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Organic Pear Production

Horticulture Production Guide

Abstract : *This introduction to commercial organic pear production covers pear diseases, disease-resistant cultivars, insect and mite pests and their treatment, Asian pears, and marketing. Electronic and print resources are provided for further research.*

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Introduction

In most of the U.S., pears may be the easiest of the tree fruits to produce organically or with minimal spraying. Pears' fertility requirements are not high, they are adapted to a wide range of climates and soils, and they have fewer pest problems than other tree fruits.

Standard cultural considerations—such as pruning, choice of rootstock, planting, spacing, and thinning—are generally the same for organic and conventional growers. For this type of cultural information consult your county or state Cooperative Extension Service and/or find the information in any number of orcharding texts, articles, and websites (see the **Further Resources** section at the end of this document). For cultural information more specific to organic production (organic fertilization, organic weed control, etc.) request ATTRA's *Overview of Organic Fruit Production*.

Pears have most of the same pest and disease problems that apples have, but usually to a considerably lesser degree. ATTRA's *Organic and Low-Spray Apple Production* identifies pests and suggests organic remedies that are just as appropriate to pears; therefore, most of these problems will not be discussed further in this publication. However, because of its importance and prevalence on pears, fireblight will be considered in more depth. Other pests and diseases peculiar or especially troublesome to pears will also be discussed.

Related ATTRA Publications

- Overview of Organic Fruit Production
- Postharvest Handling of Fruits & Vegetables
- Insect IPM in Apples: Kaolin Clay
- Farmscaping to Enhance Biological Control
- Biointensive Integrated Pest Management (IPM)
- Organic & Low-spray Apple Production
- Organic Grape Production
- Organic / Low Spray Peach Production
- Low Spray & Organic Plum Production

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NCAT

Comparing a Pair of Pears		
	European pears	**Asian pears**
Scientific names	*Pyrus communis*	*Pyrus ussuriensis* *P. serotina* *P. bretschneideri*
Common cultivars	Bartlett, Bosc, D'Anjou, Seckel, Magness, Maxine, Moonglow, Comice	20th Century, Shinseiki, Korean Giant, Shinko, Chojuro, Niitaka
Texture and flavor	Buttery smooth and sweet.	Crisp. Flavors vary widely, including bland, sweet, sweet-tart, pineapple-like, and more.
Color	Green to yellow, though russetted types are dull bronze, and there are a few red types.	Green, yellow to golden, russetted bronze, and many types with white lenticels (spots).
Shape	Pyriform (i.e., round & bulb-like on the calyx end, narrowing to a slender neck at stem end).	Most cultivars are round. Some are misshapenly round. A few are somewhat pyriform.
Harvest and postharvest	Harvest before fully ripe. Allow to ripen (cure) at room temp. Buyer usually does curing.	Allow to tree-ripen. Ready to consume or sell.
Pests and diseases	Same as for Asian (see text).	Same as for European (see text).

Diseases

Fireblight

Fireblight, caused by the bacterium *Erwinia amylovora,* is one of the most serious and economically damaging diseases of pears. Occurring throughout the pear's range, it is particularly troublesome in the humid eastern United States. Infection is triggered by heat and moisture, and can spread rapidly—even within a matter of hours. It can be transmitted by bees, aphids, psylla, or other insects, and can also be spread by blowing wind and rain. Pruning can be another source of infection. Affected branches wither and turn black or brownish black, as if scorched. Most branch tips, once infected, wilt rapidly, taking on the characteristic shape of a "shepherd's crook." The bacteria gain entry to the tree through blossoms or lush new growth and, once inside, begin to work toward the roots. If the disease spreads unchecked to the trunk and roots, it can kill the tree; however, in resistant varieties the bacteria rarely invade beyond young wood. Under the bark, the bacteria form a canker where they will survive the winter, only to infect more trees the next year. If on a warm day you see pustules on a tree, oozing an orange-brown liquid, you are looking at fireblight (1).

Fireblight development is greatly favored by the presence of young, succulent tissues. Cultural practices that favor *moderate* growth of trees are recommended. These include using only half as much compost as for apples, never using manure, and avoiding heavy populations of clovers and other legumes around the base of the tree (2). Pruning should also be limited, and only minimum fertilization applied.

Choosing fireblight-resistant pear cultivars is a good start to managing fireblight, but it is by no means a panacea (see the Appendix "Fireblight, Disease Resistance, and the Disease Triangle"). There are several European-type pears with a comparatively high level of fireblight resistance (Ayres, Magness, Potomac, Warren, Maxine, Moon Glow, Tyson, Honeysweet, Kieffer, etc.) that are adapted to most of the contiguous United States. Clapps, Bartlett, Comice, Anjou, Bosc, and most other cultivars that are *not* expressly described as "fireblight resistant" in a nursery catalog should be considered susceptible.

Asian-pear cultivars also vary in their resistance to fireblight. Shinko has a high level of resistance, while Ya Li, Chojuro, Shinsei, and Seuri are among the moderately resistant varieties (3). Shinseiki has been rated as "resistant" by Kentucky researchers and "susceptible" by Alabama A&M researchers. Korean Giant and Shin Li are listed as resistant in some literature, but grower experience with heavy fireblight pressure in Arkansas indicates that they are at best only slightly resistant (4). Blight resistance for some cultivars appears to vary with growing conditions. It may be some time before all Asian pear cultivars, being relatively new in the U.S., are well classified in terms of blight resistance.

Preventing infection is the next key to fireblight control. Sprays of agricultural-grade streptomycin, applied at early bloom to prevent infection, have been the standard commercial control since the 1950s. In some regions, particularly Western apple-growing areas, *E. amylovora* has developed resistance to streptomycin. In order to preserve the effectiveness of this antibiotic, it is important not to spray it excessively. In areas where resistance has already developed, terramycin (MycoShield®) can be used as a substitute, though in general it is less effective. Both streptomycin and terramycin are listed as approved substances for fireblight control in the National Standards on Organic Agricultural Production and Handling (5).

Bordeaux mix (copper sulfate and lime) and other copper formulations sprayed at green-tip stage are organic options that provide some protection from fireblight infection. For best results, these formulations should be applied to all the trees in a block, not only the blight-susceptible cultivars (6). Copper treatments can cause fruit scarring, and are phytotoxic to some cultivars, so careful application is important.

In 1996 a biocontrol product called BlightBan® A506 came on the market, labeled primarily for reducing frost damage, but also for fireblight suppression. BlightBan is a formulation of the bacterium *Pseudomonas fluorescens,* strain A506. *P. fluorescens* is a non-pathogenic competitor with *E. amylovora,* and as such does not directly kill propagules of *E. amylovora;* rather, it occupies the same sites that *E. amylovora* would, provided it gets there first. Therefore, in order to be effective, BlightBan should be applied to newly-opening flowers (multiple applications will probably be necessary) or applied in combination with streptomycin (*P. fluorescens* strain A506 is resistant to streptomycin). In fact, research indicates that fire blight suppression is best when streptomycin and BlightBan are combined.

Using these two substances together can reduce the amount of streptomycin sprayed each year, which may help to protect the antibiotic's effectiveness. By itself, BlightBan can provide up to 50% suppression, but not control. It cannot be used in combination with copper sprays. The biocontrol bacteria live only about three weeks in the orchard, and there is no carry-over from year to year. BlightBan is marketed by J. R. Simplot Company/Plant Health Technologies (7). Note that it is not registered for use in all states.

A computer software program called Maryblyt™ is available to help in timing antibiotic sprays for their most efficient application against fireblight. The grower enters daily minimum and maxi-

mum temperatures, rainfall, and stage of blossom development, and the program predicts infection events and symptom development for most phases of fireblight. Further information on the program is available at the USDA's Kearneysville, West Virginia, web site <http://afrsweb.usda.gov/fireblight/fb8.htm>. In the Pacific Northwest the similar but freely-distributed Cougarblite Model <http://www.ncw.wsu.edu/models.htm> is more often used to help time spraying, and elsewhere other degree-hour models from local sources may be more appropriate.

Once fireblight infection has occurred, there is no spray or other treatment, beyond quickly cutting out newly infected limbs, that will minimize damage. However, infection has almost certainly extended beyond what the grower sees; therefore, it is all too easy to spread the disease by trying to prune it out during the growing season. If you do cut during the growing season, remove all blighted twigs, branches, and cankers at least 8 inches—some sources recommend 12—below the last point of visible infection, and burn them. After each cut, the shears can be sterilized in a strong bleach or Lysol® solution (1 part household bleach or Lysol to 4 parts water) to help avoid transmitting the disease from one branch to another, although there is some disagreement about the effectiveness of disinfection. Lysol is less corrosive than bleach to the metal parts of the pruners. Some have found it more convenient to use a spray can of Lysol disinfectant carried in an apron rather than a plastic holster or glass jar with a liquid solution.

During the winter, when the temperature renders the bacteria inactive, pruning out fireblight-infected wood can proceed without sterilization of pruning tools, and need not extend as far below the visible canker.

Blossom blast

Another bacterial disease, blossom blast (causal organism: *Pseudomonas syringae,* not to be confused with *Psedomonas fluorescens* discussed above), may afflict pears, usually as a blossom blight resulting in reduced fruit set. It can also cause twig dieback and bark cankers, and may lead to severe wood damage of Asian-pear cultivars in particular. Because the presence of blossom-blast bacteria allows ice crystals to form at higher-than-normal temperatures, the disease increases the incidence of freeze damage during cold wet weather. Asian pears are especially affected because their early bloom makes them more susceptible to frost injury (8). Of the Asian-pear cultivars mentioned above, Shinko and Ya Li are moderately resistant to *P. syringae*.

Controlling this disease is difficult because its occurrence is widespread on many plant species and not easily predicted; once symptoms appear, control efforts are too late. Protecting orchards from frost damage can limit injury. An early application of BlightBan® A506 can help reduce frost damage potential by excluding the ice-nucleating bacteria. In California, the application of fixed copper at the green-tip stage followed by streptomycin at early bloom has provided reasonable control. This treatment has also been used in Oregon, where cool wet weather makes blossom blast a particular problem in pear production. Streptomycin or terramycin applied at early bloom to control fire blight also help to control blossom blast, although the most effective timing of application for the two diseases is somewhat different.

Pear scab

Pear scab (*Venturia pirina*), a fungal disease closely related to apple scab, is neither as common nor as economically important on pears as apple scab is on apples. Nevertheless, it can cause economic damage by marring the appearance of the fruit. Pear scab causes lesions on leaves, shoots, and fruit, and—unlike apple scab—infects twigs, where it can overwinter. Pear cultivars differ in their susceptibility to scab. Organic control is identical to that for apple scab (9), usually consisting of treatment with sulfur, lime-sulfur, or Bordeaux mixture. See ATTRA's *Organic and Low-spray Apple Production* for details, including the use of the Mills Table to predict infection periods.

Other diseases

Two foliar diseases, fabraea leaf spot (*Fabraea maculata*) and mycosphaerella leaf spot (*Mycosphaerella pyri*), are usually no problem in

sprayed orchards but can reach damaging levels in unsprayed ones (9). Susceptible cultivars, which include nearly all European pears, can be defoliated, resulting in reduced buds and dwarfed or—if the fruit itself is infected—unmarketable fruit. Sprays for pear scab, such as Bordeaux mixture, will generally control these two maladies as well. Also, Surround™, a kaolin-clay-based insect repellant, is registered and labeled for suppression of fabraea leaf spot. More information on Surround is available in ATTRA's *Insect IPM in Apples: Kaolin Clay*.

Insect and Mite Pests

Many of the same pests that affect apples also prey on pears, although often to a lesser degree. More information on dealing with these pests can be found in ATTRA's *Organic and Low-Spray Apple Production*. Some of the pests that particularly affect pears are discussed below. Proper pest identification and orchard scouting are key to implementing successful IPM programs. ATTRA's *Biointensive Integrated Pest Management (IPM)* publication provides additional information.

Pear psylla

The pear psylla (*Cacopsylla pyricola*), an aphid-like insect whose only host is the pear, is the crop's most significant insect pest. In conjunction with fireblight, pear psylla is largely responsible for the decline in Eastern pear production. The honeydew left by the psylla damages the fruit by supporting growth of sooty mold and causing a black russeting; these two effects account for most of the economic damage caused by the psylla. It is also an important vector of fireblight and "pear decline disease," and can weaken trees in areas of heavy infection.

Although the psylla develops resistance to insecticides, it can usually be controlled either with dormant oil sprays or with sulfur sprays (but not a combination of the two, which damages plants.) Insecticidal soap can reduce active populations during the growing season. Fortunately, the recently-introduced Surround™ (discussed above under *Other diseases*) is effective against pear psylla. In fact, use of Surround for pear psylla control has made organic pear production viable for the first time in states like Michigan (10). The psylla also has a number of natural enemies such as predatory flies, minute pirate bugs, and lacewing larvae. In organic orchards parasites and predators can help control psylla below economically damaging levels, especially when combined with a program of oil treatments (11).

True bugs

Stink bugs, tarnished plant bug, and other true bugs (insects in the order Hemiptera) will readily feed on pears throughout the growing season. Early feeding damage may result in a pucker or dimple in the fruit. Mid- and late-season feeding often results in the development of so-called "stone cells" immediately beneath the feeding site. These stone cells are very hard and can seriously compromise the marketability of affected fruit.

Some fruit and nut growers reduce true-bug damage by maintaining unmown leguminous trap crops (clovers, vetches, peas, etc.) near the orchard (12). Unmown areas and cover crops can also serve as habitat for predator insects—for more information, see the ATTRA publication *Farmscaping to Enhance Biological Control*. Surround™ is labeled for suppression of stinkbugs and lygus bugs in pears. Also, some of the relatively new biological insecticides derived from the seeds of the neem tree are effective against true bugs on fruit crops. For example, Aza-Direct™, which is listed by the Organic Materials Review Institute (OMRI) for use in organic production, is labeled for use on all pome fruits for the control of weevils, thrips, true bugs, leafhoppers, aphids, leafrollers, cutworms, flies, and mites. Aza-Direct is produced by Gowan Company (13).

Mites

In high enough numbers, pearleaf blister mites (*Phytoptus pyri*) and pear rust mites (*Epitrimerus pyri*) can reduce the photosynthetic efficiency of leaves and cause russeting on fruit. Both species will likely be more troublesome in dusty conditions, as the dust interferes with their natural predators. These predators—including green

lacewings, predatory mites, and various species of ladybird beetles, as well as bigeyed bugs, minute pirate bugs, and predatory thrips—will usually control mite outbreaks if they are not disrupted by dust or pesticides. Orchard monitoring can help establish whether adequate numbers of beneficial insects are present. If not, horticultural oils sprayed during the dormant season can suppress mite eggs through suffocation. Neither horticultural oils nor other materials approved for organic production provide economic control of damaging populations.

Another pest that contributes to poor yields and smaller fruit is the spider mite. Dormant horticultural oils and insecticidal soaps can both help control spider mite outbreaks. Neem-based biological insecticides are also labeled for controlling mites on pears. European-pear cultivars are more sensitive to mite feeding than Asian pears, and any pear that is drought-stressed will be more susceptible to mite damage (14).

Other insects

Other insect pests that may affect pears include codling moth, apple maggot, scale, and plum curculio. These insects are covered in ATTRA's *Organic and Low-spray Apple Production* publication. The pear slug (actually a sawfly larva) causes leaf damage; it can be controlled with a forceful stream of water, soap, or wood ashes. The leafroller complex—including tufted apple bud moth, variegated leafroller, and redbanded leafrollers—represents another potential, but comparatively minor, pear pest problem. Mating disruption tools that are effective for some leafrollers are being developed. In addition, there are biological insecticides labeled for control of leafhoppers, aphids, and leafrollers, among other pests.

Asian Pears

Because they are relatively new to much of the United States, Asian pears deserve some additional comment. A crisp, juicy fruit, Asian pears are also known as Oriental pears, nashi, sand pears, apple pears, or salad pears. The more than 1,000 varieties of Asian pear range widely in shape, color, and taste. Only about a dozen varieties are commonly grown in U.S. commercial orchards.

Peshastin Creek Growers Areawide Organic Project

In a Washington valley, twelve family-owned orchards with approximately 300 acres of pears have joined together to establish an areawide insect pest management program based on the use of organic insect-control tactics.

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http://entomology.tfrec.wsu.edu/pearent/pcg%20home%20page.htm

Asian pears are slightly less cold-hardy than European types; they may suffer tissue damage at temperatures below –10° F but are generally hardy to –20°, making them best adapted to USDA climatic zones 5–9. Most Asian pears bloom slightly earlier than their European counterparts and may lose some blooms or buds to freezing in areas with a highly variable spring climate.

Culture of Asian pears is similar to that of European types, but not identical. One significant difference is the common tendency for many of the Asian types to set too heavy a fruit crop, which requires hand thinning of young fruit soon after bloom. Shinko, a popular cultivar because of its high fruit quality and fireblight resistance, is especially prone to this problem. If not properly thinned, Shinko and any other heavy-bearing Asian pear cultivar will not be able to properly mature such a load. Fruit size and quality will suffer. On the other hand, thinning to promote fruit size may result in reduced yield per acre compared to European pear varieties.

Another difference between Asian and European pears is that Asian pears ripen on the tree—they do not have to be picked and then cured like European pears. This is an advantage for most

growers, especially growers who are retailing direct to consumers. The fruit can be tree ripened and is ready to eat when picked, or can be held in cold storage. You do not have to educate the buyer about curing, as you might with European pears.

It is important to note that the delicate fruit of many Asian-pear varieties must be carefully handled during and after harvest to minimize bruising, punctures, and roller marks. The skin of Asian pears discolors quickly following rough handling, making careful picking and packaging a necessity, and mechanical handling risky. To prevent damage to Asian pears, it may be best to pack them into padded boxes or trays in the field where they are picked.

More information on Asian pears can be found in the sources provided in the **References** and **Further Resources** sections.

Economics and Marketing

Worldwide, China is by far the world's largest pear-producing country, followed by Italy. The United States is the third-largest pear producer in the world. Export markets are important for U.S. producers—more than 30% of the U.S. fresh pear crop is shipped to foreign markets (15). At one time pears were grown commercially on a large scale throughout the United States. However, because of the prevalence of fireblight in the humid eastern and southern states, most pear production has been relocated to the drier areas of the Pacific Northwest. More than 95% of the pears produced in the U.S. are grown in Washington, Oregon, and Northern California (16). Bartletts remain the most popular pear variety grown commercially in the U.S., outnumbering all other species combined.

Bartlett pear production has been declining slightly since 2000, resulting in higher prices for producers who continue to grow them (15). In general, pear prices tend to fluctuate based on crop size—which can be highly variable on account of weather and fruit set rates—and on the number of growers producing pears in a given year. Fluctuation in the organic market is also based on these factors, and the premium that organic growers can expect to receive for their product is unpredictable at best.

The market for pears is weaker than it could be, largely because of consumers' unfamiliarity with the different types of pears and how to use them. One survey showed that Bartletts and winter pears were consumed by no more than half of America's households, and then only occasionally. A market study funded by the Pear Bureau showed that only 3 out of 10 people have tried d'Anjou pears, and 2 out of 10 have tried Boscs. One of the obstacles limiting pear consumption is that many consumers do not know how to ripen them. Providing information on ripening may help increase sales (though the Pear Bureau study also found that most people preferred to buy pears already ripened). A substantial percentage of purchases are impulse buys, so appearance is critical. Many appearance problems come from fruit being handled by retail employees and consumers. Pears should be handled gently, no matter what stage of ripeness they have reached. Rough handling causes brown marks on the skin that may not appear until the fruit has begun to ripen, and will decrease customer appeal. Sources of consumer, food-service, and other trade-education materials related to European pears are available from the Pear Bureau Northwest (17).

The market for Asian pears is mixed. Until 1995 or so, the wholesale market for Asian pears was quite open and prices were high, particularly on the West Coast and in cities with large Asian-American populations. But Asian pears have been heavily planted in California for more than 20 years, and those orchards are now mature and bearing, more than meeting local demand and causing price drops in some areas.

On the other hand, outside of California, Asian pear growers that serve a retail clientele—especially a local Asian-American population—report brisk sales and good prices from locations across the country (3, 4). Offering taste sampling of fruit, where practical and allowed by local health regulations, is probably a good idea for building markets, since so many Americans are still unfamiliar with Asian pears.

Asian pears are breaking out of their niche to join the mainstream market, and may represent an opportunity for producers as market awareness and demand continue to grow.

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POB 15057
Boise, ID 83715
800-535-9101

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P.O. Box 5569
Yuma, AZ 85366-5569
800- 883-1844 ext. 2
http://www.aza-direct.com/

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17) Pear Bureau Northwest
4382 SE International Way Ste. A
Milwaukie, OR 97222-4635
503- 652-9720
http://www.usapears.com/

Additional Resources (electronic):

University of California Crop Information Asian Pear Index
http://fruitsandnuts.ucdavis.edu/crops/pear_asian.shtml

Horticultural information and links to factsheets on Asian Pear production and disorders.

University of California website for European pears
http://fruitsandnuts.ucdavis.edu/crops/pear.shtml

Extensive links to sources of information on European pear varieties, disorders, and economics.

Washington State University Tree Fruit Research Center—Pear Entomology
http://entomology.tfrec.wsu.edu/pearent/

A new website designed for farmers and field workers, and devoted to information and current research on pear entomology.

Washington State University Cooperative Extension—Fire Blight: 7 Key Steps to Control
http://www.ncw.wsu.edu/fbcontrol.htm

A direct, basic fact sheet recommending 7 key steps to fireblight control.

Pennsylvania Tree Fruit Production Guide: Asian Pears Recommended cultivars
http://tfpg.cas.psu.edu/part1/part15b.htm

Discussion of Asian pears in general, and descriptions of common cultivars in the United States, and less-common cultivars.

Additional Resources (print):

Jones, A. L. and H. S. Aldwinckle. 1990. Compendium of Apple and Pear Diseases. APS Press, St. Paul, MN. 100 p.

Excellent descriptions and photos. $37 from:
APS Press
3340 Pilot Knob Rd.
St. Paul, MN 55121-2097
1-800-328-7560
http://www.scisoc.org/

University of California Statewide Integrated Pest Management Project. 1999 (2nd Edition). Integrated Pest Management for Apples and Pears (No. 3340). University of California, Oakland. 216 p.

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Out of print, but obtainable through the Interlibrary Loan System at your local library.

Appendix: Fireblight, Disease Resistance, and the Disease Triangle

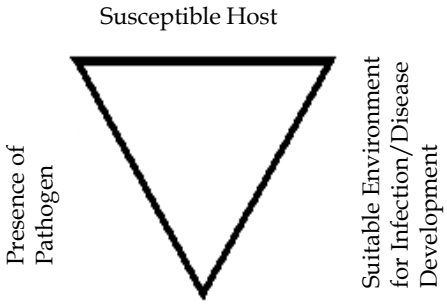

Fig. 1: The Disease Triangle

The occurrence of disease—any disease on any plant or animal—is dependent on three factors: 1) a susceptible host, 2) the presence of the disease-causing pathogen, and 3) a suitable environment for infection and disease development (the "disease triangle;" see Figure 1). This fact is very important to understanding fireblight incidence in pear orchards, especially in terms of managing this potentially devastating disease in different parts of the country.

Let's start at the top of the triangle with a corollary to point 1: heritable disease resistance is rarely absolute. When a plant breeder or plant pathologist refers to a pear cultivar as "fireblight

resistant," he or she is speaking in relative terms. Usually we read or hear something like "somewhat resistant," "very resistant," "moderately resistant," "slightly susceptible," etc. To further complicate matters, different researchers use different rating scales to describe resistance/susceptibility—there is no agreed-upon standard. For example, some published studies rely on a "1 to 10" scale, which is usually based on a visual estimate of damage, while others may use more absolute measurements, such as the centimeters of shoot tissue affected by fireblight.

Regardless of the failings of the various rating systems, the phenomenon of differential resistance/susceptibility is real—pear cultivars vary greatly in their reaction to the presence of *Erwinia amylovora*. Some cultivars, such as Magness and Shinko, will only rarely suffer any fireblight strikes, and, if they do, the blight will rarely intrude into any wood older than one year. In contrast, when all three factors of the disease triangle conspire, fireblight can kill even some older trees of susceptible European cultivars in a single year.

The second face of the triangle, presence of the pathogen, is the one that seems to prompt most of our efforts as growers. When we spray copper, Blight Ban™, or one of the antibiotics, we are trying to reduce or exclude (in the case of Blight Ban) the pathogen from potential infection sites. There is also a geographic component to this part of the triangle, as *E. amylovora* is much less prevalent in some parts of the world than in others.

The third face of the triangle—an environment conducive to the disease—is also related to geography, mostly by climate. Where the climate is warm and wet, expecially in the spring, fireblight infection and development are favored. The more arid parts of the western U.S. are not nearly as prone to fireblight problems as most of the East. But these large climatic and geographic features are not the only components of a disease-promoting or disease-suppressive environment—the orchardist can manipulate parts of the orchard *micro*-environment to help suppress disease development. For example, reducing fertilization can limit fast-growing succulent tissue, which is especially prone to infection and seems to provide the disease its fastest entry into the wood.

Another practice that can be adjusted to alter the orchard environment is pruning, which can "open up" a tree to allow more rapid drying of plant tissues and thus prevent disease. However, a grower in a different situation might need to *reduce* pruning in order to avoid fostering the lush shoot growth (which is more susceptible to fireblight) that usually follows heavy pruning.

There is considerable interplay, of course, between the faces of the disease triangle. It is especially important to understand that given high levels of inoculum and the proper environmental conditions, medium levels of varietal resistance can be overcome. For example, Shin-Li—released by the University of California as "fireblight resistant"—is relatively resistant in the climate of California, but can suffer severe fireblight infection in the Southeast if not adequately protected by spraying. If you plant Bartlett in South Carolina, for another example, and don't spray, you can watch the disease triangle imitate the Bermuda Triangle, as your trees disappear one-by-one and year-by-year.

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