OKLAHOMA COOPERATIVE EXTENSION SERVICE EPP-7669

Crown Gall of Grape

Damon L. Smith
Assistant Professor/State Specialist
Horticultural Crops Pathology

Eric T. Stafne
Assistant Professor/State Specialist
Fruit and Nut Crops

The causal agent of grape crown gall was first identified in 1897 in Italy. In those investigations, a bacterium was identified as the infectious agent causing disease of the vines. Since this discovery, it has been demonstrated that crown gall of grape is caused predominately by the bacterium *Agrobacterium vitis.* However, *A. tumefaciens* (the predominant causal agent of crown gall of other crops) has also been isolated from galls on grape and is associated with the disease at a much lower frequency than *A. vitis.* Reports of grape crown gall have come from many parts of the world including China, Japan, South Africa, several European countries, the Middle East, and North and South America. In Oklahoma, crown gall is probably the second most significant disease of grape after black rot.

Symptoms of Disease

The most prevalent and identifiable symptom of *Agrobacterium* infection is the formation of galls. Galls typically form at points of injury or at graft unions near the soil surface (Figures 1 and 2). While many galls will form low on the vine near the soil surface (Figure 1), gall formation is possible on cordons or canes in the trellis (Figure 3). Infection by the bacterium results in the abnormal expansion and shape of the plants cells at the site or near the site of infection. Actively expanding galls will be comprised of white fleshy tissue (Figure 2). Older galls will become dry and cork-like, and depending on the age, can become brittle and flaky (Figure 3). Bark cracking and peeling may also be associated with gall development (Figure 3). Gall symptoms can progress slowly and result in reduced vine vigor. Eventually vine loss can occur due to girdling as a result of gall formation. In some cases gall formation can be quite rapid, causing complete girdling and loss of the vine in a short period of time. Aerial root formation has also been associated with crown gall disease.

Fig. 1. Gall symptom on a one-year-old grape vine.

Fig. 2. Somewhat fleshy gall symptom at a graft union of an older grape vine.

Fig. 3. Corky galls and cracking of bark on a cordon in the trellis.

Disease Cycle and Pathogen Survival

One of the most important characteristics of *A. vitis* is its ability to move and survive internally throughout the vine. Termed "systemic survival," this feature allows the bacterium to take advantage of injuries induced by freeze damage or other wounding, causing disease not only at the soil level, but also in the aerial parts of the plant canopy. In the spring, as sap begins to move into shoots from the roots, bacterial cells are transported throughout the plant. Bacteria can also be disseminated in apparently healthy cuttings. Vines can remain asymptomatic for several years until conditions favorable for disease development occur, such as wounding by freeze damage. Galls can also form at sites of disbudding, at the base of rooted cuttings, and at grafts. Galled vines will exhibit reduced vigor and yield. The bacterium also has the capability of causing death (necrosis) of roots and severe infections can kill entire vines. *A. vitis* can survive without living plants for several years on grape debris in the soil. As a result, eradication of the pathogen from an infested vineyard can be difficult. Research in Italy and New York has investigated *A. vitis* infestation in wild grape populations. In both studies, wild grape vines were not implicated in the maintenance of inoculum that resulted in the direct infection of commercial vineyards. Most inoculum originates from infested planting material or soil containing infested grape debris.

How does *A. vitis* infect grape vines?

While the infection process of *A. vitis* has not been studied in great detail, it is considered very similar to that of other *Agrobacterium species* such as *A. tumefaciens,* which causes crown gall on numerous plant species. Freezing and wounding are important in the infection process. Wounding not only provides a mode of entry (infection court) for the pathogen, but also results in the production of stress-induced compounds by the plant that attracts the bacterial cells to those sites. Once the bacterium has attached to the site of wounding, the infection process involves the transfer of a portion of the bacterial genetic material into the plant cell. After the transfer has taken place, the bacterial DNA is incorporated into one of the plant chromosomes. This 'genetic insertion' results in the stimulation of several processes by the plant cell that benefit the bacterium. First, they activate abnormal cell growth which results in the formation of galls. Second, the production of compounds used by the bacterial cells is induced in the plant cells.

Management of Grape Crown Gall

Planting stock management

Using cultivars resistant to crown gall is one of the best tools a grower can use to manage crown gall in a vineyard. Susceptibility to *A. vitis* varies among grape cultivars grown in Oklahoma. In general, *Vitis vinifera* varieties are very susceptible to crown gall while many American cultivars and French-American hybrids have some genetic resistance to the pathogen (Table 1). Research in other areas of the U.S. has demonstrated that grafting of susceptible scion to resistant rootstock significantly reduced the incidence of crown gall under field conditions. While not well understood, the apparent resistance in the susceptible scion may be a result of reduced survival of *A. vitis* in the resistant rootstock or the production of compounds by the rootstock that are inhibitory to the bacterium. For more information about choosing rootstocks adequate for Oklahoma production, consult OSU Cooperative Extension Fact Sheet HLA-6253 "Rootstocks for Grape Production."

Regardless of the scion or rootstock susceptibility, care should be taken to plant material free of the crown gall pathogen when establishing or replanting a vineyard. Hot water treatment of dormant cuttings has been used with limited success. While hot water at temperatures of approximately 50°C (122°F) can reduce the amount of bacteria in cuttings, all bacterial cells cannot be eliminated. Furthermore, damage

Table 1. Relative crown gall susceptibility ratings for various grape cultivars grown in Oklahoma[a].

Cultivar	*Type*	*Crown gall*[b]
Cynthiana	American	+
Marechal Foch	Hybrid	+
Concord	American	+
Traminette	Hybrid	++
Vignoles	Hybrid	++
Chardonel	Hybrid	++
Seyval Blanc	Hybrid	++
Chambourcin	Hybrid	++
Niagara	American	++
Chardonnay	Vinifera	+++
Merlot	Vinifera	+++
Gewurztraminer	Vinifera	+++
Pinot Gris	Vinifera	+++
Sauvignon Blanc	Vinifera	+++
Cabernet Franc	Vinifera	+++
Riesling	Vinifera	+++
Cabernet Sauvignon	Vinifera	+++

[a] Susceptibility ratings and cultivar were compiled from the "Midwest Commercial Small Fruit and Grape Spray guide, 2007" and OSU circular E-999, "Profiles and Challenges of the Emerging Oklahoma Grape Industry."

[b] + = slightly susceptible; ++ = moderately susceptible; +++ = highly susceptible

can occur to fully dormant cuttings if temperatures higher than 50°C (122°F) are used.

Shoot tip propagation has been used with some success to produce *A. vitis* free planting material. Researchers have been unable to detect the bacterium in green shoots. In New York, vines propagated from green shoot-tip cuttings remained free of crown gall under cold climate conditions even after 7 years of growth. This form of propagation may prove useful for Oklahoma producers looking to maintain their own high-quality disease free planting stock. An alternative is to purchase certified free stock. While using certified stock is considered a good management practice, be aware that the certification only means that the bacterium was not detected and there is no complete guarantee that stock will be completely free of bacterial cells.

Cultural Management

Cultural practices that result in limiting mechanical and freeze injury have proven most useful for managing this disease. Proper site selection is critical for new plantings. Avoid heavy soils in wet areas where frost is likely (low areas). Limiting exposure to the north is also desirable for cold-tender cultivars. Good sanitation practices when removing infected vines is critical. Care should be taken to remove as much of the plant root system as possible. The crown gall pathogen can be present at high levels in the root system of infested plants. Removing and destroying as much of the plant debris as possible will reduce the level of pathogen propagules in the soil. The success of management strategies such as leaving soil fallow for extended periods or planting non-hosts to rid vineyards of the bacterium will have varying success depending on the level of infestation. Care should be taken to limit soilborne nematode damage. Studies have shown that crown gall incidence was positively correlated with root-knot nematode damage. Growers should have soil in potential vineyard sites tested for root-knot nematode prior to planting. Areas with infestations of root-knot nematode should be avoided.

Chemical and Biological Management

While several chemical and biological control formulations are available for managing crown gall caused by *A. tumefaciens* in other crops, these formulations have proven ineffective in field trials for management of *A. vitis*-infected grape vines. No consistently reliable chemical or biological control methods have resulted in adequate control of *A. vitis*. However, research in the area of biological control is promising. Several antagonistic strains of *A. vitis* have been identified that do not produce galls and may have potential for use in the biological control of the grape crown gall pathogen. Their efficacy and commercial viability are currently under evaluation around the world.

Need more information?

For more information pertaining to growing grapes in Oklahoma or the status of the vineyard and winery business in Oklahoma consult the OSU circular E-999 "Profiles and Challenges of the Emerging Oklahoma Grape Industry" and the OSU grape and wine research and extension webpage at http://www.grapes.okstate.edu.

The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of $1.35 per copy. 0308

EPP-7669-4