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Rust Diseases of Apple

by John Hartman

Three related rust diseases occur on apple trees in Kentucky: cedar-apple rust, cedar-hawthorn rust, and cedar-quince rust. Crabapple, hawthorn, mountain ash, pear, and serviceberry are also susceptible to these diseases. All three rusts are caused by different species of the fungus *Gymnosporangium*, each of which must spend a phase of its life cycle as a parasite on *Juniperus* species such as native red cedars or ornamental junipers.

Although cedar rusts can cause unsightly growths on *Juniperus*, they do not usually cause serious damage to these plants. Rust diseases can cause serious losses on apples, however, as a result of both fruit and leaf infections. Infected fruits can drop prematurely or have a reduced commercial value if they remain on the tree through harvest. Leaf infections often result in premature leaf loss, which reduces the size and quality of the current season's fruit crop, weakens the tree, and may cause a reduction in bloom the following year. Trees allowed to become heavily infected for several years become stunted, are increasingly susceptible to winter injury, and might eventually fail to produce fruit. In Kentucky, hawthorns and crabapple twigs infected by the cedar-quince fungus can become swollen and die.

Symptoms

Only cedar-apple rust (*G. juniperi-virginianae*) will be described in detail, since it is the most common and important of the rust diseases on apple. Significant differences among the three rusts are noted where applicable.

Apple Leaves

Small, pale yellow spots (sites of rust fungus infection) appear on the upper surface in mid to late spring. Spots gradually enlarge (up to ¼-inch in diameter, depending on the apple variety and the number of spots per leaf) and become bright yellow-orange frequently surrounded by a reddish border (Fig. 1). As the spots enlarge, black dots (a mass of fungal fruiting bodies called pycnia) develop in the centers. Shortly thereafter, the fungus grows through to the lower leaf surface, where yellow spots also appear, and the 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. As the "tubes" mature, they split toward the base in narrow strips and curl back on themselves to form "cups" within which a mass of light brown spores is revealed. Infected leaves may turn yellow and drop, especially as the tree becomes stressed for water.

Leaf spots of apple, crabapple, hawthorn, pear, and serviceberry caused by cedar-hawthorn rust are similar in appearance, but few tubular aecia form within them. Cedar-quince rust does not cause leaf spots on these hosts.

Figure 1—Typical bright yellow spots caused by the cedar-apple rust fungus on the upper surface of an apple leaf.

Apple Fruit

Fruit spots usually appear near the blossom end. They are yellow-orange in color, like the leaf spots, but are much larger (up to ¾-inch or more in diameter), and are surrounded by a dark green zone on the otherwise light green fruit. The tubular aecia frequently fail to develop but when present, they are usually found in a circle surrounding the black dots (pycnia) which form on a raised, roughened cushion of tissue. Tissue below the spots turns somewhat corky, but remains alive. Infected fruits frequently become deformed and may drop prematurely.

Fruit infected by the cedar-quince rust fungus become puckered at the blossom end while still an inch or less in diameter, then develop sunken, dark green spots. In contrast with cedar-apple rust, the flesh below cedar-quince rust spots is dead, brown, and spongy, often all the way to the core. Pycnia and aecia rarely develop, making positive diagnosis difficult. Apple fruit infection by the cedar-hawthorn rust fungus is rare. The cedar-quince rust fungus commonly infects hawthorn fruits. Such fruits become abnormally swollen and show profuse numbers of the tubular aecia.

Apple Twigs

Cedar-apple rust normally does not affect apple twigs. In Kentucky, hawthorns and crabapple twigs infected by the cedar-quince fungus can become swollen and die.

CEDARS AND JUNIPERS

Light brown to reddish or chocolate brown galls develop in the leaf axils of infected *Juniperus* species. These "cedar apples," as they are often called, are usually rounded and range from pea-sized to 2 inches in diameter. As they mature, the flesh becomes corky and the surface becomes pitted with circular depressions. Following rainy periods in the early spring, slimy, yellow-orange tendrils, or "spore horns," up to 2 inches long swell and protrude from these depressions (Fig. 2). 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. Severely rusted *Juniperus* can be very conspicuous.

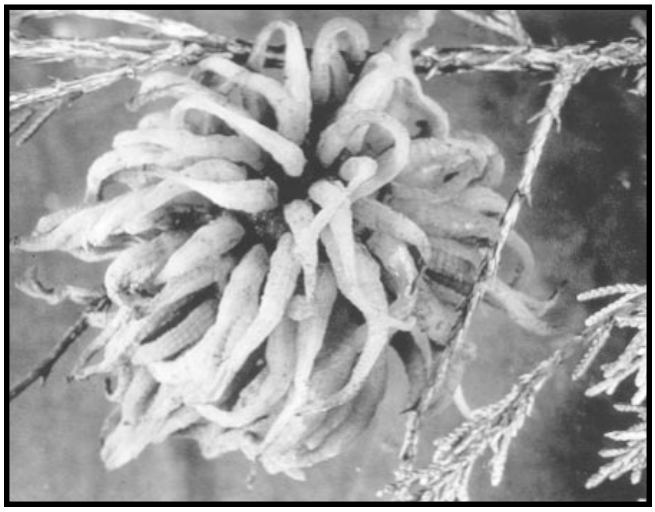

Figure 2—Yellow-orange "spore horns" protruding from a cedar gall during moist spring weather.

Galls produced by cedar-hawthorn rust (*G. globosum*) are similar in appearance but are smaller and more irregular in shape and do not develop the regular arrangement of circular depressions. Spore horns, too, are shorter, generally fewer in number, and wedge- or club-shaped. Cedar-quince rust (*G. clavipes*) does not form rounded galls but instead forms perennial, spindle-shaped swellings on the twigs, on which a gelatinous, orange-brown mass of spores is borne in the spring.

Disease Cycle

The life cycle of a cedar-rust fungus is somewhat complex, since several different spore types and two different hosts are involved. Because all three fungi have similar life cycles, only that of the cedar-apple rust (*G. juniperi-virginianae*) will be discussed.

Aeciospores (produced in the tubular aecia on diseased apple tissue) are blown to cedar during the summer where they germinate, infect, and cause small pea-sized galls to form on the twigs. The fungus over-winters in these galls which continue to grow and enlarge during the following year. The fungus survives a second winter within the gall, then begins producing its long, orange spore horns the next spring, about the time the apple buds are in the pink to early bloom stage.

These spore horns are actually columns of fungal spores (teliospores), each of which can germinate under moist conditions to form four new spores (basidiospores). Basidiospores are then carried to apple trees by wind currents where they can germinate and cause infection during relatively short periods of wetness (about six or seven hours for moderate levels of infection when temperatures are in the 50s and 60s). The danger of infection usually ends about 30 days after bloom when the fungus terminates production of basidiospores and the majority of apple leaves have aged to the point where they are no longer susceptible.

Spots begin forming on the upper leaf surface about 10 to 14 days after infection occurs, and aecia form on the underside of infected leaves several weeks later. Spores produced within the aecia are then blown to nearby cedars and junipers, completing the cycle that began two years earlier.

Control

1) Grow resistant apples (crabapples, hawthorn, mountain ash) or junipers. Apple varieties that normally show good to excellent resistance to cedar-apple rust include McIntosh, Red Delicious, Arkansas Black, Empire, Jersey-mac, Jonamac, Cortland, Baldwin, Nova Easy, MacFree, Priscilla, and Winesap. Varieties that are usually highly susceptible include Prima, Sir Prize, Lodi, Jonathan, Rome, Wealthy, and York Imperial. Resistance may vary among localities, however, depending on the specific races of the rust species present in the area.

2) Destroy nearby wild, abandoned, or worthless apples, crabapples, cedars, or junipers. When practical, prune out and destroy cedar apples found on ornamental junipers and cedars. Although apples may occasionally become infected by spores produced up to several miles away, most infections result from spores produced on infected *Juniperus* within a few hundred feet of the apple tree.

3) Follow a recommended fungicide control program. Early protection (beginning at the pink-bud stage) is especially important for control, as most infections occur within the first 30 days after bloom. For specific spray recommendations, commercial apple growers should consult UK Extension publication ID-92, "Commercial Fruit Spray Schedule." Homeowners should consult publication ID-21, "Disease and Insect Control Program for Home Grown Fruit in Kentucky." Landscape managers need to consult UK Extension publication ID-88, "Woody Plant Disease Control Guide for Kentucky." All three are available through local county Extension offices.

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