National Sustainable Agriculture Information Service
ATTRA A project of the National Center for Appropriate Technology NCAT 1-800-346-9140 • www.attra.ncat.org

Plums, Apricots, and Their Crosses: Organic and Low-Spray Production

By Guy K. Ames
and Robert Maggiani,
NCAT Agriculture
Specialists
Published May 2013

IP386

This publication focuses on organic and reduced-spray management options for disease and pest problems of plums, apricots, and their crosses (pluots, apriums, etc.). It also relates progress in broadening the practical climatic adaptability of the apricot. The publication also discusses adding these fruits as specialty crops for small-scale, diversified farms and identifies marketing opportunities.

Contents

Plums. Photo: Marisa Alcorta, NCAT

Introduction

Plums, apricots, and their crosses (pluots, apriums, etc.) are all stone fruits (*Prunus* spp.) and share most of their diseases and pests with other stone fruits like peaches. With the exception of Michigan, there is virtually no commercial organic production of plums or apricots in the eastern half of the United States. Nevertheless, there is consistent interest among small-scale eastern farmers in possibly adding these nutritious fruits to their enterprises.

Apricots and plums can be difficult to produce even under good conditions. At least two key insect pests and several serious diseases present formidable obstacles to organic or low-spray production of these tree fruits. Nevertheless, with proper management, disease-resistant cultivars, and a good site, growers can greatly reduce—and in some cases eliminate—their reliance on synthetic pesticides. Because of new directions in research emphasizing biological and other alternative pest and disease controls, the future looks promising for low-spray and organic plum and apricot orcharding.

Many considerations and practices are the same for both low-spray/organic and conventional plum and apricot growers. For instance, all growers need to make variety choices with cold hardiness and chilling requirements in mind. Also,

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/sarc_current.php*) for more information on our other sustainable agriculture and energy projects.

NCAT

Related ATTRA Publications
www.attra.ncat.org

Tree Fruits: Organic Production Overview

Biorationals: Ecological Pest Management Database

Direct Marketing

The Playbill

What a genus! The genus *Prunus* contains all the stone fruits like apricots, peaches, cherries, plums, and even almonds (really just a peach chosen for the kernel). Apricots and plums are members of the genus *Prunus*, subgenus *Prunophora*. There are two species of apricot and 20 to 40 species of plums, the number depending on whether the botanist counting is a "splitter" or a "lumper." Because of identical chromosome numbers, Japanese plums and apricots are relatively easy to cross, creating pluots, apriums, and plumcots.

Prunus persica .....almond, peach, nectarine are all the same species, *P. persica*

Prunus cerasus .....tart cherry

Prunus avium .....sweet cherry

Prunus armeniaca.....apricot; *P. siberica* is probably a sub-species of *armeniaca*

Prunus domestica .....the domesticated European plum, including prune plums (simply dried plums; though traditionally certain cultivars like Epineuse, French, etc. were chosen for drying because the high sugar content allows them to be dried whole without fermenting at the pit. All prunes are plums, but not all plums can be prunes). Examples of European plums: Green Gage, Stanley, Reine Claude, President.

Shiro plums. Photo: Marisa Alcorta, NCAT.

Prunus salicina.....Japanese plum. Probably a misnomer, the "Japanese" plum originated in China, only coming to Japan 200 to 400 years ago. This species and the hybrids made from crosses with American plum species are the fresh plums of common commerce. Examples: Shiro, Santa Rosa (cross with American plum), and Methley (cross).

Prunus americana, P. munsoniana, P. subcordata, P. maritime, and several others are all species native to North America. Native Americans and pioneers utilized many of these species. The main commercial contribution of these species is in crossing with Japanese types. A few varieties of American plums (e.g., Tonka, Wildgoose) are available in the nursery trade, but mostly they show up as ornamentals or as a fruit wildcrafted for jams and jellies (sand plums, beach plums, Chickasaw plum) .

P. armeniaca x P. salicina hybrids. A "Plumcot" is presumed to be 50% plum, 50% apricot; an "Aprium™" is 75% apricot, 25% plum; and the most popular hybrid, the "Pluot™," is 75% plum, 25% apricot.

pruning and training will be approximately the same for all kinds of culture. Information on these topics is available through traditional resource channels such as the Cooperative Extension Service, state production councils, orchard texts, and trade magazines.

This publication focuses primarily on controlling insect pests and diseases. However, because the apricot has historically been ill-adapted to much of the United States, this publication reports on recent progress that should increase the range where the apricot can be grown successfully.

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

Background

Plums

In the United States, nearly all of the commercially grown plums for fresh eating are hybrids of the Japanese plum introduced by a Berkley nurseryman in the 1870s and subsequently hybridized by Luther Burbank in the late 1800s. Today, 95% or more of them are grown in California. Burbank made many complex crosses between Japanese and American plums and was the first to cross the plum and apricot. Though the fresh plums in grocery stores today are essentially "Japanese," they might contain germplasm from many species, thanks to Burbank.

Prune plums are European, as are most canned plums. Again, most commercial production is

centered in California, but European plums are more cold-hardy than Japanese plums and bloom later, so the European plum can be grown further north.

In fact, plums are adapted to a wide range of climatic conditions; at least some cultivars can be grown in almost every state. Commercially, Japanese plums and prunes are grown where rainfall during the growing season is minimal and humidity low to prevent diseases; this is why most production is in California. Cold hardiness is excellent for European plums, similar to apple and pear, but Japanese plums are less cold-hardy (similar to peach). Plums have chilling requirements ranging from 550 to 800 hours for Japanese, up to 1,000 hours for European. (A greater chilling requirement means that the plant will be slower to break dormancy, hence, less likely to bloom too early while frost is still a danger). Rainfall during the growing season can reduce production by accentuating diseases and causing fruit cracking.

As with other *Prunus* species, deep, well-drained soils with pH 5.5 to 6.5 give best results. However, plum roots are the most tolerant of all the stone fruits with respect to heavy soils and waterlogging.

Apricots

Apricots pitted and ready for drying. Photo: Rory Register, Rory's Photography, Bugwood.org

Apricots were brought to the New World by the Spanish and were already being grown in California before it was part of the Union. In this early origin lies the source of a major problem: until relatively recently, the North American gene pool has been largely restricted to germplasm from southwestern Europe.

Though apricot trees, in general, are quite cold-hardy (to at least -30°F), the low chilling requirement of the commonly available cultivars (300 to 900 hours below 45°F to satisfy their dormancy needs) induces them to bloom, in most of the United States, as soon as temperatures begin to warm. Thus, where spring temperatures fluctuate, most of the common apricot varieties tend to bloom too early, so the blooms are frequently killed by late freezes. Consequently California, with its relatively stable Mediterranean climate, produces about 95% of all marketed apricots in this country. In the last few decades, though, breeders in the United States and Canada have worked to expand the apricot's climatic adaptability, and growers have been experimenting with these new varieties as well as other techniques (see "Grower Profile: Bob Purvis").

The Crosses: Pluots, Apriums, and Plumcots

As mentioned earlier, the apricot (*P. armeniaca*) and Japanese plum (*P. salicina*) readily hybridize, and breeders have been making such crosses since Luther Burbank first did it in the late 1800s. Though there are no formal nomenclatural conventions or scientific standards and the crosses have become complex, a "plumcot" is presumed to be roughly 50% plum, 50% apricot; an "Aprium™" is more apricot than plum; and the most popular hybrid, the "Pluot™" is more plum than apricot. The words "Pluot" and "Aprium" are trademarked by Zaiger Genetics, a firm founded by California stone-fruit plant breeder Floyd Zaiger, who is the most prolific contemporary breeder of these crosses.

These crosses are practically identical to their parents in terms of climatic adaptability and disease and insect problems. Consequently, almost all commercial production is in California and arid eastern Washington, but commercial-scale growers in Colorado, Utah, and Idaho are experimenting with them, too.

On the plus side, if you can grow them, these fruits are considered delectable by most who have tried them, and they could be an attention-getting addition to a small-scale orchard or farm operation.

Grower Profile: Bob Purvis—Apricots for Everyone

The following information was gleaned from a telephone interview as well as from an article by Bob Purvis that appeared in POMONA, *the magazine of the North American Fruit Explorers (NAFEX), Vol. XXXIX, No. 4, Fall 2006, and a PowerPoint presentation by Mr. Purvis, "Advances in Apricots for the North Country," delivered to the 2012 NAFEX Convention in Saskatoon, Canada.*

Bob Purvis epitomizes the spirit of the North American Fruit Explorers (NAFEX), a group of amateur and professional fruit aficionados who are devoted to the discovery, cultivation, and appreciation of superior varieties of fruits and nuts. That spirit is perhaps best characterized by the roots of the word amateur, which comes from the Latin (via French) for "love," i.e., amour. The object of Purvis' affection is the apricot, and, lucky for us, it is not a jealous love, for he has amassed a lifetime worth of useful information that he enthusiastically shares.

In most of the United States, the limiting factor in growing apricots is climatic, so it's significant that Purvis has grown and researched apricots in Washington, Alaska, Minnesota, and Idaho. More importantly, Purvis is linked to other apricot growers from Maine to Texas, including apricot breeders in New Jersey (Dr. Joseph Goffreda), California (Dr. Craig Ledbetter), and Ontario, Canada (Dr. R.E.C. Layne), and through these breeders, to apricot researchers as far away as Uzbekistan. Though he loves with the passion of an amateur, he is actually a professional, with an M.S. in horticulture from Washington State University.

Purvis explains that since the earliest apricots brought to North America were mostly from Spain and similar Mediterranean climates, the genetic base was narrow and did not include genes for a broader range of climatic adaptability. Modern breeders and fruit explorers have sought out germplasm in many places, including central Asia where the apricot is thought to have originated and where the gene pool is most diverse.

Homedale, Idaho, where Purvis now lives, may be as close to the climate of the ancestral apricot as any place he has yet lived. In fact, he's started his first commercial-scale orchard (still small by western standards, he hastens to add) and installed a walk-in cooler to handle the large harvests he's starting to get. But he makes more money from his apricot-tree nursery; no wonder, since there is probably no one offering more varieties suited to a wider variety of places. He seems somewhat surprised that one of his biggest money-makers is the sale of scionwood (propagation material for the various cultivars), but this might be explained by his connections with NAFEX, whose membership is well acquainted with grafting and budding fruit trees. Furthermore, no one would provide more choice and more information about those choices than Purvis.

Purvis points out that there are factors beyond variety selection that can help apricots weather the spring frost problem. Site selection can be helpful—planting on a slope helps heavier cold air drain down and away from the orchard. A north- or east-facing slope is particularly helpful since it won't heat up as a south- or west-facing slope will. Purvis also promotes one product, KDL™, a chelated potassium/sugar foliar spray (AGRO-K Corp., 800-328-2418, www.agro-k.com) as providing about 5 to 7°F of frost protection when sprayed on buds or blooms. KDL™ also improves general nutrition, according to Purvis, and has resulted in significantly larger and sweeter fruit.

Another consideration outside of variety selection is pest problems. At his current Idaho site, Purvis' biggest pest has turned out to be earwigs. He said he rather easily controlled them by applying InTice ™, a bait containing orthoboric acid, at the base of the trees. (InTice is not OMRI-approved for organic production.)

So, what are Purvis' recommendations for specific regions? For New York and New England, the Harrow series of apricots (Harglow, Harcot, Harogem, etc.) are well adapted and are already being grown commercially in western New York. Puget Gold has proven itself to be fairly well adapted to the climate in Maine. Henderson has done well in Massachusetts. Golden Giant from Iowa has done well in coastal Connecticut. Alfred and Jerseycot should do well in just about any part of New York and New England except where winters regularly drop below –30°F. Both Sundrop and Skaha have been productive in southeastern New York, and both Chinese and Tomcot bear annual crops on Long Island.

In the Middle Atlantic States, Tomcot and Puget Gold have been fairly productive in western Pennsylvania, central New Jersey, Delaware, and Virginia. Jerseycot has done exceptionally well in New Jersey. Alfred should also be adapted, though there is no hard evidence of that yet.

In the Southeast and Gulf Coast states, Alfred has been reliable in Mississippi and Texas, and Jerseycot in North Carolina. These are probably also the most reliable cultivars for the Upper South. Low-chill cultivars such as Katy, Goldkist, Newcastle, and Golden Amber may be needed in the coastal areas of the Deep South. Richard and Marie Ashton of Oak Creek Orchard list the late-blooming apricots that they grow near Brownwood, Texas (125 miles southwest of Fort Worth), as the Hunza type apricots, Shaa-kar Pareh (from Iran), Chinese, Tilton, Harglow, and Texas (a very productive local variety). Guidelines for central Texas are probably also valid for Oklahoma, Arkansas, and possibly northern Louisiana, Mississippi, and Alabama, depending on the disease resistance of individual cultivars.

In the Upper Midwest, Brookcot, M.604, Debbie's Gold, Moongold, and Westcot appear to be fully winter-hardy throughout Zone 3 and even into the warmer parts of Zone 2. Henderson, Suphany, and DR-606 have proven hardy to –29°F in central Minnesota, as has Jerseycot. Of the Harrow apricots, Harlayne is the most winter-hardy (to –34°F on the leaf buds, about –30°F on the flower buds), Harogem a close second, and Hargrand a

close third. Harglow is about as hardy as Hargrand; Harcot is significantly less winter-hardy than any of the others. Harogem is self-fertile and an excellent pollenizer for Harlayne based on Minnesota observations. In southwestern Minnesota, all of the above can be grown, plus Jerseycot. Alfred and Afghanistan have both been grown successfully in central Wisconsin in Zone 4b. In southwestern Michigan, at Tree-Mendus Fruit, where apricots are grown commercially, Harcot and Goldrich (a Washington-state introduction) do well, but so do all the other Harrow introductions and Goldcot (a Michigan introduction).

In the Lower Midwest, Henderson has done well in Illinois because it is a late bloomer. Puget Gold looks promising in Illinois, and Jerseycot has done well in Indiana. These three cultivars, along with Alfred, are well worth a try, as are Sugar Pearls and any other, future introduction from New Jersey. Golden Giant, originating in Iowa, is another possibility.

Bob Purvis with his Robada apricots. Photo: Bob Purvis

For the Northern Plains, the four hardy apricots from the Prairie Provinces (Brookcot, Debbie's Gold, M.604, and Westcot) would be Purvis' choice for areas with a Zone 3 climate. Other choices would be Suphany and Precious, which are nearly as cold-hardy but more tolerant of spring frosts. For Zone 4, the Harrow-series apricots, Jerseycot, Alfred, Tomcot, and Puget Gold are well worth a try, and in fact Puget Gold is cropping well in Nebraska after enduring temperatures as low as –23°F. DR-606, Chinese, and Henderson are worth a try in most of Zone 4, and Tomcot in 4b.

For the Southern Plains, Purvis has to extrapolate from precious little data from Missouri, where the Harrow-series apricots and Puget Gold have been grown successfully. He also suggests Jerseycot, Alfred, Tilton, or Suphany because of their similar characteristics.

In the Mountain West, given that most fruit-growing areas are in Zone 5 or warmer, almost any apricot will survive. There is one apricot that originated in Colorado—the Montrose and seedlings thereof—that is hardy throughout Zone 4. The Hoyt seedling of Montrose, one of the best, is being propagated (with scionwood from Purvis) by One Green World nursery in Molalla, Oregon, and the original Montrose is currently available from Burnt Ridge Nursery in Onalaska, Washington. The apricots from Asia, Suphany, Afghanistan, and Hunza-type apricots should be excellent choices, as would any of the later-blooming apricots such as Jerseycot, Alfred, Harogem, Harlayne, Puget Gold, or Tomcot.

The Pacific Northwest is really two different areas separated by the Cascades. In western Washington and Oregon, with wet winters and cool, lengthy springs, Puget Gold, Tilton, Jerseycot, Harglow, and Tomcot would all be good choices. In the fruit-growing districts of central and eastern Washington and Oregon, all of the above apricots are good choices, as well as DR-606. Moorpark did quite well in central Washington, and so did Chinese. Tilton is grown commercially in a few locations in central Washington. The prairie-province apricots are less desirable choices because they are smaller, bloom earlier, and are less tolerant of extreme heat. In Homedale, Idaho, Stark Sweetheart, Wilson's Delicious, and Stark Earli-Orange have all produced high-quality fruit and moderate crops in fertile soils at an elevation of 2,200 feet. Additionally, the new USDA apricots Apache, Nicole, and Robada are all worthy of trial east of the Cascades.

In Alaska, the four apricots from the Prairie Provinces, Precious, or Jerseycot would be good choices. Puget Gold has proven to be marginally winter-hardy in Anchorage, but it would seem to be well worth a try in Kenai, Seward, or Homer. The Prairie Province apricots are surviving and doing fairly well in the Matanuska Valley at the homes of several members of the Alaska Pioneer Fruit Growers, but even they are not quite winter-hardy enough for any location in Fairbanks or the Interior of Alaska where temperatures dip below –45°F most winters.

With all those apricots to choose from, which one is Bob's favorite? Robada wins that distinction (see photo).

Purvis has established a germplasm repository for cold-hardy, late-blooming, and disease-resistant apricot cultivars for his dry USDA Zone 7 climate while deferring to others (for example, the California Rare Fruit Growers) the offering of scions of commonly grown cultivars such as Blenheim, Castlebrite, and others.

Purvis says he is happy to answer questions by email, purvisrc@msn.com, but encourages people to join NAFEX first ($19 annually at nafex.org). He does business in Homedale, Idaho (fruit locally; trees and scionwood nationally), as Purvis Nursery & Orchard. Again, the email address should be the first point of contact.

Diseases

As the authors of *Ecological Fruit Production in the North* wrote, "Plums are affected by a variety of bizarre and somewhat disgusting diseases" (Hall-Beyer and Richard, 1983). Black knot, bacterial spot, leaf scald, coryneum blight, bacterial canker, and plum pocket can all cause serious damage to some part or parts of the tree. Apricots are somewhat less subject to disease but, under conducive circumstances, far from immune. There are several serious diseases directly affecting both apricot and plum fruit, including bacterial spot and scab, but brown rot is the worst. Brown rot can claim the entire harvest in a wet year if precautions are not taken.

Unless stated otherwise, the disease descriptions below pertain to both plums and apricots.

Brown rot

When plums or apricots are grown under the warm, humid conditions conducive to fungal diseases, it can be difficult to forego the use of fungicides. 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. Brown rot is the single biggest hurdle to organic production of plums in both the East and the West. (Climate has been the most significant impediment to apricot production, organic or otherwise.)

Life-cycle information on brown rot is presented in Figure 1. 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 rot infects the fruits as they soften and ripen, causing rot both at harvest and in storage. 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 (Brannen and Schnabel, 2002).

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 plums is currently extremely difficult.

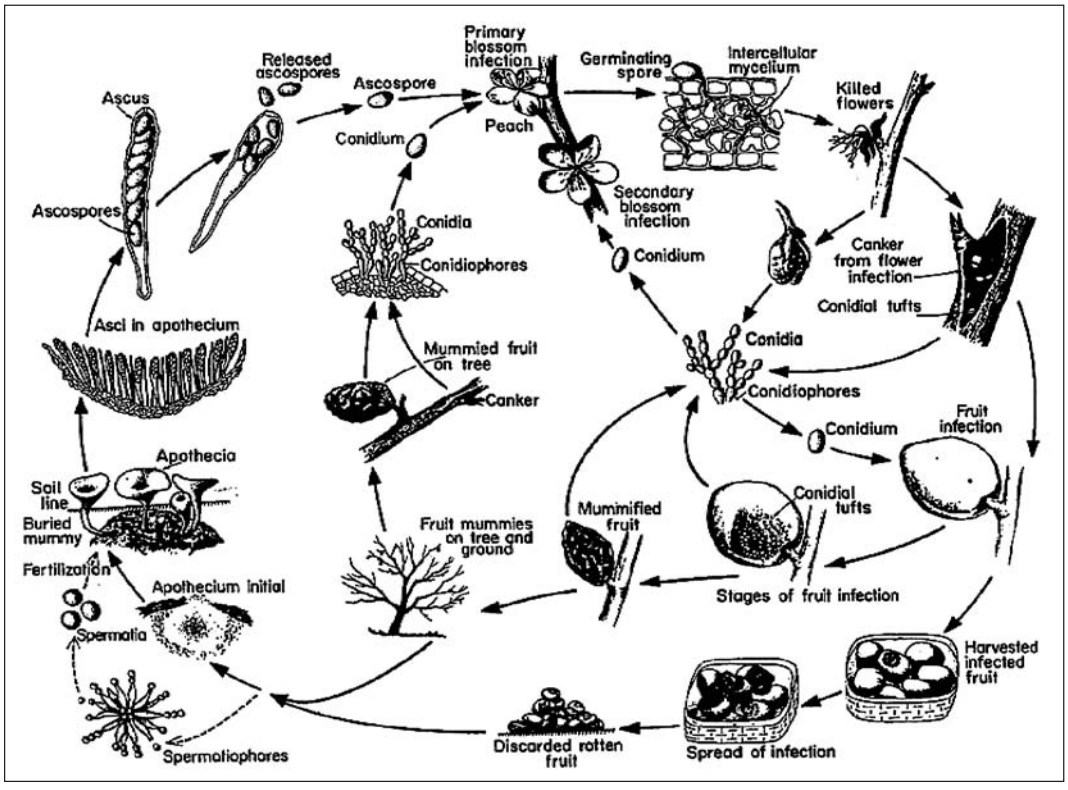


Figure 1. Disease cycle of brown rot. Reprinted by permission of author from* Plant Pathology, *3rd edition by George N. Agrios.

Cultural considerations impacting brown rot

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.

Orchard sanitation practices impacting brown rot include pruning out and removing infected twigs and cankers and disposing of dropped, culled, or mummified fruit. Andrew Brait of Full Belly Farm in California claims that being "fastidious about orchard sanitation, removing all dropped fruit and mummies" in their six acres of stone fruit is the center and mainstay of their brown-rot-control strategy (though they do augment with up to three bloom applications of lime sulfur or cuprous oxide) (Brait, 2010).

To summarize cultural contributions to controlling brown rot:

- Encourage air movement with site selection and open pruning.
- Prune out all dead wood and cankers and destroy them.
- Remove mummies—the shriveled, rotted fruit from last season.
- Thin fruits so that they don't touch.
- Remove and destroy infected fruit promptly.

Spraying for brown rot control

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 done at the "pink" stage, 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.

Augmenting sulfur with Surround™ WP Crop Protectant, according to Dr. Michael Glenn at USDA's Appalachian Fruit Research Station in Kearneysville, West Virginia, provides better disease control than sulfur alone (Glenn et al., 2001). Derived from processed kaolin clay, Surround is an organic pest-control product approved by the Organic Materials Review Institute (OMRI) and shown to control or suppress certain insects and diseases. Dr. Glenn told ATTRA that, while the sulfur-Surround mix certainly works in helping to suppress brown rot, the clay residue that often remains on the fruit is problematic (Glenn, 2010). (On long-season crops like apples, the Surround has usually weathered off by harvest.) Still, unlike peaches and apricots, plums and the plum X apricot crosses are smooth skinned and the Surround residue is relatively easy to wash or brush off.

Brown rot is THE single biggest hurdle to organic production of plums in both the East and the West.

A relatively new biofungicide, Serenade™ (*Bacillus subtilis*, QST 713 strain), is OMRI approved and has demonstrated laboratory and field control of brown rot in California. However, in Massachusetts, researchers found Serenade "relatively ineffective for controlling fungal diseases under Northeast conditions" (Cooley et al., 2009). Similarly, in British Columbia, Canadian researchers found Serenade "suppresses," but does not control, brown rot (Ministry of Agriculture, 2013). For more information on Serenade, see the AgraQuest website, www.agraquest.com. Other materials registered for brown-rot control are listed in ATTRA's *Biorationals: Ecological Pest Management Database.* (Note that simple registration does not imply a specific level of effectiveness under different conditions; for example, Serenade is registered for brown-rot control for the entire United States but might only be effective in areas of relatively low disease pressure, such as the West).

To summarize organically acceptable spray control of brown rot: apply wettable sulfur every 10 to 14 days from petal fall until harvest. Spray more often during wet seasons. Sprays may not be needed in dry seasons if the other cultural steps are followed. Surround can be added to the spray mix to augment control (as well as for plum curculio control).

Black Knot

Black knot (causal organism *Dibotryon morbosum*), another fungal disease, produces distorted, gall-like growths on branches (see photo). The galls can eventually girdle a twig or branch. Black knot can be found on apricots but is rarely serious; however, on plums, black knot can be fatal or render the trees economically impractical to maintain.

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.

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

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

Trees in Tunnels—Unnatural, Perhaps, But Organic!

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, including plums, that have heretofore proven difficult to grow organically, especially in the East. Using high tunnels began as a way to extend the season of vegetables and strawberries under the protection of plastic, but growers and researchers soon realized that brambles, grapes, and even fruit trees could benefit from the disease protection that high tunnels afford.

The main benefit to the organic grower is the ability to exclude and otherwise inhibit disease. 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 of plum can be practically eliminated! Even if an errant Monilinia spore blew in, there wouldn't be water on the fruit to allow the spore to germinate and penetrate the fruit.

Already growers and researchers all across the United States, but especially in the East, are growing plums and other members of the genus Prunus (all susceptible to brown rot) successfully in tunnels without sprays for brown rot. In China, tree fruit production in high tunnels is already big business, says Dr. Curt Rom, University of Arkansas tree fruit researcher and high-tunnel enthusiast (Rom, 2013). Many insects are also excluded, and Rom and others are experimenting with screens to eliminate more.

But, warns Rom, using high tunnels for fruit production is not a silver bullet. Insects still get inside the tunnels and sometimes, because they enjoy relative freedom from their natural enemies, their populations can explode. Mites and aphids are examples. Additionally, 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. However, there are effective organic controls for these problems. Organic controls for brown rot aren't nearly as reliable, so growing under cover may be a viable option for organic growers in areas of high rainfall.

Plums, especially the Japanese and Japanese X American hybrids, are very good candidates for small-scale culture in high tunnels because they are naturally short trees. European plums and apricots, naturally taller, will be more trouble to keep in bounds, but with dwarfing rootstocks and the right pruning and training system, even these could be grown in high tunnels.

Sweet cherries blooming in a high tunnel. Photo: Dr. Gregory Lang, Michigan State University Extension

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 and also control plum pockets.

There is some resistance among plum varieties. In general, Japanese types are less susceptible than the European types. President seems to be highly resistant.

Leaf Scald

There is no known resistance to leaf scald among the European plums. Moreover, there is no biological or chemical control for this bacterial disease. Luckily, leaf scald is largely restricted to the southeastern United States and there is resistance to leaf scald in certain Japanese, American, and Japanese X American hybrid plums.

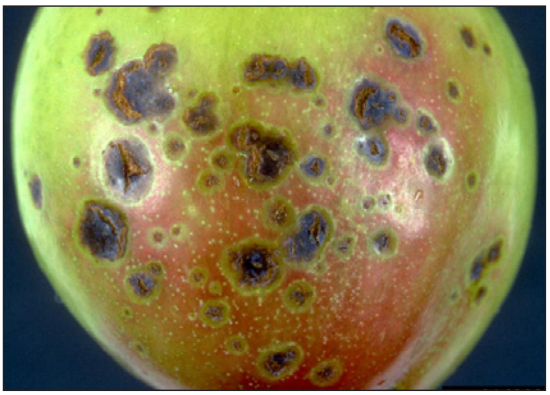
Researchers at Auburn University are focusing on detecting and incorporating disease resistance as part of their Japanese plum breeding program. For instance, they have found that AU-Producer, Morris, Explorer, and AU-Cherry are all highly tolerant of leaf scald (Tangsukkasemsan et al., 1995). AU-Rosa, also from the Auburn program, is resistant to leaf scald, bacterial canker, bacterial spot, and black knot (Anon., 1995).

Bacterial Spot

The tell-tale symptom of bacterial spot (caused by the bacterium *Xanthomonas pruni*) is small light-brown lesions on leaves. Eventually the affected tissue falls out, leaving a characteristic buckshot-hole appearance. Severe bacterial spot infections may cause premature defoliation and subsequent re-sprouting, similar to peach leaf curl. Bacterial spot on fruit (see photo) occurs as sunken, dry lesions that eventually crack, opening the fruit to secondary infections and reducing fruit quality. Selecting disease-resistant cultivars is the principal means of controlling bacterial spot. Appendix I is a table on plum cultivar susceptibility to bacterial spot from the Kearneysville Tree Fruit Research and Extension Center (West Virginia University) website.

Fortunately for organic growers, copper fungicides—unique in that they also function as bactericides—are allowed for control of bacterial spot. The first spray should be applied before the tree leafs out in the spring; this timing often allows copper-based sprays used for plum pocket to double for bacterial spot treatment. The next period when infection pressure is heavy is petal fall and three weeks thereafter. Additional spray coverage may be necessary depending on varietal susceptibility and humid weather conditions.

Since the occurrence and severity of bacterial spot depend on moisture, it is rarely a problem west of the Rocky Mountains. In the East, growers are able to rely on resistant varieties as the best line of defense. Contact the Cooperative Extension Service for resistant varieties suited to your region.



Bacterial spot. Photo: U. Mazzucchi, Università di Bologna, Bugwood.org

Coryneum Blight

Coryneum blight is primarily a disease of apricots in the western United States and is rarely found in the East. Plums are somewhat less susceptible, and Japanese plums are even less susceptible than European plums. The disease is most evident on the leaves where it causes spots or ''shothole," but the organism also attacks the fruit, causing small dry spots. The flesh below these spots is affected with rot that gradually extends to the pit or may spread over the whole fruit.

Coryneum blight on twigs and stems (see photoon page 10) can ultimately cause even more damage than it can on fruit. Infections start with purplish-brown, sunken cankers on small branches, twigs, and buds. These cankers grow and can eventually girdle the branch, twig, or bud, sometimes killing entire trees.

Coryneum blight spores can be spread by splashing rain, birds, insects, and pruning tools. The spores overwinter in the leaf scars, under the bud scales, in any cracks on the twigs and branches, and in the existing cankers on infected trees.

Remove and destroy all infected twigs and branches as you see them. Spray your tree with a fungicide (OMRI-approved copper or lime-sulfur sprays work) just as the buds begin to swell in the spring. Spray the tree again as soon as the

Coryneum blight. Photo: Marion Murray, Utah State University Extension.

petals begin to drop. In a wet year or location, sprays may have to continue every two weeks until symptoms subside or the weather turns dry.

Cytospora Canker

The two related fungi (*Leucocytospora cincta/L. leucostoma*) that incite cytospora canker are opportunists, invading sites where damage has occurred due to mechanical injury, cold, poor pruning techniques, improper pruning time, borers, or other causes. The first visible symptom is the oozing of gummy sap near the wound, beginning when temperatures warm in the spring. Since plums exude this gummy sap in response to almost any wound (e.g., borer attack), it can be difficult to diagnose this disorder correctly. One diagnostic clue is that, because the fungus advances more rapidly up and down the branch than around the branch, cytospora cankers usually have an elongated or elliptical shape (Snover, 2011). The bark dries out and dies but usually remains intact the first year. In succeeding years, the bark becomes broken, disfigured, and covered with a black fungus overgrowth. The disease progresses slowly, and a tree with cytospora can survive for many years past the initial infection.

Management begins by choosing planting sites away from older peach and plum trees and by eliminating wild or untended plums and peaches near the orchard. Because cold damage is often the primary infection site, painting trunks with whitewash to reflect the winter sun can be helpful (the winter sun warms south-facing trunks during the day, and subsequent nighttime temperatures freeze and crack those surfaces). Likewise, avoid planting on a south- or southwest-facing slope because such a site can induce the trees to warm up too early in the early spring or late winter, resulting in cold damage if temperatures fall.

Other management techniques likewise center around minimizing damage to the trees, thus denying infection sites to the pathogens. Such techniques include pruning only in the early spring when temperatures have warmed, avoiding leaving pruning stubs, removing dead and diseased branches, and controlling borers.

Rootstocks

Because of the prevalence of soil-borne diseases, the selection of disease-resistant or disease-tolerant rootstocks for plums and apricots can be important. Size-controlling rootstocks (dwarfing rootstocks) can also be advantageous to the grower trying to reduce or eliminate synthetic pesticides because: 1) a smaller tree can allow for better spray coverage with organic pesticides; and 2) smaller trees are more easily accommodated in high tunnels where the blowing rains that often spread disease can be eliminated (see the box "Trees in Tunnels").

Because many scion-root combinations are compatible within the genus *Prunus*, researchers and nurserymen have a lot to work with to find the best plum and apricot rootstocks for any given condition. For instance, Citation rootstock is a peach-plum hybrid developed by private breeder Floyd Zaiger. Citation produces a tree about three-quarters the size of a tree budded onto a standard seedling rootstock (e.g., Marianna or Myrobalan). Moreover, Citation is resistant to root-knot nematode and very tolerant of wet soils. It's compatible with either plum or apricot and is probably the rootstock of choice for the plum X apricot hybrids.

If you're looking for dependably dwarfing rootstocks for plum or apricot, Citation and the Krymsk series (Krymsk 1 for plums and Krymsk 9 for apricots) are probably the most reliable choices, and Citation should get the nod for most growers because of its broad disease resistance. The Krymsk series seem resistant to nematodes, but bacterial canker could still be a problem.

Standard seedling rootstocks are still widely used, especially in the part of the nursery trade geared to home growers. In most cases, these rootstocks will function well enough, but growers will need to avoid sites where plums, cherries, peaches, or apricots have grown before because of the chance of infection by nematodes, verticillium wilt, oak root wilt, and crown gall.

For sites where plant-parasitic nematodes are likely (sandy and/or where *Prunus* species have been planted before) or have actually been detected, rootstocks have been specifically developed for nematode resistance. These include Flordaguard, Nemaguard, and Nemared.

In any case, if you're considering planting on a commercial scale, it would be advisable to contact state Cooperative Extension fruit specialists to see what rootstocks are recommended for your area.

Other Diseases

Root and crown rot diseases like *Phytophthora*, *Verticillium*, and *Armillaria* are important when choosing planting locations and rootstocks. Replanting in ground previously planted to stone fruit can be problematic.

Bacterial canker on trunks (more commonly a disease of cherries) can also affect plums, though research shows that hedgerows can provide a protective barrier for organic orchards (Tabilio et al., 1998). The control is presumably due to protection from driving rains and sun scald, since the causal bacterium, *Pseudomonas syringae*, is an "opportunistic" pathogen that often achieves primary infection at wound sites.

Insect Pests

In the eastern half of the United States, all stone fruits share one very important insect pest: the plum curculio. Other serious arthropod pests of plum and apricot include oriental fruit moth, aphids, mites, "cat-facing" insects (stink bugs, tarnished plant bugs, and other true bugs), and trunk borers. In California, the codling moth, usually thought of as a pest of apples and pears, is also a serious pest of stone fruit.

Plum Curculio

The main insect pest of plums east of the Rocky Mountains is the plum curculio (*Conotrachelus nenuphar*). 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. The damage can be severe—damage to more than 90% of fruit is not uncommon in unsprayed orchards.

A look at the life cycle of the curculio will illustrate why this pest is so hard to control, as well as indicate windows of opportunity for control. The adult weevils overwinter in woodlots, fence rows, and hedges and move into the orchard during bloom to feed on young flowers and to mate. After mating, the female bores a small hole in the skin of a developing fruit, deposits a single egg, and then makes a crescent cut (see photo) below the hole to protect the egg from being crushed by the rapidly expanding fruit tissue. The female (shown in the photo) lays an average of 150 to 200 eggs, which hatch two to 12 days later. The grub tunnels into the fruit's central seed cavity where it feeds until it has completed its development—about three weeks. Then it generates and releases pectin enzymes that "trick" the host fruit into dropping prematurely, eats its way out of the fallen fruit, and enters the soil to pupate. At the end of pupation, adults emerge to eat again and look for an overwintering site. In other words, the curculio spends much of its life hidden from sight: under leaf litter in the woods, inside the fruit, and under the soil surface. Moreover, when the curculio larva moves from the fruit to the soil, it does so after first inducing the fruit to drop to the ground, and then it tunnels out the bottom of the fruit to enter the soil and pupate. Even an orchardist rarely glimpses the plum curculio!

Cultural Controls for Plum Curculio

The life-cycle information suggests cultural control methods for the plum curculio, but none of these methods alone or in combination provide a cost-effective level of control for the commercial orchard. As already mentioned, fruits that are infested with curculio larvae normally drop from the tree before the larvae complete their feeding. Therefore, prompt gathering and disposal of fruit drops—before the larvae leave them to enter the soil—reduces the number of first-generation adults. Sometimes the fruit that drops in May contains very few curculio larvae; in these cases the drop may be a result of heavy fruit set, poor pollination, or both. Examine a sample of the drops to determine whether enough are infested to justify quick disposal. The drops on the two or three outside rows of the orchard are more likely to be heavily infested than those farther inside the orchard. Carefully destroy the infested drops.

Plum curculio oviposition scar. Note crescent shape. Photo: Gus Howitt, Michigan State University Extension

Disking or otherwise cultivating during the pupal period is a mechanical control method for plum curculio. In its pupal form the plum curculio is very fragile. If the pupal cell is disturbed, it fails to transform into an adult. Pupation usually occurs within the upper two inches of soil. The most desirable time to begin cultivation for destruction of pupae appears to be about three

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

weeks after the infested fruits start to drop from the tree. Cultivation should be continued at weekly intervals for a period of several weeks. Cultivation before the curculios pupate is of little value. If the pupal cell is broken before pupation occurs, another cell is made by the larva. Covering the drops with soil before the larvae emerge from them is undesirable because it protects the larvae from drying in the sun.

Although whole-orchard cultivation is moderately effective in controlling the curculio, it can lead to severe erosion and loss of soil organic matter. It is a non-chemical means of curculio control, but its soil-degrading effects make it unsustainable in most situations.

Historically, when homesteads just had one or a few trees, penning enough chickens under the trees to keep the soil bare seems to have provided good control. While no one is suggesting that large-scale orchardists control curculio with chickens, this apparently successful management of this hard-to-control creature should offer some hope for small-scale orchardists and, perhaps, insights into other control techniques.

Similarly, Michigan State research with apples indicates that allowing hogs to graze orchards could provide significant mortality to the curculio during fruit drop and pupation (Grieshop et al., 2010).

One more innovative technique is worth mentioning. C.J. Walke, Organic Tree Fruit Specialist with the Maine Organic Farmers & Gardeners Association says that in his small (roughly one acre) commercial plum orchard, he augments his sprays of Surround by laying large pieces of carpet scraps under the tree (Walke, 2010). This greatly eases his collection of curculio-infested drops and probably blocks the curculio larvae from entering the soil to pupate.

Monitoring for Plum Curculio

Because the plum curculio moves into orchards from adjacent woodlots, fence rows, or hedges during bloom, it can be worthwhile to carefully check fruit growing along the perimeter of the orchard for the tell-tale crescent-shaped oviposition (egg laying) marks (see photo on page 11). Only recently have effective traps become available for detecting this pest (the "Tedders" pyramid traps available through Great Lakes IPM; see Further Resources section).

Growers with any orchard history of plum curculio damage often tend to forego early monitoring and simply begin sprays at petal fall for three reasons: 1) the curculio is a "given"—if you've had the pest in the past, you will almost certainly have it again; 2) it can be so devastating to a high-value plum crop that any monitoring misses are serious; and 3) growers should not spray insecticides during bloom (in order not to kill pollinators) when the curculio is moving into the orchard; therefore, when the petals fall, the curculio is already present in some numbers and needs to be controlled.

Nonetheless, monitoring still has a place in determining the frequency and for how long into the season spraying must continue. For example, a grower might correctly assume from orchard history, even without monitoring, that at petal fall she needs to apply Surround. However, if a heavy rain washes off some of the Surround, but not all, she might want to determine by examining the fruit for oviposition scars (see photo on page 11) whether she needs to reapply. Or, for another example, perhaps the grower is relying on PyGanic™ for curculio control. Because of the short environmental persistence of PyGanic, there is little residual control even 12 hours after application, and she will need to determine by periodic (every two to three days) monitoring of traps whether new curculios are still entering the orchard.

Spraying to Control the Plum Curculio

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.

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 are not adequate). 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.

The synthetic insecticide Imidan™ (phosmet) has been the mainstay of integrated pest management of plum curculio because of its relatively low mammalian toxicity, its two-week persistence (meaning usually only two sprays for plum curculio control—at petal fall and two weeks later), and its low impact on beneficial insects. Some of the new neonicotinoids, such as Actara™, are registered for plum curculio control and boast even lower mammalian toxicity than Imidan; however, the neonicotinoids are under increasing suspicion regarding honeybee colony collapse disorder and have been banned in several European countries.

Check with your Cooperative Extension Agent or ATTRA's *Biorationals: Ecological Pest Management Database* for the latest recommendations for pesticides and their safe use.

Peach Tree Borers

The peach tree borer (*Synanthedon exitiosa*) and lesser peach tree borer (*S. pictipes*) can be major pests of plums and apricots. Borers feed on the inner bark of trees, where they may kill the tree by girdling or cause the bark to peel away, exposing the tree to other pests and diseases. Other hosts for the borers include wild and cultivated cherry, plum, prune, nectarine, apricot, and certain ornamental shrubs of the genus *Prunus*. The adult peach tree borer (see photo) is a clearwing moth, steel blue with yellow or orange markings. The moths are day fliers and can easily be mistaken for wasps.

These insects overwinter as larvae in burrows at the base of the host tree. Because the eggs are laid over a long period of time, the larvae vary greatly in size. Some are more than half an inch in length, while others are very small, not more than one-eighth of an inch long. The larvae pupate in the trunk of the tree and usually begin to emerge as adults in May in California and June in much of the rest of the United States (state Extension entomology specialists can provide approximate emergence times for each state or region). Mating and egg laying begin almost immediately after emergence. Pheromone traps are commercially available for site-specific monitoring (see Further Resources).

Peachtree borer (female L.). Photo: A.R. Biggs, West Virginia University Extension

The females are attracted to trees that have previously been damaged by borers, or to which some mechanical injury has occurred. Therefore, it is important to prevent damage to the tree trunk in order to minimize borer attack. Trees in poor vigor because of weed competition or drought stress also seem to be more susceptible to borer attack and damage.

Plum growers seeking to reduce pesticides can use a variety of tactics to control peach tree borers. Pheromones for both monitoring and mating disruption are effective and available (see "Pest Control" in Further Resources section), but growers should be aware that in order for pheromones to work properly, the orchard needs to be at least three, and some say greater than five, acres (www.ca.uky.edu/entomology/entfacts/ef200.asp).

Interior white latex paint, painted or sprayed on the base of trunks, provides a physical barrier, inhibiting newly hatched larvae from entering the trunk. The paint also fills cracks in the bark, the preferred site for oviposition and larval feeding. According to OMRI, use of latex paint, a

Borer damage and resulting gummy exudate. Photo: Rex Dufour, NCAT

synthetic substance, is not allowed in organic production systems, but homemade whitewash is acceptable.

It is easy to detect a tree that is infested with peach tree borers, since large amounts of gum exude from the damaged areas (see photo). The grower can use this exudate to locate a larva, and then kill it by using a knife or flexible wire to probe it out of the trunk. The soil should be removed from around the base of the tree to a depth of three inches before starting this process, since larval damage also occurs under the soil line. This method of control is feasible for small plots but probably not practical in a commercial orchard.

The bacterium *Bacillus thuringiensis* (Bt) can be used to control the larvae before they have entered the trunk. Because Bt does not have a long residual effect, the trunk should be sprayed weekly during the period of peak moth flight, late July through August.

A biological control, the commercially available insect-parasitic nematode *Steinernema carpocapsae* has also been used successfully to manage peachtree borers when applied as a lower-trunk drench in warm spring or fall weather (Tabilio et al., 1998).

Oriental Fruit Moth and Codling Moth

The Oriental fruit moth (OFM, *Grapholitha molesta*) and the closely related codling moth (*Cydia pomonella*) cause the same type of fruit damage. In addition to the fruit damage, the OFM larvae burrow in the new shoots in the spring (see photo), then move through the stem into the developing fruit. The codling moth lays eggs on fruit or leaves and the resulting larvae seek fruit into which they can burrow. Both pests feed near the pit, so there may be no visible damage to the fruit on the surface, but the fruits become much more susceptible to brown rot and break down rapidly after harvest.

Depending on the climate, there can be up to seven generations of Oriental fruit moth each year, with the earliest one feeding on young leafy shoots in the same way the peach twig borer does, and later ones feeding on the fruit, like the codling moth. Codling moths can produce up to four generations in warm climates. The overwintering stage of both these moths is similar: a full-grown larva from the last generation of the previous season spins a cocoon in the litter around the trees or on the bark itself. Pupation and adult emergence occur in the spring, and the moths lay their first eggs just after bloom. Trees that are allowed to grow dense, succulent foliage are especially attractive to the moths.

Pheromone-based mating disruption systems for Oriental fruit moth and codling moth are proven, effective, and easy to use. Some pheromone products are not approved by OMRI for use in organic production because of inert ingredients that they contain. Organic growers should check to make sure that the particular products they intend to purchase are approved.

Degree-day models or charts can help growers in timing pesticide application or placement of

Oriental fruit moth damage to twig. Photo: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

mating disruption lures to coincide with the emergence of the pest. Many state Extension offices or universities provide such tools developed specifically for their regions.

Good orchard sanitation—removing leaf litter and dropped or culled fruit where larvae overwinter—will further reduce attacks. Remove infested fruit and stem tips to further reduce populations. Dormant larvae can be destroyed by cultivating to a depth of two to four inches, one to three weeks before bloom. Another part of cultural control is annual pruning to control overly vigorous growth on trees, making them less attractive to the moths.

Parasitic braconid wasps can be used as part of an IPM strategy against the Oriental fruit moth. Growers have had success with five releases of adult wasps four days apart, beginning in May and using about 500 adults per acre. To control the moth effectively, some growers supplement a parasitic insect program with a single spray of an appropriate insecticide shortly before harvest.

Tarnished Plant Bug and Other "Cat-facing" Insects

Tarnished plant bugs, lygus bugs, and stink bugs are insects that pierce and feed on young fruit, causing depressions known as "cat-facing" in the mature fruit. The best cultural control for these insects is orchard sanitation and regular, close mowing of the orchard floor to deny them habitat (they prefer legumes); however, if the orchard-floor vegetation is allowed to get lush and is then mowed, it can force these pests into the trees to feed on the fruit. An alternative strategy is to use habitat plantings that attract these bugs (again, clovers and other legumes are preferred) as well as their predators. Keeping the habitat watered, lush and unmown, or mowing alternate alleys, may keep the bugs from migrating to the crop. Predators of these pests include bigeyed bugs, damsel bugs, assassin bugs, and collops beetle, as well as the egg predator minute pirate bug, and the egg parasite Anaphes ioles. In addition to these potential controls, botanicals such as PyGanic and neem appear effective against tarnished plant bug. Surround is also effective but will leave a residue on the fruit if used mid-season, when these insects are a problem.

Brown Marmorated Stink Bug

The brown marmorated stink bug (BMSB) (see photo) is a recently introduced (1998 was the first official sighting in the United States) pest from Asia, where it is a major agricultural pest. Like a lot of other introduced pests, it has, at least temporarily, left its natural enemies behind and is spreading rapidly across the country, damaging fruit and vegetable crops along the way. The mid-Atlantic states have been especially hard-hit. In Pennsylvania in 2010, losses to fruit and vegetable crops approached 50% (Gill, 2010). The damage is similar to that done by other cat-facing bugs, but the damage is usually deeper into the flesh.

The BMSB is shield-like in shape similar to other stink bug species but is a mottled light-brown in color with dark-brown "marmorations"—regularly spaced indentions—around the margin of the "shield." For more information and photos, visit http://ento.psu.edu/extension/factsheets/brown-marmorated-stink-bug.

Brown marmorated stink bug. Photo: Steven Jacobs, Pennsylvania State University

Currently there is little control information specific to the BMSB, and growers are relying on various broad-spectrum insecticides to control it. There is considerable concern that this pest and efforts to control it "could reverse much of the progress we've made in IPM, which has helped Pennsylvania growers to reduce pesticide use by as much as 75% in recent decades," according to Pennsylvania State University entomologist Greg Krawczyk (2011).

Spotted Wing Drosophila

While the exotic brown marmorated stink bug is invading the Northeast, the spotted wing drosophila (*Drosophila suzukii*, SWD), an accidental

introduction from Asia, is wreaking havoc on the West Coast and Florida (in 2010 the first SWD were found in Michigan and Wisconsin, and in 2012, Arkansas). A member of the vinegar fly family, the SWD is related to the tiny fruit flies that are commonly seen in households around damaged, cut, or over-ripe fruit, but the SWD attacks undamaged, ripening fruit in the field.

The fly is gnat-size, with red eyes and a light brown body. Males have visible spots on the tips of their wings. The female deposits her eggs in fruit (host range includes just about any thin-skinned fruit, including peaches, blueberries, grapes, plums, and tomatoes). The eggs soon hatch and the larvae tunnel and feed around the egg-laying site, causing noticeable depressions in the fruit. Often at this point, opportunistic bacteria and fungi invade the site and cause additional damage. The SWD can have ten or more generations per year, and each female can lay 300 or more eggs. The potential for damage is huge. Damage to California crops the first year the spotted wing drosophila was discovered (2008) was estimated at $500 million.

There is not yet an established control protocol. The least-toxic, effective pesticide appears to be GF-120 NF Naturalyte Fruit Fly Bait, which attracts and kills the SWD. The active ingredient in GF-120 is spinosad, a biological insecticide which is OMRI approved.

Oregon State University has developed a simple and inexpensive trap for monitoring. For more information and photos, visit http://swd.hort.oregonstate.edu/files/webfm/editor/FINAL_Monitoring_Trap_5-15-2010.pdf.

University of California also has a helpful SWD site at www.ipm.ucdavis.edu/EXOTIC/drosophila.html.

Other Pests

Scale and plant-feeding mites can become serious pests, especially if their predators have been thinned out by broad-spectrum pesticides, organic or not. Late-dormant-season (when temperatures are warm but the trees are still dormant) applications of crop oils can smother scale and some mite species.

Aphids can also be major pests, particularly for organic growers in the West. A wide variety of "soft" control techniques exists—including organic pesticide spraying, habitat manipulation, and release of beneficial insects.

Nematodes are another potential pest; see ATTRA's *Biorationals: Ecological Pest Management Database* and ATTRA's *Nematodes: Alternative Controls* for more information on alternative nematode-control strategies.

Marketing Considerations

For small- and medium-scale growers, orchard sizes will rarely be over 10 to 20 acres. Therefore, most of the fruit sold from these operations will be direct-marketed through farmers markets, CSAs, pick-your-own operations, and roadside stands. See the ATTRA publications *Direct Marketing and Farmers' Markets: Marketing* and *Business Guide* for some of the considerations involved in marketing through these outlets. In addition, there are three observations about plums and apricots not specifically dealt with in those publications that are worth highlighting here.

The first observation is that the apricots and plums sold through direct marketing outlets or marketed as local should always be described as "tree-ripened." This description separates this fruit from most fruit sold at grocery stores and creates in the mind of the customer the expectation of a better eating experience. So, all printed materials used to market these fruits, including farmers market signage, brochures, and orchard signage, should use this term. In addition, when any grower is given the chance to describe her plums and apricots on the radio or on TV or on YouTube, she should always use that term. "Tree-ripened" is a phrase that cannot be overcommunicated to customers.

A second consideration is the fact that both plums and apricots produce high amounts of ethylene gas when in storage and both are sensitive to being stored with other products that produce ethylene. For direct marketers of tree-ripened fruit that will be sold within three or four days of picking, this is probably not an issue. But larger growers who are supplying pallets of plums or apricots to grocery stores or other wholesalers need to pay attention to how the plums and apricots are stored. The production of ethylene by these fruits varies directly with the temperature at which they are stored. Ideally, both fruits should be stored at low temperatures, as close to freezing as possible without going below 32°F. So, small growers who don't

have coolers need to be careful not to store pallets of these fruits next to each other in enclosed spaces for very long because this will substantially reduce the shelf life of their fruit. Retailers will eventually reject fruit that has a shorter shelf life than expected.

And third, most growers of apricots and plums, particularly in areas other than the West Coast, will have a substantial amount of fruit harvested that will not meet USDA No. 1 Standards. The current applicable standard for U.S. No. 1 apricots reads as follows:

"'U.S. No. 1' shall consist of apricots of one variety which are mature but not soft, overripe, or shriveled and which are well formed, free from decay, cuts, skin breaks, worm holes and free from damage caused by limb rubs, russeting, growth cracks, dirt, scab, scale, hail, bruises, disease, insects or mechanical or other means" (USDA, 1994).

Marketing plums at a farmers market. Photo: Marisa Alcorta, NCAT

For most growers outside of the West, it will be difficult to harvest anywhere near 100% of fruit that will meet this standard. It wouldn't be surprising for a grower outside of the West to have 25% to 30% of fruit not meet this standard. This would include fruit that is overripe, misshapen, or just plain ugly. The grower will need options for selling this fruit other than in the fresh market.

The first place to look for customers for this less-than-perfect fruit is among food processors within the state. Most state departments of agriculture now have listings of agribusinesses by product categories (e.g., jams, jellies, ice cream makers, dried fruit products, bakery products). For example, the Texas Department of Agriculture has a marketing program called GO TEXAN that lists all members in the state by category. Anyone can search on the program website for a listing of Texas companies that might use frozen, dried, or otherwise-processed apricots and plums in their products. Similarly, North Carolina has the Goodness Grows Program and listings. Kentucky has the Kentucky Proud Program. Florida has the Fresh from Florida Program. New York has the Pride of New York Program. A fruit grower in any given state can go to the website of the National Association of State Departments of Agriculture (www.nasda.org) to look up food manufacturers in that state who are part of the state's marketing program.

Another resource is a state's trade association for food processors. In Texas, the Texas Food Processors Association (www.tfpa.org) is a trade organization that provides services to hundreds of members, many of which might use apricots and plums in the manufacture of their products. An Internet search for "(state X) food processors association" should generate leads for producers in any given state.

At the national level, there are also some resources to check for potential buyers of less-than-perfect plums and apricots. The National Association for the Specialty Food Trade (www.specialtyfood.com) is the association of processors and marketers of fancy foods, both for the domestic market and the international market. The association has two major trade shows per year: one in New York and one in San Francisco. Accessing the list of its members will indicate to growers the names of companies that might be in the market to buy plums and apricots as ingredients.

The National Frozen and Refrigerated Foods Association (www.nfraweb.org) is another organization whose members might be in the market for less-than-perfect plums and apricots.

And last, for growers of certified organic plums and apricots, the Organic Trade Association (www.ota.com) offers listings of members that might buy organic fruit as ingredients in their products.

These are but a few of the possible customers for less-than-perfect apricots and plums. Regardless of where growers look for customers, it is imperative that they find them. Growers who do not sell their less-than-perfect fruit are leaving $1,000 to $3,000 per acre on the table. Who wants to do that? No one.

Conclusion

Organic production of plums and apricots is favored by the climate in the West. In most of the East, commercial-scale organic production of plums and apricots is greatly complicated by the plum curculio and brown rot. Furthermore, any production, organic or otherwise, of apricots has been hampered by a lack of climatically adapted varieties. However, with new pest-management tools—Surround, PyGanic, Serenade, Isomate-M—organic plum and apricot production is far more plausible than just a few years ago. What's more, potential apricot production is being favored by fruit explorers and plant breeders looking and breeding for broader climatic adaptability.

Bluebyrd plum. Photo: Scott Bauer, USDA Agricultural Research Service, Bugwood.org

References

Agrios, George. 1997. Plant Pathology. 4th ed. Academic Press. New York, NY.

Anon. 1995. Variety spotlight. American Fruit Grower. April. p. 10.

Brait, Andrew. Full Belly Farm. Personal communication, 2010.

Full Belly Farm
P.O. Box 83
Guinda, CA 95637
530-796-2214

Brannen, Phillip and Guido Schnabel. 2002. Management of preharvest and postharvest brown rot of peach in the Southeast. Southeastern Regional Peach Newsletter. May. p. 1.

Burnham, T. J. 1994. UC researchers find dicloran alternatives for stone fruit. California Grower. September.

Cooley, Daniel R. et al. 2009. New England Tree Fruit Management Guide. University of Massachusetts. p. 5.

Gill, Chuck. 2010. Researchers seek elusive answers to stink bug infestations. Penn State Live. March 29. http://live.psu.edu/story/48793

Glenn, D. M., T. van der Zwet, G. J. Puterka, E. Brown, and P. Gundrum. 2001. Efficacy of Kaolin-based particle films to control diseases in apples. Plant Health Progress. www.plantmanagementnetwork.org/php/elements/sum.aspx?id=891&photo=113

Glenn, Michael. USDA Appalachian Fruit Research Station. Personal communication, 2010.

Grieshop, Matt, Mark Whalon, David Epstein, John Wise, and Larry Gut. 2010. Organic management of plum curculio. Fruit CAT Newsletter, Michigan State University. www.treefruit.msu.edu/extension/CAT/25_4.pdf

Hall-Beyer, Bart and Jean Richard. 1983. Ecological Fruit Production in the North. Jean Richard Publishing Co., Trois-Rivieres, Quebec, Canada. p. 84.

Kaplan, Kim. 2007. Plum pox resistant trees move forward. Agricultural Research Service News and Events. July 25. www.ars.usda.gov/is/pr/2007/070725.htm

Krawczyk, Greg, Ph.D. Penn State University. Personal communication, 2011.

Ministry of Agriculture. 2013. Brown Rot of Stone Fruits. www.agf.gov.bc.ca/cropprot/tfipm/brownrot.htm

Rom, Curt, Ph.D. University of Arkansas. Personal communication, 2013.

Tangsukkasemsan, B., J.D. Norton, and G.E. Boyhan. 1995. The occurrence of plum leaf scald on plum cultivars in Alabama. HortScience. June. p. 437.

Snover, Karen L. 2011. Cytospora canker of fruit trees. Cornell University Plant Disease Diagnostic Clinic. http://plantclinic.cornell.edu/factsheets/cytosporacankerfruit.pdf

Tabilio, M.R., A. Chiariotti, P. Di Prospero, andM. Scortichini. 1998. Hedgerows: A barrier against Pseudomonas syringae pv. syringae infections in an organic peach orchard. Acta Horticulturae. (ISHS) 465:703-708. www.actahort.org/books/465/465_88.htm

Walke, C.J. Organic Tree Fruit Specialist, Maine Organic Farmers & Gardeners Association. Personal communication, 2010.
207-568-4142
cjwalke@mofga.org

USDA. 1994. United States Standards for Grades of Apricots, Effective October 28, 1994, Agricultural Marketing Service. www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5050341

Further Resources

Trees

Adams County Nursery
26 Nursery Road
P.O. Box 108
Aspers, PA 17304
717-677-8105
717-677-4124 FAX
www.acnursery.com

Widely respected fruit tree nursery for Northeast.

Dave Wilson Nursery
Modesto, CA
800-654-5854
209-874-1821
www.dwnbeta.com

Home to Zaiger Genetics, a premier breeding facility for stone fruit, including plum X apricot hybrids.

Purvis Nursery & Orchard
Bob Purvis
1568 Hill Rd
Homedale, ID 83628
208-407-6781
purvisrc@msn.com

Specializes in apricots but has a large collection of other stone and pome fruit cultivars also. Sells both trees and scionwood; probably widest variety of apricot cultivars anywhere (see box in text).

Raintree Nursery
391 Butts Rd.
Morton, WA 98356
800-391-8892
customerservice@raintreenursery.com

Huge selection of plums, including beach plums, heritage varieties, plum-apricot hybrids, etc., mostly on Krymsk 1 rootstock. Aimed primarily at home growers.

Womack Nursery Co.
Larry J. Womack and Larry Don Womack
2551 State Hwy. 6
De Leon, TX 76444-6333
254-893-6497
254-893-3400 FAX
www.womacknursery.com

Good selection of plums and apricots for southern climates.

Pest Management Products

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
Litchfi eld 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

Publications

Titles from the University of California:

ANR Communication Services
1301 S. 46th Street
Building 478 - MC 3580
Richmond, CA 94804
800-994-8849
http://anrcatalog.ucdavis.edu

Integrated Pest Management for Stone Fruits
Publication 3389. 1999. A manual for managing pest problems and diseases in apricots, cherries, nectarines, peaches, plums, and prunes. ($35)

Peaches, Plums, and Nectarines: Growing and Handling for Fresh Market
Publication 3331. 1989. From orchard site selection to produce distribution. 153 color photos, 36 black and white photos, 44 tables and charts, glossary, and index. ($45)

Selected titles from American Phytopathological Society:

APS Press
3340 Pilot Knob Road
Saint Paul, MN 55121-2097
800-328-7560
651-454-7250
651-454-0766 FAX
aps@scisoc.org
www.shopapspress.org

Compendium of Stone Fruit Diseases. 1995. 168 color images ($49)
www.apsnet.org/apsstore/shopapspress/Pages/41744.aspx

Diseases of Orchard Fruit and Nut Crops-CD Rom. 2002. 500 full color images ($79)
www.apsnet.org/apsstore/shopapspress/Pages/42945.aspx

Selected titles from North Central Regional Extension

(available through Michigan State University)

MSU Bulletin Office
10-B Agriculture Hall
Michigan State University
East Lansing, MI 48824-1039
517-353-7168 FAX
http://bookstore.msue.msu.edu/

Diseases of Tree Fruits in the East, NCR 045. ($10)

Common Tree Fruit Pests, NCR 063. ($10)

From Natural Resource, Agriculture, and Engineering Service (NRAES):

NRAES
152 Riley-Robb Hall
Ithaca, NY 14853-5701
607-255-7645
607-254-8770 FAX
nraes@cornell.edu
www.nraes.org

Mid-Atlantic Orchard Monitoring Guide
NRAES-75. 1995. 322 color images.
www.nraes.org/publications/nraes75.html

Titles from Good Fruit Grower:

Good Fruit Grower
105 South 18th Street, Suite 217
Yakima, WA 98901
509-575-2315
800-487-9946
509-453-4880 FAX
www.goodfruit.com

Orchard Pest Management: A Resource Book for the Pacific Northwest. 1993. Published by Good Fruit Grower. ($35).

Organic Tree Fruit Management
1998. Published by Certified Organic Associations of British Columbia. ($38).

Web-Based 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 Photographs, 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.

Insect and Disease Control On Peaches, Apricots, Nectarines, and Plums
http://gregg.agrilife.org/files/2011/09/insect-and-disease-control-on-peaches_8.pdf

This Texas A&M online extension bulletin includes a spray schedule for peaches and contains information on pesticide toxicity.

Appendix I

Plum cultivar susceptibility to the bacterial spot pathogen, Xanthomonas pruni
Source: Kearneysville Tree Fruit Research and Extension Center (West Virginia University); information and credits provided at the bottom of the page.

Plum cultivar	Bacterial spot susceptibility rating*
Abundance	HS
Beauty	S
Bradshaw	R
Burbank	S
Elephant Heart	S
Fellenburg	S
Formosa	HS
Frontier	HS
Gold Shiro	S
Methley	S
Ozark Premier	S
President	R
Queen Rosa	S
Redheart	S
Santa Rosa	S
Satsuma	HS
Shropshire	R
Stanley	S
Wickson	HS
Yellow Gage	R

*R = Resistant. Specific control needed under high disease pressure.
S = susceptible. Control usually needed where disease is prevalent.
HS = highly susceptible. Control always needed where disease is prevalent. These cultivars should receive first priority when control is called for.

Data compiled by K. S. Yoder and A. R. Biggs from personal observations and the following sources:

Shepard, P. H. 1942. Growing plums in Missouri. Bulletin 31. Missouri Fruit Experiment Station.

Ritchie, D. F. 1995. Bacterial spot. In: Compendium of Stone Fruit Diseases. J. M. Ogawa, E. I. Zehr, G. W. Bird, D. F. Ritchie, K. Uriu, and J. K. Uyemoto, eds. APS Press, St. Paul, MN.

Notes

Notes

Plums, Apricots, and Their Crosses: Organic and Low-Spray Production
By Guy Ames and Robert Maggiani
NCAT Agriculture Specialists

Published April 2013© NCAT
Tracy Mumma, Editor
Robyn Metzger, Production

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

IP386
Slot 38
Version 052213