A *QUICKER* WAY TO DETERMINE SCAB RISK IN YOUR ORCHARD

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For a number of years, the 'delayed first-spray strategy' has been a scab management option for orchards with low levels of potential overwintering inoculum. There are a number of benefits to delaying the first fungicide spray for apple scab including: a reduction in the total number of fungicide sprays during the growing season and a subsequent reduction in spray cost and, possibly, a reduction in pressure for fungicide resistance; and less travel through the orchard in the early Spring when the ground is usually wet and prone to ruts. However, an assessment of the potential ascospore dose (PAD) or scab-risk of an orchard has to occur in the previous Autumn to determine if the orchard is a candidate for this strategy in the Spring. In the past, the assessment either involved calculating the PAD using a somewhat complicated formula or counting the number of scabbed leaves on 600 shoots in an orchard and comparing the result with an established threshold. Both methods involved a significant amount of time, which hindered their adoption. A better, less time-consuming method needed to be developed.

In 1999, based on historical research data of orchard assessments, a sequential sampling technique was proposed where as few as 100 shoots (10 shoots on each of 10 trees) would produce a risk assessment (MacHardy et al. 1999). A description of the sequential sampling technique to determine scab risk was included in the 2000-2001 New England Apple Pest Management Guide (NEAPMG) (Koehler 2000).

As described in the NEAPMG, the sequential sampling technique for trees approximately 9-13 ft tall on semi-dwarfing rootstock involves:

1. Selecting 10 trees dispersed throughout the entire orchard. For example, if there were 1000 trees, every 100th tree would be examined.

2. On each tree, 10 extension shoots selected randomly from high, low, exterior, and interior parts of the tree canopy are examined. If sucker shoots are present, one sucker shoot should be selected.

3. On each shoot, the upper and lower surfaces of each leaf are examined and the number of scabbed leaves recorded. There are pictures in the NEAPMG of the types of spots that might be present in the Fall. When in doubt, call it a scab lesion and include the leaf in the total of scabbed leaves.

4. The number of scabbed leaves recorded on the 10 trees are totaled and then the chart in the NEAPMG (Fig. 1) is used to tell whether sampling can stop or whether an additional 10 trees will need to be sampled to determine the scab-risk rating of the orchard.

However, although the sequential sampling technique was developed based on years of historical assessment data, it had not been field validated in the orchard. Thus, a research project was designed to: (i) determine whether or not the outcome of the sequential sampling technique consistently agreed with the outcome of looking at 600 shoots, which was the previous method, to estimate the 'scab-risk' of an orchard; and (ii) determine how consistent the sequential sampling

technique is in identifying whether an orchard is a 'low-' or 'high-risk' orchard when different trees and shoots were chosen for sampling. The research was conducted by Jessica Reardon, a graduate student in the UVM Department of Plant & Soil Science, as part of her graduate studies (Reardon 2002).

Materials & Methods

In the Autumn of 1999, three orchards were assessed for scab-risk using the sequential sampling technique. After the initial 10 trees were sampled, 5 additional sets of 10 trees were sampled, whether or not the number of scabbed leaves indicated further sampling was needed according to the sequential sampling chart. Thus, in each orchard, 6 sets of 10 trees were examined for a total of 600 shoots, which was the number of shoots required for the older assessment method. The time it took to assess the sets of 10 trees was noted.

In the Autumn of 2000 and 2001, 15 orchards were assessed to determine their 'scab-risk' levels using the same sequential sampling technique except that 20 shoots were sampled from each tree. This gave additional shoots per tree to analyze whether or not choosing different shoots on a tree would make a difference in the scab-risk rating.

Results

In 1999, all 3 orchards that were evaluated were below the threshold of 5 scabbed leaves on the first 10 trees sampled; thus, the orchards were considered at 'low-risk' for apple scab the next season. Assessing 5 additional sets of 10 trees in two of the orchards produced the same 'risk' level. However, in the third orchard, if the third, fifth or sixth set of 10 trees had been the initial sampling set, the sequential sampling technique chart would have indicated further sampling of trees was necessary to determine the scab-risk rating.
Nevertheless, the total number of scabbed leaves on all 60 trees was below the threshold (i.e., 50 scabbed leaves), as it was in the other two orchards, which indicated the orchard was at 'low-risk'.

The sequential sampling technique, in which only 10 trees (i.e., 100 shoots) were sampled, required an average of 36 min, which was 3.63 hr less than the average of 4.23 hr that was needed to complete the older assessment method in which 60 trees (600 shoots) are sampled. ***Sequential sampling can potentially save 3.6 hours!!***

In 2000 and 2001, when each of the 6 sets of 10 trees in the 15 assessed orchards was evaluated as if each were the initial sampling set in the sequential sampling technique (the first set of 10 trees) and the number of scabbed leaves on each set of trees was compared to the thresholds illustrated in the sequential sampling chart, there were ***only 20 assessments out of a total of 180 assessments where sampling a single set of 10 trees did not result in a 'low-risk' or 'high-risk' rating*** -- in only 20 assessments would you have had to sample more than the initial set of 10 trees to obtain a scab-risk rating. However, when the numbers of scabbed leaves from sets of trees were added together, as they would be in the sequential sampling technique, a rating usually could be attained by adding only 1 or 2 additional sets of 10 trees,

In other words, ***in 160 out of the 180 assessments, the sampling stopped at the initial 10 trees (100 shoots) because the number of scabby leaves either indicated a high risk or a low risk.*** In only 20 assessments was the number of scabbed leaves above the threshold for 'low-risk' but below the threshold for 'high-risk', indicating sampling should 'continue'. But, again, a rating usually could be attained by adding only 1 or 2 additional sets of 10 trees.

There is the important question: ***Would we have gotten the same results if we used different combinations of trees and different shoots on those trees?*** Therefore, the 2000 and 2002 data were further analyzed by a computer simulation program (Reardon 2002). The program randomly selected a tree on which to begin the assessment from all of the 60 possible trees in the data set, then randomly selected 10 extension shoots from the total of 20 extension shoots on that tree. The program continued to randomly select trees and extension shoots until a total of 10 trees had been selected. Once a tree was selected by the program, it was taken out of the selection pool so that it could not be selected twice. The program then determined whether the first 10 trees were above or below threshold, or whether sampling had to continue, according to the sequential sampling technique. If it was determined that sampling had to continue, the process of selecting 10 random trees and 10 extension shoots from the remaining trees was repeated until a maximum of 60 trees had been sampled. This entire process was repeated 100 times per orchard, generating data on how many times an orchard was determined to be at 'low-risk' or at 'high-risk' and how many trees it took to get that rating.

The simulated, sequential sampling produced very consistent results within all orchards in both years. ***All 100 simulations within each orchard, using different trees and different shoot combinations, produced the same result: either all simulations generated a 'low-risk' rating or all generated a 'high-risk' rating.*** The simulated sequential sampling rating was always the same as the rating obtained by the initial sequential sampling conducted in the field and the same as using the 600 shoot method. However, not all simulations required only 1 set of 10 trees to determine 'scab-risk'. In some orchards, 20 to 30 trees were required in simulations and, in one orchard, 50 and 60 trees were required in 2 simulations, respectively, to produce a 'scab-risk' rating.

Conclusion

The Sequential Sampling Technique provided the same scab-risk ratings as the 600 shoot assessment method in significantly less time. It's Quicker !!

Literature Cited

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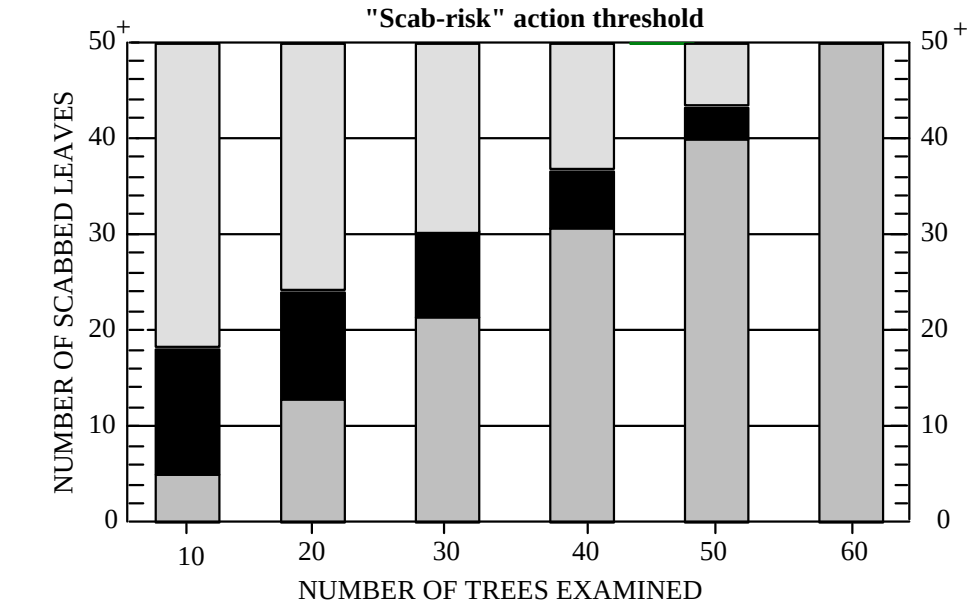
MacHardy, W.E., Berkett, L.P., Neefus, C.D., Gotlieb, A.R., and Sutton, D.K. 1999. An autumn foliar scab sequential sampling technique to predict the level of "scab-risk" next spring. Phytopathology 89: S47.

Reardon, J.E. 2002. Field validation of a new sequential sampling technique for determining 'risk' of apple scab in Vermont apple orchards. M.S. Thesis. University of Vermont. Burlington. 91 pp.

Figure 1. Sequential sampling chart in the 2000-2001 New England Apple Pest Management Guide describing 'scab-risk' thresholds based on the number of scabbed leaves for each set of 10 trees sampled.



LEGEND

Incidence of scabbed leaves	Prediction of scab-risk	Scab Management Recommendation
	TOO HIGH: no further sampling necessary.	**Follow the full fungicide schedule recommended in the New England Apple Pest Management Guide (NEAPMG).**
	UNCERTAIN: sample 10 additional trees.	See SAMPLING PROCEDURE
	LOW: no further sampling necessary.	**Delay initiating a scab fungicide program until pink or after three infection periods (but before the 4th infection periods), whichever comes first.**