Apple Scab

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NYS IPM Tree Fruit Crops Fact Sheet Series (Revised)

Introduction - Apple scab is the most economically destructive disease of apples in the world and can be especially severe in the Northeastern states. It is usually not possible to produce apples commercially without some program to control apple scab.

Early apple scab lesions on the lower leaf surface (fig. 1), and more advanced lesions on upper leaf surfaces and flowers (fig. 2).

Symptoms - The first symptoms of the disease are usually found on the underside of emerging cluster leaves (fig. 1). However, symptoms may first develop on the upperside of these leaves in cases where significant infection was delayed (fig. 2). Young lesions are velvety brown to olive green and have feathery, indistinct margins. Lesions expand with time and may coalesce with other leaf lesions. The number of lesions can vary from very few to several hundred per leaf. Young leaves with significant infection often curl, shrivel, and fall from the tree. However, it is not atypical for infected leaves to remain on the tree for the entire season. The term sheet scab refers to the condition when the entire leaf surface is covered with the disease; when this occurs, leaves typically shrivel and fall to the ground. Eventually, fungal growth stops and the lesions develop distinct margins. The infected leaf tissue around lesions often becomes thickened and results in a bulging of the infected and corresponding cupping of the area underneath the leaf lesion. Lesions on the petiole (leaf stem) extend along the length of the petiole and are

similar in appearance to those on the leaf. Severe infection of the petiole typically leads to a yellowing of the infected leaf and eventual leaf drop (fig. 3).

Leaves turning yellow due to apple scab lesions on leaf stems (fig. 3), and apple scab infection on young fruit (fig. 4).

On the fruit, young lesions appear similar to those on leaves (fig. 4). Although the entire surface of the fruit is susceptible to infection, lesions often cluster around the calyx end of the fruit. As lesions get older they become brown and corky and take on a "scabby" appearance (fig. 5). Early infections kill the expanding tissue which often results in deformed fruit. As lesions age, they will often crack and may serve as an opening to invasion by secondary pathogens. Infections later in the season are often not detectable until after harvest when the fruit are in storage. This is referred to as "pin-point scab". The term "storage scab" refers to incipient infections that were too small to see prior to fruit storage or may be the result of infections during storage that occur as a result of sporulation from older scab lesions.

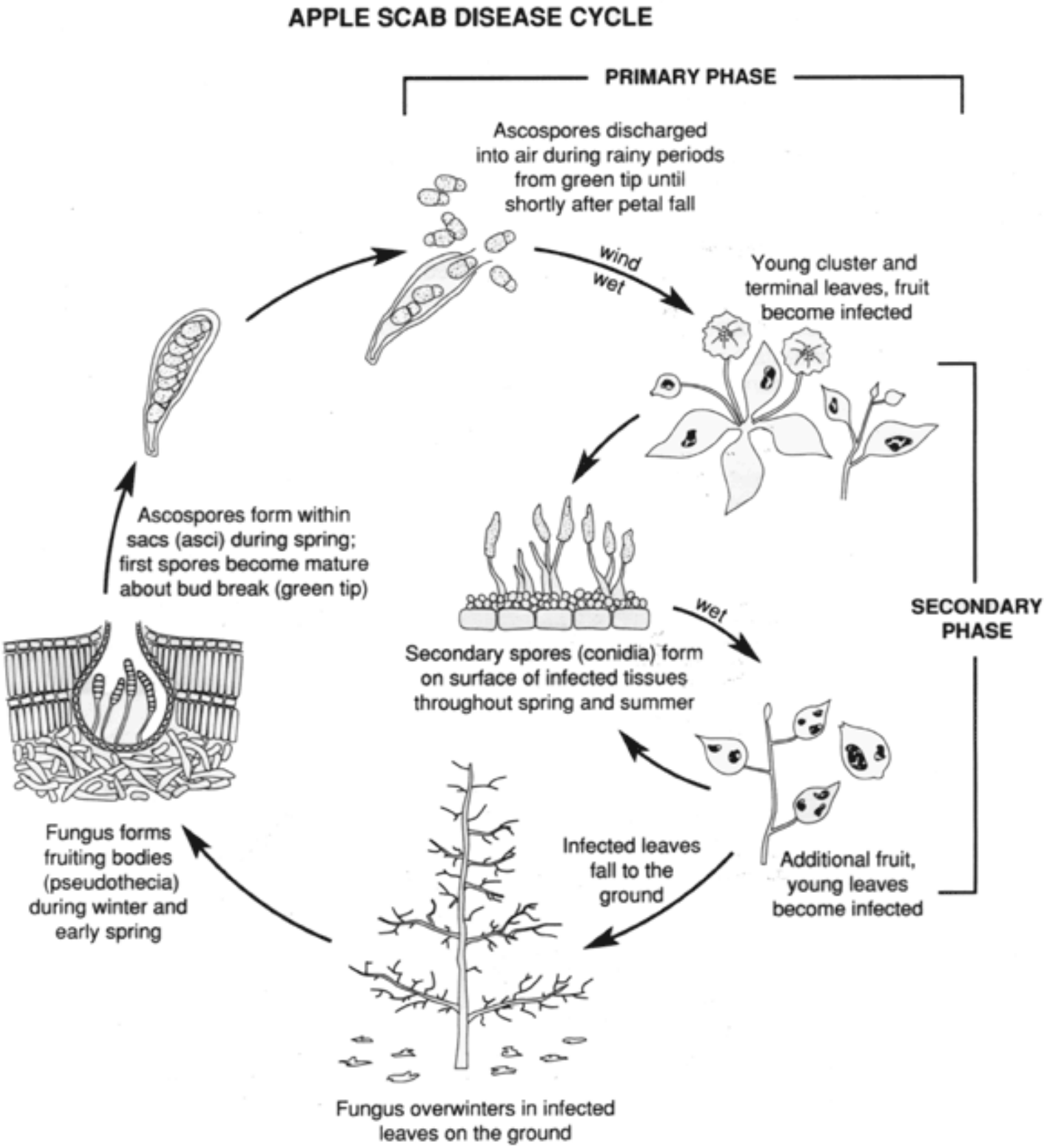
Apple scab lesions on fully developed fruit (fig. 5), and an example of an old leaf harboring apple scab

lesions for the next years epidemic (fig. 6).

Disease Cycle - Apple scab is capable of infecting crabapple, hawthorn, mountain ash, and firethorn. Different but closely related Venturia species cause scab on European and Japanese pear.

Close-up of leaf surface with apple scab pseudothecia (green circle) under the leaf surface (fig. 7), and ascospores within an ascus of *Venturia inaequalis* (fig. 8).

In the Northeastern United States, the scab fungus overwinters in infected leaves that have fallen to the ground (fig. 6). During autumn, the fungus begins to form tiny fruiting bodies, called pseudothecia, which are embedded in the leaves near the surface (fig. 7). Sacs, called asci, filled with the primary spores, called ascospores, start to develop within the pseudothecia by late winter or early spring (fig. 8). The ascospores continue to develop and become mature as spring progresses. 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.



Life Cycle of *Venturia inaequalis* (Cornell University, NYSAES, Geneva, NY.).

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 between the stages of pink throught 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 film of water on the surface of leaves and fruit. If surface wetness continues long enough at prevailing temperatures (Apple Scab Disease Index), growth from the germinated spore penetrates and infects the tissues just beneath the outer cuticle (waxy surface layer of the plant). Typical lesions, each bearing tens of thousands of secondary spores, called conidia, appear about 9 to 17 days following the initial infection. The rate of secondary spore production is dependent on temperature and long periods of low relative 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. Numerous additional conidia are produced on each new lesion causing repeated secondary infections. These secondary infections, if left unchecked, have a snowball or epidemic effect on the rate of 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 Measures - 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. This information is available through Cornell Cooperative Extension's The Pest Management Guidelines for Commercial Tree-Fruit Production.

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.I. Greening, Crispin, 20-Ounce, and Northern Spy are moderately susceptible; Golden Delicious, Ida Red, Jonathan, and PaulaRed are moderately resistant. These susceptibility rankings are not necessarily applicable to other regions where different races of the apple scab fungus 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.