Apple Scab

PNW0582

Figure 1. Apple Scab. Warty, necrotic lesions on leaves, infected by *Venturia inaequalis*. (Photo courtesy of Dr. M.A. Ellis, Department of Plant Pathology, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH)

Figure 2. Apple Scab. Circular, necrotic lesions on fruit infected early in development. (Photo courtesy of M.A. Ellis)

Figure 3. Apple Scab (Pinpoint Scab). Small black spots resulting from infections occurring late in fruit development.

Apple scab is a fungal disease most common in areas of relatively high rainfall and relative humidity. However, scab outbreaks can occur even in arid climates, such as central Washington and southwestern Idaho. If uncontrolled, the fungus may defoliate trees and blemish fruit to a point where it is unmarketable. The disease is particularly troublesome under overtree irrigation.

Symptoms

The apple scab fungus infects leaves and fruits. Initially, velvety olive-green spots appear on the leaves (Figure 1). Eventually the lesions enlarge, turn brown or black and assume a scabby appearance. Infection on or near the petiole may result in leaf drop.

The scab fungus can also infect fruit during any stage of fruit development, but fruit becomes less susceptible with maturity. Infections occurring very early in development may result in a blossom blight and possibly fruit drop.

Symptoms on mature fruit infected early in development include olive-green or brownish warty lesions (Figure 2). Sometimes the scab lesions may develop deep cracks in the fruit. Small black spots resulting from infections occurring late in fruit development are termed "pinpoint" scab (Figure 3). Although infection occurs only in the orchard, pinpoint scab symptoms do not develop until the apples are in storage.

Pathogen and Disease Cycle

The fungus causing apple scab, *Venturia inaequalis*, overwinters in colonized dead leaves (Figure 4). The fungus survives the winter in these leaves in the form of a structure called a pseudothecium or perithecium.

Spores (known as ascospores) are produced within the pseudothecia and are discharged during rainy or wet periods in the spring. Ascospores landing on wet leaves or fruit germinate in the water film if temperatures are suitable.

Once the initial ascospore-caused infections (called primary scab) are established, the fungus continues to grow in the infected tissue and eventually produces a second type of infectious spore (known as a conidium) in the scab lesions. Infections resulting from conidia are termed secondary infections. After leaf fall, pseudothecia form ensuring a means for the fungus to survive the upcoming winter.

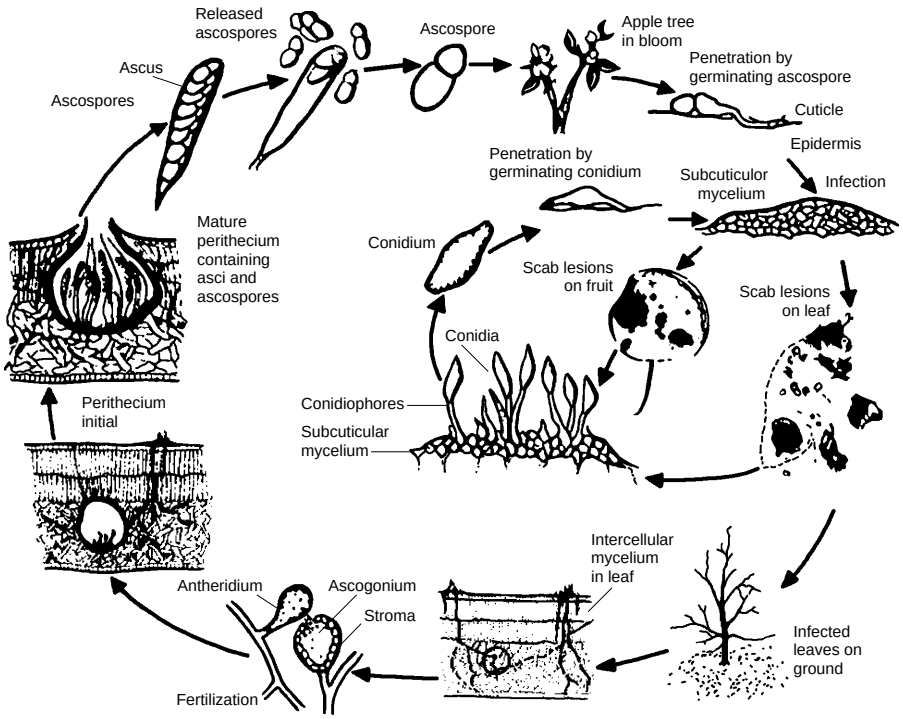

Figure 4. Disease cycle of apple scab. (From G.N. Agrios, Plant Pathology, [Second Edition], copyright 1978 by Academic Press, Orlando, FL. Used with permission of G.N. Agrios and Academic Press)

All spores of the apple scab fungus require a film of free water for a given period of time to ensure germination and subsequent infection. The wetness periods required are temperature dependent and are presented in Table 1.

The optimum temperature for ascospore germination is 70˚F (20˚C). At this temperature a wetness period of nine hours is required to result in a light level of infection. As the wetness period lengthens at a given temperature, the level of infection becomes more severe. As temperatures increase or decrease away from this optimum temperature, longer wetness periods are required for spore germination, e.g., 20 hours of wetness at 45˚F are required to reach the level of infection expected after 9 hours of wetness at 70˚F (20˚C).

If two wetness periods are separated by a period of eight hours or less, the wetness periods should be added together. Recent research in the eastern U.S. indicates that the wetness periods required for secondary foliar infections are about 2.5 hours more than those required for primary infections.

Control

Apple cultivars vary in their susceptibility to apple scab. Scab resistance or susceptibility of various apple cultivars is presented in Table 2. Ornamental crabapples can also be severely impacted by scab. The most susceptible cultivars can be defoliated every year and also exhibit tip dieback if spray programs are not followed. Ornamental crabapple cultivars suggested for use in the region are presented in Table 3. They will produce showy flowers, maintain their leaves throughout the summer, and produce showy fruit with minimal or no fungicide application.

Because the scab fungus overwinters in fallen leaves, the disease can be partially controlled by raking and burning. However, fungicide sprays usually provide the only practical means of scab control in commercial orchards.

Correct spray timing during the primary scab cycle lessens the need for extensive fungicide applications during the latter stages of disease development. The critical period for scab control is from the beginning of bud growth until the apples are $^1/_2$ inch (1.27 cm) in diameter.

In order to properly control secondary scab, orchards should be closely monitored for primary scab. Fungicides should be applied if one or two scab lesions per tree are present. Irrigation sets 12 hours or longer should be avoided.

There are two approaches to control apple scab using fungicides—protective and postinfective (kickback or eradicant). A combination of both types of programs can be followed. The protective schedule is the least complicated, but usually requires more applications.

Sprays should be applied as soon as susceptible tissue is exposed in the spring and every 7–10 days throughout the season if scab is present on the leaves, or until all of the overwintering spores are gone. The interval between sprays is dependent

Table 1. Approximate hours of wetting necessary to produce primary apple scab infections and approximate number of days required for lesions to appear.

Average temperature (ºF)	Light infection	Moderate infection	Heavy infection	Days for lesions to appear
33–36	48	72	96	?
37	48	72	96	?
38	41	55	68	?
39	33	45	60	?
40	29	41	56	?
41	26	37	53	?
42	23	33	50	17
43	21	30	47	17
44	19	28	43	17
45	17	26	40	17
46	16	24	37	17
47	15	23	35	17
48	15	20	30	17
49	14.5	20	30	17
50	14	19	29	16
51	13	18	27	16
52	12	18	26	15
53	12	17	25	15
54	11.5	16	24	14
55	11	16	24	14
56	11	15	22	13
57	10	14	22	13
58	10	14	21	12
59	10	13	21	12
60	9.5	13	20	11
61	9	13	20	10
62	9	12	19	10
63–75	9	12	18	9
76	9.5	12	19	–
77	11	14	21	–
78	13	17	26	–

[1] Hours of wetness from the beginning of rain (data of W.D. Mills as modified by A.D. Jones). If sporulating lesions are already present, wetting periods required to produce secondary infections are approximately 3 hr less than those listed in the table for primary infection.

[2] Number of days required for lesions to appear after infection has been initiated. No further wetting is required. Additional days may be required if conditions are unfavorable for lesion development (prolonged periods above 80˚F or very dry weather).

[3] From W.D. Mills, Cornell University. Mills, W.D. 1994. Efficient use of sulfur dusts and sprays during rain to control apple scab. N.Y. Agr. Exp. Sta. Ithaca Ext. Bull. 630, 4 pp.

Table 2. Apple cultivar resistance or susceptibility to apple scab.

Cultivar	Resistance
Akane (W)*	resistant
Braeburn	susceptible
Chehalis (W)*	resistant
Criterion (E)	susceptible
Fuji (E)	susceptible
Gala (E,W)	susceptible
Golden Delicious (E,W)	susceptible
Granny Smith (E)	susceptible
Gravenstein (W)	susceptible
Idared (W)	susceptible
Jonagold (E,W)	susceptible
Liberty (W)*	immune
McIntosh (E)	susceptible
Melrose (W)	susceptible
Mutsu (E,W)	susceptible
Paulared (W)*	resistant
Prima (W)*	immune
Red Delicious (E)	susceptible
Rome (E)	susceptible
Spartan (W)	susceptible
Summer Red (W)	susceptible
Tydeman's Red (W)*	resistant
Yellow transparent (E,W)	susceptible

(E) Cultivars commonly grown east of the Cascade Mountains.
(W) Cultivars commonly grown west of the Cascade Mountains.
(*) Resistant cultivars not usually requiring fungicide applications even in western Washington's wet climate.

Table 3. Scab tolerant flowering crab varieties recommended for use in the Pacific Northwest.

Cultivar	Flower Color	Fruit Color	Growth Habit
Donald Wyman	W	R	T
Red Jewel	W	R	T
Sugar Tyme	W	R	T
Zumi (cv. calocarpa)	W	R–O	T
Jewelberry	W	R	S
Sargent's Flowering Crab (Malus sargentii)	W	R	S
Bob White	W	Y	T
Japanese Flowering Crab (Malus floribunda)	W–P	Y–P	T
Ormiston Roy	W–P	Y–P	T
Professor Sprengler	W–P	Y–O	T
Adams	R	R	T

W = white, O = orange, P = pink, R = red, Y = yellow, T = tree, S = shrub

on the rate of growth of the host, weather conditions, and stability of the fungicide.

The postinfection approach to control requires accurate monitoring of orchard temperatures and length of time the leaves remain wet. It is imperative the grower has access to accurate local weather information. When conditions are favorable for scab development (when an infection period occurs), sprays are applied.

Most fungicides having postinfective (kickback, reach-back, or eradicant) activity indicate on their labels the maximum time available to complete spraying after the beginning of the infection period.

Three items should be considered when interpreting these times: (1) maximum times available for post-infective fungicide activity; (2) times are determined under optimal infection conditions and can thus be extended under less favorable temperatures (the fungus requires longer wetness periods for infection at hotter or cooler extremes); (3) times specified are given under the assumption a high level of control is desired (if the application is not complete when the time limit is reached, spraying should continue as some control will be achieved for a period after that listed on the fungicide label).

Some of the newer systemic fungicides have excellent postinfective activity, but limited protective capabilities. Resistance of the scab fungus to certain fungicides may develop after the products have been used exclusively. Be sure to follow label directions regarding the limitations on maximum seasonal use rates, spray intervals, and information about tank mixtures of protectant and postinfective type fungicides. For the most current fungicide recommendations, growers are referred to EB0419, *Crop Protection Guide for Tree Fruits in Washington*, which is updated every year by Washington State University Extension. Information also is available in *Pacific Northwest Plant Disease Management Handbook*, which is annually updated by Oregon State University.

Homeowners not wanting to apply fungicides should plant scab-resistant cultivars. If desired cultivars are susceptible, dwarf or semi-dwarf trees should be planted to allow good spray coverage. Rake and destroy leaves; do not put them in a compost. Prune to open the tree up allowing good air circulation and light penetration. Apply a registered fungicide at prebloom (prepink to pink stage), petal fall, and then every 7–10 days until dry weather.

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