WASHINGTON STATE UNIVERSITY EXTENSION

ANTHRACNOSE CANKER INTEGRATED MANAGEMENT PLAN FOR HOME GARDENERS IN WESTERN WASHINGTON

Home Garden Series

By
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Anthracnose canker integrated management plan for home gardeners in western Washington

Figure 1. Anthracnose canker on apple tree.

Anthracnose canker (Figure 1), caused by the fungal pathogen *Neofabraea malicorticis* (synonym *Cryptosporiopsis curvispora)*, and potentially *Phlyctema vagabunda* (synonym *Neofabraea alba*), is a major disease limiting apple production in western Washington, western British Columbia, and the Columbia Gorge (Spotts et al. 2009; Zang et al. 2011). The relatively mild temperatures combined with high humidity and frequent rains that occur during the autumn, winter, and spring in this region promote infection and disease development. Anthracnose canker is rare, or absent, on apple trees in the dry interior areas of the Pacific Northwest. Spores of the fungus infect healthy bark tissue, and the pathogen grows in the cambium beneath the bark for a period of time before killing the bark to form a visible canker. In the absence of effective management, the disease can readily spread in a short period of time, killing young trees, and structurally weakening established trees. Spores produced on the dead canker bark can cause additional cankers in infected trees, as well as surrounding trees, and also cause a postharvest fruit rot (known as bull's-eye rot). The key to effectively managing anthracnose canker is to inspect apple trees regularly and apply treatments within the appropriate timeframe.

Pathogen and Disease Cycle

In the maritime Pacific Northwest, stem and trunk infections appear to occur primarily in the autumn, but infection can occur throughout the winter and early spring when weather is mild and moist. Initial disease symptoms include the appearance of a reddish-purple lesion on the tree bark (Figure 2A and 2B) (Davidson and Byther 1992).

As the lesion enlarges, the necrotic tissue begins to peel away, and a margin develops between the healthy and necrotic tissue, causing a separation of the bark tissue around the infected area (Figure 2C). The necrotic bark will eventually slough-off leaving bast fibers (strong, woody fibers from the phloem) behind, giving the appearance often referred to as "fiddle-string" (Dugan et al. 1993). Once the canker reaches the "fiddle-string" stage, it no longer increases in size.

Cankers can attain full size in one year, and can range from 1 to 10 inches long. By mid-summer to late autumn, acervuli (asexual fruiting bodies) are formed on mature cankers, producing conidia (asexual spores) that are held together in a water-soluble matrix. Rain dissolves the matrix, and the spores are disseminated by rain and wind to other parts of the tree, as well as to surrounding trees and fruit, causing new infections (Creemers 2014). The acervuli first appear as cream-colored pustules on the center of the canker surface and later on the canker margin, and as acervuli age they become dark in color. Germination of conidia can occur under high humidity and temperatures between 30°F and 84°F (Cordley 1900; Spotts and Peters 1982). On cankers that are allowed to overwinter, the pathogen may produce apothecia (sexual fruiting bodies) in the old acervuli and release ascospores (sexual spores) into the air that can be carried over substantial distances.

Ascospore production begins by the end of March or early April and can continue throughout the summer and into the autumn when there is high humidity and temperatures between 40°F and 55°F (Jurkemikova and Rahe 1998). While, the capacity of ascopores to incite infection is uncertain, it is presumed that airborne ascospores are the cause of initial infection (Rahe 1997). The pathogen can survive as mycelium in cankered limbs or in fruit left lying under the tree, and can produce spores that incite new infection during cool, moist weather.

Disease Management

Eradication of anthracnose canker is not guaranteed once the infection has become established. Managing the disease requires an integrated plan that includes sanitation, removing cankers during dry weather year-round, and applying fungicides to limit or prevent infection during the dormant and growing seasons.

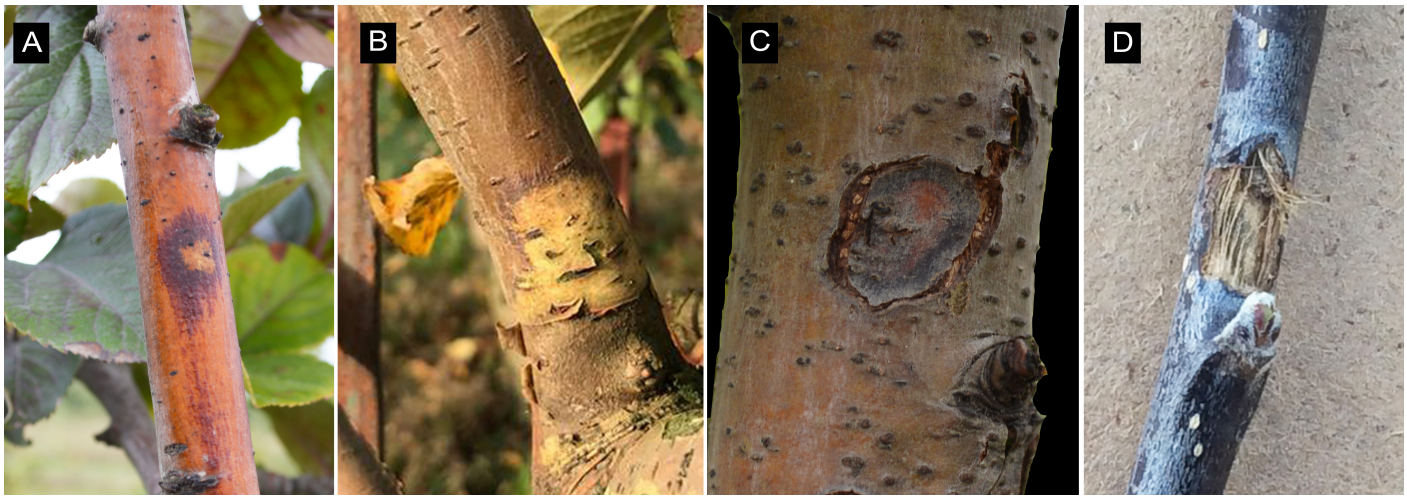

Figure 2. Anthracnose canker progression: a reddish-purple lesion is the first symptom of infection (A), necrotic tissue peels away from the infected area (B), a margin develops between the healthy and necrotic tissue (C), mature stage canker with "fiddle-string" appearance (D). Photos by Whitney Garton.

Cultural Controls

- Avoid planting trees adjacent to older and/or neglected apple or pear trees that may have existing cankers, as these can serve as a constant source of inoculum.
- Fully inspect new trees for symptoms of canker initiation or development (Figure 2).
- Plant certified disease-free trees and return or destroy infected trees if symptoms are visible.
- Keep trees healthy and vigorous through proper planting, watering, soil management, and pruning. Refer to apple home orchard management extension publications (see Information Resources).
- Prune out and discard stems and branches that are infected with cankers. On trunks and larger limbs, remove cankers with a pruning knife (Figure 3A).

Canker Removal

Scout your trees once per month to look for first symptoms of infection, such as bark discoloration (Figure 2A and 2B). During dry weather, excise infected tissue as well as any cankers (Figure 2C and 2D) found on larger limbs, branches, or the main trunk. To excise tissue, use a pruning knife to remove canker and approximately ¼-inch of healthy tissue beyond the canker margin (Figure 3A); remove any infected tissue including brown strands (Figure 3B and 3C) that may extend beyond the canker. Sterilize the knife after each canker removal with 10% bleach or 70% ethanol solution. Tie flagging tape next to the carved area and check monthly to determine whether the infection progresses. Prune out stems and branches that are heavily infected with four or more cankers (Figure 4A and 4B); make cuts at, but do not remove, the branch collar (Figure 4C). Avoid leaving stubs (Figure 4D).

Figure 3. Anthracnose canker removal: cut out the canker and healthy tissue ¼ inch beyond the canker margin (A); remove infected tissue (brown strands) that may extend beyond the canker (B,C). Photos by Whitney Garton.

Figure 4. Prune out stems that are heavily infected with cankers (A,B). Make cuts at the branch collar (C), avoid leaving stubs (D). Photos by Whitney Garton

Trees that are heavily infected (having four or more cankers on the majority of branches and trunk) should be removed and discarded to remove potential inoculum sources and prevent disease spread. Apply Bordeaux paste (see Bordeaux mix preparation section) to all pruned and carved areas of the tree. In the autumn, remove all cankers and infected branches before the winter rains begin. Discard all canker pieces and prunings. Never leave diseased plant material under the tree because the pathogen survives as mycelium in cankered limbs or in fruit left lying on the ground and can produce spores during cool, moist weather at almost any time of the year. It is important to eliminate all sources of inoculum.

Chemical Control

Chemical treatments are most effective if applied before disease appears. In western Washington, where the canker phase of this disease can kill apple trees, a year-round spray program is needed to prevent the disease from becoming established. ***Always read and follow all label directions and safety precautions.*** Apply a protectant fungicide (Table 1) every 10–14 days from late autumn through winter (November–February). Apply fungicide sprays at a time when there will be 12 hours of dry weather following application. Starting shortly before bud break (March), spray trees with a protectant fungicide (Table 1) every 10–14 days until mid-July. Rotate products to limit potential for development of fungicide resistance. Use caution when applying copper-based fungicides during the growing season to avoid potential phytotoxicity (leaf burn and fruit russeting) problems. Excise any cankers found during this time and remove heavily infected stems or branches. Monitor trees monthly for new infections and remove diseased tissue and new cankers as they appear.

Diligence is key for successfully suppressing this disease once it has become established. Do not skip disease monitoring or management as the disease can resurge and cause significant damage to a tree, or even death, if left unmanaged for even one season. Remove and discard all fruit that has fallen to the ground so the pathogen cannot overwinter on the fruit. In eastern Washington, where the disease rarely results in tree cankers, scouting the trees and removing diseased tissue should provide adequate control.

Protectant fungicides

are active on plant surfaces, where they form a chemical barrier between the plant and fungus. There is no movement of the fungicide into the plant. Protectant fungicides must be applied before spores land on the tree surface and infect the tree. These products can prevent spore germination but have no affect once the infection is established.

Active ingredient

is the chemical component of a pesticide formulation that is toxic to the pest. Other or inert ingredients are carriers that are not toxic to the target pest. Pesticide products generally are recognized by their trade names. Pesticides with different trade names can have the same active ingredient. It is important to rotate sprays with different active ingredients to limit potential for development of pathogen resistance.

Table 1. Fungicides and timing of their application to control anthracnose canker on apple trees in western Washington; use this spray program to limit disease progression and spread for newly planted trees in areas where the disease is prevalent, and also for established trees where disease has been detected.

Application time	Product	Active Ingredient
Dormant season (Nov - Feb)	Monterey Liqui-cop Copper Fungicidal Garden Spray	copper-amonia complex
	Soap-Shield Flowable Liquid Copper Fungicide	copper octanoate
	Bordeaux mix	basic copper sulfate and lime
	Bonide Liquid Copper Fungicide Concentrate	copper octanoate
Growing season (March - July)	Bonide Captain 50 WP	captain
	Bonide Liquid Copper Fungicide Conentrate	copper octanoate
	Bonide Copper Fungicide Bordeaux Modern Replacement Spray	basic copper sulfate
	Soap-Shield Flowable Liquid Copper Fungicide	copper octanoate
Pre-harvest	Bonide Captain 50 WP	captain

Note: This fungicide spray program is targeted for apple orchards in western Washington. In central Washington, where environmental conditions are not favorable for disease development, the disease may be managed by lower fungicide inputs.

Bordeaux Mix Preparation

Bordeaux mix is commercially available in premixed packages, but freshly made Bordeaux mix adheres and weathers better on trees. To be in compliance with Washington State Department of Agriculture, the person making the mixture cannot sell it to someone else for application. Bordeaux mix is a combination of basic copper sulfate, lime, and water (Figure 5A and 5B). A ratio of 10-10-100 works well for many disease-causing fungal pathogens. The three hyphenated numbers represent the amount (by weight) of each material to add. You can purchase basic copper sulfate and hydrated lime at most garden centers or online. Do not use fixed copper fungicides to make Bordeaux mix because they are less soluble and effective. You can use either dry hydrated lime or slaked lime to prepare Bordeaux mix. Most importantly, use fresh lime. Do not use lime from last season, so purchase only what you can use in the current season (Broome and Donaldson 2010).

Also, the mixture will deteriorate upon standing so apply the Bordeaux mix or paste the same day you prepare it. A manageable amount of Bordeaux mix for a home gardener to prepare at one time is 2 gallons, which would contain 1 pound of basic copper sulfate and 1 pound of dry hydrated lime in 2 gallons of water (Broome and Donaldson 2010). Adjust the amount of mixture made based on the area to be covered.

The effectiveness of Bordeaux mix depends on following the correct procedure for mixing the materials. Read the label directions carefully on the basic copper sulfate regarding the proper protective equipment to wear when preparing and applying the mixture. When mixing hydrated lime, protect your eyes, nose, and mouth by using a dust and mist-filtering respirator. For more information on methods of preparing and applying Bordeaux mix, please refer to the publication provided in the Information Resources section.

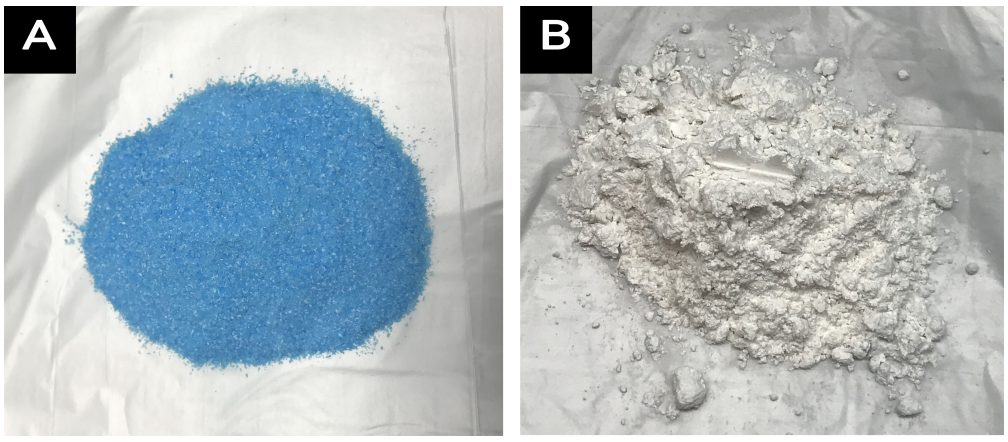

Figure. 5. Basic copper sulfate (A), and dry hydrated lime (B). Photos by Whitney Garton.

Figure 6. Preparation of Bordeaux mix: in separate containers, mix basic copper sulfate into water (A), and mix dry hydrated lime into water (B). When ready to use, mix the lime suspension into the basic copper sulfate suspension (C). For preparation of Bordeaux paste (D), follow the same mixing procedure with less ingredients. Photos by Whitney Garton.

To create a 2 gallon preparation of a 10-10-100 Bordeaux mix:

1. Obtain a 2 ½ gallon spray container or corrosive-resistant container and add 1 gallon of warm water to the container.
2. Slowly pour 1 pound of basic copper sulfate into the 1 gallon of warm water, while constantly stirring to ensure all of the basic copper sulfate is mixed into solution (Figure 6A).
3. In a separate corrosive-resistant container, mix 1 pound of dry hydrated lime into 1 gallon of water (Figure 6B).
4. When ready to use, slowly pour the lime suspension into the basic copper sulfate suspension and mix thoroughly (Figure 6C).

Bordeaux paste

consists of the same materials and mixing process as that of Bordeaux mix, but it will form a paste as less water is used. To make a small amount of Bordeaux paste (Figure 6D):

1. Mix 40 grams (4 ½ tablespoons) of basic copper sulfate in 100 mL of water.
2. Mix 40 grams (7 ½ tablespoons) of dry hydrated lime in 100 mL of water.
3. Pour the lime suspension into the basic copper sulfate suspension and mix thoroughly

Acknowledgements

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