

# CROWN GALL OF WOODY PLANTS

## Rising concerns of crown gall in woody nursery production systems

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Crown gall on rose

Crown gall remains a significant challenge for the nursery industry, affecting more than 90 plant families worldwide. Infected plants may grow poorly and die prematurely. The unsightly appearance of crown gall is especially important in nursery operations, where affected plants are often discarded, resulting in significant economic losses.

In Tennessee, crown gall was observed on apples, arborvitae, blueberries, crabapples, dogwoods, incense cedar, maples, peaches, redbuds, and roses.

### What causes crown gall disease

*Agrobacterium tumefaciens*, known as *Rhizobium radiobacter*, is a Gram-negative rod-shaped bacterium found in soil. It causes crown gall disease, characterized by tumor-like growths mostly on trees and shrubs. It damages the plant's vascular system, making it difficult to transport nutrients and water, which ultimately kills the plant. The pathogen enters the host through any injury site, and its DNA (deoxyribonucleic acid) is then integrated into the plant genome. These galls are the result of uncontrolled cell division in plant tissues induced by the pathogen.

### Symptoms

Crown gall is characterized by the formation of abnormal, tumor-like growths (galls) that typically develop at the crown (soil line), on roots, and on lower stems of trees and other woody plants (Figure 1). Young galls are

### Important facts

**Causal agent:** *Agrobacterium tumefaciens*

**Symptom:** Gall

**Infection method:** The bacteria enter through wounds on the roots, crowns, or stems.

**Mechanism:** The bacteria inject a plasmid into the plant cells, causing genetic transformation and abnormal growth.

**Environmental Factors:** The bacteria survive in the soil for years and spread via contaminated water, soil, or infected nursery stock.

soft, spongy, and light-colored, but they become hard, rough, and dark brown to black as they age. Gall size can range from small swellings to large masses that may partially or completely girdle stems or roots. As galls enlarge, they interfere with water and nutrient movement, resulting in reduced plant vigor, stunted growth, increased susceptibility to drought and winter injury, and, in severe cases, plant decline or death. Aboveground symptoms may be minimal, particularly in mature plants, allowing infected nursery stock to remain undetected until plants are removed from containers or soil.



Figure 1. Galls formed on the crown (soil line) in incense cedar (a) and red maple (b), and roots of redbud (c) and flowering dogwood (d).

## How the pathogen infects the host plant

The infection process occurs in four distinct phases: 1) injury to host plants; 2) bacterial cells attach to the surface of host plant cells; 3) the bacterium replicates rapidly, forming the tumor-like gall inducing plasmid (Ti-plasmid) into the host's plant cells; and 4) the bacterial Ti plasmid integration into the host

cell genome and the normal plant cells are altered. The bacterial Ti-plasmid replicates and forms the gall structure.

## How the pathogen survives and spreads

The bacterium infects plants only through fresh wounds caused by pruning, grafting, transplanting, mechanical injury, freezing damage, or insect activity. After entering the plant, the bacterium reach high population levels within developing galls, particularly near the outer tissue, which can break down and contaminate the surrounding soil. The pathogen can persist for many years in soil and infected plant tissue. It survives between growing seasons in infected plant tissue or in soil and is most often introduced to new planting sites via infected nursery stock. When contaminated soil, water or plant material contacts wounds on susceptible host, new infections can occur and the disease cycle continues.

## Host plants

The disease infects more than 600 plant species and is considered one of the most serious plant diseases worldwide, affecting a wide range of crops. Susceptible shrubs and woody plants of economic importance include: almond, apple, apricot, birch, blackberry, citrus, cherry, clematis, ficus, grape, hydrangea, incense cedar, lilac, macadamia, maple, olive, peach, pear, plum, poplar, quince, raspberry, rhododendron, rose, sequoia, spindle tree, spruce, walnut, willow and wisteria. The frequency of *Agrobacterium* infection in shrubs/woody host plants can vary (Table 1).

## Environmental conditions

After the pathogen enters the host plant, the incubation period, which is the time between pathogen infection and symptom appearance, varies with plant age and environmental conditions, such as temperature and humidity. At 20-25°C, the incubation period

is 13-14 days; at 10-15°C, it is 27-28 days. Relative humidity of 80-90% favors infection. Favorable conditions for this disease to develop include wet, compact soils with a slightly alkaline pH, a moisture level of 25 to 50% (water-holding capacity), excess nitrogen fertilizers, an incomplete graft union, nematode and insect pest attacks, hail, and frost. *Agrobacterium tumefaciens* becomes dormant in winter and is most active in summer.

## Management strategies

Management of crown gall primarily relies on preventive cultural practices and biological control agents, with chemical control as a supplemental strategy. Best management strategies include:

- Start with crown gall-free plant material.
- Use clean, sterile potting or propagation media.
- Try to minimize wounds when pruning, borer insect pests, frost damage, and mechanical injury.
- Disinfect pruning and grafting tools. Some sanitizers/disinfectants such as quaternary ammonium compounds (**KleenGrow™**, **Lysol®**, **Green-Shield®**, **Simple Green Pro 5®**, **Physan 20™**, **benzalkonium chloride**), peroxygen compound (**Virkon™ S**), alcohol compound (**ethyl alcohol**), chlorine compound (**Clorox™**) and sodium salt compound (**sodium dodecyl sulfate**, **sodium cholate hydrate**) were reported to prevent the pathogen from spreading from plant to plant.
- Remove plants showing crown gall symptoms to prevent spread.
- Improve drainage and/or avoid wet, poorly drained soils.

Biological control products based on nonpathogenic *Agrobacterium* strains may reduce gall formation on some hosts but are preventative only and do not eliminate the pathogen. The biological control agents *Agrobacterium radiobacter* strain K84 and K1026 (**NOGALL®**) have been effective

on some crops when applied to protect fresh wounds, such as pruning cuts. These biological control agents can be applied as a pre-plant dip or to the trunk or graft union. Similarly, some chemicals, such as copper compounds, were used for pre-plant dip and/or on the trunk or graft union (Table 2). Products such as **GALLEX®** are intended to kill gall tissue, but their effectiveness varies by crop and growing conditions.

## Take home message

The wound serves as a “**gateway**” for the pathogen. It infects through wounds and cannot be cured once established. Therefore, avoid wounding plants, especially at or below the soil line.

**Pruning tools** may remain contaminated for extended periods, contributing to pathogen spread. Therefore, sanitizing tools and careful handling can greatly reduce plant-to-plant spread.

**Disease-free** planting material and clean soil or substrate are the foundation of control.

Biological and chemical products offer preventative benefits and are best when combined with **good cultural practices**.

Table 1. Frequency of *Agrobacterium* infection in shrubs/woody host plants.

High	Low	Occasional/Rare
<i>Euonymus</i> sp.	<i>Citrus</i> sp.	<i>Acer</i> sp.
<i>Juglans</i> sp.	<i>Clematis</i> sp.	<i>Betula</i> sp.
<i>Malus</i> sp.	<i>Cydonia</i> sp.	<i>Calocedrus</i> sp.
<i>Populus</i> sp.	<i>Ficus</i> sp.	<i>Hydrangea</i> sp.
<i>Prunus</i> sp.	<i>Macadamia</i> sp.	<i>Picea</i> sp.
<i>Rosa</i> sp.	<i>Olea</i> sp.	<i>Rhododendron</i> sp.
<i>Rubus</i> sp.	<i>Pyrus</i> sp.	<i>Sequoia</i> sp.
<i>Salix</i> sp.	<i>Ribes</i> sp.	<i>Vaccinium</i> sp.
<i>Vitis</i> sp.	<i>Rubus</i> sp.	
	<i>Syringa</i> sp.	
	<i>Wisteria</i> sp.	

Table 2. The list of biological and chemical products used as a pre-plant dip treatment for preventing *Agrobacterium tumefaciens* infection.

Treatment*	Application rate	Trade name	Manufacturer
<i>Agrobacterium radiobacter</i> strain K1026	0.623 g. L <sup>-1</sup>	Nogall®	Evergreen Growers Supply
<i>Agrobacterium radiobacter</i> strain 1	1.2 x 10 <sup>9</sup> CFU. mL <sup>-1</sup>	Galltrol A®	AgBioChem Inc.
<i>Agrobacterium radiobacter</i> strain 2	1.2 x 10 <sup>9</sup> CFU. mL <sup>-1</sup>	Galltrol A®	AgBioChem Inc.
Didecyl dimethyl ammonium chloride	4 mL. L <sup>-1</sup>	KleenGrow™	PACE 49
Copper octanoate	10 mL. L <sup>-1</sup>	Camelot® O	SePRO
Didecyl dimethyl ammonium chloride + copper octanoate	2 mL. L <sup>-1</sup> + 5 mL. L <sup>-1</sup>	KleenGrow™ Camelot® O	PACE 49 SePRO

\*The listed treatments were tested on the rose plant as a host of *Agrobacterium tumefaciens* (Oksel et al. 2024).

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### Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone’s responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

### Disclaimer

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