Blueberry rust management guide

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- Monitor weather conditions to identify potential infection events
- Optimise the spray timing by evaluating the prevailing of environmental conditions and blueberry physiology for infection potential
- Monitor temperature, rainfall, relative humidity and leaf wetness
- When spray is needed, spray as soon as practical after the occurrence of conducive conditions or infection event

Blueberry rust thrives in warm, wet conditions, especially when there are extended periods of leaf wetness and susceptible host tissue is present. The disease is caused by the fungus *Thekopsora minima*. The fungus primarily infects leaves, causing a reduction in plant vigour and fruit set. When fruit is infected, marketability can be affected.

Management of blueberry rust requires an integrated approach, including scouting of orchards to detect early infections, monitoring of weather to identify conditions conducive to the infection and development of disease symptoms, cultural measures and targeted application of fungicidal sprays.

Symptoms

Although rust symptoms are most obvious on leaves when red-brown lesions are visible on the upper surface, and corresponding yellow pustules can be seen on the corresponding lower surface, infection takes place much earlier.

Leaves

Rust first appears as small pale-bright yellow lesions on the upper surface of infected leaves (Figures 1a, 1b). On the underside of the leaf, the fungus erupts through the surface and small pustules containing spores form (Figures 2a, 2b). As the disease progresses, the lesions become red to brown in colour and may increase in size, coalescing when disease is severe. The spores are powdery when touched, and when there are many, they may be seen to float with air currents or wind. The infected tissue within the lesion becomes darker as it dies, reducing the photosynthetic capacity of the leaf. When disease pressure is high, defoliation may occur.

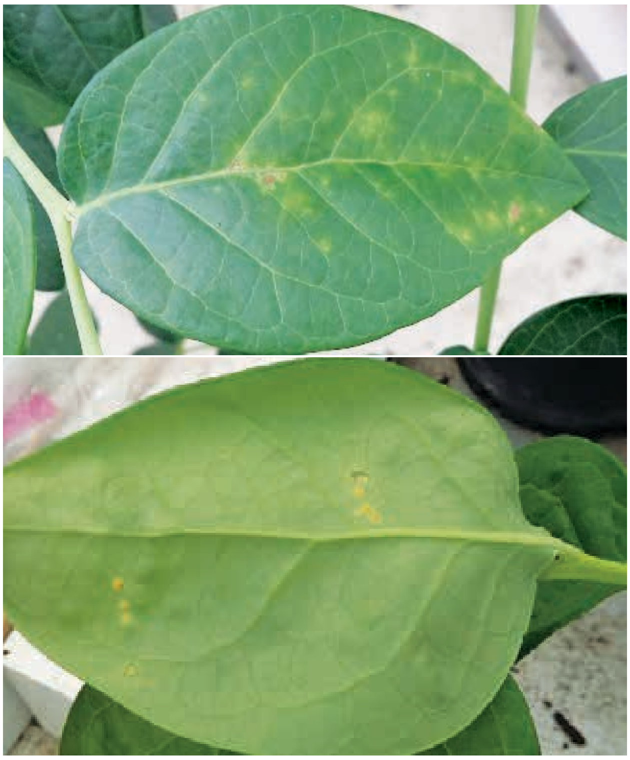

Figure 1a and 1b. Rust first appears as small pale-bright yellow lesions on the upper surface of infected leaves. Photo credit: Rosalie Daniel

Figures 2a and 2b. On the underside of the leaf, the fungus erupts through the surface and small pustules containing spores form. Photo credit: 2a Melinda Simpson, 2b Rosalie Daniel.

Shoots

Lesions containing spores have been observed on twigs and Thekopsora minima DNA has been extracted from these twigs. It is likely that infected shoots play a role in the survival of the fungus.

Fruit

Lesions develop on ripening fruit when disease pressure is high. Rust lesions can reduce the marketability of ripe berries. It is likely that infection takes place during flowering. Fungal DNA corresponding to *T. minima* has been detected in flowers and ripening asymptomatic fruit. The infection process needs to be confirmed microscopically.

Diagnosis

Early diagnosis is the key to effective management. It allows diseases to be treated early and minimises the potential for inoculum build up. The first symptoms due to blueberry rust are small pale-yellow spots that develop on the upper leaf surface (Figure 1a).

To confirm the symptoms are due to blueberry rust, turn the leaf over and look for yellow spores. The presence of powdery yellow pustules on the corresponding lower surface are characteristic of blueberry rust (Figures 2a and 2b).

Disease cycle

Survival

The blueberry rust fungus survives primarily in infected leaves that remain on the plant after pruning. In the evergreen system, where leaves are continuously present on the plant, DNA analysis has shown that asymptomatic leaves can be infected with *Thekopsora minima* throughout the year. When conditions become conducive (warm, moist) the fungus is stimulated to form pustules and sporulate to re-infect.

Infected leaf debris on the orchard floor is unlikely to be a major source of inoculum as spore survival is generally less than six weeks, depending on agronomic and environmental factors practiced in the orchard. Sporulation could be initiated from infected leaves two weeks after leaves were placed on the orchard floor, but after this, too many other fungi were present on the leaves to effectively distinguish the rust fungus. DNA could not be detected in infected leaf samples placed on the orchard floor after six weeks.

First infection

The rust fungus, Thekopsora minima, is biotrophic. That means it will only infect living plant tissues. Spores require moisture for germination and infection. Infection can begin at any plant growth stage from when the leaves first emerge if moisture is present on the leaves. Younger leaves are more susceptible. Older leaves are more difficult for the fungus to penetrate as the cuticle becomes thicker.

Latent period

Following infection, the fungus colonises the leaf. The period of time between infection and the appearance of symptoms is known as the latent period. The length of the latent period is largely dependent on temperature but is generally between 10 and 21 days. At 20°C pustules begin to appear on infected leaves after 10 days. After this time, the small yellow lesions appear on the upper surface of the leaf, wherever infection has taken place.

Spread

Spores produced in pustules on leaves are the main infective propagule of blueberry rust in the evergreen production system practiced in coastal northern NSW. They can be present in the air all year (Figure 3).

Rain, water-splash, air currents, insects and humans can spread spores to infect new plant tissues. Pustules will continue to develop and spores will be released as long as conditions are favourable, and many cycles of infection can occur in a given production season.

The disease cycle continues as long as conditions are favourable (warm, moist) and susceptible foliage is available to infect. Initially only a few pustules may be present, but as the season progresses, if control measures are not adequate, then rust urediniospore numbers can increase significantly, and the rust spreads throughout the orchard.

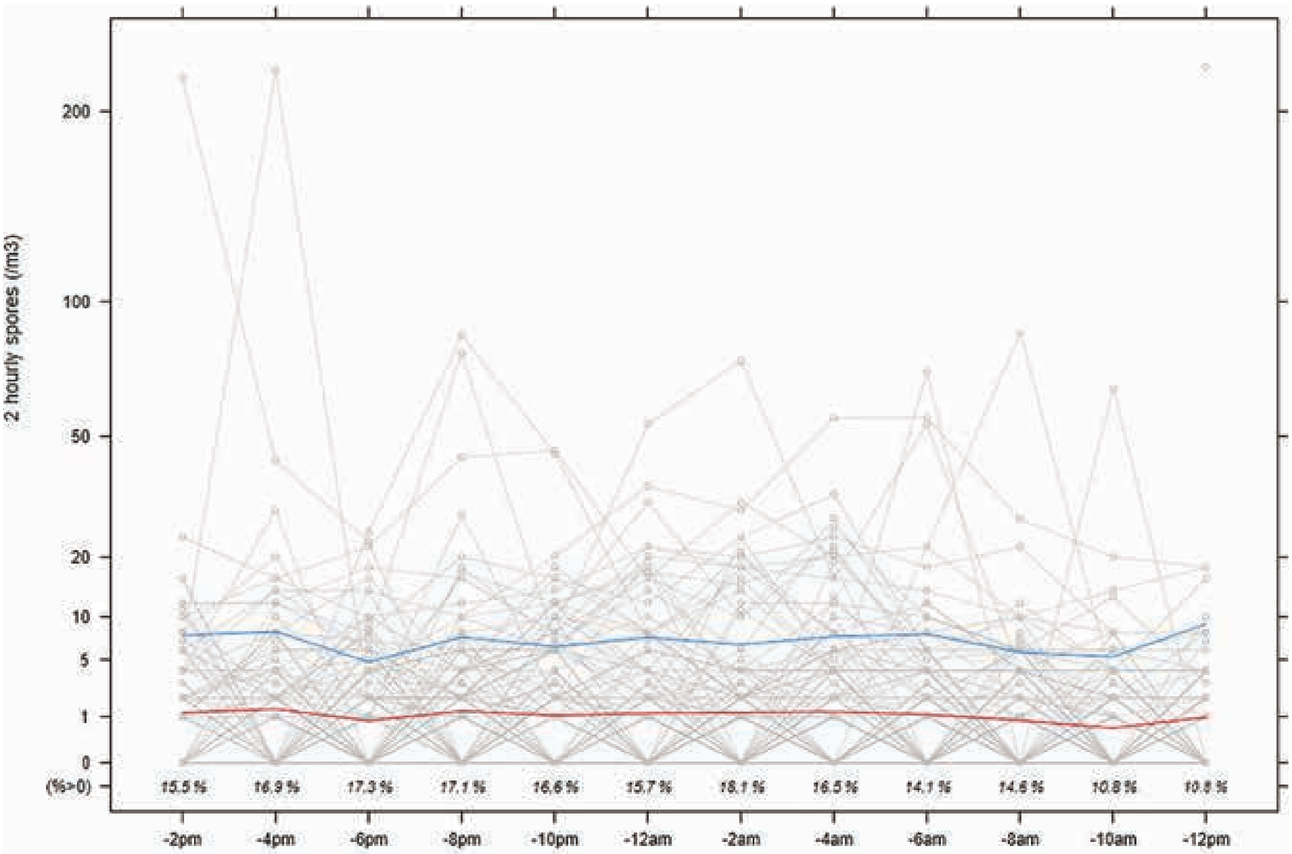

Figure 3. Spore count versus hour for 2016-17 with the proportion of occasions where spores were observed (base of the plot, just above x-axis) as well as the mean spore count when spores were observed (blue line) by two-hour period, and the overall mean spore count (including zeros) (red line). Source: Rosalie Daniel

Favourable conditions

Infection

Rainfall or moisture for leaf wetness along with warm temperatures are required for infection to take place. Spores of *Thekopsora minima* germinate at temperatures between 5 and 30°C under 100% relative humidity, but optimum growth occurs at 15-25°C.

Incubation period

Blueberry rust requires at least 7 hours of leaf wetness to infect at 24°C.

Spread

Factors affecting the rate of spread of blueberry rust through an area are the initial inoculum load (i.e. the number of spores present at the start of the season, or after pruning), the frequency and length of rain events, factors affecting leaf wetness, the prevailing temperature and the susceptibility of the cultivar in the orchard.

A higher initial inoculum load means there are more spores present in the beginning that can infect, causing new pustules to form, and produce more spores.

Where highly susceptible cultivars are grown, the likelihood of successful infections, and production of spore-containing pustules is greater.

Managing the disease

The most important factors in managing blueberry rust are:

- Implement Biosecure Best Practices: "Come Clean, Go Clean".
- Source clean, disease free planting material when establishing new blocks or orchards. Be aware that fungicides can mask symptoms.
- Minimise or eliminate inoculum carry over from season to season, for example when pruning, remove infected plant parts. By reducing the carry-over of inoculum, there is less inoculum to start new epidemics the following production season.
- Prune to open the canopy. This will promote ventilation and more rapid drying of the foliage, reducing the length of time that leaves remain wet and conditions favourable for rust infection. Opening the canopy can also assist in improving contact and penetration of fungicides.

Spray Management options

Fungicides should be regarded as one component of the arsenal available for an integrated approach to disease management. They protect a potential yield that may be realised in the absence of disease. Securing effective disease control from fungicide applications is dependent upon prevailing environmental conditions, disease pressure and the effectiveness of the fungicide to control that disease. Understanding the pathogen, environmental conditions and host susceptibility is essential to establishing a targeted and effective spray program.

Fungicide selection

Selection of the fungicide to suit the timing of disease events is important.

Protectant fungicides

Protectant fungicides act on the surface to protect the plant from infection. These fungicides do not move to cover new leaf and shoot growth. They should be applied as close as possible prior to an infection event. There is some evidence to suggest that application just after a rainfall event is more effective (Friskop et al. 2015; Zambolim 2016). Examples of these fungicides that are currently permitted for use in blueberry are mancozeb (APVMA PER13958), chlorothalonil (APVMA PER14309), Copper (APVMA PER84176) and dithianon (APVMA PER82601).

Curative fungicides

These fungicides are trans-laminar, meaning that they are absorbed by the foliage and can, to varying degrees, move across the leaf, and maim or kill the rust fungus inside the foliage. Because they are absorbed into the plant tissue, these fungicides are also rain-fast to a certain degree. They do not move systemically through the plant. Because many curative fungicides also have some protective properties, they are best applied as close to an infection event as possible. Examples of these fungicides that are permitted for use in blueberry production include the DMIs propiconazole (Tilt®; APVMA PER1470). The QoI fungicides (FRAC 11) have curative and translaminar activity. They have been reported to kill germinating spores (Buck et al. 2003). Pristine® (APVMA PER82986) contains the QoI pyroclostrobin, and the SDHI (FRAC 7) boscalid.
The SDHI fungicides can also be translaminar, inhibit spore germination, mycelial growth and sporulation.