

BACTERIAL CANKER IN WASHINGTON SWEET CHERRIES



Bacterial canker in sweet cherries is caused by the bacterium *Pseudomonas syringae* pv. *syringae* (PSS) van Hall (Romoli 1963; Latorre 1980) and is commonly associated with production areas characterized by wet and cold weather, such as western Washington, Oregon, and southern Chile, among others (Latorre 2008). Historically, until about 1970, bacterial canker was not considered a significant threat in the arid, sweet cherry producing region of eastern Washington. However, since then, this disease has been observed more frequently, especially in newer plantings where tree losses of up to 75% have been reported (Cameron 1970). In 2021, several orchards reported up to 60% incidence (proportion of trees affected). The apparent increase in disease levels observed in Washington can be attributed to several factors, with the seemingly most evident being the high susceptibility of the cultivar ‘Coral Champagne’. Released in 1984, ‘Coral Champagne’ has been gaining popularity over the last decade in Washington and was the third-leading cultivar ordered in 2012.

Additional factors influencing bacterial canker infection include extreme weather conditions and irrigation practices. For example, in 2021, a frost event with temperatures below freezing impacted many tree fruit orchards in eastern Washington during the month of April, followed by cool and wet conditions, ideal for *P. syringae* growth. Record high temperatures in June that continued throughout the summer led to additional plant stress and increased susceptibility to infection. The presence of other diseases, such as Little Cherry Disease (LCD) or Verticillium wilt, can further predispose trees to infection by PSS. This publication provides additional information on bacterial canker caused by PSS and provides an overview of the disease management practices for Washington sweet cherry growers and guidelines to better diagnose the disease and prevent confusion with other threatening diseases affecting the Washington sweet cherry industry.

Pathogen

Bacterial canker disease in sweet cherry is caused by the bacterium *Pseudomonas syringae* pv. *syringae* and can infect numerous species including tart cherry, peach, plum, berries, and many weeds found on orchard floors. Additionally, *P. syringae* can form ice inside the plant cell, called ice nucleation activity (INA), and generate damage (Lindow et al. 1978). Pathogen colonization can occur on any plant tissue without provoking infection or symptoms (Kennelly et al. 2007). Infection requires a wound or a natural opening accompanied by wet conditions or standing water. In infected trees, PSS survives in cankers and buds, which are the primary sources of inoculum for initial infections in the following growing season. PSS populations increase during spring after bud break, and symptoms of infection develop over the spring and summer. In late summer, PSS populations decline; however, there can be a second spike of infection during the cooler, wetter conditions of autumn.

PSS can be transmitted by grafting and can translocate systemically throughout the plant. Vigorous rootstocks have a greater chance of root grafting and transmitting PSS to surrounding trees than dwarfing and semi-dwarfing rootstocks. The pathogen can also be dispersed and disseminated by wind, rain or irrigation water, and insects. Mechanical movement throughout pruning appears not to be of risk but should not be overlooked if the equipment is in direct contact with fresh gummosis and conditions are favorable (i.e., cool and wet).

Predisposing Conditions

PSS requires a wound or other opening to enter the plant and initiate infection; thus, any condition that damages the tree will



increase the risk of infection. Bacterial canker is highly associated with winter freezes and spring frost events. Trees damaged by extreme weather conditions will have wounds that, when exposed to water (rain or irrigation) and cool temperatures (between 59 and 77°F [15–25°C]), are ideal conditions for infection to occur. Thus, PSS infection is most likely during the winter, spring, or fall. However, symptoms are commonly observed between spring and summer. In Washington, most infections have been associated with heading cuts (during planting in the spring) that become exposed to irrigation water and cold temperatures. Freeze or heat damage in the trunk, pest wounds (e.g., deer and rodents), or mechanical wounds create favorable infection sites. Fresh leaf scars due to abscission in the fall or leaf hand removal of spurs in the base of the new planted trees can also increase infection risk.

Weaker trees are also more susceptible to PSS infection, especially when trees are affected by other pathogens (e.g., viruses, phytoplasmas, *Verticillium* sp., *Leucostoma*, nematodes). *Verticillium* sp. have been found in combination with *P. syringae* in Washington orchards. Environmental conditions that lead to additional abiotic stress when the pathogen is present will increase the level of infection and promote symptom development. Alkaline soils or the presence of calcareous layers may create soil conditions that limit root growth, increase nutrient deficiencies, or exacerbate water stress due to extreme heat, any one of which promotes susceptibility to PSS.

Genetic Susceptibility

While all sweet cherry cultivars and rootstocks can get infected by PSS, some cultivars have been shown to be more susceptible than others. In Washington, the cultivars Sweetheart, Bing, Staccato, Royal Ann (Napoleon), and Van are susceptible while Coral Champagne has been shown to be highly susceptible. Higher levels of resistance have been reported in Corum, Regina, Moreau, Lambert, and Sam (Junior 2000; Spotts et al. 2010). Rainier has contradicting results but might be somewhat resistant in certain environments (Spotts et al. 2010; Roche 2001; Mgbechi-Ezeri et al. 2017). Among the rootstocks, Mazzard and Colt seem to be more resistant, while more dwarfing rootstocks, like Gisela 6 and Krymsk, are more susceptible (Spotts et al. 2010).

Symptoms in Sweet Cherry

The most distinct symptoms of infection in sweet cherry is a dark canker sometimes accompanied by gummosis (reddish-brown exudate; Figure 1) (Latorre 2008; CABI 2020). New limbs can die back, affecting buds or newly developed blooms that remain attached to the spur (Figure 2 and Figure 3) (Moore 1988; CABI 2020). Infection is more common in young trees, although it can occur in trees at any stage of development if conditions are favorable. Reddish, malodorous lesions in the root cortex are indicative of infection by PSS (CABI 2020).

Symptoms commonly develop at the base of trees, an area that, in young trees, receives higher exposure to damage by machinery, rodents, frost, and irrigation, providing numerous opportunities for PSS infection to occur. While there are other conditions that can lead to gummosis in sweet cherry, generally, noninfectious gummosis is clear to amber colored; thus, diagnosis usually requires expert assessment or laboratory testing.



Figure 1. Gummosis due to bacterial canker in a broken branch of sweet cherry (top photo). Gummosis pictured on trunk of tree (bottom photo). Photos: B. Sallato.



Figure 2. Limb with canker and dead flower buds that remain attached to the limb. Photo: B. Sallato.



Figure 3. Limb dieback in sweet cherry 'Coral Champagne' on Gisella 6. Photo: B. Sallato.

When PSS infects the trunk or main leaders, it can create a girdle (Figure 4), weakening the whole tree or branches distal to the canker and inducing symptoms that are similar to water stress or nutrient deficiency (e.g., chlorosis, small leaves, small fruit, and tree death; Figure 5). Thus, PSS infection can be confused with other abiotic and biotic (e.g., *Leucostoma canker*) conditions that have the same symptoms. Additional symptoms of PSS infection are necrotic tissue beneath the bark, with a defined reddish-brown pattern that affects the vascular system. This necrosis can be observed by cutting the bark and wood tangentially with a clean, sharp knife.

Weak trees or limbs that have been girdled as a result of bacterial canker infection do not always appear with gummosis or signs of infection in the upper portion of the trees. Instead, these weaker limbs will have reduced water and nutrient uptake, leading to small fruit and yellowing leaves. Due to the high

incidence of Little Cherry Disease (LCD) in Washington cherry orchards, caused by Little Cherry virus 1 (LChV1) and Little Cherry virus 2 (LChV2), as well as X-disease, caused by *Candidatus Phytoplasma pruni*, symptoms can be confusing. Symptoms of LCD and X-disease are distinct when fruit is present, with mature, ripe fruit of adequate size present on the same limb or spur as unripe, small, and yellow fruit (Figure 6). Small fruit associated with bacterial canker infection are uniformly similar in size and color throughout the entire affected limb or tree (Figure 7). Additional symptoms such as cankers, gummosis, scars in the trunk, or overall tree decline can help distinguish between the diseases. Ultimately, testing for LCD, X-disease, or bacterial canker should clearly distinguish between pathogens. Bacterial canker is also sometimes confused with *Leucostoma canker* (also known as *Cytospora canker*), which is caused by the fungus *Leucostoma cinctum*. Cankers produced by *L. cinctum* tend to have a well-defined margin. The canker surface can also contain minute, pimple-like structures known as pycnidia; the spores that spread the disease in orchards are produced in these structures. Note that it is also possible to have multiple diseases in one tree.

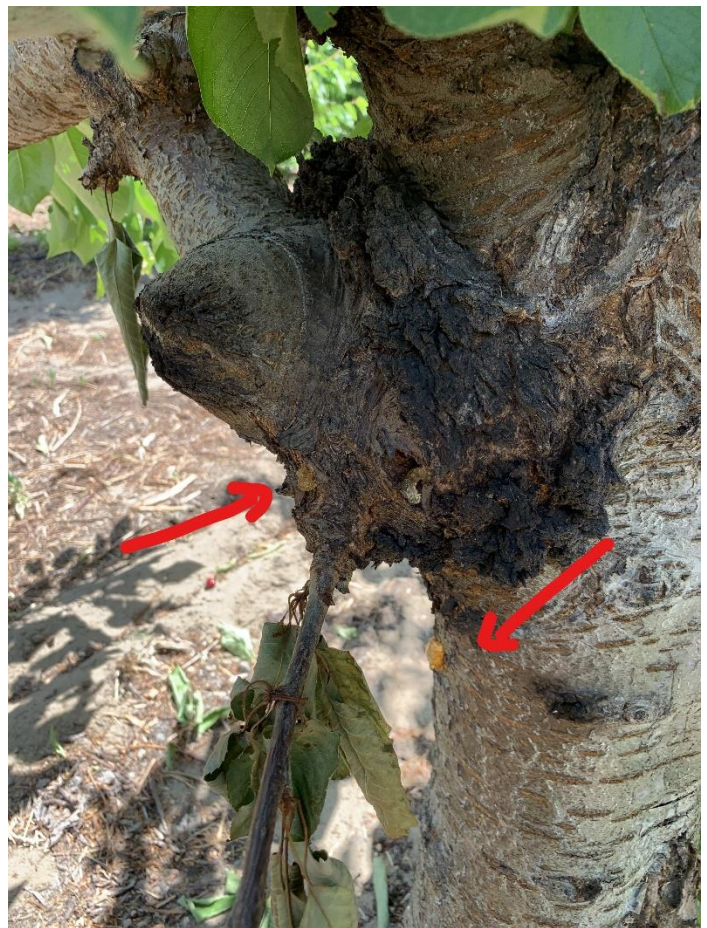


Figure 4. Canker and callus developed in the lower part of the tree creating a girdle. Gummosis are present below the canker and include a weak limb with wilted leaves. Photo: B. Sallato.



Figure 5. Sweet cherry tree infected by *P. syringae* generating a girdle in the main leader and weakening the tree. Symptoms can be confused with water stress or advanced decline due to Little Cherry Disease, other viruses, or Leucostoma canker. Photo: B. Sallato.

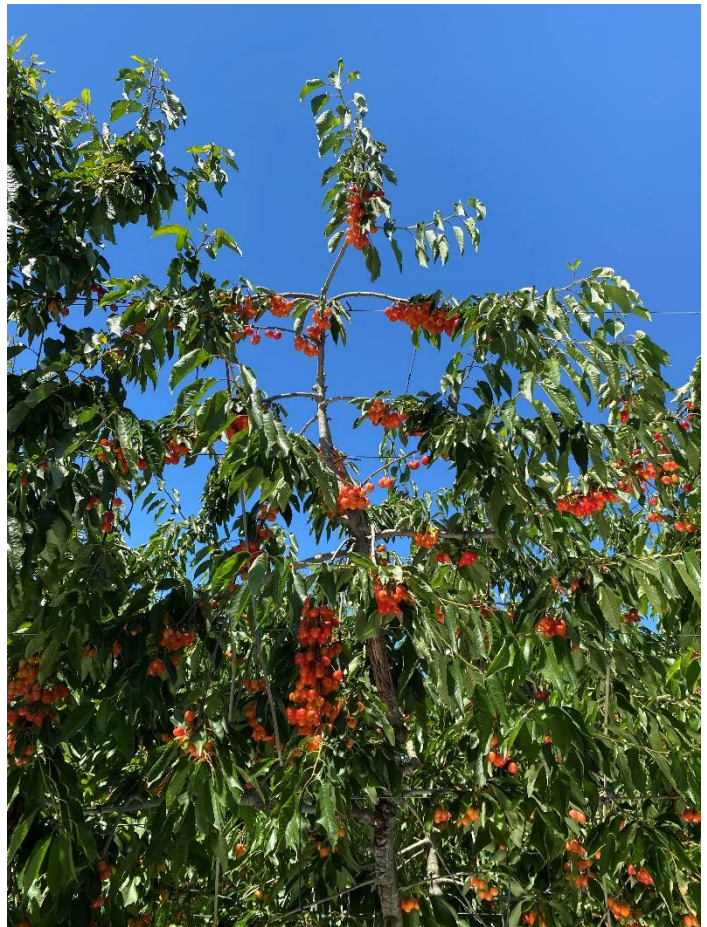


Figure 7. Small fruit and overcropped 'Early Robin' tree affected by bacterial canker. The whole tree is weak, with small-sized fruit above the girdle created by *P. syringae*. Photo: B. Sallato.



Figure 6. Little Cherry Disease (LCD) symptoms in sweet cherry 'Skeena' on Gisella 12. Ripe, dark-colored fruit in an asymptomatic limb (right) shown next to light, small, red to yellow fruit in symptomatic spurs (left). Leaves are green, adequately sized, and with no disease symptoms. Photo: B. Sallato.

Cases in Washington Sweet Cherry

Case 1: 'Coral Champagne' on Mazzard rootstock planted in 2021 in a Yakima Valley orchard.

Trees were planted in April and headed back to approximately knee high immediately after planting to generate a "Y trellis" formation. Irrigation is applied via micro-sprinkler. After planting and heading, water from the irrigation was in direct contact with the heading wound. Temperatures during tree establishment ranged between 30 and 50°F. A neighboring site planted with 'Black Pearl' on Gisella 12, showed no signs of infection. While it is not possible to determine if the new plants obtained from the nursery already had PSS or if the bacteria infected the trees post-planting, several conditions were conducive for the infection: susceptible cultivar, cool temperatures during spring, heading cut during spring, and irrigation in contact with the heading cut.

Case 2: ‘Coral Champagne’ on Krymsk 5 rootstock planted in 2018.

The site faces south and has a slope above three percent and a cool area in the southeast corner. The cooler area coincides with a soil section that has low drainage and a high water table. At planting, trees were headed back during spring and trained into a “Y trellis” system. Irrigation was provided mostly via drip; however, sprinkler irrigation was also used for frost protection and ground cover maintenance. Tree decline started after the first year of planting and progressed over subsequent years. In 2021, symptoms of bacterial canker infection increased dramatically after a frost event in April, which included three days of temperatures below freezing and was then followed by record high temperatures during the summer. Symptoms of infection in 2021 included cankers, gummosis in buds and trunk, dead buds and blooms, small, yellow fruit, as well as whole tree decline due to trunk girdling. Tree condition improved towards the upper side of the block, where water in the soil had better drainage and temperatures were milder. The pollinizer ‘Chelan’, which was also present in the block, as well as the contiguous planting of ‘Rainier’ were found to have significantly fewer symptoms of infection.

In both cases involving the cultivar Coral Champagne, a highly susceptible scion was used and environmental conditions were conducive to infection (cold and wet spring). Furthermore, in both cases, trees were headed after planting to generate a “Y trellis” formation. However, in the first case, infection-favoring environmental conditions were exacerbated by performing tree heading cuts during cool weather followed by wetting the cuts with micro-sprinkler irrigation. In the second case, PSS was present in the block and freezing conditions during spring could have damaged limbs and buds creating wounds. While the block has drip irrigation, micro-sprinklers utilized for frost protection and lack of soil drainage provided the wet conditions needed for PSS infection to occur.

Management

Several methods have been developed for bacterial canker management in sweet cherry orchards. The best approach is an integrated one that considers cultural practices, cultivar and rootstock decisions, and biological and chemical controls. In Washington, efforts should target frost protection, cultivar selection, irrigation strategies, pruning, and sanitation.

Cultural Practices

The following is a list of cultural practices to mitigate bacterial infections in sweet cherry orchards:

- Verify new material is clean (i.e., free of cankers) and has healthy buds prior to planting.
- Avoid planting during frost periods or in cool areas of the orchard. Frost conditions after planting can increase the infection rate.
- Monitor new plantings during spring and summer for symptoms of gummosis, cankers in limbs, dead buds, or vascular necrosis.
- After planting, if heading is needed for tree training, wait until the weather is hot and dry and allow the wound to dry before irrigating.
- Paint the trunk of young trees with white paint to protect from frost or heat damage (Figure 8).
- If there are open wounds due to frost, rodents, pruning, or other injuries, avoid sprinkler irrigation until the wound is dry or closed.
- While overhead cooling in sweet cherries is uncommon, it is important to consider the higher risk of open wounds when exposed to water.
- Prevent exposing green tissue to irrigation: drip irrigate the first years, protect tree trunks with paint or plastic covers, and remove lower shoots or spurs (Figure 8).
- In susceptible cultivars, summer pruning during dry conditions is recommended. Fall and spring pruning can increase the risk of infection due to a potential concurrence with cooler, moist weather. If winter pruning is needed to promote growth or renew branches, this should be done during dry conditions (Spotts et al. 2010).
- Excessive vigor due to increased water or nitrogen as well as late pruning (September) can delay dormancy in the fall. Regrowth or green tissue during the fall increases the risk of frost damage due to early frost events and consequently increases the infection risk.
- Avoid excessive irrigation that leads to runoff to prevent PSS present on leaf surfaces and nearby weeds from being transported through the orchard.
- When removing tree trunks due to bacterial canker, do not interplant immediately or near infected trees.
- Remove all infected material including branches or trees from the orchard and then burn.
- Monitor physical and chemical soil conditions and adjust for adequate growth. Keep soil free of ring nematodes. Soil limitations, such as extreme pH, calcareous layers, shallow water table, among others, can weaken trees and increase susceptibility.
- Early fall defoliation might provide additional control in areas at high risk of early frost damage by increasing bud hardiness or by promoting leaf scarring prior to ideal conditions for infection (i.e., wet and cool weather).



Figure 8. Best cultural practice in new plantings of ‘Coral Champagne’ on Mazzard, with double drip line and tree trunk protected with white paint. Photo: B. Sallato.

Physical and Chemical Management Techniques

P. syringae infection and spread can be controlled and mitigated using a variety of physical and chemical strategies:

- Cutting and removing infected tissue, including limbs with gummosis or cankers.
- Cauterization or burning of the cankers on limbs with a handheld propane burner. This should be done in the spring (Hawkins 1976; Hortsense 2012).
- Dormant sprays, including fixed copper (copper hydroxide, Cu^{++}). Copper oxides (Cu^{+}) have shown to be ineffective in controlling the disease (Torres and Latorre 2009).
- During pre-bloom: copper sprays + antibiotic (Kasugamycin HCL hydrate).
- Sulfur sprays (Hortsense 2012).

When using pesticide products, always read and follow all label instructions. Do not apply copper products after full bloom

(Hortsense 2012). Note that there are reports of resistance of *P. syringae* to copper and antibiotics in Oregon (Pscheidt and Ocamb 2021). Poor control can be due to resistance to pesticides, poor chemical coverage, inadequate timing, or high pressure of disease caused by PSS in the orchard.

Future Alternatives

Much of the infection and high incidence of bacterial canker around the world is closely related to areas at high risk of frost (southern Chile, Canada, Washington, Oregon); thus, control has been mostly directed to frost management (Lindow 1983). The prospect of cellulose nanocrystals to protect wood and buds against frost damage might offer additional tools to prevent bacterial canker in sweet cherry orchards (M. Whiting, personal communication).

Another future alternative solution to managing bacterial canker infections in sweet cherry orchards is utilizing trees that are naturally resistant to infection from PSS. While certain cultivars have been reported to naturally have some resistance to bacterial canker infection, the precise underlying genetic factors responsible for infection resistance have yet to be elucidated. Once heritable genetic factors involved in bacterial canker resistance are identified, these factors might then be targeted by breeders to develop new, superior cultivars for sustaining the sweet cherry industry.

Useful Additional Information for WA Growers

[2021 Crop Protection Guide for Tree Fruits in Washington](#). 2021. Washington State University.

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