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report on **PLANT DISEASE**

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APPLE SCAB

Apple scab, caused by the fungus *Venturia inaequalis*, is an important disease of apple and crab apple in Illinois. Apple scab develops in all unsprayed orchards in Illinois. The losses from apple scab are: (1) yield reduction; (2) fruit quality reduction; (3) premature defoliation; (4) weakened trees; and (5) increased production costs.

SYMPTOMS

The first scab infections appear on the under surface of the flower sepals or flower cluster leaves as small, irregular spots that range from light brown to olive green. Gradually, all leaves may be infected. As the infection progresses, the spots become circular and slightly velvety and olive green. The spots gradually turn dark brown to metallic black. 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 (Figure 1). Petioles (leaf stems) are also infected by the scab fungus, which results in early defoliation. Early defoliation results in reduced fruit bud development for the next year's crop.

Figure 1. Apple scab symptoms on upper and lower leaf surfaces.

Figure 2. Spots, cracking, and deformation of apple fruit caused by apple scab. Babadoost

Fruit infections appear a few weeks after bloom as nearly circular, velvety, dark olive green lesions with the cuticle ruptured at the margins. Older lesions become black, scabby, and fruit often cracks (Figure 2). This cracking of the fruit provides avenues of infection for various rot-producing fungi. Severe early infection results in deformed fruit. Later infections result in small lesions either in the orchard or during storage.

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DISEASE CYCLES

The scab fungus overwinters in infected leaves that have fallen to the ground. The fungus forms fruiting bodies (pseudothecia) which are embedded in the leaves near the surface. Sacs (asci) filled with the primary or spring spores of the fungus (ascospores) start to develop within the pseudothecia during winter and spring and mature at the time of bud break (green tip). Mature ascospores are released in early spring; usually peaks are during the time from pink through bloom. Ascospores are blown to nearby trees by wind currents, then germinate in a film of water on the surface of leaves and fruit and infect the tissues. On each infection site, thousands of secondary or summer spores (conidia) are produced, which are dispersed and cause new (secondary) infections. Because numerous additional conidia are produced on each new spot, repeated secondary infections have an epidemic effect on disease development.

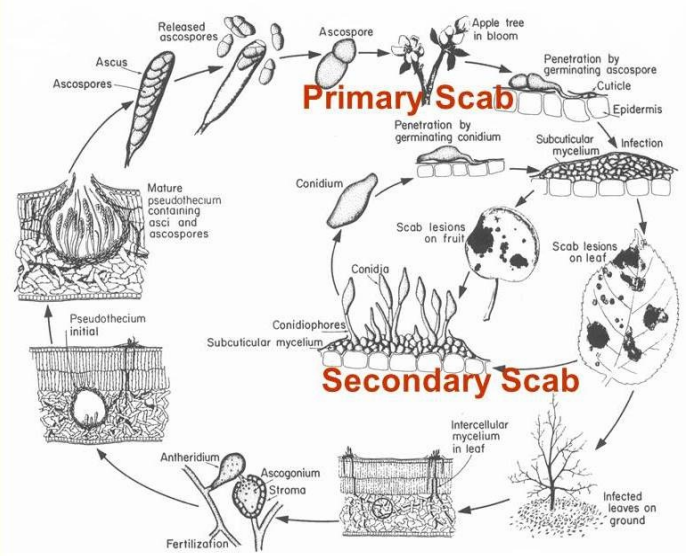

Figure 3. Life cycle of apple scab, caused by the fungus Venturia inaequalis.

The production of conidia is affected by humidity: levels of at least 60-70% are required for spore production. Infection of leaves by ascospores and conidia is highly dependent on how long the leaves or fruit stay wet, and on the average temperature. The Mills table relating leaf wetness duration and temperature is used to determine the likelihood that infection will occur if conidia are present (Figure 3). For example, at an average temperature of 18° C (65° F), light infection will result if leaves remain wet for nine hours, but if

Table 1. Wetting period (in hours) required for apple scab infection at different air temperatures, and time required for development of conidia by lesions at different air temperatures. W.D. Mills, Cornell University, as modified by A.L. Jones, Michigan State University. Adapted from the website of the American Phytopathological Society.

		Wetting period (HOURS)			
Average Temperature (F)	Average Temperature (C)	Light Infection	Moderate Infection	Heavy Infection	Incubation Period (days)
78	25.6	13	17	26	...
77	25.0	11	14	21	...
76	24.4	9.5	12	19	...
63-75	17.2-23.9	9	12	18	9
62	16.7	9	12	19	10
61	16.1	9	13	20	10
60	15.6	9.5	13	20	11
59	15.0	10	13	21	12
58	14.4	10	14	21	12
57	13.9	10	14	22	13
56	13.3	11	15	22	13
55	12.8	11	16	24	14
54	12.2	11.5	16	24	14
53	11.7	12	17	25	15
52	11.1	12	18	26	15
51	10.6	13	18	27	16
50	10.0	14	19	29	16
49	9.4	14.5	20	30	17
48	8.9	15	20	30	17
47	8.3	17	23	35	17
46	7.8	19	25	38	17
45	7.2	20	27	41	17
44	6.6	22	30	45	17
43	6.1	25	34	51	17
42	5.5	30	40	60	17

leaves are wet for 18 hours or more heavy infection will occur. Lesions will produce conidia after nine days if the temperature averages 18° C (65° F), but not until 17 days if the temperatures are lower, averaging only 8° C (49° F). The Mills table continues to be revised as more data are gathered from different regions (Table 1).

DISEASE MANAGEMENT

Management of apple scab can be achieved by planting resistant cultivars, cultural practices, and fungicide applications.

Scab-resistant apples are available. Fungicide applications to these trees are not needed for scab management, although they may be necessary to control other fungal diseases. Some of the resistant cultivars to scab are 'Dayton', 'Enterprise','Freedom', 'Gold Rush', 'Honeycrisp', 'Jonafree', 'Liberty', 'McShay', 'Pixie Crunch', 'Pristine', 'Redfree', and 'William's Pride'. Some of the susceptible cultivars are 'Beacon', 'Cortland', 'Fuji', 'Gala', 'Golden Delicious', 'Haralson', 'Honeygold', 'Keepsake', 'McIntosh', 'Paula Red', 'Sweet Sixteen', 'Wealthy', 'Winesap', and 'Zestar'.

Cultural practices. Main cultural practices are disposing fallen leaves on the ground, removing crab apple at the edges of the orchard, and proper pruning of trees. To reduce the overwintering scab fungus, leaf litter on the orchard floor after leaf fall can be disposed by raking and burning or by moving and application of 5% urea (approximately 40 pounds urea in 100 gallons of water) onto leaves on the floor. To prevent spread of inoculum from crab apple trees to apple trees, crab apple trees at the edges of the orchard should be removed. To have good air movement in the canopy and good coverage of canopy with fungicides, apple trees should be pruned properly.

Chemical management. Apple scab is primarily managed by fungicide application. For the update on chemical management of apple scab, refer to the Midwest Fruit Pest Management Guide 2016 (https://ag.purdue.edu/hla/Hort/Documents/ID-465.pdf). Management of apple scab on susceptible trees is focused on the prevention of primary infection by ascospores in the spring. The initial fungicide sprays are therefore timed to coincide with the spring release of primary inoculum. Later sprays are often targeted at other fungal diseases, in addition to scab, but also are effective against apple scab secondary inoculum. In commercial orchards, airblast sprayers are typically used to apply fungicides.

Chemical fungicides for apple scab control are generally of two types, preventive (protectant) and curative. Most growers use a combination of the two for maximum effectiveness. Preventive fungicides are applied to the leaves and fruit before infection. When ascospores or conidia are present on susceptible plant surfaces and leaf moisture and temperature are suitable, the fungicide prevents the fungal spores from germinating or penetrating the host tissue. Good spray coverage and uniform deposition are essential. To ensure coverage of newly emerging tissues and to replace the chemical as it is lost to weathering, fungicides must be re-applied on a regular schedule. Usually this consists of spraying every 7 days in the early season. Curative fungicides have limited systemic activity and if applied soon after infection, they are capable of penetrating the leaf and stopping further development of the fungus. In Illinois, effective chemical control of apple scab from the green-tip growth stage of trees through the fist-cover spray (approximately 10 days after petal fall) is essential.

During 2011-2013, severe scab was observed in some apple orchards in Illinois. Incidence of scabby fruit of some varieties (e.g., Fuji) exceeded 50%. Samples of infected fruit were tested for resistance of the fungus to fungicides. The results showed that there were strains of *V. inaequalis* resistant to fungicides Rally (myclobutanil), Sovran (kresoxim-methyl), and Syllit (dodine), which are major scab fungicides in Illinois. According to the fungicide resistance action committee (FRAC), modes of actions of these fungicides are in the groups 3, 11, and M for Rally, Sovran, and Syllit, respectively. To develop effective management of the fungicide resistant of *V. inaequalis* strains, we conducted some orchard trials, which had excellent results. So, the recommendation for management of apple scab in the early season in Illinois is. Dithane M-45 (mancozeb) at 3-4 lb per acre (lb/A), Inspire Super (difenoconazole + cyprodinil) at 12 fl oz/A, and Fontelis (penthiopyrad) at 20 fl oz/A. Dithane M-45 + Inspire Super are applied at green-tip, tight cluster, and one week after petal fall (the first-cover). Dithane M-45 + Fontelis are applied at ½-inch green, apple pink, and petal fall. Label recommendations of the fungicides should be closely followed.