What Part do Flyspeck Ascospores Play in Disease Development?

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Flyspeck is one of the major summer-disease concerns of apple growers in the Northeast. Yet for most of the season, there is little evidence of the fungus within the orchard. In a dry year, signs of infection may not appear until as late as August.

For several years we have been conducting investigations aimed at gaining a better understanding of the natural biology of this fungus. We know that it survives the winter on a number of wild hosts that are common to most orchard borders such as blackberry, maple, grape, Virginia creeper, and red oak. We also know that, like the apple scab fungus, it produces two types of spores: ascospores in the late spring and repeating cycles of conidia or asexual spores later in the season.

However, unlike apple scab, which produces its first cycle of spores within the orchard where well-timed sprays can control the disease, flyspeck ascospores are produced primarily in the orchard borders on alternate hosts. We wanted to know what part these early spores play in disease development later in the season.

The flyspeck spots that form on apples, blackberries, and other hosts in late summer are pseudothecia, the overwintering structure of the organism. By late winter these structures have matured and are ready to produce spores. In the laboratory, we have seen that spore development is driven by both temperature and humidity. Humidity must be quite high - mature spores are produced at 99% humidity but not at 96%. Average temperatures above 50°F are also necessary for spores to develop and mature. In New England, these conditions can be met for significant portions of the day in the field by late May.

In the spring of 1997, blackberry canes with pseudothecia were gathered weekly from three sites in Western Massachusetts from late May into July. Fifty pseudothecia from each cane were examined microscopically and the presence of mature spores was recorded. Table 1 shows the results of this study.

The 1997 information conforms with data gathered in Amherst during 1996 that showed that there is a single period of ascospore release that occurs in late spring to early summer. An unusually warm, wet spring in 1996 compressed the period of ascospore maturity to a shorter period of time, earlier in the season. Apple-tree phenology can be used as an aid to predict when this period will occur in a given year.

The ascospores produced on the host plants in the orchard borders are released into the air but we do not know if they are transported as far as the orchard block.

Even if these initial spores are carried to apple trees however, it is likely that the spray program aimed at controlling apple scab ascospores will also control early-season infections of flyspeck.

Information from Dr. David Rosenberger indicates that the broad-spectrum protectant fungicides commonly used for scab, Mancozeb and Captan, will protect against flyspeck for a significant period. Mancozeb used at 1 lb/100 gal. or Captan 50W at 2 lb/100 gal. will protect fruit for at least 21 days or 2.5 inches of rain, whichever comes first. Captan 50W at 1b/100 gal. protects for 14 days or 2 inches of rain. If the last scab spray of the season contains one of these fungicides, and is made in early to mid-June, fruit will be protected to late June or early July.

Table 1. Flyspeck ascospore maturity in relation to apple tree phenology.

Site	First mature spores: Date	First mature spores: Apple phenology	Last mature spores: Date	Last mature spores: Apple phenology
Amherst, 1997	May 24	mid petal fall	July 3	1 1/8" fruit
Shelburne, 1997	June 3	90% petal fall	July 6	1 1/4" fruit
Sterling, 1997	May 20	full bloom	July 10	1" fruit
Amherst, 1996	May 13	late bloom	May 29	1/4" fruit

If infections from the initial cycle of spores are not the primary cause of late season symptoms in the orchard, then conidia must be. We wanted to know if inoculum could be building up in the woods and borders, in the form of conidia, and moving into the orchard sometime later in the summer.

Previous studies have shown that trees closer to the borders have a much higher incidence of flyspeck (*Fruit Notes* 61(2):1-4, 1996). But flyspeck symptoms are rarely seen before the end of July and have never been seen early in the season.

Based on the fact that there are repeated yearly infections of the numerous host plants in the orchard border, we knew that ascopores germinate in the field and cause infections. The typical lifecycle of the fungus begins with the ascospore germinating to form a colorless mycelium which live off the nutrients of the waxy surface layer of its host. Repeating cycles of conidia or asexual spores form on this mycelium, and then the typical flyspeck symptoms appear.

It is possible that ascospores create local infections in the borders and cycles of conidia proliferate on these hosts creating a reservoir of additional infections and inoculum that can move into the orchard block when environmental conditions are conducive. We know from research conducted by Dr. T.B. Sutton that flyspeck conidia are discharged primarily in the early morning hours, after periods of high humidity or heavy dews or rain, and as the levels of high humidity decrease (Sutton, *Plant Disease* 74:643-646, 1990).

During the summer of 1997 we attempted to find out if and when asexual spores or conidia were typically present within an orchard in Shelburne, Mass. The trees had been sprayed following a first-level integrated pest management schedule with the last spray of Rubigan and Pencozeb occurring on June 4. Spore traps were placed within the blackberry border, in the first row of trees about seventeen feet from the border, and in the third row of trees about seventy feet from the border. Spore trapping rods were brought back to the laboratory and spores counted twice a week starting in mid-July.

Actual numbers of spores caught on the traps were too small to analyze statistically. However, the number of conidia trapped increased dramatically during the second week of August, coinciding with an increase in heavy morning dews. The first symptoms of flyspeck were observed two weeks later on August 31. Additional data are needed to be able to predict the environmental conditions that will lead to an increase in conidial inoculum in the orchard. It does seem, though, that there is a period of time between the end of primary scab season and mid-July to mid-August, particularly in dry years, when there are few conidia in the blocks and the likelihood of flyspeck infection is very low.

In the orchard where spores were trapped, the first row of trees was sprayed only on the side away from the border. The border side of those trees was highly vulnerable to infection by ascospores, being unprotected by fungicide and in close proximity to the blackberries. Yet no flyspeck occurred until late summer, when it also occurred on the sprayed side of the trees as well as in other blocks in the orchard. This coincided with a change in environmental conditions that either stimulated the fungus to grow or promoted an influx of conidial inoculum into the orchard from the borders. This supports our contention that ascospores play little or no role in direct infections on fruit, but instead it is conidia moving from border plants that inoculate the crop.

In summary, flyspeck ascospores form in the orchard borders and surrounding woods rather than in the orchard. Ascospores are released during a single discrete period in the late spring and early summer, making it possible to relate the period of heaviest inoculum dose to apple tree phenology, generally 10 to 14 days after petal fall. These spores probably cause infections on border plants but not on orchard fruit. If any infection occur, sprays aimed at controlling scab will most likely control them. Therefore, ascospores do not seem to play a major role in producing the flyspeck symptoms that are seen in late summer in Massachusetts, and efforts need to be focused on controlling infections caused by conidia from mid-July thru harvest.

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