Crown Gall
Agrobacterium tumefaciens

Hosts: The host range is extremely broad and various strains of the pathogen infect most if not all dicotyledonous plants. Some *Agrobacterium* spp. are host specific.

Disease common name: Crown gall (usually includes the common name of the host). Hairy root is caused by a closely related pathogen.

Pathogens: *Agrobacterium tumefaciens*, *Agrobacterium vitis*, and *Agrobacterium rhizogenes* (hairy root). There are tumorigenic and nontumorigenic strains in this group. Only the tumorigenic strains have a tumor-inducing Ti plasmid that transfer genes to the host plant and confer gall formation. The nontumorigenic strains are sometimes grouped together in the species *Agrobacterium radiobacter*. Syn.: *Rhizobium* spp.

Disease Cycle

Inoculum: The pathogen resides in soil presumably by colonizing the rhizospheres of plants and living as a saprophyte. Infected plants also are a major source of inoculum.

Transmission: The pathogen can be disseminated in plant debris, soil, water, plant propagation material, equipment, storage sheds, etc. The disease can be spread in nurseries or farms by practices such as budding, grafting, and planting.

Infection: Infection occurs when inoculum contacts wounds, natural (e.g., growth cracks) or caused by equipment, such as from plowing or pruning roots when planting and harvesting for the market. Bacteria multiply in wounds when moisture is present and the temperature is not extreme. Wounds must remain moist for several hours for infection to occur. Bacteria attach to plant cells and transfer a portion of the Ti plasmid, the tumor-inducing genes (T-DNA), to plant cells. This results in overexpression of plant hormones, which causes gall formation. Multiple galls on grape result from systemic infection by *Agrobacterium vitis*.

Symptoms and signs: Small, round hyperplasias or overgrowths are first seen on infected plants and may occur on roots, crowns, stems, and trunks. They usually occur close to the ground line, but in some cases, galls may be found considerable distances above the soil line. Galls, depending upon the host, may reach diameters of 13 cm or more. Older galls are brownish and frequently exhibit decayed regions as they enlarge. They may be somewhat spongy in texture with rough, knobby surfaces. The severity of crown gall on plant health depends on a number of factors, such as when the infection took place, the part of the host plant that was infected, and the number of infection sites. Stunting is a common symptom when young trees, such as walnuts, are heavily infected and more than 50% of the crown region is covered with galls. Later, such trees may blow over during strong winds. Also, fungi may enter the galls and infect the trees, causing additional problems. If only a few galls develop on roots, no apparent effect on tree vigor may be noticed. Figures 1–17 give a sample of the pathogen's wide host range. The extent of crown gall damage on grapes depends greatly on a number of factors, such as the site of the gall (trunk, root, or cane), when infection occurred (planting time or older plants), and region. In cold, humid areas, the disease can be devastating since freezes cause numerous galls to form on canes and trunks, often leading to death of the plants.

Survival: *Agrobacterium tumefaciens* survives in infected host tissue but also survives in rhizospheres of various plants and likely as a soil saprophyte. It is found in native soils and in cultivated areas. The disease is not common in warm areas of the tropics.

Disease Management

The most important control practices are sanitation, such as storing plants in clean facilities, and rotation of fields to prevent the buildup of inoculum. In nurseries, methods are adopted to minimize spread and infection by the pathogen. Biological control strains of *Agrobacterium radiobacter*, K-84 or K-1026, the latter being a genetically engineered strain of K-84, are frequently used to treat seeds and plants to be planted in nurseries and fields. The biocontrol strains multiply in the wounds and prevent gall formation if applied soon after a wound occurs. However, there are tumorigenic strains of *Agrobacterium* spp. that are not controlled by the biocontrol strains at prescribed concentrations. For control of some strains, experiments in field and greenhouse studies indicated that the ratio of cell density of the biocontrol agent to the pathogen were effective when the number of cells were around 1,000:1. Another practice is to treat galls on established trees with Gallex, a chemotherapeutant, which selectively penetrates and kills tumorous tissues. This treatment has little value for plants that are carrying the pathogen systemically. Plants and plant varieties vary in susceptibility to crown gall. For example, different clones of rootstocks of various trees, such as plum, cherry, and walnut, differ considerably in susceptibility.

References

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Figure 1. Severely infected, stunted root stock for almond (left) and healthy root stock (right). (Courtesy M. Schroth)

Figure 2. Zinfandel grape with gall at base of stem. (Courtesy M. Schroth)

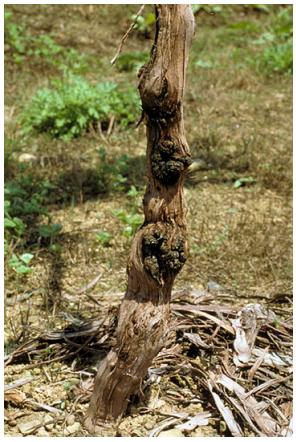

Figure 3. Systemically infected grape with multiple galls. (Courtesy H. Sawada/M. Goto)

Figure 4. Cherry with galls. (Courtesy H. Sawada/M. Goto)

Figure 5. Pear with galls. (Courtesy H. Sawada/M. Goto)

Figure 6. Apple with gall. (Courtesy H. Sawada/M. Goto)

Figure 7. Blackberry with galls. (Courtesy J. Young/D. Watson)

Figure 8. Forsythia with galls. (Courtesy M. Shurtleff)

Figure 9. Rose with galls. (Courtesy M. Goto)

Figure 10. Aspen with gall. (Courtesy S. Thompson)

Figure 11. California poppy with gall. (Courtesy M. Schroth)

Figure 12. Kiwi with gall. (Courtesy H. Sawada/M. Goto)

Figure 13. Dahlia with galls. (Courtesy M. Shurtleff)

Figure 14. Datura with leafy gall. (Courtesy M. Schroth)

Figure 15. Chrysanthemum with leafy galls. (Courtesy K. Ohata/M. Goto)

Figure 16. Euonymus with galls. (Courtesy L. Claflin)

Figure 17. Peach with gall. (Courtesy M. Schroth)