Scholefield Robinson
HORTICULTURAL SERVICES

Bacterial Spot on Almonds

INTRODUCTION

Bacterial spot is a disease caused by the bacterium *Xanthomonas arboricola pv pruni* (Xap). This organism was formerly called *X. campestris pv pruni*. Bacterial spot was first confirmed on almonds in Australia in 1994/95 but it is likely that the disease was present in some production areas before then. The similarity of leaf and nut symptoms of bacterial spot and of the fungal disease 'shothole' likely resulted in bacterial spot going unrecognised as a new disease for some time. Many growers reported 'ineffective shothole control' before being alerted to the presence of bacterial spot in almonds in Australia. Since 1996/97 bacterial spot of almonds has been confirmed in all producing states (SA, Vic, NSW, WA).

SUSCEPTIBLE ALMOND CULTIVARS

Almond varieties, like stone fruit, vary in their susceptibility to bacterial spot. NePlus and Fritz are the most susceptible almond cultivars. A small number of gummed nuts have also been observed on Mission and Carmel, but these cultivars are considered to have a moderate degree of tolerance. Since the disease has not been confirmed on either Non-pareil or Price we believe these varieties have a high degree of tolerance.

Both young and established trees are susceptible and the losses attributable to this disease vary seasonally and in severity. Yield reductions through nut gumming and premature nut fall cause the major economic losses. Twig dieback and defoliation will have long-term effects on tree productivity and longevity, particularly if trees are infected at the time of, or soon after, planting.

Management of this disease, especially in areas that experience spring and summer rains and humid conditions, requires a combination of chemical and cultural strategies. Regardless of the orchard's history of disease, all growers should implement routine inspection of delivered trees (pre-plant) and high standards of orchard hygiene.

OTHER HOSTS

Stone fruit, especially plums, apricots, peaches and nectarines are susceptible to Xap. Those cultivars bred in areas not prone to this disease (i.e. California) have not been selected or tested for resistance to bacterial spot, and are generally susceptible. Some cultivars are highly susceptible while others exhibit varying degrees of tolerance.

The disease is found now in all stone fruit districts of Australia and almonds planted nearby should therefore be considered 'at risk', when suitable environmental conditions present.

SYMPTOMS

Walk your orchard to monitor for this economically-important disease! Although affected trees can develop symptoms on leaves, twigs, young and fully developed nuts, from a distance tree vigour initially may not appear compromised. On close inspection severely-affected trees may have a majority of nuts and leaves with characteristic lesions. The symptoms of bacterial spot become more obvious as temperatures increase during the late spring and summer. The infection period however is predominantly in the spring and during periods of high moisture and mild-warm temperatures.

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Because of the similarity of bacterial spot symptoms with those of other almond diseases and copper phytotoxicity, a laboratory diagnosis is required to confirm the presence of Xap. Without correct identification of the cause, inappropriate management decisions may be made.

Leaves

Both young and old infected leaves exhibit leaf spot and tatter symptoms, but it is believed that most infection is initiated in the leaves while young. The lesions are generally clustered in the area of the leaf that stays wet longer – leaf tips, sheltered parts of the leaf blades, along the midrib. The lesions are circular, angular or irregularly-shaped, and reddish to dark in colour. As the lesions dry out, shotholes and leaf tatter result. These bacterial spot symptoms are easily confused with those caused by the fungal disease 'shothole' and also by copper phytotoxicity. Affected leaves, in each of these cases, may fall prematurely.

Nuts

Infected nuts develop corky lesions from which a lightly coloured-tan ooze and gum may stream or clump. The gum contains bacteria. Small lesions on nuts may be confused with insect injury sites. The larger bacterial spot lesions that are sunken and surrounded by a grey-yellow area are also reminiscent of those caused by fungal pathogens. Infected nuts are often clustered within the canopy; some may fall prematurely. Others may remain as 'stick tights'. These mummies harbour viable bacteria and serve as a source of inoculum thereafter.

Twigs

Twig lesions have not been observed as commonly as the leaf and nut symptoms. The twig lesions on current season's wood are dark and elongated along the length of the twig, slightly depressed and often have a shiny, greasy appearance with a water-soaked margin. If the lesion expands it may girdle the twig and dieback will occur. In stone fruit, open cankers develop from these lesions on older wood but these are yet to be found on almonds.

DISEASE CYCLE

Introduction and Spread

It is most likely that bacterial spot will be introduced to an orchard in budwood or nursery trees, via wind-blown rain from neighbouring infected stone fruit or almonds, or on equipment.

Once present within an orchard, insects, birds, equipment, and irrigation (especially if overhead) may play a role in tree-to-tree spread of the bacteria. Infected leaves, nuts and mummies within the tree canopy or fallen, are sources from which bacteria may be splash distributed during rains and overhead irrigation.

Entry and Infection

Once present on susceptible tissue, the bacteria enter wounds or natural entry points, in a moisture film. These may be injury sites, pruning wounds, growth or frost cracks, leaf scars, axils, microscopic sites of wind, dust or sand abrasion or injury sites caused by hail or chemical sprays.

The rates of infection and disease development are dependent on environmental conditions. Moist conditions and warm temperatures promote disease development and proliferation of the bacteria. While late spring/summer rains frequently present perfect conditions for infection and disease development, the required humidity may also be induced by heavy dew, fogs, and irrigation. In the absence of conditions conducive to infection, the bacteria have the capacity to survive extended periods, in protected areas on the trees. During cold periods and

dormancy it is known that the bacteria may persist in mummies and in protected sites like buds, axils, and twig lesions. The over-wintering or survival sites are not necessarily symptomatic.

CONTROL AND MANAGEMENT

Accurate identification of the causal organism is important in determining the correct management strategies. Bacterial diseases are difficult to control and therefore maximum efforts should be made to avoid introduction of the causal bacteria.

Avoidance

- Check the source of budwood used by nursery, for symptoms of disease.
- Check nursery growing conditions and treatment program for bacterial spot.
- Purchase nursery stock grown in less bacterial spot-prone areas and in heavier soil.
- Check all in-coming trees of susceptible varieties for cankers and lesions.
- Minimise plantings of NePlus and Fritz.
- Avoid overhead irrigation of susceptible cultivars. Overhead irrigation provides both a means of spread for the bacteria, and induces conditions favourable for disease development. Orchards using high frequency drip irrigation may also see higher levels of disease incidence as a result of higher humidity associated with constantly moist soil.
- Avoid planting susceptible cultivars in exposed or windy sites, especially if soil is light.
- Avoid planting stone fruit alongside almonds, or almonds alongside an existing stone fruit orchard.

Protection

- Establish wind breaks
- Practice excellent orchard hygiene
  - Remove fallen fruit, prunings
  - Remove mummies during dormancy
  - Harvest least susceptible trees first
  - Clean all equipment
- Practice good frost control
- Avoid tree, leaf and nut injuries
- Do not prune or tree train during wet weather
- Prune such that air flow through canopies is enhanced
- Do not cross-use equipment for both almonds and infected stone fruit
- Implement a chemical program that includes early copper (see below)

If ***X. arboricola pv pruni*** is **present in your orchard** then strategies to reduce its rate of spread and disease development must be employed. This disease is difficult to manage because;

1. susceptible varieties are present in many orchards;
2. stone fruit are often planted near almonds; and

3. available bactericides are limited and efficacy is highly dependent upon multiple, appropriately-timed applications.

An integrated management scheme includes the planting of 'resistant' varieties, the application of bactericides, injury minimisation, minimisation of the duration of orchard conditions conducive to disease development, stress reduction in trees through nutrition and water management.

Chemicals

There has been limited trialling of spray programmes specifically for bacterial spot control in almonds, and therefore chemical recommendations for almonds are principally those that have been proven effective in stone fruit.

Copper is one of very few available and registered chemicals with proven efficacy against a range of bacteria. Some antibiotics are effective on some bacteria, but they are not registered for use in Australia and are unlikely to be.

Even in orchards without a bacterial spot history, apply copper:

- to protect leaf scars in late autumn; then
- during late dormancy - just before budswell

Continue copper applications on *susceptible varieties,* especially in orchards with a disease history. Ensure all new tissue is protected during conditions conducive to spread and disease development. Apply copper:

- at pink bud
- at bloom (combine with fungicides for shothole, brown rot control), and
- before (within 7 days) each spring-early summer rain event*****

*** Copper is potentially phytotoxic.** Leaf spotting and premature leaf fall may occur as a result of excessive rates of application and late applications of copper. If copper use is required after late October, reduce the applied rates. Consult with applicators and copper manufacturers before applying copper.

About Copper

- Copper is not very soluble. Crystals of fixed copper (copper hydroxide, copper oxychloride, cuprous oxide, tribasic copper sulphate) dissolve slowly in contact with moisture on the leaf, thereby releasing the free copper ions. These effectively disrupt the functioning of bacterial and some fungal cells.
- Chelated coppers have a higher potential for phytotoxicity. Copper phytotoxicity results in leaf spotting and premature leaf fall. Cupric hydroxide is less phytotoxic, but also less persistent.
- Copper is not systemic and it is therefore essential that it is applied uniformly over the entire area to be protected. The efficacy of copper sprays is dependent on several variables: Timing, formulation, coverage, particle size and surface area.
- Copper should not be applied in a solution of pH 6.5 or less. No do not apply copper with lime.
- Adding mancozeb to copper applications has enhanced the copper efficacy in some trials with older formulations of copper.

- New formulations of copper offer higher levels of bio-available copper and reduced levels of metallic copper which can accumulate and contaminate soils.

Bacterial spot management requires multiple applications of copper, starting early in the season: early budswell, pink bud, prior to (within 7 days) rain events throughout the spring. Cease applications when weather becomes warm and dry.

Bacterial spot is manageable but it demands **wide-ranging** and **consistent effort.** If other diseases, cultural practices, irrigation or nutrition are poorly managed, bacterial spot will, in turn, be more difficult to manage.