

Grapevine Crown Gall

Disease Management White Paper



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Grapevine crown gall is a truly complex disease, without any immediate cures for affected vineyards. Understanding the basic biology of the bacterial causal agent, what triggers gall development, how plants get infected and how to manage the disease, are all critical in maintaining the viability and profitability of a vineyard.

What exactly is crown gall?

Caused by the bacterium *Agrobacterium vitis*, this disease is akin to “plant cancer”, where the bacterium hijacks the plant’s cellular-level machinery and manipulates it to serve its own growth and development. The bacterium is actually genetically altering the plant host by inserting two specific pieces of bacterial DNA (Ti plasmid, for “tumor-inducing”; and a plasmid for tartrate utilization), into the host DNA. This results in uncontrolled callus development (“galls”; **Fig. 1**), which is the namesake of the disease. From the bacterium standpoint, this gall formation serves a very specific purpose: (i) it causes infected cells to produce plant hormones (auxin and cytokinin) which

stimulate callus/gall development and the production of more genetically altered plant cells; and (ii) these modified cells create opines, which serve as bacterial-specific carbon and nitrogen sources for development.

Agrobacterium vitis establishes and induces initial gall formation in the grape cambium. When gall formation is induced, it disrupts the vasculature, and thus water and nutrient flow, to other parts of the plant. Common early symptoms of crown gall include a wilting and yellowing of the canopy (**Fig. 2**), stunted shoot growth, and cluster desiccation (**Fig. 3**). On vines trained to a single trunk, the whole plant can collapse; on vines trained to two or more trunks, typically only the associated canopy with a particularly infected trunk will collapse (**Fig. 4**).

How do plants get infected?

Infection commonly occurs via two routes: (i) *A. vitis* residing in the soil on root debris can directly cause lesions on developing roots and infect the plant through those wounds; or (ii) the bacterium can enter through other wounds, such as grafting wounds, mechanical or cold damage, or pruning/cutting wounds (**Fig.**



Figure 2- Because the galls are developing from the cambium, they disrupt water and nutrient flow to the rest of the plant. This can manifest itself as a collapsing canopy.



Figure 1- Gall development, or uncontrolled undifferentiated cell division, is characteristic of grapevine crown gall.

5). For the latter, infested soil, water, or tools are the potential carriers of the bacterium to the wound location.

After initial infection, bacteria will survive systemically in xylem vessels of the plant. During spring sap flow, *A. vitis* can be detected in the bleeding sap even if galls are not readily apparent on the plant.

Grapevine cuttings are prone to infection. The combination of multiple wound sites (for root-induction), close proximity to other plants (bundles), shared water sources, and ideal conditions for callus development greatly increase the risk of infection and gall development. Unless propagation bed media is routinely sterilized, clean water is circulated, and certified clean cuttings are propagated, the risk for potential crown gall outbreaks is high. Since the bacterium can also survive in the soil on root debris, planting rooted cuttings in fields where previously infected plant material was grown also greatly



Figure 3- Another sign of a collapsing canopy as a result of crown gall infection is desiccation of clusters near véraison.

increases the risk of infection. Root debris should be thoroughly managed in propagation fields, and removed in the case of vineyard renewal, or long-term rotation should be practiced to avoid cross-contamination.

What triggers gall formation?

When plants are wounded, the immediate response is to repair the site. Callus tissue will develop, and these dividing cells are easy for *A. vitis* to infect. Sugars and phenolics that are released from wounds attract the bacterium; they also cause the bacterium to express the genes necessary for infection.

How do you manage crown gall?

Chemical control: There are currently no truly effective chemical options for controlling crown gall in the field. While topical antibiotics and compounds such as copper can kill bacteria in small surface galls, they are not effective against bacteria that are systemically established in the vine. There is some preliminary work on co-infection with non-tumorigenic strains of *A. vitis*, but long-term effectiveness are not known.



Figure 4- In multiple trunk systems, symptom expression is often limited to one side of the vine, or associated with only one of the trunks.

Multiple trunk systems: Using multiple trunks in a bilateral cordon or cane system allows for trunk replacement if an outbreak occurs without losing an entire vine. It is also a good practice for areas prone to cold damage. In many cases, shoots retrained from below the gall will remain symptom-free until a wound event occurs.

Replacement vines: If dieback is severe, entire vine replacement may be warranted. However, *A. vitis* can survive on root debris, and reinfection is likely to occur unless root debris is removed.

How do you prevent crown gall?

Clean plant material: When an outbreak of crown gall is on the scale of an entire vineyard, and is at a location that has not had issues in the past, this generally indicates that infected planting material was used. Clean material is the first line of defense. Shoot-tip propagation of vines is currently the best way to increase the likelihood of clean propagation material. If propagating your own plant material (typically not recommended unless you are also working closely with state authorities to certify your material), cleanliness is of the utmost importance. Sterilization of propagation bed media is recommended if crown gall has been a problem in the past. In addition, a hot-water treatment (122-125.6°F for 30-60 minutes) has been shown to reduce *A. vitis* in cuttings. This treatment should only be done on fully dormant cuttings, otherwise bud damage can occur.

Site selection and cold protection: Gall formation is triggered in response to wound signals generated by the plant. Therefore, to reduce the likelihood of galling (the stage of infection that causes long-term consequences), use practices that help to mitigate damage, particularly cold damage. These include: choosing a vineyard location where rapid temperature changes in the fall and spring are not common, using irrigation to properly shut down vines for the winter while supplying sufficient moisture to insulate (but not saturate) the root system, and using wind machines when necessary to raise surface air temperature during winter temperature inversions.

Using resistant rootstocks: Using resis-

tant rootstocks may help in the case of root infection by *A. vitis*. Rootstocks such as Courderc 3309 and Mgt 101-14 are resistant. Rootstocks such as Richter 110 and Teleki 5C are considered susceptible. However, there are drawbacks to using rootstocks, especially in eastern WA and OR. Own-rooted vines allows viticulturists to retrain after severe winter cold damage. However, this may not be possible if vines are grafted. The cost of replanting after every damaging event vs. retraining needs to be carefully considered when considering the use of rootstocks for crown gall management.



Figure 5- Grafting wounds are common points of infection, and gall expression, for *A. vitis*.

Conclusions

The best means of managing crown gall is to avoid getting it. This can be done by planting certified clean materials, not planting directly into previously infested sites, and mitigating cold damage in vines. Once a vine has the bacterium, it is impossible to eradicate, and management will be a constant battle of slow vine decline.

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