BACTERIAL SPOT OF ALMOND (AL16005)

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- *Caused by the bacterium Xanthomonas arboricola pv. pruni*
- *Symptoms include sunken brown corky lesions on fruit, often oozing amber coloured gum, and small brown angular spots along the midrib, tip and margins of leaves, sometimes coalescing into larger patches*
- *Wet weather with extended periods of leaf wetness is needed for infection. Optimum temperature is 25-30°C*
- *Spread by wind-driven rain, rain splash, pruning tools and insects*
- *Survives on mummies, peduncles, dormant buds, leaf scars, cankers and fallen leaves*
- *Control is through orchard hygiene and minimising in-canopy wetness*
- *No chemical products are registered for bacterial spot in almonds in Australia. However, copper products are recommended in California*

Introduction

Bacterial spot is caused by *Xanthomonas arboricola* pv. *pruni* which infects all *Prunus* species including almonds. It is present worldwide in almond and stone fruit growing areas. It can reduce yield and tree vigour as well as affecting nut quality. Most of the research into this disease has been conducted on stone fruit as occurrence on almonds is relatively recent. It was first recognised on almonds in Australia in 1994/5 and has been confirmed in all almond producing states (Anon, 2004). During a two-year survey conducted by AL16005 we found 2.4% (2018/19) and 8.4% (2019/20) of trees with fruit or leaves affected by bacterial spot, mainly on Monterey, Fritz, Independence and Nonpareil.

Identification and symptoms

Infected fruits have sunken lesions that often ooze amber coloured gum; these brown corky lesions extend into the hull. Once the hull begins to dry the lesions become raised. Severe infections penetrate through to the shell and sometimes the kernel, leaving dark marks resulting in downgraded quality. Some infected fruit may fall prematurely, others remain attached to the tree as mummies, these are the main causes of yield reduction (Figure 1) (Haake *et al.* 2020, Lamichhane 2014).

Leaf symptoms first appear as pale green or yellow spots, becoming purplish brown angular lesions over time, often joining up to form larger necrotic patches. Sometimes the leaf spots may drop out, giving a shot-hole effect. Symptoms are most often found at the leaf tip and margins or along the rib where moisture accumulates (Lamichhane 2014) (Figure 3). Severe cases can lead to defoliation and twig dieback reducing long term productivity. Twig cankers occur on stone fruit but are rare on almonds. Twig cankers are dark and shiny, slightly depressed with water-soaked margins (Garita-Cambronero *et al*. 2018, Anon 2004).

Bacterial spot is difficult to diagnose as symptoms on fruit are easily confused with anthracnose and/or insect bites, both of which may cause similar gumming. Leaf symptoms can easily be confused with shot hole or copper phytotoxicity (Haake *et al.* 2020).

Figure 1. Bacterial spot fruit symptoms a. and b. amber gumming, c. lesion extending into the hull, d. raised lesion on drying hull.

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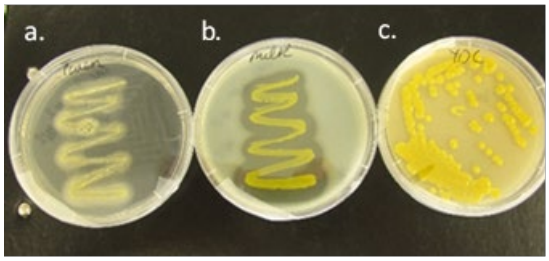

Figure 2. *Xanthomonas arboricola* pv pruni on different diagnostic media, a. Tween agar, b. Milk agar and c. YDC agar.

Figure 3. Bacterial spot leaf symptoms.

Where it comes from

The bacteria are spread by rain splash and wind-driven rain, contaminated pruning tools and machinery or by mites and insects.

Mummified fruit and associated peduncles are the main source of overwintering inoculum in almonds (Haake *et al.* 2020). The bacteria can also survive on dormant buds, leaf scars, twig cankers and fallen leaves.

From the overwintering sites, the bacteria spread to new leaves in spring where they multiply on the leaf surface without causing infection. From there, they can spread to susceptible tissue entering through natural openings such as stomata, leaf scars and lenticels or through wounds (Lamichhane 2014).

Favourable conditions

In peach, water congestion, *i.e.* the accumulation of excess water in the intercellular spaces, is important for disease development (Zehr *et al.* 1996). This is favoured by rain, high humidity and high water uptake by the trees as well as growing on light sandy soils. Frequent periods of moisture during late bloom lead to initial infections, with at least 24 hours of leaf wetness needed for significant disease development.

Warm weather favours growth of the bacteria. The optimum temperature is between 25 and 30°C, although they can grow at temperatures as low as 5°C (Morales *et al.* 2018). In direct sunlight, leaf temperatures may be 5-10 degrees higher than the air temperature (Young et al 1977), so weather conditions in early spring could easily be warm enough for bacterial development. It may take between 7 and 25 days for disease symptoms to appear, depending on the temperature.

There is little information available on the relative susceptibility of almond cultivars. Cultivars Fritz and Ne Plus are known to be very susceptible (Anon 2004, Haake *et al.* 2020), but the disease has been reported on other varieties including those commonly grown in Australia such as Nonpareil, Price, Carmel, Monterey and Maxima. During industry wide disease surveys from 2018 to 2020, it was detected on Independence in the Riverina and there is anecdotal evidence that Shasta is also affected.

Disease management

Disease control starts with good orchard hygiene. Symptomatic plant material including mummies should be removed. Pruning tools should be regularly disinfected especially after working in disease-affected areas. Disease is promoted by free water, so irrigation methods that wet the foliage should be avoided. Lush young growth is susceptible, so excessive nitrogen that promotes this should also be avoided.

There are no chemical controls registered in Australia specifically for bacterial spot of almonds (APVMA). In California, the application of copper-based products is recommended during dormancy or in-season (University of California, 2017). Copper is only effective on direct contact with the so needs to be applied before they get inside the plant tissue. This relies on accurate timing and good spray coverage. Copper or copper/mancozeb sprays during dormancy, full bloom or petal fall were found to give good protection during wet years (Haake *et al.* 2020). Copper sprays applied early in the season have been reported to have moderate efficacy (Morales *et al.* 2017). However copper resistance has developed in some situations (Haake *et al*. 2020, Garita-Cambronero *et al.* 2018).

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For further information about the “Integrated disease management program for the Australian almond industry (AL16005)” project led by Agriculture Victoria please visit

https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/al16005/

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