COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT

Plant Pathology Fact Sheet PPFS-FR-T-05

Apple Rust Diseases

Nicole Ward Gauthier
Extension Plant Pathologist

Annette Meyer Heisdorffer
Extension Horticulture Agent

Importance

Cedar-apple rust is the most common and economically important rust disease occurring on apple in Kentucky. Two other rusts, cedar-hawthorn rust and cedar-quince rust, are of lesser importance on apple, but can significantly impact ornamental plants. All three diseases occur on crabapple, hawthorn, mountain ash, pear, and serviceberry.

Rust diseases may cause serious losses within orchards. Leaf infections weaken trees and result in a reduction in fruit size and quality of the current crop, as well as reduced bloom the following year. Heavy infections occurring over several consecutive years result in stunting, increased susceptibility to winter injury, and failure to produce fruit. These stresses may result in tree death. Infected fruit may drop prematurely, while those that remain on trees until harvest have reduced market value.

Symptoms & Signs

On Apple

Leaves

Cedar-apple rust infections begin as small, pale yellow spots on upper leaf surfaces in mid- to late spring. Spots gradually enlarge (up to ¼ inch in diameter), become bright yellow-orange, and

Figure 1. Cedar-apple rust on apple leaves are bright yellow-orange with a red border.

are frequently surrounded by a reddish border (Figure 1). Fungal fruiting bodies (pycnia; not the same as pycnidia) appear as black dots in spot centers (Figure 2). As the fungus continues to colonize infected leaves, yellow spots develop on lower leaf surfaces and tissue becomes noticeably thickened. In late spring or early summer, clusters of small orange-yellow, tubular fruiting bodies (aecia) project downward from these lower surface spots (Figure 3); aecia

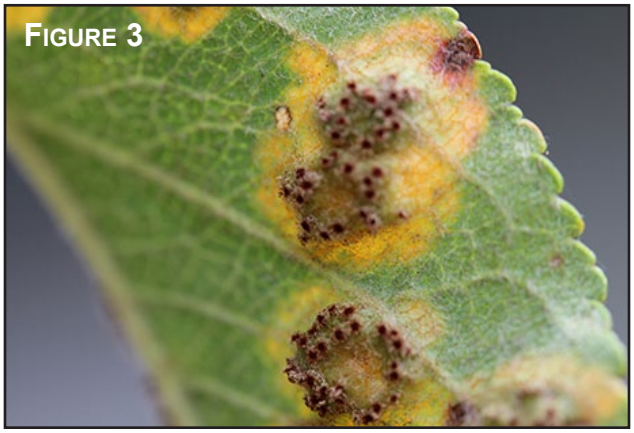

Figure 2. Fruiting bodies of cedar-apple rust on apple appear as pycnia (black dots) in lesions.
Figure 3. Advanced signs of cedar-apple rust on apple include tubular fruiting bodies (aecia) projecting downward.

eventually release mass of light brown spores (aeciospores). Infected leaves may turn yellow and drop, especially as trees become stressed (e.g., drought).

Cedar-hawthorn rust spots on apple, crabapple, hawthorn, pear, and serviceberry are similar in appearance to cedar-apple rust, but few tubular aecia form.

Cedar-quince rust often does not cause leaf spots on these trees.

Fruit

Cedar-apple rust fruit spots usually appear near the blossom end (calyx) of fruit (Figure 4). They are similar in color to leaf spots (yellow-orange), but are much larger (¾ inch or more in diameter). Each fruit spot is surrounded by a dark green zone on otherwise light green

Figure 4. Cedar-apple rust occurs on or near blossom end (calyx) of apple fruit.

fruit. When present, tubular aecia are found in a circular pattern surrounding black dots (pycnia); pycnia develop on a raised, roughened cushion of tissue. Fruit flesh underneath surface lesions turns somewhat corky, but remains alive. Infected fruit frequently becomes deformed and may drop prematurely.

Cedar-quince rust causes fruit to become puckered at the blossom end (calyx) if infection occurs when fruit are an inch or less in diameter. Later, sunken, dark green spots develop. Fruit flesh underneath surface lesions dies and becomes brown and spongy, often all the way to the core. Pycnia and aecia rarely develop, making positive diagnosis difficult. Hawthorn fruit, on the other hand, show profuse numbers of the tubular aecia on abnormally swollen fruit (Figure 5).

Figure 5. Cedar-quince rust on hawthorn fruit includes protruding tubular aecia.

Cedar-hawthorn rust fruit infections are rare.

Figure 6. Cedar-apple rust galls (called 'cedar apples') develop on cedar and juniper, appearing initially as brown globular masses. **Figure 7**. Telia begin to emerge from cedar-apple rust galls following rainy weather. **Figure 8**. Eventually, bright yellow-orange tendrils (telial horns) develop.

Twigs

Cedar-apple rust seldom affects apple twigs. Cedar-quince rust causes infected hawthorn and crabapple twigs to become swollen; tissue above infected sites dies as twigs are girdled.

On *Juniperus* species

Apple rusts affect junipers and cedars in what is considered an alternate host relationship. These alternate hosts include many *Juniperus* species, such as native red cedars and ornamental junipers. These hosts are not seriously damaged by cedar rust diseases.

Cedar-apple rust results in the development of brown, rounded galls (known as 'cedar apples') in leaf axils of infected cedars and junipers. Galls are pea-sized to 2 inches in diameter with surfaces that become pitted with circular depressions (Figure 6). In early spring, slimy, jelly-like, yellow-orange tendrils ('spore horns') up to 2 inches long protrude from these depressions following rainy periods (Figures 7 & 8). A single gall may produce from one to more than 100 spore horns, which often cause the galls to resemble orange-colored blossoms from a distance.

Cedar-hawthorn rust galls are small, irregular in shape, and do not develop a regular arrangement of circular depressions. Spore horns are short, generally few in number, and wedge- or club-shaped.

Cedar-quince rust does not form rounded galls, but instead forms perennial, spindle-shaped swellings on twigs. A gelatinous, orange-brown mass of spores (teliospores) is produced in the swellings in spring (Figure 9).

Figure 8. Cedar-quince rust causes swellings of orange telia on juniper.

Cause & Disease Development

The cedar rusts are caused by different species of the fungus *Gymnosporangium:*

- Cedar-apple rust—*G. juniper-virginianae*
- Cedar-hawthorn rust—*G. globosum*
- Cedar-quince rust—*G. clavipes*

The life cycle of each fungus is very similar and quite complex—several spore types are produced, and two different hosts are required to complete a cycle that spans 2 years.

On *Juniperus* species

Rust fungi overwinter as galls or swellings produced on *Juniperus* species. These galls/swellings expand under favorable environmental conditions over a period of 2 years and then produce yellow-orange gelatinous masses (teliospores) in spring following the second winter. Teliospores germinate under moist conditions to form another spore type (basidiospores).

On Apple

In early spring, basidiospores are carried by air currents from cedar/juniper to apple trees (or other related hosts). Although trees may occasionally become infected by basidiospores produced up to several miles away, most infections result from spores produced on infected *Juniperus* species within a few hundred feet of trees. Basidiospores can cause infections during relatively short periods of wetness (about 6 or 7 hours) when temperatures are in the 50s and 60s (°F). Danger of infection usually extends from leaf expansion and pink bud stage (early blossom stages) and ends about 30 days after bloom when basidiospore production ceases and leaves mature.

Leaf spots develop on upper apple leaf surfaces about 10 to 14 days after infection by basidiospores. Another spore type, pycniospores, forms in the developed lesions. Several weeks later, aecia form on the undersides of leaves; aeciospores are then blown to nearby cedars and junipers. The infection of *Juniperus* species by aeciospores results in the formation of cedar-apple galls or swellings, thus completing the cycle that began 2 years earlier.

Disease Management

Resistant Cultivars

- Select and grow apple or juniper cultivars that are resistant or immune to rust. See Table 1 for information on apple cultivars and their response to cedar-apple rust, as well as other common apple diseases.
- Resistance may vary among localities, depending upon the specific races of the rust species present in the area.

Sanitation

- Destroy nearby unmanaged, abandoned, or wild apple, crabapple, cedar, or juniper trees.
- When practical, prune and destroy cedar apples found on ornamental junipers and cedars.

Fungicides

- Follow a recommended fungicide management program for apple. Early protection beginning at the pink-bud stage is especially important for management since most infections occur within the first 30 days after bloom.
- For specific spray recommendations, refer to the appropriate publications listed in Additional Resources; these are available online and at county Extension offices.

Table 1. Disease-resistant apple cultivars.[1]

Cultivar	Disease Resistance Ratings To[2]			
	Apple Scab	Cedar Rust	Fire Blight	Powdery Mildew
Pristine[3]	VR	S	S	R
Williams Pride	VR	S	MR	R
Redfree[3]	VR	VR	S	S
Dayton[3]	VR	R	MR	R
Liberty[3]	VR	R[4]	R	R
Nova Easygro	VR	VR	R	S
Spartan[3]	MR	R	MR	R
Jonafree[3]	VR	S	S	R
Pixie Crunch[3]	VR	—	—	—
Macfree	VR	VR[4]	MR	S
Priscilla[3]	VR	VR[4]	VR	R
WineCrisp	VR	MR	VR	MR
CrimsonCrisp	VR	MR	S	S
Enterprise[3]	VR	VR[4]	MR	R
GoldRush[3]	VR	S	MR	S
Sundance[3]	VR	VR	VR	VR

Ratings
VR = very resistant
R = resistant
MR = moderately resistant
S = susceptible
— = insufficient information.

Notes
All apples require cross-pollination by a different variety. Winesap and Sir Prize cannot serve as pollinizers because they have sterile pollen.

[1]For the complete table that includes apple cultivar characteristics, harvest period, and storage comments, refer to ID-21, listed in Additional Resources.

[2]Resistance to diseases other than scab has not been fully evaluated and may differ in some locations from that reported here.

[3]Produces high-quality apples in Kentucky.

[4]Although these cultivars are resistant to cedar apple rust, they are susceptible to cedar quince rust.

Additional Resources

- Disease and Insect Control Program for Homegrown Fruit in Kentucky including Organic Alternatives, ID-21
http://www.ca.uky.edu/agc/pubs/id/id21/id21.pdf

- Midwest Tree Fruit Spray Guide (for commercial growers), ID-92
http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/MwTreeFruitSprayGuideID92.pdf

- Simplified Backyard Apple Spray Guides, PPFS-FR-T-18
http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-FR-T-18.pdf

- Woody Plant Disease Management Guide for Nurseries and Landscapes, ID-88
http://www.ca.uky.edu/agc/pubs/id/id88/id88.pdf

August 2015

Acknowledgement—The authors thank Mohammad Babadoost, Extension Professor, University of Illinois, for his review of this publication.

Photos—James Chatfield, The Ohio State University (fig. 1), Brian Olson, Oklahoma State University (fig. 2), Dawn Dailey O'Brien, Cornell University (figs. 5 & 9), Elizabeth Bush, Virginia Polytechnic Institute (fig. 8), Bugwood.org; and Nicole Ward Gauthier, UK (figs. 3, 4, 6, 7)

Revised from the fact sheet, *Rust Diseases of Apple* (PPA-23), originally written by W.F. Wilcox, C.A.Kaiser, J.R. Hartman, and R.E. Stuckey