



## RUST DISEASES OF APPLE, CRABAPPLE, AND HAWTHORN

Three rust diseases commonly occur on apple and crabapple trees in Illinois. All are caused by species of the fungus *Gymnosporangium* and have various junipers and red cedars (*Juniperus* species) as alternate hosts. These diseases can result in the following:

1. Fruit infection, resulting in lower value of fruit for commercial and home use;
2. Premature fruit drop;
3. Early defoliation, resulting in reduced size and quality of fruit during the current season; and,
4. Devitalization of trees from repeated infection.

Apple and crabapple trees that have been repeatedly infected for a period of years may be stunted and may fail to produce fruit. A loss of all the fruit is not unusual on unsprayed or poorly sprayed trees when growing close to junipers. The rust diseases can also destroy the ornamental value of susceptible junipers.

### CEDAR-APPLE RUST

#### Symptoms on Apple and Crabapple

Cedar-apple rust is caused by *Gymnosporangium juniperi-virginianae*. It infects the leaves, fruit, and occasionally young twigs.

**On leaves.** Pale yellow spots appear on the upper surface of leaves during May and June (Figure 1). The spots gradually enlarge to about 1/4 inch in diameter (1/2 to 3/4 cm) and turn orange, frequently with a reddish border. As many as 300 spots may form on a single apple leaf.



Figure 1. Cedar apple rust on leaf of a Jonathan.



Figure 2. Cedar-quince rust on Delicious apples. Affected areas are sunken and dark green.



Figure 3. Cedar apple rust gall on Juniper.

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Pycnia (black dots) of the fungus form in these spots and exude an orange fluid containing pycniospores. As the pycnia develop, yellow spots appear on the underleaf surface. These spots thicken and during late spring and early summer, small, orange-yellow tubular projections (aecia) appear. These aecia eventually develop open, cylindrical tubes. The tubes split into narrow strips and curl backward. As the rust pustules develop, a leaf may turn yellow and drop. The defoliation of infected leaves is most prevalent during dry summers but more frequently the leaf remains on the tree until autumn.

**On fruit.** Yellow-orange lesions appear on immature fruit, usually at or near the calyx end. These are much larger than the leaf infections, up to 3/4 inch (3 cm) or more in diameter. The light green color of the young apple becomes a darker green around the infected area. The tubelike aecia generally appear in the fruit lesions, usually in a circle surrounding the black pycnia. Infected fruits are generally stunted and misshapen and may crop early.

**On twigs.** The current-season growth of very susceptible apple and crabapple varieties may develop slightly swollen sections about one inch long that bear typical pycnia and aecia. Seriously affected twigs are stunted and may die back.

## Symptoms on Juniper

Light brown to reddish or chocolate brown galls, ranging from about 1/8 inch (0.3 cm) to over 2 inches (5 cm) in diameter, develop on susceptible junipers. The round to kidney-shaped, corky galls (often called “cedar apples”) develop circular pits or depressions over the surface, something like those on a golf ball. During damp spring weather a small protuberance develops in the center of each pit and the protuberances elongate rapidly. Within several hours, they develop into gelatinous, yellowish to golden brown sporehorns up to about two inches (5 cm) long (Figure 3). A single gall may produce from a few to over 100 sporehorns. When they are bent over and covered with expanded galls the size of oranges, heavily rusted junipers are very conspicuous.

During dry weather the gelatinous horns contract into wrinkled threads. When remoistened, the sporehorns swell again to their original size. During late May to mid-June, after six to eight rains, the sporehorns exhaust their spores and wither permanently. During the summer months, the withered sporehorns drop off. The galls turn dark brown to black and become hard. Old, blackened galls may remain on a juniper for a year or longer, but do not produce spores again.

The juniper species, varieties, and cultivars that have been reported as susceptible to cedar-apple rust include:

1. *Juniperus chinensis* or Chinese juniper, cultivar ‘Globosa’, cv. ‘Pfitzeriana’, and var. *sargentii*;
2. Several cultivars of *J. communis* or common juniper;
3. Several cultivars of *J. horizontalis* or creeping juniper including cv. ‘Alpina’, and c. ‘plumosa’;
4. *J. pinchotii*;
5. *J. scopulorum* or Rocky Mountain juniper, cv. ‘Funalis’, cv. ‘Hilli’, c. ‘Hilli Argfentea Pyramidalis’, cv. ‘Hill’s Silver’, cv. ‘Horizontalis’, cv. ‘Moffreti’, cv. ‘Pendula’, cv. ‘Pillaris’, and cv. ‘Viridifolia’;

6. *J. silicicola* or southern red cedar,
7. *J. utahensis*, and
8. Numerous cultivars of *J. virginiana* or eastern red cedar including cv. 'Albospica', cv. 'Canaertii', cv. 'Chamberlainii', cv. 'Cinerascens', cv. 'Glauca', cv. 'Pyramidiformis', cv. 'Reptans', cv. 'Schottii', cv. 'Skyrocket', and cv. 'Variegata'.

## **CEDAR-QUINCE RUST**

### **Symptoms on Quince**

Cedar-quince rust, caused by *Gymnosporangium clavipes*, affects quince, flowering quince, Juneberry or serviceberry, chokeberry, hawthorn, mountain ash, photinia, and pear leaves, fruit, and young stems. Twigs may die back. This disease is generally not as prevalent as cedar-apple rust. It is more common in central and western Illinois. Cedar-quince rust sometimes infects apple fruit but not the leaves. Fruit of susceptible cultivars, such as Golden Delicious, Red Delicious, Stayman, and Winesap, become puckered at the blossom end and develop a sunken, dark green area (Figure 2). Under the craterlike, dark green area, the flesh is brown and spongy, often extending to the core of the fruit. The formation of pycnia and aecia is very unusual. Apples are susceptible to the cedar-quince rust fungus during the period from early bloom through third cover.

### **Symptoms on Juniper**

Perennial, spindle-shaped swellings form on the twigs and branches of common juniper (*Juniperus communis*), eastern red cedar (*J. Virginiana*), mountain juniper (*J. sibirica*), and prostrate juniper (*J. communis* var. *depressa*). Young branches may be killed. Elongated, swollen patches or cankers may occur on twigs and on the trunk. In damp spring weather, older galls are covered with conspicuous, cushion-shaped masses of gelatinous, orange to brown sporehorns.

## **CEDAR-HAWTHORN RUST**

### **Symptoms on Apples and Crabapple**

Cedar-hawthorn rust, caused by *Gymnosporangium globosum*, is a very minor disease of apple, crabapple, mountain ash, and pear trees but a major disease of ornamental hawthorns. The orange leaf spots are small on apple and crabapple, but larger and gray to brown on hawthorns. Few, if any, aecia are produced on apple or crabapple, and these are clustered in the center of the pustule. Fruit infections are very rare on apples. Defoliation and deformation of fruits and twigs on hawthorns are very common and particularly severe.

### **Symptoms on Juniper**

The galls produced on junipers resemble those of cedar-apple rust, except that they are smaller (usually under 1/2 inch), more irregular in shape, and do not develop the regular arrangement of circular depressions. The gelatinous sporehorns are also shorter, fewer in number, and wedge-shaped.

The juniper species, varieties, and cultivars reported as susceptible to cedar-hawthorn rust include:

1. *Juniperus chinensis* cv. 'Globosa' and var. *sargentii*
2. *J. communis*
3. *J. horizontalis* cv. 'Alpina'
4. *J. pinchotii*
5. *J. scopulorum* cv. 'Hill's Silver', cv. 'Horizontalis', cv. 'Moffeti', cv. 'Pendula', and cv. 'Viridifolia'
6. *J. silicicola*
7. Numerous cultivars of *J. virginiana* including cv. 'Albospica', cv. 'Berg's Rust Resistant', cv. 'Canaertii', cv. 'Chamberlaynii', cv. 'Cinerascens', cv. 'Cupressifolia', cv. 'Elegantissima', cv. 'Glauca', cv. 'Nova', cv. 'Pendula', cv. 'Pyramidiformis', cv. 'Reptans', cv. 'Schottii', and cv. 'Variegata'.

## Disease Cycle for Cedar-Apple Rust

Cedar-apple rust is the most common of the three rust diseases that attack apple and crabapple. The disease cycle for cedar-apple rust, essentially the same as the cycles for cedar-quince and cedar-hawthorn rusts, is given in detail in Figure 4.

The fungus overwinters as mycelium in the galls on junipers. The sporehorns begin to extrude in the spring, usually when the apple buds are in the pink to early bloom stage. As the galls become rainsoaked, the thorns appear, become jelly-like, and swell very rapidly. A single, large cedar gall may produce as many as two billion teliospores, each producing four sporidia or basidiospores. Each basidiospore is capable of initiating an infection. As the sporehorns begin to dry, the sporidia are forcibly discharged. These sporidia are carried by air currents to nearby developing apple leaves, fruits, and young twigs. The basidiospores generally are not carried great distances by the wind, as they dry quickly and lose their vitality. A few infections of apple and crabapple may occur up to 5 miles from a juniper but most infections develop within several hundred feet. About 30 days after apples and crabapples have bloomed, the sporehorns have exhausted their spores. By this time, most leaves and fruit are no longer susceptible. Apple leaves become immune to cedar-apple rust about 28 days after they unfold.

Within 5 to 6 hours after landing on a leaf, the basidiospores become attached. Short germ tubes directly penetrate the cuticle and the upper leaf tissue. After 10 to 14 days, small yellow spots can be seen on the upper leaf surface and black pycnia develop on these spots. Several weeks later, the aecia form on the underside of the leaf. The aecia, or "cluster-cups", produce a tremendous number of brown aeciospores. The aeciospores are produced in cylindrical tubes and fall out of the tubes in chains. They are carried by air currents to nearby junipers.

The aeciospores become lodged in the juniper leaf axils and in the cracks or crevices of twigs. There they attach, germinate, and infect the twigs in the warm, moist weather of late summer and early fall (75°F or 24°C is optimum). The young, pea-size, greenish-brown galls become evident in the leaf axils the following spring. These galls continue to grow during the year. They normally do not produce spores until the second spring. The complete disease cycle, therefore, usually requires almost 2 years.

## Control

Cedar-apple and related rusts are fairly easy to control on both apple and crabapple and on juniper hosts.

1. Grow resistant or immune species, varieties, and cultivars of apples, crabapples (Tables 1 and 2), and junipers (Table 3). A careful selection will greatly reduce the problem with these diseases. The resistance of a species, variety, or cultivar may vary greatly from one locality to another, depending on the physiologic races of the rust species prevalent in the area.
2. Destroy nearby worthless, wild or cultivated apples, crabapples, and junipers. Although eradicating (removal) rust-susceptible junipers within 1 to 2 miles of commercial apple orchards has been advocated for many years, it is usually impractical. Removal of infected junipers within 1/2 mile will significantly influence incidence on apple and crabapple. In ornamental plantings where only a few rather small junipers are infected, snip off and destroy the galls sometime during the fall, winter, or early spring. Some smaller galls may be missed, but the chances of apple and crabapple trees becoming infected will be considerably reduced, especially if you can convince your neighbors to do likewise.
3. Spray apples and crabapples for rust control starting at the pink-bud stage. Commercial orchardists should follow the suggested spray program outlined in Illinois Commercial Tree Fruit Spray Guide. In the home orchard, follow the spray schedule for apples, crabapples, pears, and quinces in Midwest Tree Pest Management Handbook. These circulars are revised periodically.

When applied at two-week intervals during July and August, the same fungicides used to control rust on apples and crabapples will prevent rust infections on susceptible junipers. Read the fungicide labels for specific recommendations and legal uses.

The apple cultivars that are normally resistant to cedar-apple rust and adapted to part or all of Illinois include Cortland, Dutchess, Golden Delicious, Grimes Golden, McIntosh, Red Delicious, Stayman, and Winesap. The apple cultivars that are usually susceptible to cedar-apple rust are Beacon, Jonathan, Rome, Wealthy, and York Imperial.

Apples resistant to cedar-apple rust, but very susceptible to cedar-quince rust include Cortland, Golden Delicious, McIntosh, Red Delicious, Stayman, and Winesap. On the other hand, Jonathan and Wealthy are very susceptible to cedar-apple rust but highly resistant to quince rust. Apples that are susceptible to cedar-apple rust are usually resistant to quince rust.

There are numerous flowering crabapple species, varieties, and cultivars that are highly resistant to rusts, as well as to such serious diseases as scab, fire blight, powdery mildew, and frog-eye leaf spot (Tables 1 and 2). Other crabapple species, varieties, and cultivars that are highly resistant to rust diseases and only slightly or moderately susceptible to scab, fire blight, and powdery mildew include cv. Albright, *M. baccata* var. *mandschurica*, cv. Candied Apple, cv. David, cv. Ellwangeriana, cv. Golden Hornet, cv. Indian Magic, cv. Inglis, cv. Kibele, cv. Profusion, *x rocki*, *M. margentii*, *M. sieboldi*, cv. Fuji, cv. Simpson 4-17, cv. Simpson 7-62, cv. Simpson 12-77, cv. Simpson 328 AA, and cv. White Gold.

The juniper species, cultivars, and varieties that are reported as resistant to both cedar-apple and cedar-hawthorn rusts are given in Table 3.

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*Publications referred to in this RPD are available from the Office of ITCS, (217)333-2007 at the University of Illinois.*

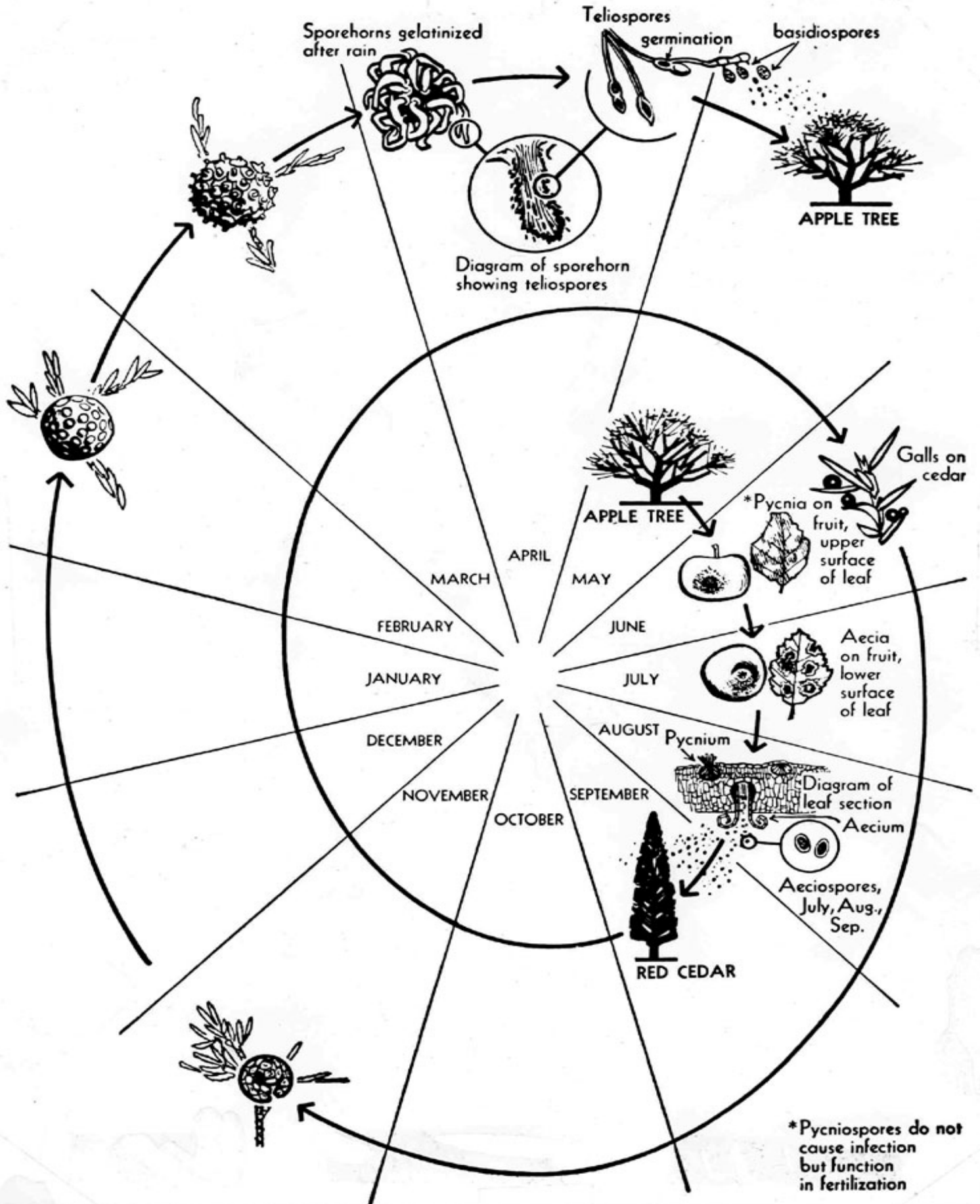


Figure 4. Disease cycle of the cedar-apple rust fungus, *Gymnosporangium juniperi-virginianae*. (Photo courtesy USDA).

**Table1. Characteristics of Crabapples Suggested for Growing in Illinois**

Crabapple species, variety, or cultivar	Tree height, feet	Flower	Fruit				Resistant to <sup>a</sup>	Comments
			Color	Diameter, inches	Texture	Shape		
<u>Malus</u> cv 'Adams'	24	Single, pink	Carmine red	3/4	Dense	Rounded	Scab, fire blight rusts, mildew	Carmine buds; annual bloomer; fruit persistent
<u>Malus</u> <u>baccata</u> cv 'Jackii'	30-40	Single, white	Purplish or maroon red	1/2		Broad upright	Scab, fire blight, rusts, mildew	Siberian type; buds white blooms are fragrant
<u>Malus</u> cv 'Beverly'	25	Single, pink	Bright red	1/2-3/4	Dense	Rounded upright	Scab, rusts, mildew	Very susceptible to fire blight. Buds open pink.
<u>Malus</u> cv 'Bob White'	20	Single, white	Yellow	5/8	Dense	Rounded	Scab, rusts, mildew	Fragrant, alternate bloomer; fruit persistent
<u>Malus</u> cv 'Coralburst'	12	Double, pink	Red	5/8	Fine	Rounded bushy	Scab, rust, fire blight, mildew	Dwarf; few fruit; dark green foliage
<u>Malus</u> cv 'Dolgo'	40	Single, white	Bright red, cone-shaped	1 1/4	Coarse	Open vigorous	Scab, fire blight, rusts, mildew	Fragrant; alternate bloomer
<u>Malus</u> cv 'Donald Wyman'	15-20	Single, white	Glossy, bright red	3/4		Rounded	Scab, fire blight, rusts	Somewhat susceptible to powdery mildew; buds pink
<u>Malus</u> <u>floribunda</u>	25	Single, pink	Yellow and red	3/8	Dense	Broad rounded	Scab, rusts, mildew	Fragrant, annual bloomer; buds pink to red
<u>Malus</u> cv 'Gibb's Golden Gage'	20	Single, white	Yellow	1		Rounded	Scab, fire blight, rusts, mildew <sup>b</sup>	Fruit holds into winter; buds pink
<u>Malus</u> cv 'Gorgeous'	25-30	Single, white	Glossy red	1	Dense	Rounded	Scab	Slow-growing; annual bloomer
<u>Malus</u> <u>halliana</u> var. <u>Parkmanii</u>	15	Double, rose	Dull reddish brown	1/4	Dense	Upright	Scab, fire blight	Annual bloomer; tree is almost vase-shaped
<u>Malus</u> <u>hupehensis</u> 'Tea'	20-25	Single, pink	Greenish-yellow & red	1 1/2		Vase-shaped	Scab, rusts, mildew	Very susceptible to fire blight; picturesque
<u>Malus</u> cv 'Indian Magic'	20-25	Single, pink	Glossy red, elongate	1/4-1/2		Rounded	Fire blight, rusts, mildew	Moderately susceptible to scab; fruit are persistent
<u>Malus</u> cv 'Liset'	15	Single, red	Glossy dark crimson	1/4-1/2	Dense	Columnar	Scab, fire blight, rusts, mildew	Expanding buds are dark crimson
<u>Malus</u> cv 'Makamik'	40	Single, purplish red	Purplish-red	3/4-1		Rounded	Scab, fire blight, rusts	Bronze foliage; fruit holds into winter
<u>Malus</u> cv 'Mary Potter'	10	Single, white	Red	1/2	Dense	Mounded	Rusts	Buds pink; moderately susceptible to other diseases
<u>Malus</u> cv 'Ormiston Roy'	25-30	Single, pink	Orange-yellow	3/8		Upright	Scab, fire blight, rusts, mildew	Annual bloomer; fruit are persistent into winter
<u>Malus</u> cv 'Red Jewel'	15	Single, white	Bright cherry-red	1/2		Upright	Fire blight, rusts, mildew	Fruit are persistent mid-December
<u>Malus</u> cv 'Red Splendor'	25	Single, pink	Red	3/8		Upright	Rusts, mildew	Buds rose-red; dark green foliage
<u>Malus</u> x <u>robusta</u> cv 'Pescifolia'	40	Semi-double white	Bright red	3/4	Dense	Oval rusts, mildew	Scab, fire blight, rusts, mildew	Fruit persistent; tree has peach-like leaves
<u>Malus</u> <u>sargentii</u> cv 'Sargent'	6-8	Single, white	Red or purplish red	1/4	Dense	Mounded	Scab, fire blight, rusts, mildew	Wide-spreading; annual bloomer; flowers fragrant
<u>Malus</u> <u>sieboldii</u> var <u>Zumi</u> cv 'Calocarpa'	25	Single, white	Bright red	1/2	Dense	Pyramidal	Scab, rusts, mildew	Blooms and fruits heavier in alternate years
<u>Malus</u> cv 'Selkirk'	20	Single, purplish red	Deep red, glossy	3/8-1/2	Open	Spreading	Fire blight, rusts	Upright habit; red buds
<u>Malus</u> cv 'Snowdrift'	15-20	Single, white	Orange-red	3/8	Dense	Rounded	Scab, rusts, mildew	Vigorous growers with lustrous green foliage
<u>Malus</u> cv 'Spring Snow'	20	Single, white	No fruit		Dense	Rounded	Rusts, mildew	Bears no fruit; susceptible to scab and mildew
<u>Malus</u> <u>sargentii</u> cv	10-12	Single, white	Red	1/4-1/2	Sprawling	Open	Scab, fire blight, rusts, mildew <sup>b</sup>	A dwarf form of <u>M. sar-</u> 'Tina' <u>gentii</u> ; buds are red
<u>Malus</u> cv 'White Angel'	20-25	Single, white	Glossy red	1/2-3/4	Dense	Rounded	Scab, rusts, mildew	Profuse bloomer; heavy fruiter; lustrous foliage

<sup>a</sup>The major diseases of crabapple are scab, fire blight, rusts, and powdery mildew. The crabapples listed are resistant to the diseases given and moderately or very susceptible to the major diseases NOT listed.

<sup>b</sup>The cultivars 'Gibb's Golden Gage' and 'Tina' have been FREE of scab, fire blight, rusts, powdery mildew, and frog-eye leaf spot for at least the past 3 years in the annual national survey coordinated by Prof. Emeritus L.P. Nichols, Pennsylvania State University. The editor is indebted to Wayne Seifert, former Area Extension Horticulturist, who helped prepare this table.

Table 2. Modern Crabapples Not Suggested for Illinois but Highly Resistant or Immune to Rusts, Scab, Fire Blight, Powdery Mildew, and Frogeye Leaf Spot

cv Amers White	cv Golden Gem	cv Morden 19-27
cv Bakatong	(PLT 788-58)	cv Mount Arbor Special
cv Burton	cv Henningi	cv Professor Sprenger
cv Case Seedling	cv Henry Kohankie	cv R.M.J. 102
cv Centennial	cv Honeywood #14	cv Robinson
cv Golden Gem	hybrid (scab immune	cv Simpson 4-28
cv Golden Gem	clone GR 700-58)	cv Simpson 11-57
(BD 115-58)	cv Minn 1492	cv Simpson 11-58

<sup>a</sup>The author extends his appreciation to Prof. Emeritus Lester P. Nichols, Pennsylvania State University, who has coordinated an annual national effort to evaluate crabapple cultivars, varieties, and species for disease resistance since 1961. Only crabapples found to be FREE of all 5 diseases nationwide for at least a 3-year period are included.

Table 3. Juniper Species, Cultivars, or Varieties Reported Resistant to Cedar-apple and Cedar-hawthorn Rusts<sup>a</sup>

Juniperus ashei			
J. chinensis (Chinese juniper)	'Aureo-globosa'	<u>J. conferta</u>	
	'Columnaris'	<u>J. formosana</u>	
	'Femina'	J. horizontalis	Adpressus'
	'Fortunei'	(Creeping juniper)	'Argenteus'
	'Hetzii'	'Eximius'	
	'Janonica'		'Filicinus'
	'Keteleeri'		'Glomerata'
	'Leeana'		'Lividus'
	'Mas'		'Petraeus'
	'Oblonga'		'Variegata'
	var. parsonsii		'Wiltoni'
	'Pendula'	<u>J. procumbens</u>	
	'Pfitzeriana Aurea'	<u>J. Rigida</u>	
	'Pfitzeriana Aurea Nana'	J. sabina	
	'Pfitzeriana Compacta'	(Savin juniper)	'Fastigiata'
	'Plumosa'		var. tamariscifolia
	'Pyramidalis'		'Variegata'
'Variegata'	<u>J. squamata</u>		
'Watereri'	(Singleseed juniper)	'Albo-variegata'	
J. communis (Common juniper)	'Aurea'		'Meyeri'
	'Aurea-spica'		'Wilsonii'
	'Cracovica'	<u>J. virginiana</u>	
	'Hibernica'	(Eastern red cedar)	'Aurea'
	'Oblonga-pendula'		'Burkii'
	'Pyramidalis'		'Pseudocupressus'
	'Pallas'		'Pyramidalis Glauca'
'Suecica'		'Venusta'	
'Suecica Nana'			

<sup>a</sup>Many of these are the result of observations made at the Morton Arboretum near Lisle, Illinois, by Drs. E.B. Himelick and Dan Neely, Emeritus, Plant Pathologists with the Illinois Natural History Survey, Urbana, Illinois.