Final Project Report to the NYS IPM Program, Agricultural IPM 2000 – 2001

Title:
Using Apple Scab Pseudothecial Squash Mounts for Timing Early Scab Sprays

Project Leader(s):
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Cooperator(s):
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Type of grant:
Monitoring, forecasting, and economic threshold

Project location(s):
All of NY and portions of New England

Abstract:
Apple scab is the most important disease of apples in New York State where apples are grown on more than 50,000 acres. Apple growers control apple scab by applying fungicides to prevent infections on leaves and fruit. Growers can avoid unnecessary fungicide sprays if they know when the apple scab ascospores in the over-wintering leaf litter will be released. Eliminating one fungicide spray on all of the apple acreage in New York would save growers approximately $1.2 million each year, but eliminating a spray when it is really needed could cause losses equal to at least four times that potential savings. In a project funded by the New York State IPM program, samples of apple leaf litter from seven locations around New York State were assessed at critical times during spring to determine the status of apple scab ascospore maturation and release. Each of the 18 assessments involved detailed microscopic examinations of the fungal spore-producing structures after they had been removed from the leaf litter. The lead scientist provided results to extension educators who then used e-mail, code-a-phones, faxes, radio spots, and newsletters to inform apple growers about results of scab spore assessments. The scab spore assessments helped apple growers recognize that spores were available for discharge unusually early in the 2001 growing season. As a result, growers were advised to be especially careful about protecting trees during the very earliest stages of tree growth so as to avoid infections that, if allowed to occur, would have necessitated extra fungicide sprays throughout summer. This cooperative effort between scientists and Cooperative Extension field staff contributes to the profitability of the New York apple industry.

Background and justification:
Apple scab is the most important disease of apples in New York State where apples are grown on more than 50,000 acres. Apple growers control apple scab by applying fungicides to prevent infections on leaves and fruit. The disease is initiated by fungal spores (ascospores) that are

released from leaf litter remaining on the ground from the previous year. In most years, the first scab ascospores become available about the same time that the first green tissue appears in apple buds, release of spores peaks during the early stages of apple flowering, and the supply of ascospores is depleted shortly after apple trees reach the petal fall stage of development. However, factors that affect maturation and release of scab spores are not identical to the factors that govern the rate of bud development in apple trees. As a result, window for scab spore release may be shifted either forward (earlier in the season) or backward vis-à-vis tree development.

In years when scab ascospore development is advanced compared to tree development, fungicides must be applied to protect trees beginning at bud break. Failure to protect against early infections can result in establishment of fungal infections on the new leaves. These infections produce secondary spores (conidia) that spread to additional leaves and fruit. Early-season scab infections are especially damaging because they can provide abundant secondary inoculum at a time when new leaves and fruit reach maximum susceptibility. Early infections also allow time for the completion of more secondary infection cycles than would occur if infections were delayed until after bloom. When scab infections become established in an orchard before bloom, then more fungicide sprays and higher rates of fungicides are usually required throughout the remainder of the season to protect fruit against infections. Infected fruit have no commercial value.

However, when scab ascospore development is delayed compared to tree development, the first fungicide application can also be delayed, sometimes by as much as two weeks, thereby saving fungicide applications that serve no purpose. The cost of an early-season fungicide application (fungicide plus application costs) probably averages $25 per acre, so saving one application across all of the apple acreage in New York State would save New York apple growers approximately $1.2 million.

Deciding when to apply the first fungicide spray in spring represents a critical economic decision for apple growers. If growers can eliminate one spray per season by delaying the first scab spray, then they can increase profitability by reducing their production costs by about $25 per A. However, delaying the first spray in the wrong year could incur significant losses. In an orchard producing 800 bushels of high-quality fruit per A, each fruit with apple scab will represent a loss of approximately 7 cents if one assumes an orchard run price of $7.00 per bushel for 100-count fruit. If delaying the first spray ultimately results in 1% fruit scab at harvest, then the grower will lose $56 per A of marketable fruit. More importantly, to hold fruit scab losses to 1% in an orchard where prebloom scab infections occurred, the grower will need to apply fungicides more often, use higher rates of fungicides, and/or use more expensive fungicides throughout the remainder of the growing season. The amount of additional expense will vary considerably depending on how weather conditions evolve during the season. However, a grower who misses an early scab infection period in a critical year will probably incur at least $45 worth of additional fungicide costs over and above what would be necessary for orchards where early-season scab was completely controlled.

The bottom line for apple growers is that omitting one early-season scab sprays can save $25 per acre, but the cost for omitting a needed spray will be at least $100 per acre and often much more than that.

In New York State, apple scab ascospore maturity assessments have been used for many years to help growers decide when the first scab spray is needed. Pseudothecia from over-wintering apple leaves are squashed on a microscope slide and the maturity of the ascospores is assessed using standardized methods. Results from these ascospore maturity assessments provide a basis for determining if spore maturity and discharge are likely to be advanced or delayed

relative to apple tree phenology during the period between the green tip and tight cluster bud stages. Information from squash mounts has probably eliminated more fungicide applications on apples over the past 20 years than any other single IPM practice.

The microscopic examinations necessary for a squash mount assessment of scab spore maturity are time-consuming and require considerable technical expertise. Furthermore, precision of these estimates is questionable sample location, sampling methods, and the observer's technique can all affect the results. To improve accuracy and reduce costs associated with the traditional squash mount assessments, Gadoury and MacHardy (1982) developed a predictive model that uses degree-days to estimate apple scab ascospore maturity. However, the model uses the green tip bud stage as a biofix point and therefore lacks accuracy during the first week or two after bud-break. In years when weather conditions favor advanced ascospore maturity at green tip (e.g., the 1998 season in eastern NY), squash mounts can provide earlier and more accurate assessments of scab risks. In dry years, the Gadoury/MacHardy model may prematurely predict the end to the ascospore discharge season because spore development can be arrested by dry conditions, but the model does not consider leaf litter moisture content.

Mr. Frederick Meyer, technician at the Hudson Valley Laboratory, has provided apple scab ascospore maturity counts for Hudson Valley growers for more than 25 years. For the past decade, he also provided similar information for northeastern New York. A private consultant requested similar real-time information for the western part of New York State in 2001, and the New York State IPM program provided the funding necessary for this project.

The initial plan was to evaluate two early-season samples from each sampling location so as to provide ascospore maturity information during the first 7-10 days after bud break when the Gadoury-MacHardy model seems least reliable. After that, we anticipated that the model could be used for subsequent assessment of spore maturity and discharge. However, the 2001 season was exceptionally dry, and additional assessments were therefore made to assist in determining the end of the ascospore release period.

Objective:

Provide apple growers throughout New York State with reliable information on apple scab ascospore maturity during the interval between the silver tip and half-inch green bud stages.

Procedures:

Samples of apple leaf litter that contained apple scab pseudothecia were collected at critical times during spring by regional fruit specialists in Western NY (Deborah Breth) and northeastern NY (Kevin Iungerman). Similar samples were collected by Frederick Meyer at the Hudson Valley Laboratory in Highland. Optimum timing for sampling was determined via phone consulations or e-mail exchanges between the lead scientist and the sample collectors. Sampling dates were selected with the objective of collecting leaves as close as possible to critical days when growers would be making early-season spray decisions. These decision points generally occur one or two days prior to predicted rain events anytime after green tissue has developed on apple trees in spring. Cooperators in this project attempted to collect and mail samples approximately three to five days ahead of weather systems that might generate the rainfall necessary for scab infection periods. That timing allowed counts to be completed and results to be relayed back to growers before the growers had to make a final spray decision.

Leaf samples were sent by over-night mail to the Hudson Valley Lab where samples were usually counted with 24 hours. Sampling locations are shown in Fig. 1 and included all of the major apple-producing regions within the state. In Wayne and Orleans Counties, samples were

collected from two different locations because spore maturity and tree phenology can differ significantly depending on elevation and distance from Lake Ontario.

Because spring of 2001 was exceptionally dry, additional samples were collected from several sites in late May to determine when the supply of ascospores was depleted. This information was forwarded to growers in the same manner as for pre-bloom assessments.

Results and discussion:

A total of 14 pre-bloom scab maturity assessments were provided for seven different locations around New York State (Table 1). In all locations, advanced ascospore maturity during the week of bud break indicated a higher-than-normal risk from early-season infection periods. Weather forecasters repeatedly predicted extended periods of rainfall that failed to develop. Because weather systems failed to deliver the combinations of rainfall and temperature that would have been necessary for early-season scab infection periods, very little early-season scab developed in unsprayed orchards.

Throughout the state, an extended dry period developed shortly after bud break and extended until after bloom. Four additional scab assessments were made after bloom to determine if the dry weather had delayed the end of the ascospore release. The assessments confirmed that ascospore releases had been delayed and growers were therefore advised to continue fungicide coverage.

Results of the scab spore assessments were evaluated by Rosenberger and action recommendations were forwarded to the regional fruit specialists in the respective regions (Breth, Iungerman, and Fargione). The fruit specialists edited and/or reformatted this information, added their own comments relevant to their specific regions, and then released the information to growers and consultants via radio messages, code-a-phones, e-mail, faxes, and newsletters.

Action recommendations provided by Rosenberger were formulated after considering tree growth stage, results of the most recent and previous scab spore assessments for the region in question, and predicted weather patterns for the next 5 to 7 days. An example of action recommendations sent to the Cooperative Extension field staff is shown below:

April 12:

Following are the results of recent spore counts that Fritz Meyer conducted on leaves from various regions:

Collection Date	Location	% ascospores that were Immature	Mature	Empty	No. of spores in tower shoot test
April 9	Saratoga	94%	6%	0%	0 spores
April 11	Highland	76%	23%	<1%	--
April 11	Barre	76%	24%	0%	3 spores

These counts support the conclusion from our earlier count in the Hudson Valley indicating that spore maturity is advanced this year compared to tree phenology. Spores in from Saratoga are not yet ready to discharge (we need to pass 15% mature spores before that will happen on a commercially significant basis). However, trees in that area are not yet at green tip.

In the Hudson Valley, we are just now at or very close to green tip and our maturity is running parallel to what we saw in 1998 when scab got a very early start. (Official green tip = 50% of fruiting buds on Macs showing green). I think this is a year when we should caution growers to be prepared to spray as soon as green tissue is evident.

This project provided useful information that could be immediately applied by apple growers throughout the state. As noted in the "Background" section of this report, information on apple scab ascospore maturity is essential for deciding when early-season scab fungicides are needed and when they are not. Making the correct decision on early sprays saves growers money by eliminating unnecessary sprays and by helping growers to avoid losses to scab.

The information generated in this project was extensively used by private consultants. At least one consultant reported that this information had reduced losses to apple scab among the growers in his region.

The apple scab assessments conducted as part of this project were possible and effective only because of the cooperative effort from the Cooperative Extension field staff who collected and mailed leaves and then disseminated the results. Private consultants also played an essential role in helping growers to use the information to best advantage.

References: (if applicable)

Gadoury, D. M., and MacHardy, W. E. 1982. A model to estimate the maturity of ascospores of Venturia inaequalis. Phytopathology 72:901-904.

Figure 1: Locations in New York State where samples were collected for apple scab ascospore assessments during spring of 2001.

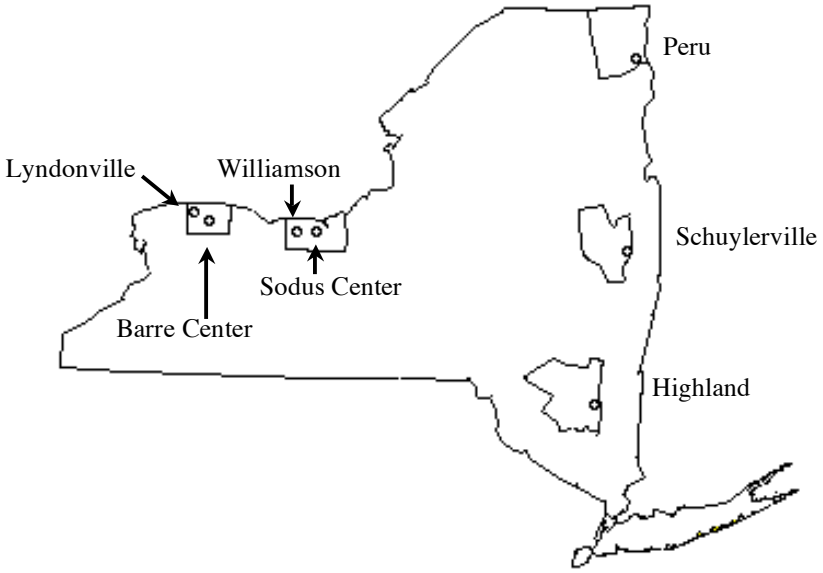

Table 1: Locations and collections dates for apple leaf samples that were used for apple scab ascospore maturity assessments during spring of 2001, and results of those assessments

			Scab assessments: % of asci with			Spores
Location	County	Date	immature spores	mature spores	discharged spores	discharged in tower shoot
Highland	Ulster	April 5	86	14	0	8
Highland	Ulster	April 11	76	23	trace	3
Highland	Ulster	May 24	27	44	30	no data
Highland	Ulster	June 5	4	11	85	80
Barre Center	Orleans	April 11	76	24	0	3
Barre Center	Orleans	April 17	59	40	1	21
Lyndonville	Orleans	April 16	82	18	0	1
Williamson	Wayne	April 16	86	14	0	6
Williamson	Wayne	April 23	57	41	2	876
Sodus Center	Wayne	April 16	87	13	0	6
Sodus Center	Wayne	April 24	51	45	4	667
Sodus Center	Wayne	May 24	25	49	26	>1000
Sodus Center	Wayne	May 31	8	22	70	483
Schuylerville	Saratoga	April 10	94	6	0	0
Schuylerville	Saratoga	April 18	93	7	trace	0
Schuylerville	Saratoga	April 26	86	14	0	39
Peru	Clinton	April 18	96	4	0	2
Peru	Clinton	April 26	83	17	0	6