). Entrust^{TM} is a spinosad-based product that kills flies both by contact and residue, and, unlike GF-120NF, it can be applied with air-blast sprayer. Sprays of Entrust every seven to 10 days, beginning with fruit fly emergence (determined by trap catch), have provided excellent fruit fly control. One source of trap catches is Peaceful Valley Farm Supply; see Further Resources section.

Plum Curculio

The plum curculio exists only in the eastern half of the United States, but where it is present, it can be particularly destructive to cherry fruit; its damage is exceeded only by that of the cherry fruit fly. The problem can be made worse where cherries are interplanted with other stone fruit or apples (NSF Center for IPM, 2003).

This pest is especially difficult to control organically and damages fruit in three ways: 1) by direct feeding; 2) by laying eggs which become larvae and tunnel in the fruit; and 3) by spreading brown rot.

Since the plum curculio adult moves into orchards from adjacent woodlots, fence rows, or hedges during bloom, it can be valuable to carefully check fruit along the perimeter of the orchard for damage at bloom or soon thereafter. Only recently have effective traps been made available for detecting this pest (the "Tedders" pyramid trap available through Great Lakes IPM; see Further Resources section).

Beetles are more active on warm, damp, cloudy days and in thick, heavy trees that provide abundant dampness in the centers. Temperature is the most important factor in plum curculio activity, particularly early in the spring. High winds, which cause considerable movement of the trees, will shake the beetles from the trees. Both high winds and low humidity cause beetles to leave the trees and burrow into the soil in search of moisture (Howitt, 1993).

Although whole-orchard cultivation is moderately effective in controlling the curculio, it can lead to severe erosion and loss of soil organic matter.

Plum curculio adult. Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

It is a non-chemical means of curculio control, but its soil-degrading effects make it unsustainable in most situations.

Surround™ WP Crop Protectant, derived from processed kaolin clay, is an OMRI-approved organic pest control product shown to be effective for control of plum curculio. Surround is unique in that it provides pest control through particle-film technology rather than toxic chemistry. Particle films deter insects by creating a physical barrier that impedes their movement, feeding, and egg-laying. Surround can leave a (harmless) residue on the fruit if there is not enough time for it to weather off, so timing can be crucial. Cherries are such an early crop that there may only be time enough to apply a couple of sprays before discontinuing in order to allow for weathering off of the residue.

The American plum borer is the major borer pest of tart cherries in Michigan and New York, causing up to a 33% decline in the life span of tart cherry trees there.

PyGanic™ is an OMRI-approved, pyrethrum-based (from the pyrethrum daisy), quick-knockdown, short-residual, broad-spectrum insecticide. At this point, it seems to be the pesticide of choice for organic plum curculio control (Surround is technically not a pesticide, and the new spinosad-containing pesticides that are so effective against fruit flies are not adequate for curculio). One of PyGanic's beneficial qualities—the short residual life (i.e., it biodegrades quickly, in about 12 hours)—is also one of its weaknesses because you have to spray often. The adult curculios are in the orchard and active for two to three weeks after petal fall. Another trait of PyGanic, its non-selective toxicity to insects, is also both boon and bane. It can be employed against a wide variety of pests, but it will also kill beneficials. In fact, it is highly toxic to bees and should never be sprayed during bloom. Moreover, an over-reliance on PyGanic or any pyrethroid for pest control can result in a "secondarily induced pest outbreak," that is, an outbreak of scale or mites or aphids because their natural enemies, like lady beetles and green lacewings, have been killed by the pyrethroid.

Finally, cherries infested with plum curculio larvae float because larval feeding near the pit leaves air bubbles (this is not true for fruit fly-infested fruit, which sink), so the cherries can be "floated off" and disposed of (Howitt, 1993).

American Plum Borer

The American plum borer (APB), *Euzophera semifuneralis,* is the major borer pest of tart cherries in Michigan and New York, causing up to a 33% decline in the life span of tart cherry trees there (Biddinger, 1989; Kain and Agnello, no date). Its rise to major pest status in tart cherry can be traced to bark damaged by mechanical harvesters.

The adult is a small (less than one inch), light grayish-brown moth. Because it is nocturnal, it is seldom seen. There are two moth flights per year in most of its range. The first begins in mid-May and peaks about two weeks later. The second flight peaks near the end of July. Male activity can be monitored using wing traps baited with a commercially available APB pheromone lure (see Further Resources). The female is attracted to gum exuded from wounds in the bark of stone fruit trees. It lays 20 to 50 eggs in a couple of days on or near this gum.

APB larvae feed on cambium, which they access through openings created by mechanical damage, diseases, sunscald, or winter injury. In western New York, most tart cherry orchards damaged by mechanical harvesting shelter APB larvae, with an average of eight to nine larvae per tree. Trees may harbor 40 or more larvae. The number of larvae per tree is correlated with the severity of bark damage.

This borer can also spread plant pathogens. Larvae may contribute to the enlargement of *Cytospora* cankers and egg-laying females can carry spores from one tree to another.

Sample in the fall or early spring for larvae by using a hammer and a long screwdriver to pry back the bark where damage is apparent. Remove bark until live cambium is reached and look for larvae feeding along the edge of the live cambium or for cocoons attached to the inside of the bark.

There is no experimentally determined action threshold for APB control with insecticides. Generally, the greater the amount of existing injury from mechanical harvesting, cankers, and previous borer feeding, the greater the need for control. Cornell University IPM specialists suggest that a representative sample of randomly selected trees be examined for the presence of wounds containing frass to determine whether they are infested by borers. If 30% or more of the trees examined contain frass and damage is severe enough that 25% or more of the circumference of the trunk of each is girdled, an insecticide application is probably warranted (Kain and Agnello, no date).

Spotted-Winged Drosophila

The spotted-winged drosophila (SWD) is a recently and accidentally imported "vinegar fly" from Japan that has quickly become a serious pest of soft fruits like berries and stone fruits. Cherries are among its favorite targets. Unlike other vinegar flies (the small fruit flies on overripe fruit that many homeowners are familiar with), the SWD attacks fruit that is ripening in the field. It is established on both coasts and is working its way inland. Crop losses vary widely but can reach as high as 80% (Lee et al., 2011). Damage takes the form of the "sting," a small depressed spot on the fruit surface where the adult fly has laid her eggs under the skin, and then subsequent feeding damage by the maggots in the fruit.

Because the pest is so new, monitoring traps are still being perfected, but there are some currently in use, see www.ipm.ucdavis.edu/PDF/MISC/2013_Cherry_Spotted_Wing_Drosophila.pdf to learn more. It is advisable to contact your state IPM specialists about this pest, since trapping and management options are still in flux.

Currently, for organic growers, pyrethrum and spinosad-containing products are effective against the SWD.

Other, Intermittent, and Minor Pests

Other pests of intermittent or minor importance include stink bugs, cherry tree slugs, orange tortrix, mites, aphids, cherry leafhopper (vector of buckskin virus), and the cherry ermine moth. For control information for these pests, access the ATTRA *Biorationals: Ecological Pest Management Database* at https://attra.ncat.org/attra-pub/biorationals, or call ATTRA at 1-800-346-9140.

Major Diseases

Bacterial Canker

East or West, bacterial canker is probably the single most common cause of sweet cherry tree death (tart cherries are slightly less susceptible) and is certainly one of the most difficult diseases to control. "Where conditions have been favorable for disease development, tree losses of 75% have been observed in young orchards. Under normal conditions, losses between 10% and 20% are not uncommon" (Spotts et al., 2010).

Gumming from bacterial canker infection. Photo: Jay W. Pscheidt, Oregon State University

Every part of the tree can be affected: leaf, fruit, twig, branch, trunk, and root. The causal organism, *Pseudomonas syringae,* has hundreds of alternate hosts, including other stone fruit, grasses, pears, and many other plants. Any other stress factor—nematodes, drought, freezing, pruning, other diseases—renders the tree more susceptible to bacterial canker. One of the few effective pesticides, copper, can itself be toxic, and overuse leads to resistant bacteria. There is some genetic resistance among cherry cultivars and rootstocks, but not enough to rely on it alone for control. In fact, multiple strategies will almost certainly have to be brought to bear to manage this devastating disease.

Oregon State Extension (Spotts et al., 2010) offers 12 steps to manage bacterial canker of sweet cherry:

1. Do not interplant new trees with old trees, which are major sources of *P. syringae*.
2. Keep irrigation water off aboveground tree parts as much as possible for the first two or three years after planting.
3. Avoid all types of injury, including mechanical, insect, and frost injuries. Paint all trunks white to prevent winter injury.
4. Less disease occurs when summer pruning is used. Prune only during dry weather.
5. Remove and destroy branches and trees killed by *P. syringae.*
6. Where possible, use resistant or tolerant cultivar/rootstock combinations (for

example, Cavalier, Ranier, Regina, Sam, Corum, Attika, Kristin, Black Gold, and White Gold cultivars grafted onto Performer, Colt, or Mahaleb roots).

7. Locate the orchard in an area less likely to be affected by frost and slow drying conditions.

8. Provide optimal soil conditions for growth of sweet cherries, including attention to pH and nutrition. Application of excess nitrogen, especially late in the growing season, may promote late-season growth that is susceptible to low-temperature injury in early winter, followed by bacterial infection.

9. Control weeds, especially grasses. They often support large populations of *P. syringae.* Clover and vetch groundcovers support lower populations. Consider clean cultivation of row middles for the first three years.

10. Strains of *P. syringae* resistant to copper-based bactericides are widespread in the Mid-Columbia area. Copper sprays may result in more bacterial canker and should not be used.

11. Test for and control plant-pathogenic nematodes before planting. High populations of ring nematode have been associated with more bacterial canker.

12. In high-infection areas, plant trees later in spring to avoid cool, wet conditions.

Black knot. Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Northeastern researchers add to that list the advice to NOT make pruning cuts flush to the trunk. When removing a branch connected directly to the trunk, leave a six- to eight-inch stub. Otherwise, the pathogen has an increased chance of girdling the trunk and killing the tree (Robinson et al., 2007).

The injunction against copper in the Pacific Northwest is worth noting because copper-resistant strains of *P. syringae* have not been detected in the East, and Cornell researchers recommend using a copper spray program that includes two sprays in the fall, near leaf drop (20% leaf drop and 90% leaf drop), and two sprays in the spring, at bud break and immediately following pruning, if pruning is done in the spring.

In California, researchers have declared copper ineffective against bacterial canker (Adaskaveg and Caprile, 2009).

Black Knot

Black knot (causal organism *Apiosporina morbosum*), another fungal disease, produces distorted, gall-like growths on branches (see photo). The galls can eventually girdle a twig or branch. The disease becomes progressively worse during each growing season and unless effective control measures are taken, it can stunt or kill the tree.

The knots are the primary source of inoculum for spread of the disease. In the spring, spores are released from infected areas and are moved by blowing rain. Infection sites are on new growth, usually at the base of the leaf petiole or on a fruit spur.

Trees should be checked several times throughout the season, and the knots pruned out by making cuts three to four inches below the knot. Pruners should be sterilized between cuts by dipping them in a 10% bleach or Lysol® solution. A single lime-sulfur spray before budswell (same material and timing as for peach leaf curl) will reduce black knot problems.

Phytophthora Root Rot

Cherries are notoriously susceptible to root rots in wet, poorly drained soils. Clay soils should be avoided, though some soil drainage problems can be mitigated by berming, ditching, or tiling. Sandy or sandy loam soils are best.

Phytophthora root rot can be a serious obstacle anywhere—East or West—where the soil remains saturated or very wet for any appreciable period of time. The causal organisms can be any of several species in the genus *Phytophthora*, but they all share one important trait: the spores spread and are infective only where and when the soil is saturated with water.

The main symptom is often an indistinct unhealthiness or lack of vigor. An infected tree might simply grow poorly or exhibit off-color foliage. Sometimes a tree will die quickly, especially after a period of soil saturation, but it's just as likely that a tree will linger and die over a period of seasons. If phytophthora is suspected, a better diagnosis can be obtained by pulling back the soil from around the crown and shallow roots and, using a knife to cut away the bark, looking for a reddish-brown discoloration of the cambium (Wilcox, 1992). Infected tissue may also smell sour.

The major controls are good site selection or site modification. Pick sites with light, well-drained soils and/or ditch and berm to insure good drainage. Cherry roots are especially susceptible; thus, the oft-repeated warning, "Cherries don't like wet feet." Though there is no high level of resistance among the various cherry rootstocks, some, like Mahaleb, are especially susceptible to phytophthora, whereas Mazzard, Morello, and Colt are moderately resistant (Wilcox, 1992).

Cornell researchers recommend that if planting in a heavy soil or in any situation where drainage is suspect, plant the trees on 12-inch-high berms and/or ditch and tile the planting site (Robinson et al., 2007).

Armillaria Root Rot

Also known as shoestring rot, honey rot, and oak root rot, armillaria has a cosmopolitan distribution but has become a very serious threat to the tart cherry industry in Michigan. Unlike phytophthora, armillaria seems to thrive even in sandy soils. The causal organism, *Armillaria mellea*, is capable of infecting over 700 woody species and can survive on the dead and dying roots, as well as living tissues, of those species. In fact, old roots are probably the most common source of infection, and recently cleared land can be especially hazardous for establishing new cherry orchards.

As with a phytophthora infection, symptoms of armillaria on cherry trees might first be noticeable as a general tree decline, but unlike phytophthora, diagnostic signs quickly become noticeable. "Positive signs are found at the trunk base or in the main roots near the root collar. White or creamy white, paper-thick, fan-shaped sheets of armillaria mycelium can be seen growing over the water-soaked sapwood when exposed. The armillaria fungi have a strong mushroom odor. By the time a tree or shrub wilts and dies, the trunk is usually encircled by the fungus. With time, diseased wood becomes light yellow to white, soft and spongy, and marked on the surfaces by black zone lines" (University of Illinois Extension, 2000).

Researchers are looking for resistance among rootstocks, but nothing highly resistant is available yet (Lang, 2013). The only other control at this point is to avoid planting on recently cleared sites or on sites known to have had armillaria. A past recommendation to remove all pieces of trunks and roots from a newly cleared site has not proven practical or effective.

Brown Rot

Brown rot (causal organisms: *Monilinia fructicola* and *M. laxa*) is foremost among fungal diseases of stone fruit, and producers struggle with it continually as it affects both fruit yield and quality, infesting blossoms, twigs, and fruit in all stages. Brown rot is less prevalent west of the Rocky Mountains than in the East, but even in the West brown rot can be troublesome in seasonably wet or foggy microclimates.

Ideal conditions for infection arise during warm rainy periods (70 to 77°F is optimum). Brown rot occurs as blossom blight early in the growing season. Two to three weeks before harvest, brown

Brown rot of cherry. Photo: Erin Lizotte, Michigan State University Extension

Thinning branches to open the center of the tree is a good practice—this can be done in July, as well as during the regular dormant-season pruning.

rot infects the fruits as they soften and ripen, causing rot both at harvest and in storage (see photo on page 11). Some of the infected fruit may not display symptoms until after harvest. Blossom blight during bloom is an indicator for extensive brown rot infections later in the season, although a wet year can produce heavy infections of brown rot from residual inoculum present in cankers and fruit, even without blossom blight (Schnabel, 2005).

In the East, control of brown rot is complicated not only by higher rainfall and humidity but also by increased levels of insect feeding (especially by the plum curculio), which spreads the inoculum and opens the fruit to infection. Moreover, the presence of alternate hosts such as wild plums and other wild or untended *Prunus* species can further aggravate the situation. Under such conditions, commercial-scale organic production of cherries, especially sweet cherries, is currently extremely difficult.

Organic control of brown rot involves the integration of several tactics. Although not adequate for brown rot control by themselves, cultural practices and orchard sanitation are the first lines of defense.

Planting-site selection and pruning are critical to providing sufficient air circulation and sunlight penetration within the canopy. In terms of brown rot control, this helps by speeding the drying of fruit and plant surfaces and, thereby, inhibiting germination and growth of the brown rot fungus. A slight slope will enhance air drainage. Another helpful practice to enhance air movement through the orchard is to keep the orchard some distance from surrounding woods. This really has a two-fold effect on brown rot in the orchard: 1) air movement is not blocked or slowed by the presence of surrounding trees; and 2) the plum curculio, which spreads brown rot, is kept somewhat at bay because it overwinters in the forest-floor leaf litter and moves from the woods into the orchard during bloom and petal fall in the spring.

Pruning to open the tree to sunlight penetration and good air circulation facilitates rapid drying of the foliage and flowers after rain or overhead irrigation. Thinning branches to open the center of the tree is a good practice—this can be done in July, as well as during the regular dormant-season pruning.

Organic growers have traditionally relied on sulfur or sulfur-containing fungicides to control brown rot, and nothing better has yet been developed. The first application of sulfur should be just before the petals open. This should be repeated at seven-day intervals, especially if rain occurs, for a total of three applications. Two other applications should be made—one at petal drop, the other at sepal drop (usually about 10 to 14 days after petal drop). The crop is still susceptible to infection later in the season, but treatments during the early "critical" stage will reduce the amount of crop loss without leaving a sulfur residue at harvest. When the weather is hot and dry, the need to spray is not as great. Conversely, since sulfur is only a protectant (it has to be on the plant tissues before and during an infection period), a period of frequent, heavy rains could require the orchardist to spray more often.

Botrytis Blossom Blight and Fruit Rot

Botrytis blossom blight starts when the pathogen attacks the calyx and flower petals, causing them to wither. As fruit starts to develop, a brown lesion forms and quickly spreads over the entire fruit, killing it while it is still very small. Tufts of gray-white spores form on infected plant parts. Quiescent or latent infections—infection has occurred but does not become apparent until later when the fruit begins to ripen—are common with botrytis. In such cases, the disease may seem to arise from nowhere to devastate ripening fruit or harvested fruit in storage.

Botrytis is usually only a problem in wet coastal areas, or in other growing areas when there is prolonged wet and cool weather during bloom.

The main source of inoculum for infection can be found on fruit mummies in the tree or on the orchard floor, but botrytis can also spread from twig lesions and even from weeds (Ogawa and English, 1991). Weather conditions in coastal districts usually favor botrytis blight every season, and a fungicide application is recommended at full bloom to prevent serious losses. In other areas, treatment is necessary only when wet weather is expected during bloom.

Powdery Mildew

Powdery mildew (causal organism: *Podosphaera clandestine*) is not especially troublesome on conventionally grown sweet cherries in the major western production districts; however, it can become a serious disease in organic production (Hansen, 2010). It is also a threat in the nursery or in regions with high heat and humidity, and it is one of the few diseases that can plague trees in high tunnels because it does not need rain to flourish; it only needs high humidity.

The fungus attacks leaves and twigs, producing whitish, felt-like patches on leaves and young twigs (see photo), which serve to distort the leaves. Trees can become severely stunted and defoliation of trees is possible.

The fungus most commonly overwinters in infected buds. When infected buds swell in the spring, the new leaf and petiole growth becomes colonized by the fungus. Warm temperatures without rain, but with high humidity, morning fogs, dews, or intermittent rains, are ideal for rapid increase of the disease.

Cultural practices to reduce mildew include pruning to facilitate drying of fruit and foliage. Choice of training system can also impact mildew: dense systems, like the Spanish bush, foster mildew, while more open training systems inhibit mildew infection (Hansen, 2010).

Choosing resistant cultivars might be another option in the near future (Warner, 2011), but for now it is probably prudent to assume that most cultivars are susceptible. Bing, Black Tartarian, and Rainier sweet cherries are confirmed susceptible, as are most tart cherry cultivars (Gubler and Koike, no date). Late-ripening cultivars can also be more problematic than earlier-ripening ones.

Organic control is possible with sprays of sulfur, but the "softest" organic control is probably with baking soda products like Kaligreen™ and Milstop™. Since these are eradicants with little protective power, in some seasons or areas they might have to be sprayed as often as every seven days to keep mildew in check (Hansen, 2010).

Leaf Spot

Cherry leaf spot, caused by the fungus *Blumeriella jaapii,* presents a serious challenge to the production of tart cherries and, less commonly, sweet cherries. In fact, it can be a limiting factor of organic tart cherry production in warm and humid climates.

The synonyms 'yellow leaf' and 'shothole disease' have sometimes been used because infected leaves turn yellow and, later, lesions drop out and the remaining holes look as if buckshot has passed through. On sweet cherry leaves, the circular spots are often larger. Premature defoliation is common if left unchecked.

Powdery mildew. Photo: www.utahpests.usu.edu

The fungus overwinters on fallen cherry leaves and, in the spring, produces large numbers of spores that are moved by air currents and rain. Organic control of cherry leaf spot is greatly enhanced by raking up and destroying infected leaves in the fall or early spring before new leaves emerge on the tree.

Currently, copper-based fungicides are the only effective organic spray option. Preventive sprays of a copper-based fungicide are recommended at petal fall, shuck fall, and two weeks later. However, "when copper compounds are applied to tart cherry trees in advance of hot, dry weather, the trees can exhibit phytotoxicity symptoms such as bronzing on the undersides of leaves, large yellow and brown blotches on the upper surface of a few leaves, or blackening of veins on the undersides of leaves. In severe cases, copper phytotoxicity can also cause defoliation. Thus, the second and third cover timings are good for copper use if temperatures are not projected to remain above 80°F for several days" (Sundin and Rothwell, 2011).

Birds

Birds are an ever-present threat to cherries whether you are an organic or conventional grower, and the control methods, for the most part, are the same regardless of the growing system. Accordingly, bird control is largely outside the purview of this publication, but this is a topic that cannot be ignored. One of the most comprehensive website pages on protection from birds is managed by the University of California's Integrated Pest Management group (www.ipm.ucdavis.edu/PMG/r105600111.html). This site understandably focuses on bird species common in California. Cornell University offers pest-bird management options relevant to most of the East (www.fruit.cornell.edu/berry/ipm/ipmpdfs/byebyebirdies-mallfruit.pdf). Your state may have more specific information for the bird species most common in your locale.

Marketing

Although organic production is more costly than conventional production, the price premium for organic cherries remains significant despite fluctuations. However, studies reveal that the consumer who will pay up to 50% more for certified organic cherries also expects those cherries to be especially large and sweet (Kirby and Granatstein, 2010). Consequently, the aspiring organic cherry producer will have to pay very close attention to quality in every aspect of production if he or she expects to earn the organic premium.

Most organic cherries are produced in the West, and mid- to large-scale producers often use conventional brokers to get their fruit to market. Many such packer/brokers are now experienced in marketing organic fruit. Stemilt (www.stemilt.com) is one example of a large packer/broker with long-time experience serving organic growers. Rainier Fruit Company (www.rainierfruit.com) is another. A simple Web search for organic cherry brokers will reveal more.

Small-scale growers will likely choose to forego fruit brokers and market their product directly at farm stands and farmers markets. Direct sales to grocers are generally less profitable since the grower is competing with larger growers (represented by brokers), who have economies of scale on their side. However, "locally grown" is currently a powerful marketing tool, so local grocers may well pay a good price for a local product, especially if that product is certified organic.

The Cherry Marketing Institute (www.choosecherries.com) focuses on serving tart cherry growers, mostly in the Midwest. In addition to helping growers directly, the Cherry Marketing Institute is spearheading a major effort to inform the public about the newly discovered health benefits of tart cherries.

Outside of major production areas, it will probably be difficult to find brokers with experience in the organic fruit market.

If you plan to retail your cherries yourself, remember that they are considered a "soft fruit" for a good reason. Post-harvest cooling is very important, as is safe and gentle handling.

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Further Resources

Pest Management Products

Arbico
10831 N. Mavinee Dr., Ste.185
Oro Valley, AZ 85737-9531
800-827-2847
arbico-organics.com

Great Lakes IPM
10220 E. Church Rd.
Vestaburg, MI 48891
800-235-0285
989-268-5311 FAX
www.greatlakesipm.com

Harmony Farm Supply
3244 Hwy. 116
North Sebastopol, CA 95472
707-823-9125
www.harmonyfarm.com

Pacific Biocontrol Corporation
620 E. Bird Lane
Litchfield Park, AZ 85340
623-935-0512
www.pacificbiocontrol.com

Peaceful Valley Farm Supply
P.O. Box 2209
Grass Valley, CA 95945
530-272-4769
www.groworganic.com

Trees

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717-677-8105
717-677-4124 FAX
www.acnursery.com
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Boyer Nurseries & Orchards, Inc.
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Biglerville, PA 17307
717-677-8558
info@boyernurseries.com
Twenty sweet cherry cultivars.

Cummins Nursery
1408 Trumansburg Rd.
Ithaca, NY 14456
607-227-6147
cumminsnursery@gmail.com
Wide selection of tart cherries and more.

Fowler Nurseries, Inc.
525 Fowler Road
Newcastle, CA 95658
800-675-6075
916-645-8191
www.fowlernurseries.com
Wide variety of cultivars and possibly widest variety of rootstocks, including both Krymsk and Gisela types. Very informative website.

Gardens Alive
5100 Schenley Place
Lawrenceburg, IN 47026
513-354-1482
www.gardensalive.com
U.S. source of Canadian bush cherries.

Van Well Nursery
P.O. Box 1339
Wenatchee, WA 98807
509-886-8189
800-572-1553
www.vanwell.net
Twenty-nine cultivars, five rootstocks.

Web Resources

Virginia Fruit Web Site: Virginia Stone Fruits
www.virginiafruit.ento.vt.edu/VirginiaPeachSite.html

University of California Fruits and Nuts Research and Information Center
http://fruitsandnuts.ucdavis.edu

Penn State College of Agricultural Sciences' *Pennsylvania Tree Fruit Production Guide* http://tfpg.cas.psu.edu/37.htm

West Virginia University Index of Fruit Disease Photo-graphs, Biology, and Monitoring Information
www.caf.wvu.edu/kearneysville/wvufarm8b.html
This portion of the Mid-Atlantic Orchard Monitoring Guide Web Site for Tree Fruit Pathology furnishes photos that can be used to help identify diseases on leaves and fruit.

Washington State University Sweet Cherry Research
http://cahnrs-cms.wsu.edu/sweetcherryresearch/Pages/default.aspx

Michigan State University Cherry Research
www.cherries.msu.edu

Cornell University Tree Fruit
www.fruit.cornell.edu/tree_fruit/index.htm
Entry portal for Cornell's many pages of tree fruit information.

Oregon State University Mid-Columbia Agricultural Research and Extension Center
http://oregonstate.edu/dept/mcarec
OSU's cherry research program is centered here.

Cherries: Organic Production
By Guy K. Ames, NCAT Horticulture Specialist
Published March 2014

Tracy Mumma, Editor
Amy Smith, Production

This publication is available on the Web at:
www.attra.ncat.org

IP463
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Version 033114