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## G97-1327 Cedar-apple and Related Rusts of Apple and Ornamentals

Don Steinegger

University of Nebraska--Lincoln, [dsteinegger1@unl.edu](mailto:dsteinegger1@unl.edu)

Jane A. Christensen

*Strawberries are a favored fruit of home gardens. They have been adapted to a wide range of environmental conditions, but sometimes can be challenging to grow. Strawberry yields and fruit quality are influenced by interactions of environment, diseases, pests, and soil conditions.*

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# Cedar-apple and Related Rusts of Apple and Ornamentals

Discussion of complex inter-species disease life cycle in junipers and apple trees, description of symptoms, control measures, and lists of varieties of species resistant to cedar-apple rust and related rusts.

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*Jane A. Christensen, Extension Assistant, Plant Pathology*  
*Donald Steinegger, Extension horticulturist*

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Cedar-apple rust is a disease that causes substantial injury to apple and crabapple trees in Nebraska. The disease is caused by the fungus *Gymnosporangium juniperi-virginianae* and occurs wherever apples and junipers are grown in close proximity.

## Disease Cycle

*G. juniperi-virginianae* has a complex life cycle (*Figure 2*). Two hosts are required for the fungus to complete its life cycle. One set of hosts includes members of the rose family (apple) and the other set includes *Juniperus* species. Distinctly different spores and symptoms are produced on the deciduous and evergreen hosts. Spores produced on the rosaceous host infect only juniper plants and those originating on the evergreen host infect only rosaceous plants.



**Figure 1. Overall infection of cedar-apple rust. (33KB JPG)**

The first sign of the disease in spring is the production of orange gelatinous tendrils or "fingers" (teliohorns) on the juniper host (*Figure 2*). Spores (basidiospores) released from these "fingers" are blown to apple trees where they germinate and infect leaves, fruit and occasionally twigs. Spore production and release are favored by wet weather during May and June. Orange spots develop at the

point of infection on the rosaceous host. Pycniospores produced in these spots cross and produce hyphae (fungal strands) that grow through the leaf. As rust lesions mature, they produce spores (aeciospores) that are windblown back to the juniper host during mid to late summer. Gall formation at the point of infection does not become evident until July the next year. The galls increase in size until that October and become fully mature the next spring when they produce teliohorns under favorable weather conditions and start the cycle over again. Two years are required for the fungus to complete its life cycle.

### **Symptoms on *Juniperus* Hosts**

The most common alternate host of *G. juniperi-virginianae* in Nebraska is eastern redcedar (*J. virginiana*). Other susceptible hosts include Rocky Mountain juniper (*J. scopulorum*), creeping juniper (*J. horizontalis*) and common juniper (*J. communis*). Galls produced on these hosts are initially brownish green and corky (*Figure 2*). They vary in size from 1/8 inch to more than 2 inches in diameter.

As they mature, galls become reddish brown and their surface becomes dimpled, resembling a golf ball. The gelatinous tendrils extrude out of the dimples during wet weather (*Figure 2*). These tendrils may shrivel during dry weather but can expand again during and shortly after wet periods several times in the spring. Ultimately they dry out and harden into firm, woody structures. Once spent, the galls no longer produce the jelly-like fingers, although they may remain attached to the tree for several years. Infection of junipers rarely results in economic injury, but galls produced near twig tips may cause some dieback. In addition, small twigs may be killed if many galls are produced.

### **Symptoms on Apple and Other Rosaceous Hosts**

Cedar-apple rust causes the most injury, physical and economic, to its cultivated apple host. Other rosaceous hosts of *G. juniperi-virginianae* include crabapple and hawthorn. Symptoms on the upper leaf surface are yellowish-orange spots (*Figure 2*). The spots vary in size depending on the susceptibility of the host and may be bordered by a red band or chlorotic halo, a characteristic that is also dependent on host susceptibility. Small, dark brown spots (pycnia) develop within the spots as they mature. The fungus grows through the leaf and forms long (1/4 inch) tendrils (aecia) on the lower leaf surface directly below the orange spots (*Figure 2*). Aecia have a papery texture and contain rust-brown spores. Injury to the host occurs when extensive infection leads to premature defoliation. Repeated infection for several growing seasons will weaken the tree and may result in decreased productivity and death.

Fruit symptoms are similar to leaf symptoms. Infection occurs near the calyx (blossom) end and spots are yellowish orange (*Figure 2*). Rust spots are superficial, extending 1/4 inch or less into the flesh. Brown pycniospores are also produced on the fruit. Aecia are produced less frequently than on the leaves. Although infection sites are superficial, their presence may decrease fruit quality by causing a decrease in size, distortion or premature abortion from the tree.



*Spores blown to susceptible host in spring*

Gall with mature teliohorns on juniper (50KB JPG)

*First year of disease cycle*



Pycnia on upper apple, crabapple, hawthorn leaf surface (46KB JPG)



Fungus grows through apple, crabapple, hawthorn leaf to lower surface and forms aecia (46KB JPG)



Apple  
Crabapple  
Hawthorn



Rust lesion on apple, crabapple, hawthorn fruit (50KB JPG)



*Spores blown to juniper in late summer*



Infection of juniper. Gall requires 18 months to mature (34KB JPG)

*Spring of second year*



Gall with emerging teliohorns on juniper (37KB JPG)

Juniper

**Figure 2. Life cycle of cedar-apple rust.**

## Related Rusts

Two other rusts caused by *Gymnosporangium* species produce similar symptoms on the same hosts infected by *G. juniperi-virginianae*. These rusts are American hawthorn rust and quince rust.

Symptoms of American hawthorn rust, *G. globosum* (also known as hawthorn rust or cedar-hawthorn rust), are the same as those for cedar-apple rust. Leaf symptoms are similar in color but may be slightly smaller in size. Galls on junipers have similar physical characteristics, but produce teliohorns for three to five years rather than one year. *G. globosum* also has an expanded host range that includes pear, quince and serviceberry in addition to those of *G. juniperi-virginianae*.

Quince rust (also known as cedar-quince rust) is caused by *G. clavipes*. Infections occur on fruit but not the leaves of its rosaceous hosts. The fungus also produces cylindrical galls, often referred to as cankers, rather than round galls on junipers. These galls are perennial and increase in size from year to year. They may remain active up to 20 years. *G. clavipes* also has a larger host range than *G. juniperi-virginianae*. Additional hosts include mountain ash, chokeberry, cotoneaster, medlar, pear, photinia, quince, flowering quince and serviceberry.

## Control

Effective control includes both cultural and chemical approaches. Many cultivars of apple, crabapple, hawthorn and juniper show some degree of resistance. It is always advisable to plant a resistant variety since doing so will reduce time and money invested in chemical control. Planting a rust-susceptible variety will require annual fungicide treatment to maintain the health and aesthetic value of the tree. *Tables I-IV* present a partial list of popular resistant and susceptible cultivars of apple, crabapple, hawthorn and juniper.

Unfortunately some very popular older varieties of apple and crabapple are susceptible to cedar-apple as well as the other rusts caused by *Gymnosporangium* species. If you have these plants already established in your landscape or orchard, chemical control measures may be necessary. *Table V* lists fungicides labeled for rust control. The infection period for the rust fungi on flowering trees is generally from the pink stage of the blossoms until petal drop (May and June). Susceptible trees need to be sprayed regularly during this time.

Chemical control is usually not recommended on junipers since the disease rarely causes economic injury on this host. However, treating junipers before galls are actively producing teliohorns or when aeciospores are being released from apples may reduce disease development. One disadvantage of applying fungicides to junipers is that treatments may be needed from July to September and are costly in both time and product. Fungicides labeled for control of cedar-apple and other rust diseases on juniper species are listed in *Table V*.

Growers interested in controlling the disease on junipers also may find it helpful to physically remove galls from the twigs. Galls may be picked or pruned from infected tissue. Cankers associated with quince rust also can be removed. This is practical if a few plants are infected and the number of galls per plant is limited.

Eradication of nearby junipers has been recommended as a control, but its effectiveness is debatable. This practice may reduce the amount of inoculum reaching susceptible apples, but widespread eradication is not practical due to the large number of redcedars in the state. Established redcedar windbreaks also play an important role in erosion control. A much better means of control is to select

resistant varieties of plants for orchards, landscapes, and windbreaks near orchards.

<b>Table I. Apple cultivar reaction to cedar-apple rust.</b>		
<b>Resistant</b>	<b>Intermediate</b>	<b>Susceptible</b>
<ul style="list-style-type: none"> <li>• Delicious, Red</li> <li>• Early McIntosh</li> <li>• Freedom</li> <li>• Granny Smith</li> <li>• Liberty</li> <li>• Northwestern Greening</li> <li>• Nova Easygrow</li> <li>• Priscilla</li> <li>• Redfree</li> <li>• Sharon</li> <li>• Sir Prize</li> </ul>	<ul style="list-style-type: none"> <li>• Courtland</li> <li>• Delicious, Golden</li> <li>• Duchess</li> <li>• Haralson</li> <li>• Macfree</li> <li>• Paulared</li> <li>• Turley</li> <li>• Winesap</li> <li>• Wolf River</li> <li>• Yellow Transparent</li> </ul>	<ul style="list-style-type: none"> <li>• Akane</li> <li>• Beacon</li> <li>• Grimes Golden</li> <li>• Jonafree</li> <li>• Lodi</li> <li>• Minjon</li> <li>• Prairie Spy</li> <li>• Prima</li> <li>• Rome Beauty</li> <li>• Secor</li> <li>• Stayman</li> <li>• Wealthy</li> </ul>

<b>Table II. Crabapple cultivars resistant to cedar-apple rust.</b>		
<ul style="list-style-type: none"> <li>• Adams</li> <li>• <i>Baccata</i> 'Jackii'</li> <li>• Beverly</li> <li>• Bob White</li> <li>• Candied Apple</li> <li>• Dolgo</li> <li>• Donald Wyman</li> <li>• Floribunda</li> <li>• <i>Halliani</i> 'Parkmanii'</li> <li>• Indian Magic</li> </ul>	<ul style="list-style-type: none"> <li>• Indian Summer</li> <li>• Liset</li> <li>• Mary Potter</li> <li>• Molten Lava</li> <li>• Mt Arbor Special</li> <li>• Ormistron Roy</li> <li>• Pink Spires</li> <li>• Prairie Fire</li> <li>• Profussion</li> <li>• Professor Sprenger</li> </ul>	<ul style="list-style-type: none"> <li>• Red Jade</li> <li>• Red Jewel</li> <li>• Robinson</li> <li>• Royalty</li> <li>• Sargentii</li> <li>• Strawberry Parfait</li> <li>• Sugar Tyme</li> <li>• Tina (<i>sargentii</i>)</li> <li>• White Angel</li> <li>• Zumi 'Calocarpa'</li> </ul>

<b>Table III. Hawthorns resistant to rust.</b>
<ul style="list-style-type: none"> <li>• <i>Crataegus crus-galli</i> (Cockspur Thorn)</li> <li>• <i>C. intricata</i></li> <li>• <i>C. laevigata</i> (Autumn Glory)</li> <li>• <i>C. phaenopyrum</i> (Washington Thorn)</li> <li>• <i>C. pruinosa</i></li> <li>• <i>C. viridis</i> (Winter King)</li> </ul>

<b>Table IV. Junipers resistant to cedar-apple rust.</b>	
<i>J. ashei</i> (Ashe juniper)	<i>J. procumbens</i> (= <i>J. chinensis</i> var. <i>procumbens</i> )

*J. chinensis* (Chinese juniper)

- Fortunei
- Hetzii
- Keteleeri
- Pfitzeriana
- Pfitzeriana compacta
- Pfitzeriana glauca
- Plumosa aurea
- Pyramidalis
- Sargentii

*J. communis* (common juniper)

- Aurea
- Aureo-spica
- Cracovia
- Depressa
- Hibernica
- Oblonga pendula
- Pyramidalis
- Saxatilis
- Saxatilis pallas
- Suecia
- Suecia nana

*J. horizontalis* (creeping juniper)

- Admirabilis
- Adpressa
- Argenteus
- Blue Rug
- douglassi
- Filcinus
- Glomerata
- Livida
- Petraea
- Plumosa

*J. sabina* (savin juniper)

- Broadmoor
- Fastigiata
- Skandia

*J. scopulorum* (Rocky Mountain juniper)

- Dewdrop
- Medora
- Moonglow
- Pathfinder
- Platinum
- Silver Globe
- Sky Rocket
- Welchii
- Wichita Blue

*J. squamata*

- Blue Star
- Meyeri

*J. virginiana* (eastern redcedar)

- Globosa
- Kosteri
- Pseudocupressus
- Pyramidalis
- Tripartita
- Venusta

Crop	Fungicide	Rusts Controlled	Fungicide restrictions
Apple	fenarimol (Rubigan)	cedar-apple, quince, American hawthorn	Do not apply within 30 days of harvest.
	ferbam	cedar-apple, quince, American hawthorn	Apply prebloom to bloom.
	mancozeb	cedar-apple, quince, American hawthorn	

	mycolobutanil (Nova)	cedar-apple, quince, American hawthorn	Do not apply within 14 days of harvest.
	propiconazole (Banner)	cedar-apple rust	Non-bearing trees only.
	sulfur, micronized	cedar-apple, quince, American hawthorn	
	triadimefon (Bayleton)	cedar-apple, quince, American hawthorn	Do not apply within 45 days of harvest.
	zinc ion (Ziram 76)	cedar-apple , quince	Do not apply within 14 days of harvest.
<b>Crabapple and hawthorn</b>	chlorothalonil (Bravo)	cedar-apple	
	mancozeb	cedar-apple, quince, American hawthorn	
	mycolobutanil (Eagle)	cedar-apple, quince, American hawthorn	
	sulfur, micronized	cedar-apple, quince, American hawthorn	
	triadimefon (Bayleton)	cedar-apple, quince, American hawthorn	
<b>Crabapple only</b>	fenarimol (Rubigan)	cedar-apple, quince, American hawthorn and quince	
	propiconazole (Banner)	cedar-apple rust	Do not apply if fruit will be used in edible products.
	thiophanate-methyl (Cleary's 3336 WP)	cedar-apple, quince, American hawthorn	Do not tank mix with copper fungicides or highly alkaline pesticides.
<b>Juniper</b>	Bordeaux	cedar-apple	
	liquid copper	cedar-apple	
	triadimefon (Bayleton)	cedar-apple, quince, American hawthorn	

This list of fungicides is to be used as a guide and may not be a complete list of products available for the control of this disease. No criticism is intended for fungicides not listed nor endorsement given to those listed by Nebraska Cooperative Extension.

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***File G1327 under: PLANT DISEASE***

***D-9, Fruits***

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