BACTERIAL SPOT

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Bacterial spot is caused by *Xanthomonas arboricola* pv. *pruni* (Smith 1903) Vauterin, Hoste, Kerstters & Swings 1995 = *Xanthomonas campestris* pv. *pruni* (Smith 1903) Dye 1978. This disease is also referred to as bacteriosis, bacterial leaf spot, or bacterial shot hole. Bacterial spot was first described in 1902-1903 on plums in Michigan. Bacterial spot occurs on leaves, twigs, and fruit of peaches and nectarines, and almost all other stone fruits (*Prunus* spp.).

SYMPTOMS

Leaf Symptoms

The most obvious leaf symptoms are yellow, chlorotic leaves (Figure 1) with angular lesions at the leaf tip, mid-rib, and/or along the leaf margin. Infected leaves frequently experience premature drop. Developing foliar lesions are water-soaked, sometimes grayish colored, and angular in shape, being delimited by the veinlets of the leaf. Initially, individual lesions (Figure 2) are only 1 to 2 mm (pencil point) in size, usually expanding to 2 to 3 mm, but seldom exceeding 5 mm. As lesions age, centers may become dark or purple in color and necrotic (Figure 3); when lesion center abscission occurs, a shot-hole appearance results. The very earliest leaves to emerge in spring, on some varieties before bloom, can become infected and serve as secondary sources of inoculum for later emerging leaves and fruit. Leaves are most susceptible before becoming fully expanded. Leaf symptoms usually are first visible 5 to 14 days after infection. Rapid symptom expression is dependent on warm temperatures. Care should be taken to differentiate bacterial spot lesions, which are angular in shape, from foliar lesions caused by pesticide sprays or other injuries that are usually circular in shape and do not have a water-soaked appearance.

Figure 1. Chlorotic leaves with multiple bacterial spot lesions that commonly develop in areas where moisture aggregates and evaporates slowly (e.g., at the leaf tip). Once leaves develop these symptoms, they readily drop.

Figure 2. Newly formed bacterial spot lesions. Light yellowish-green halo surrounds the water-soaked, angular-shaped, brownish-yellow center of the lesion.

Figure 3. Lesions develop a dark brown center. If the center of the lesions abscises, a shot-hole symptom develops, giving the leaf a tattered appearance.

Twig Symptoms

On peaches and nectarines, twig symptoms usually consist of cankers on the previous year's growth associated with and initially extending 1 to 2 cm (~ 1 inch) either side of leaf and flower buds; these affected buds usually fail to open.

These overwintering cankers, often termed *spring cankers* (Figure 4), are first visible during bloom. When a canker extends downward from the terminal bud, which fails to open, it is termed a *black tip* (Figure 5). When conditions are moist, the canker surface has a black, water-soaked appearance. As the season progresses, the canker can lengthen and the bark surface cracks (Figure 6). *Summer cankers* are formed on current-season growth and are visible early to mid-summer (June through early August).

Figure 4. An overwintering canker or spring canker on the previous year's growth. Spring cankers are first visible during bloom and develop a black, water-soaked appearance. They extend along the length of the twig from a leaf/flower bud that has failed to open.

Figure 5. An overwintering canker that developed from the terminal bud downward; such cankers have been termed *black tip*.

Figure 6. An overwintering canker soon after the shuck-off stage of fruit growth that did not completely girdle the twig. The canker color changes from black to brownish red and the outer bark begins to crack as the tissue beneath the canker grows.

Fruit Symptoms

The earliest fruit lesions are normally observed about three weeks after petal fall. Fruit infection is favored by moist and warm conditions from petal fall to early shuck split. Developing fruit lesions have a water-soaked appearance with a small necrotic area in the center (Figure 7). As the lesions mature, they become brown to black in color and enlarge (Figure 8). Infections that occur for approximately four weeks from petal fall develop into large, open lesions that extend deep into the fruit flesh, sometimes almost to the pit by harvest (Figure 9). In contrast, infections that occur after initiation of pit-hardening usually remain near the fruit surface. These shallow lesions may coalesce, resulting in cracking of the skin (Figure 10).

Figure 7. Newly formed, water-soaked lesions on fruit first visible near the time of pit-hardening. Gum also may exude from lesions.	**Figure 8.** Lesions resulting from infections occurring near the time of shuck split become black and start to extend into the fruit flesh. Gum commonly exudes from these lesions. Fruit growth stage is about three weeks after pit-hardening.	**Figure 9.** Fruit that was infected soon after bloom; lesions continued to develop throughout the season and now extend deep into the flesh. Fruit is about two weeks from harvest.	**Figure 10.** Fruit having lesions that remain near the fruit surface and do not extend deep into the flesh. Such "surface lesions" are associated with infections that occurred near or after pit-hardening rather than near or just following shuck-split.

DISEASE DEVELOPMENT

The bacterial spot pathogen overwinters in association with buds, in protected areas on the woody surface of the tree (e.g., cracks in the bark), and in leaf scars that become infected during leaf drop the previous season. Leaf scar infections usually result in spring cankers. In late winter as temperatures warm, leaf and flower buds swell, new tissue emerges, and the bacteria begin to multiply. The bacteria are spread from cankers by dripping dew and in splashing and/or wind-blown rain to the newly emerging leaves. Bacteria spot can also infect through natural openings or wounds. High moisture conditions are very favorable for both leaf and fruit infections. Leaf infections can occur for at least as long as terminal growth and leaf emergence continue. Several highly susceptible varieties (e.g., O'Henry and Ryan Sun), experience early leaf emergence, usually before bloom buds, and can be infected very early in the growing season. This results in a high concentration of bacterial inoculum, which is available to infect other emerging leaves and young fruits as they emerge from the shuck. Severe fruit infections are more common when frequent periods of rainfall or even extended heavy dews and very high humidity occur from late bloom to near pit-hardening. Bacterial spot is more severe in areas where peaches are grown in light, sandy soils than in heavier soils. Wind and wind-blown sand can increase the severity of bacterial spot by creating wounds for the bacteria to infect.

CONTROL

Bacterial spot is very difficult to control on highly susceptible varieties. Under optimal environmental conditions for infection and disease, control can be similarly difficult on moderately susceptible varieties. Control and management measures must be applied preventatively to successfully reduce losses from this disease. Once bacterial spot symptoms are observed, it is almost impossible to bring the disease under control if environmental conditions remain favorable.

There is a wide range of susceptibility within peach varieties, from highly resistant varieties such as Sentinel and Clayton to highly susceptible varieties like O'Henry and Ryan Sun. Most, if not all, varieties developed west of the Rocky Mountains are highly susceptible because bacterial spot is so uncommon there that breeding programs cannot screen new selections for susceptibility. Unfortunately, several varieties with excellent bacterial spot resistance lack desirable fruit quality characteristics. When establishing an orchard in areas prone to bacterial spot, varieties having at least moderate resistance should be strongly considered. In years when disease pressure is low, such varieties will sustain little to no fruit loss; in years when disease pressure is high, chemical sprays are much more effective on less susceptible varieties.

Because trees under nutrient stress are more severely affected by bacterial spot than trees not experiencing stress, it is advisable to maintain optimum soil fertility. High populations of ring nematode have also been associated with increased bacterial spot, which may be related to stress caused by this nematode.

Minimize blowing sand within and surrounding the orchard by employing appropriate ground covers and abstaining from disking. Windbreaks appropriately placed to blunt the damaging effects of strong winds, while still allowing for air movement through the orchard, may reduce bacterial spot severity.

Available antibacterial materials, copper-containing compounds and oxytetracycline, have limited efficacy. To optimize the performance of these modestly effective materials, they must be used preventatively. The foliage of peaches is very sensitive to copper and can be easily damaged, which results in leaf discoloration, shot holes, and premature leaf drop if sprays are not correctly applied. Use of copper sprays is focused early in the growing season, from dormant through early shuck split, when only a limited amount of new growth is present. The goal of the early-season copper sprays is to cover the tree surface and serve as a barrier through which bacteria must pass (being killed in the process) as they move from their overwintering sites. Dormant sprays contain relatively high rates of copper, which are significantly reduced as the new growth emerges. By shuck split, initiate use of oxytetracycline, which is relatively safe to peach foliage and fruit. In orchards where bacterial spot has been a problem in previous years, an early-season

copper spray program should be used. Subsequently, the number and frequency of applications can be adjusted based on the occurrence of precipitation. If at least one period of precipitation occurs weekly, a 7- to 10-day spray program should be followed using oxytetracycline starting at shuck split. Local, annually updated spray guides should be consulted for specific application times and rates of chemicals. Most chemicals for bacterial spot control are not labeled for use within three weeks of harvest.

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