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report on
PLANT
DISEASE

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APPLE AND CRABAPPLE SCAB

Apple scab, caused by the fungus *Venturia inaequalis*, is generally the most serious apple and crabapple disease in Illinois. Related fungi cause similar scab diseases on aspen, birch, Christmasberry (*Photinia*), cotoneaster, cottonwood, firethorn (*Pyracantha*), hawthorn, loquat, maple, mountain ash, pear, poplar, quince, and willow.

Apple scab is found in **all** unsprayed orchards in Illinois. Loss from scab is greater than that from any other disease of apples. The losses result from: (1) yield reduction; (2) premature defoliation; (3) fruit quality reduction; (4) weakened trees; and (5) increased production costs. Spray programs provide almost complete control if initiated early in the growing season, but once started, this disease is nearly impossible to control.

Figure 1. Apple scab lesions on McIntosh leaves and fruit. Leaf yellowing is followed by defoliation (courtesy A.L. Jones, APS photo).

Figure 2. Cracking and deformation of McIntosh fruit caused by apple scab, with large primary and numerous small secondary scab lesions (courtesy A.L. Jones, APS photo).

SYMPTOMS

The first scab infections appear on the under surface of the flower sepals or flower cluster leaves as small, irregular spots (lesions) that range from light brown to olive green. These host tissues are infected first because they are the first to be exposed as the tree breaks dormancy. As the infection progresses, the lesions become circular and slightly velvety and olive green. The spots gradually turn dark brown to metallic black (Figure 1). Tissue around the scab thickens, causing the upper surface of the lesion to be convex and the leaves become dwarfed, curled, and scorched at the margins. Petioles (leaf stems) and pedicels (fruit stems) are also infected by the scab fungus. Petiole or pedicel infections result in leaf drop and premature fruit drop. Early defoliation results in reduced fruit bud development for the next year's crop.

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Fruit infections appear a few weeks after bloom as nearly circular, velvety, dark olive green lesions with the cuticle ruptured at the margins (Figure 2). Older lesions become black, scabby, and fruit often cracks. This cracking of the fruit allows water to escape and forms avenues of infection for various rot-producing fungi. Severe early infection results in knotty, deformed, and russeted fruit which commonly drop. Later infections, as the fruit approaches maturity, results in small lesions that may not be visible at harvest but develop into small, dark scab spots during storage.

DISEASE CYCLE

In October-November, warm days stimulate fungal growth in dead, fallen, previously diseased apple and crabapple leaves. The mycelium grows through the leaf tissues and forms a structure called a pseudothecia, in which the fungus overwinters. During winter/early spring, the fungus forms minute, black, flask-shaped perithecia. Within each perithecium, 50 to 100 saclike structures called asci are formed, each containing eight ascospores. Each ascospore contains two cells of unequal size. Mature perithecia have been found in dead, fallen leaves in southern Illinois as early as February (early March in northern Illinois). Spring temperature and moisture conditions cause both apple buds and perithecia to develop simultaneously. Rains cause the mature, pimplelike, embedded perithecia to forcibly discharge the ascospores into the air. Air currents then carry the spores to the new developing green leaves and flower buds. Spore discharge is at its peak 30 minutes after the leaves become wet.

Three hours after the start of rain (a wetting period), up to 75 percent of the mature ascospores have been discharged. The peak of ascospore release often occurs near the end of the tree flowering and may continue until three to five weeks after petal fall. Since not all perithecia or ascospores mature at the same time, each spring rain brings new spore discharges that produce new infections of the green leaves and young fruit.

Wet periods are absolutely necessary for infection to take place. A wet period is defined as a time during which the apple foliage and fruit remain continuously wet with either rain or dew. The period of time necessary for spore germination and infection depends on the temperature during the wet period (Table 1). Thus, by knowing the duration of the wet period and the average temperature during the wet period, you can determine from Table 1 whether or not an infection has occurred.

The ascospore, upon contact with susceptible apple tissue, sends out a germ tube with a disklike, peglike growth (appressorium) from which a slender mycelial tube penetrates the leaf or fruit cuticle. After penetration this germ tube develops into a hypha of normal diameter and sends out numerous branching filaments (hyphae) between the cuticle and the outer epidermal cell wall. The fungus draws nutrients from the epidermal cells and the living host tissues beneath. A week or more later, depending on the temperature (Table 2), infection becomes visible as a dull, smokey, light brown or olive-colored spot. The spots enlarge and darken to become more or less circular superficial lesions with an irregular margin.

A microscopic examination of these “velvety” spots shows that the cuticle ruptures to expose hundreds of short, erect, brownish stalks (conidiophores) on which are borne the one- or two-celled, reddish brown conidia or “summer spores”. Rains splash the conidia from these spots to other leaves and to developing young fruit, where the spores initiate secondary infections. The conidial state, named *Spilocaea pomi*, causes secondary infections on all succulent plant parts throughout the period of apple growth. Secondary lesions on leaves are often diffuse and tend to be more prominent along the veins. On fruit, secondary lesions may appear as small spots around larger primary scab lesions.

Tissues that become infected while still enlarging are initially stimulated to overgrow, which results in raised lesions (scabs) on fruit, bumps on succulent twigs, and curled or puckered leaves. Such tissues

cease growth prematurely resulting in additional deformity which is most noticeable on the fruit.

Conidia require **less** time than ascospores (Table 1) for germination, penetration, and infection. Unless controlled, new secondary infections by conidia develop with each rain during the summer and may occur into the early autumn. Severely infected leaves turn yellow and drop from early summer into the autumn. The scab fungus overwinters in these dead fallen leaves completing the disease cycle.

Table 1. Time of Continuous Wet Foliage Required for Scab Infection at Different Temperatures

Temperature, degrees Fahrenheit	Temperature, degrees Celsius	Wet period required for infection: Primary (ascospores)	Wet period required for infection: Secondary (conidia)
		hours	
32 to 40	0 to 4	48	45
41 to 42	5 to 6	30	27
43 to 45	6 to 7	20	17
46 to 50	8 to 10	14	11
51 to 53	11 to 12	12	9
54 to 58	12 to 14	10	7
59 to 76	15 to 25	9	6
77+	25+	11	8

Table 2. Time Required at Different Temperatures from Scab Infection to Formation of Conidia (Summer Spores)

Temperature, degrees Fahrenheit	Temperature, degrees Celsius	Period required for conidial development following infection
		days
30 to 40	1 to 4	18
41 to 45	5 to 7	16
46 to 50	8 to 10	14
51 to 55	11 to 13	13
56 to 60	13 to 15	12
61 to 65	16 to 18	10
66 to 70	18 to 21	8
71 to 75	21 to 23	7

CONTROL

1. Maintain trees by annual pruning, watering during summer droughts (soil should be moist 12 inches deep), and other beneficial cultural practices. These are outlined in Midwest Tree Fruit Pest Management Handbook.

2. Apple scab is controlled primarily by thorough applications of fungicides sprayed at 7- to 10-day intervals. Make the first application when the buds begin to open (budbreak or green tip) and continue until frequent and prolonged wetting periods are uncommon (usually about July 1). It is important to thoroughly spray the developing buds, expanding young leaves, and fruit with each spray. Apply sprays on calm days or nights when the temperature is above 40°F (4°C) but below 80°to 85°F (26.7° to 29.4°C).

Home fruit growers should follow the spray program for apples and crabapples outlined in Midwest Tree Fruit Pest Management Handbook. Collecting and composting or burning fallen leaves is of limited value in controlling scab in the home orchard.

Nurserymen and arborists should follow the spray program for crabapple, apple, and pear outlined in the Midwest Tree Fruit Pest Management Handbook.

Commercial fruit growers should follow the spray schedule for apples outlined in the Illinois Commercial Tree Fruit Spray Guide, 2000 which is revised annually and contains up-to-date information on fungicides and rates necessary to control this disease. Thorough coverage is essential. There are a number of fungicides that provide a "kickback" action for a period of 96 hours after the start of a scab infection. These fungicides become locally systemic in the plant. Commercial growers needing extended kickback action will find them particularly useful.

3. Commercial fruit growers and nurserymen interested in reducing the number of fungicide applications might rent or buy a microcomputer that monitors the amount of rainfall, duration of wetting periods, and records the temperature during these periods in the orchard or nursery. The computer makes recommendations as to whether an infection period has occurred, whether or not a spray is required, and which type of fungicide (protective, curative, or both) should be used.

4. Apple varieties in Illinois vary considerably in their susceptibility to apple scab. Red Delicious (with its bud spots), Golden Delicious, McIntosh, and Winesap are very susceptible. Jonathan is also very susceptible. Prima, Priscilla, Jonafree, Freedom, Liberty, Dayton, Williams Pride, Goldrush, and Enterprise are new apple varieties that are highly resistant or immune to the scab fungus.

5. Crabapples also vary in their susceptibility to apple scab and other important diseases. Table 3 lists important characteristics of 27 crabapple species, varieties, and cultivars that are suggested for growing in Illinois. Many of these crabapples are highly resistant or immune to scab and several other major diseases. Table 4 lists other modern crabapples, not suggested for growing in Illinois, that are highly resistant or immune to scab and other important diseases. Your local nursery will probably have several of these modern crabapple varieties or will order them for you.

Publications referred to in this RPD are available at Information Technology Communications Services, 58A Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801 (217)333-2007.

Table1. Characteristics of Crabapples Suggested for Growing in Illinois

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

[a]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.

[b]The cultivars 'Gibb's Golden Gage' and 'Tina' have been FREE of scab, fire blight, rusts, powdery mildew, and frogeye 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 4. 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 (PLT 788-58)	cv Morden 19-27
cv Bakatong	cv Henningi	cv Mount Arbor Special
cv Burton	cv Henry Kohankie	cv Professor Sprenger
cv Case Seedling	cv Honeywood #14 hybrid (scab immune clone GR 700-58)	cv R.M.J. 102
cv Centennial	cv Minn 1492	cv Robinson
cv Golden Gem		cv Simpson 4-28
cv Golden Gem (BD) 115-58)		cv Simpson 11-57
		cv Simpson 11-58