CROWN GALL

Harald Scherm
Department of Plant Pathology
University of Georgia
Athens, GA 30602

Crown gall is caused by *Agrobacterium tumefaciens* Smith & Townsend (Conn), a widespread soil bacterium in temperate regions of the world. This bacterium has one of the widest known host ranges among plant pathogens, having been reported on more than 140 genera of broadleaf plants. The disease can be very severe in stone fruit nurseries, but it is generally not a problem in established orchards unless infected nursery stock is planted.

SYMPTOMS

Crown gall is characterized by the development of tumorous overgrowths (galls) on roots, crowns, and occasionally trunks and scaffolds (Figure 1). These galls are initially soft and smooth, but they turn dark, hard, rough, and woody as they enlarge and age. Mature galls, which may reach more than 10 cm in diameter, often appear gnarled and fissured (Figure 2). Cracking allows secondary decay organisms to enter, leading to the breakdown of gall tissues. Such cracks also have been reported as entry sites for the fungi causing Armillaria root and crown rot.

Figure 1. A mature crown gall that has girdled and killed a first-leaf peach tree. Image by P. F. Bertrand.

Figure 2. An enlarged view of an active crown gall. Image by P. F. Bertrand.

On roots, young galls of *A. tumefaciens* may be confused with galling due to root-knot nematode infection. However, *A. tumefaciens* galls generally occur only on one side of the root, while those caused by root-knot nematodes encompass swelling of the root across its entire diameter.

If galling is limited to the root system, there may be no clear above-ground symptoms in mature trees. Symptoms are variable in *Prunus.* Infected peaches may appear stunted, while infected cherry trees will often reveal no consistent effects on growth.

DISEASE DEVELOPMENT

Pathogenic crown gall bacteria occur commonly in nursery soils and less frequently in orchard soils. The pathogen is able to survive in the soil for extended periods of time, even in the absence of a suitable host plant. Infection of the host invariably occurs at sites of natural or mechanical wounding. In stone fruit nurseries, such wounds are created during seed germination, during mechanical cultivation of nursery beds, and at harvest. In the orchard, natural growth cracks on roots and wounds generated during mechanical cultivation (such as disking or harrowing; practices now less commonly used by peach producers) can serve as entry points for the pathogen. Above-ground plant parts, such as crown or trunk tissues, become infected when crown gall bacteria are rain-splashed from the soil to wounds such as those caused by careless operation of farm equipment. Cells of *A. tumefaciens* attach to and release part of their genetic material into the wounded host cells. Incorporation of this genetic material prompts the affected host cells to proliferate in an uncontrolled fashion (not unlike a human tumor), leading to gall formation. The galls provide nutrients and physical protection for the pathogen. Individual galls may expand and persist for several years, after which the ingress of secondary decay organisms leads to their breakdown and the release of *A. tumefaciens* back into the soil.

CONTROL

Established orchards. In stone fruit, prevention is generally the only viable management option against the disease. Prevention involves the use of crown gall-free nursery stock from a reputable nursery. Carefully inspect nursery stock before planting and return the entire lot if symptomatic trees are found. Crown gall symptoms are generally well developed on finished nursery stock, making inspection a useful prevention strategy.

Paint application to galls of xylenol- and cresol-based products has been proposed as a therapeutic treatment for affected orchard trees. However, this procedure would only be feasible for above-ground galls, due to the cost associated with excavating and treating roots of established trees.

Nursery. As stated above, crown gall can be very problematic in stone fruit nurseries because affected nursery stock cannot be sold. Unfortunately, management options are limited. Crop rotation will be effective only if the land can be planted to non-hosts (such as grasses) for an extended period of time. Fumigation does not control crown gall because it does not completely eradicate *A. tumefaciens* from the soil, and bacteria in gall tissue are protected from the fumigant. Biological control of the disease by seed-application of non-pathogenic *A. radiobacter* strains K84 or K1026, a practice developed in Australia, has been used successfully in stone fruit nurseries worldwide, but this is not widely utilized in southern nurseries. This bacterium acts by producing an antibiotic that kills most pathogenic strains of *A. tumefaciens.* Heat treatment of root systems of dormant nursery trees at 18° to 25°C for one to three weeks has been shown to reduce crown gall incidence on affected roots. With this practice, the root-heating boxes are maintained in a cold room at 2° to 4°C to prevent bud break of the dormant trees.

Resistance breeding is a long-term strategy for managing the disease. Development of crown gall resistance in *Prunus* rootstocks currently is only a secondary objective behind more pressing root disease problems such as peach tree short life, Armillaria root and crown rot, and nematodes. Furthermore, with the exception of *P. mahaleb* (Mahaleb cherry), the incidence of useful crown gall resistance in *Prunus* accessions is very low.

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