



Crown gall in Australian vineyards



Background

Crown gall disease is a significant global problem of horticultural and agricultural crops, including grapevines, mainly caused by two bacterial genera: *Agrobacterium* and *Allorhizobium*, both of which belong to the *Rhizobiaceae* family. These gram-negative, motile, rod-shaped bacteria do not form spores and are closely related to the nitrogen-fixing *Rhizobium* bacteria. Globally, 90% of grapevine crown gall is caused by *Allorhizobium vitis* and the remaining 10% by *Agrobacterium spp*. Historically, in Australian vineyards the main causal organism of crown gall disease has been *Allorhizobium vitis* (previously known as *Agrobacterium vitis*).

Allorhizobium vitis (*All. vitis*) typically exhibits a narrow host range, primarily infecting *Vitis vinifera*, whereas *Agrobacterium* species can infect more than 140 species of dicotyledons, including pome fruit, stone fruit and nut trees. While the most severe outbreaks of crown gall on grapevines have been documented in cooler climate regions, occurrences of the disease have also been reported in Mediterranean regions (Burr et al. 1998).

Agrobacterium and *Allorhizobium* species are commonly found in soils and water worldwide, where they survive independent of a host. However, when found in plants, they can either be pathogenic (causing disease) or non-pathogenic. Pathogenicity is linked to important virulence genes on a tumour-inducing plasmid (Ti plasmid), which is only present in pathogenic *Agrobacterium* and *Allorhizobium* strains.

This fact sheet provides information about the cause, symptoms and disease cycle of crown gall. A second fact sheet 'Crown gall disease: risk factors and management' provides additional information on management practices and risk factors.



Fact Sheet

Classification of Agrobacterium, Allorhizobium and Rhizobium

Historically, the classification of *Agrobacterium* was based on symptoms in host tree and crop plants. Strains causing crop galls were classified as *Agrobacterium tumefaciens*, and those causing hairy roots as *Agrobacterium rhizogenes*. However, the bacterium classification has changed over time with the accumulation of more molecular data.

Agrobacterium species were divided into three biovars (biovar 1, 2, and 3), based on physiological and biochemical analyses. Biovar 2 was later reclassified as a genus in *Rhizobium* spp. and *Agrobacterium vitis* (biovar 3) was reclassified as *Allorhizobium vitis* (*All. vitis*) (Ophel and Kerr 1990). Biovar 1 is a complex of *Agrobacterium* species, including *A. tumefaciens;* biovar 2 is a complex of *Rhizobium* species, including *R. radiobacter;* and biovar 3 is a complex of *Allorhizobium* species of which only a small number have a Ti plasmid and are therefore pathogenic (e.g. *All. vitis K309*) (Figure 1).



Figure 1. Taxonomic classification of bacteria in the Rhizobiaceae family



Fact Sheet

Symptoms

The most distinct characteristic of grapevine crown gall disease is the formation of galls on the crown of vines, where the main roots join the trunk, and also on roots. Galls may also form on the trunk above the soil line or on shoots and canes. Beyond the presence of galls, the disease may not cause any other visible symptoms. Galls tend to evolve from fleshy, white tissue to dry, cork-like structures over time. Peeling and cracking of bark, as well as a gradual decline in vine vigour due to girdling and root necrosis, may occur as the disease progresses. Young vines are especially susceptible, as galls can impede water and nutrient flow, potentially resulting in vine death in severe cases. Aerial root formation has also been associated with crown gall disease. Frost injury causing cracking of the bark can lead to small tumours forming in a line along the cracks.



Figure 2. Crown gall-like symptoms on young vine



Figure 3. Crown gall-like symptoms on young vine. Note the reddening of the leaves in response to girdling.



Figure 4. Crown gall-like symptoms on a young vine. Note the cracking and peeling of bark.



Figure 5. Crown gall-like symptoms on a young vine. Note the cracking and peeling of bark and gall formation.





Symptoms of crown gall disease can sometimes be mistaken for those of vine strangulation (Figure 6) and root knot nematodes (Figure 7) as well as overactive callusing or graft incompatibility swelling.



Figure 6. Young vine with tightly tied string around trunk causing 'strangulation'.



Figure 7. Grapevine roots with root knot nematode (Reproduced from State of New South Wales. Department of Primary Industries NSW (2013) licensed under CC BY 4.0).

Disease cycle

The disease cycle for *Agrobacterium* and *Allorhizobium* species encompasses several stages: an initial wound to a host plant, integration of the bacterial T-DNA into the plant cell genome, and eventually gall formation.

Potential sources of pathogenic bacteria in vineyards include infected planting material, soil and plant debris (Krimi et al. 2002, Burr et al. 1995, Dodds and Fearnley 2023). The bacteria can spread from infected vines (symptomatic or asymptomatic) to healthy vines via pruning equipment and tools and through the movement of infected soil (Dodds and Fearnley 2023). Irrigation, rainfall and flooding may further aid the dissemination of the bacteria and they can also survive on the roots of vineyard weeds or the remnants of previous crops (including the roots of previously planted vines) (Burr et al. 1995, Dodds and Fearnley 2023, Smith 2019). The bacteria may also spread during the grafting process via contaminated tools, water or soil/media. Importantly, both asymptomatic and symptomatic vines can carry pathogenic bacteria and act as the source of new infections (Dodds and Fearnley 2023).

In established vines, spread may be caused by pruning with contaminated secateurs or through wounds to roots (e.g. by soil-dwelling insects like nematodes, mechanical damage or from waterlogging). In already affected vines, galls can develop in any part of the vine from new wounds





caused by mechanical damage, hail, pruning and frost (Burr et al. 1995, Dodds and Fearnley 2023, Smith 2019).

What to do if you observe crown gall-like symptoms

- Photograph, record and tag the location of affected vines
- For new vine plantings, contact your nursery supplier and the Vine Industry Nursery Association (VINA)
- Contact the AWRI helpdesk on <u>helpdesk@awri.com.au</u> or 08 8313 6600 for advice.

Testing and identification

Diagnostic techniques using polymerase chain reaction (PCR) are currently available to identify *All. vitis,* which is known to cause crown gall in cases where the Ti plasmid is present. Laboratories can also detect the presence of *Agrobacterium* species, but are currently unable to confirm if the strains are pathogenic. This means that a sample submitted could be positive for *Agrobacterium* or *All. vitis* but this does not necessarily indicate the presence of crown gall disease or future risk.

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Resources and references

An extensive list of resources on crown gall is available in the AWRI's crown gall information pack.

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