# Apple Scab

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Bemis Note: This is information from the Cornell Cooperative Extension Service. It is intended for commercial orchards and there is more detail than home gardeners need, so just skim through what you don't feel like reading.

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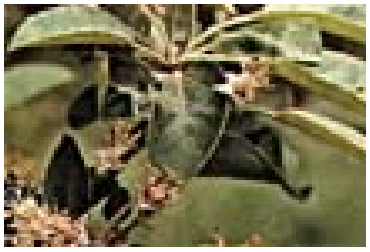
Apple scab is the most economically destructive disease of apples in the world. In the Northeast it is usually not possible to produce apples commercially without some program to control this disease.

**Symptoms**

Scab may occur on leaves, fruit, leaf and fruit stems, and green twigs. Infections of the leaves and fruit are most common and obvious. Early season infections usually occur on the underside of the blossom cluster leaves because these are the first tissue surfaces to emerge from buds in the spring. Once the cluster leaves have unfolded and terminal leaves begin to develop, infections become evident on the upper surface of the leaves. Individual infections appear as roughly circular, brown to dark olive-green spots (lesions), which often seem slightly fuzzy or velvety in texture (fig. 1). Lesions along the veins or margins often cause those regions of the leaves to distort or crinkle. Primary (ascospore) infections are usually limited to one or two distinct spots per leaf, whereas secondary (conidia) infections are often much more numerous.



Secondary infections occasionally are so numerous that the entire surface of the leaf appears covered with scab, a condition commonly referred to as sheet scab (f ig. 2).

Lesions on young fruit initially resemble those on leaves but turn dark brown to black and become corky or scablike with time. Cells near lesions on young fruit may be killed, causing these regions to become deformed or cracked as they fail to grow and expand along with the remainder of the apple (fig. 3). Primary (ascospore) infections are usually limited to one or two distinct spots per fruit, often near the blossom end because it is upturned during the early stages of fruit development (fig. 4). Secondary infections are frequently much more numerous and may be clumped or grown together, particularly if the fruit is directly beneath a concentrated source of secondary spores such as an infected leaf (fig. 5). Secondary infections that occur in late summer or early fall are often numerous and relatively small in size, a symptom referred to as pin-point scab. Infections that occur just before harvest may

be symptomless at picking yet develop into storage scab lesions after harvest.

**Disease Cycle and Causal Organism**

Apple scab is caused by the fungus *Venturia inacqualis*, which also is capable of infecting crabapple, hawthorn, mountain ash, and firethorn. Different but closely related *Venturia* species cause scab on European and Japanese pear.

In the Northeast, the scab fungus overwinters in infected leaves that have fallen to the ground. During autumn, the fungus begins to form tiny 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 by late winter or early spring. The ascospores continue to develop and become mature as spring progresses (fig. 6). A few spores are usually mature at the time of bud break (green tip), and maturity progresses slowly until about the tight cluster stage of blossom development. After this time, the percentage of mature spores begins to increase rapidly whenever temperatures are favorable for tree growth. Most ascospores have matured by the end of bloom.

Mature ascospores are discharged into the air during periods of rain. In daylight, discharge usually begins within 30 minutes after the start of the rain and is largely completed within 3 to 6 hours. When rainfall begins at night, discharge is often delayed until daybreak, although significant night discharge can occur under some conditions. The number of spores discharged during any one rain is determined by both the size of the potential ascospore "crop" for the season (how many leaves were infected the previous year) and the percentage of these spores that have matured since the last discharge. Ascospore discharge usually peaks in the time from pink through bloom, and nearly all ascospores have been discharged within 1 or 2 weeks after petal fall.

Ascospores are blown to nearby trees by wind currents, then germinate in a f ilm of water on the surface of leaves and fruit. If surface wetness continues long enough at prevailing temperatures (table 1), growth from the germinated spore penetrates and infects these organs just beneath the outer cuticle. Typical lesions, each bearing tens of thousands of secondary or summer spores (conidia), appear about 9 to 17 days later depending on temperature (table 1), although long periods of low humidity can delay their development. Conidia are dispersed by splashing rain throughout the rest of the season and are capable of causing new (secondary) infections. Because numerous additional conidia are produced on each new lesion, repeated secondary infections have a

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

| Average temp. (°F) | Infection (Hours)[a] | Lesions (Days)[b] | Average temp. (°F) | Infection (Hours)[a] | Lesions (Days)[b] |
|---|---|---|---|---|---|
| 33–36 | 48 | ? | 49 | 14.5 | 17 |
| 37 | 41 | ? | 50 | 14 | 17 |
| 38 | 37 | ? | 51 | 13 | 16 |
| 39 | 33 | ? | 52–53 | 12 | 15 |
| 40 | 29 | ? | 54 | 11.5 | 14 |
| 41 | 26 | ? | 55–56 | 11 | 13–14 |
| 42 | 23 | 17 | 57–59 | 10 | 12–13 |
| 43 | 21 | 17 | 60 | 9.5 | 11 |
| 44 | 19 | 17 | 61–75 | 9 | 9–10 |
| 45 | 17 | 17 | 76 | 9.5 | |
| 46 | 16 | 17 | 77 | 11 | |
| 47–48 | 15 | 17 | 78 | 13 | |

[a]Hours of wetness from the beginning of rain (data of W. D. Mills as modified by A. L. Jones). If secondary spores (conidia) are already present, wetting periods required to produce secondary infections are about 3 hours shorter than listed in the table for primary infection.

[b]Number of days required for lesions to appear after infection period has begun. Additional days may be required if temperatures are above 80° F or weather is dry for long periods of time.

snowball or epidemic effect on disease development.

Incidence of infection is affected by the age of leaves and fruit; young tissues generally are most susceptible. Leaves are most susceptible 1 to 5 days after unfolding and become completely resistant from the time they finish expanding until shortly before leaf drop in the autumn. Fruit are highly susceptible until about 3 to 4 weeks after petal fall, but much longer wetting periods are required for infection to occur after this time. Precise requirements for infection of mature fruit are not known, but limited data indicate that wetting periods must last at least 48 hours for significant infection to occur immediately before harvest.

**Control**

On most apple varieties, fungicide sprays are required every year for control of scab. Fungicide programs can be minimized and made most efficient by designing them around weather conditions (infection periods), inoculum availability, cultivar susceptibility, and specific characteristics of the available fungicides.

Season-long control of apple scab is difficult if primary infections are allowed to develop. Even moderate numbers of primary lesions can produce an extremely large population of conidia, requiring an intensive fungicide program to protect fruit throughout the summer. Conversely, good control of primary infections allows use of fungicides to be reduced or omitted during the summer, once ascospores have been depleted and fruit become less susceptible.

Control of primary infections has traditionally begun at or shortly after green tip, when the first ascospores become mature. The percentage of spores that are mature at this time is low, and the actual number of mature spores may be insignificant during the early stages of bud development if very little leaf scab developed the previous year (that is, the seasonal ascospore "crop" is small). Various systems for determining when fungicide programs must begin in "clean" orchards have been developed; check with your adviser for their current status.

Apple scab fungicides control disease in different ways. Some are most effective as protectants, some when applied after an infection period, and some can suppress production of conidia from established lesions. Understanding these activities and knowing which fungicides exhibit them is important for maximizing the efficiency of a fungicide program. Such information is available through Cornell Cooperative Extension.

Standard apple cultivars vary widely in their susceptibility to scab, which will influence the intensity of the control program necessary for a particular variety. In the Northeast, Jersey Mac is extremely susceptible; Mclntosh and its progeny (Cortland, Macoun, Empire) are highly susceptible; Rome, Red Delicious, R. 1. Greening, Crispin, 20-Ounce, and Northern Spy are moderately susceptible; and Golden Delicious, IdaRed, Jonathan, and PaulaRed are moderately resistant. (Because the scab fungus has different races, these rankings are not necessarily applicable to other regions where different races may predominate.) Cultivars that are immune to apple scab are available, including some with fruit quality that appears to be commercially acceptable (e.g., Liberty, Florina, Goldrush); additional selections are being evaluated. Growers interested in minimal or "organic" pesticide programs should strongly consider planting such varieties.

Apple Scab Disease Cycle