SCAB MANAGEMENT STRATEGIES

IDENTIFYING SECONDARY INFECTION PERIODS *(AFTER* PRIMARY LESIONS DEVELOP)

Count the hours of leaf wetness from the first hour rain is recorded until the leaves are dry, regardless of the time of day rain began, and refer to Table 3.

DETERMINING AN INFECTION PERIOD WHEN TWO RAIN EVENTS ARE SEPARATED BY A SHORT DRY PERIOD

There is no one rule strongly supported by research that is best for deciding if two leaf wetness periods separated by a short dry period should be considered as separate or combined. For that reason, one apple production guide may state that two rain events should be considered one continuous wetness (infection) period unless the two wetness periods are separated by at least 12 hours of dry weather (i.e., relative humidity below 90%). In another apple guide the minimum hours of dryness may be as few as four hours or as many as 32 hours. The following rules appear to best account for research on "split wetting periods":

- Two successive wet periods, the first started by rain and the second started by rain or dew, should be considered a single, uninterrupted wet period if the intervening dry period is *24 hours or less*, regardless of weather conditions (sunshine, temperature, and relative humidity) during the intervening dry period. Dew at night is common in early spring, but only one dew period should be considered as the second wetting period.

- Note: Combine only the hours the leaves were wet during the two wet periods; *do not include the hours the leaves were dry.*

- **Interpretation**: This rule implies that a high enough percentage of the spores survive up to 24 hours of drying on the leaves and fruits to consider the infection process to be uninterrupted when the surfaces become wet again. The hours the surfaces are dry are *not* included in calculating the infection period, because the infection process stops during the dry period.

1) PREVENTION

Scab-resistant cultivars offer the possibility of not having to use fungicide to manage scab, but chemical control is essential in orchards planted with cultivars rated moderately or highly susceptible to scab (see Table 2). On susceptible cultivars, the best preventive strategy is to effectively manage scab during the primary season which will allow for a possible reduction in fungicide use in the latter part of the growing season and less overwintering inoculum for the following spring.

Cultural practices. Cultural practices to reduce inoculum and enhance the efficacy of fungicides are important in scab management.

Pruning to open the tree canopy promotes penetration by air and light which, in turn, will reduce the time it takes for wet leaf and fruit surfaces to dry and affect potential infection. Opening the tree canopy also allows greater penetration of pesticide spray.

Removing unsprayed alternate host trees (such as flowering crabs and abandoned apple trees) from within 100 yards of an orchard will reduce the number of ascospores entering the orchard from outside sources to an insignificant level.

Sanitation practices. Research has demonstrated that sanitation practices such as flail-mowing fallen leaves in autumn or early spring (before bud break) or applying 5% urea to fallen leaves decreases the amount of ascosporic inoculum approximately 50–75%. This means that for any one infection period, there would be approximately 50–75% fewer scab lesions compared to the number of lesions that would develop if there had been no sanitation practice.

***When should sanitation practices be used*?** Sanitation practices will not be cost-effective unless they reduce scab management costs during the growing season. Whether or not the sanitation program presented below is cost-effective will depend on each grower's situation.

Sanitation program

Assess the orchard for foliar scab (see following section on *Predicting an orchard's level of scab-risk*) and select the sanitation practices that best fit your situation. Sanitation options are:

- Flail-mow after leaf fall or in spring. If leaf fall is very late, then flail-mowing should be delayed until early spring, but as soon as possible after snow cover is gone.

- If flail-mowing is not possible, a 5% urea solution (42 lbs. urea/100 gals. water) should be applied to fallen leaves at 100 gals. per acre so that the leaf litter is thoroughly wet.

- Another option is to flail-mow and then apply urea to the "in-row" area that could not be reached by the flail mower.

- Schedule fungicide sprays according to the delayed first-spray strategy and action threshold described below.

2) DELAYED FIRST-SPRAY STRATEGY

By delaying the first fungicide spray until pink, or until after three infection periods have occurred (whichever comes first), the 'delayed first-spray' strategy can potentially reduce the total fungicide dose applied per orchard and allow for better integration of fungicide and insecticide application at the pink bud stage. This strategy may translate into reduced pressure for the development of fungicide resistance, and has many other advantages including: reduced cost of labor, equipment, and materials, and reduced early season travel through the orchard in wet spring conditions.

The "action threshold" for the delayed first-spray strategy is: Delay the first scab fungicide spray until after three infection periods (but before the fourth infection period) or until pink, whichever comes first. Determination of infection periods should begin at green tip.

When using this strategy for the first time, it is best to try it in only one block or in a small segment of the orchard, preferably on small to moderately-tall trees on semi-dwarfing rootstock. *Old blocks of standard trees are not recommended for this strategy. Also, caution is suggested using this strategy in any block where more than 1 sterol-inhibiting (SI) fungicide application was made during the previous growing season*. SI fungicides inhibit rather than kill the pathogen, so the fungus may be active in the leaf even though visible scab lesions do not develop. Thus, significant ascosporic inoculum may develop in leaves that would be assessed as "scab-free" in the autumn, perhaps placing the orchard at "high-risk" although the assessment indicated the orchard was "low-risk."

Predicting an orchard's level of "scab-risk" can be done using a **sequential sampling procedure** presented here. Using this procedure, an orchard's level of "scab-risk" can be predicted after examining potentially as few as 100 shoots on 10 trees.

STEP 1: Assess the orchard for leaf scab after harvest but before leaf-fall:

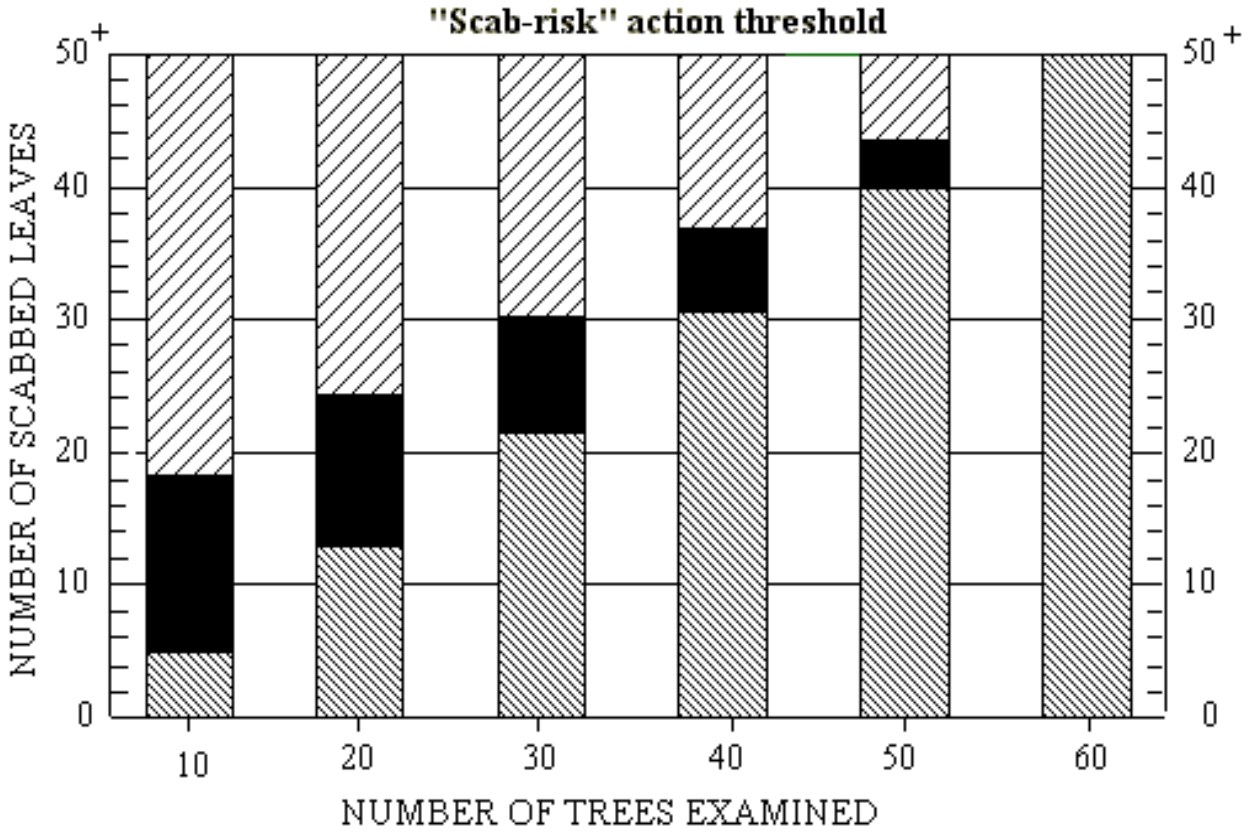
- **Examine 10 trees** selected randomly from the entire orchard (usually every nth tree; e.g., in an orchard with 1000 trees, examine every 100th tree).

- On each tree, **examine 10 extension shoots** selected randomly from high, low, exterior, and interior parts of the tree canopy. If sucker shoots are present, randomly select one sucker shoot.

- This protocol is for trees approximately 3–4 meters tall on semi-dwarfing rootstock. For trees approximately 2 meters tall, examine 5 extension shoots/tree on 20 trees if the tree size and shape provide an adequate sampling of the canopy. For very high density plantings with trees 1–2 meters tall and sparse canopy, examine 2 extension shoots/tree on 50 trees.

- On each extension shoot, examine the upper and lower surface of each leaf and record the ***number of scabbed leaves***. If a lesion or spot is doubtful, it should be considered a scab lesion and the leaf should be counted as a scabbed leaf.

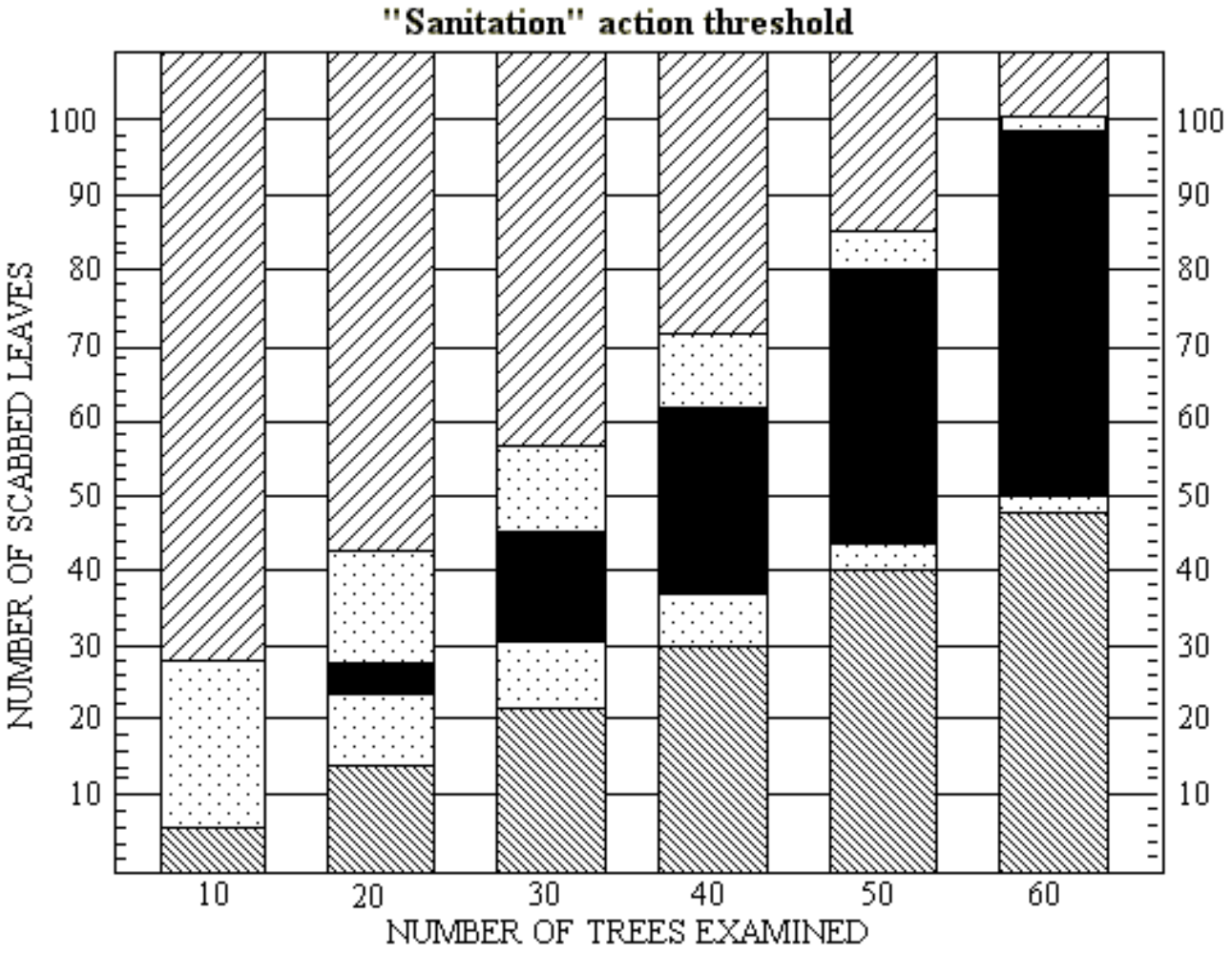
- Total the **number** of scabbed leaves you have recorded and use Chart 2 or 3 to determine if further sampling is necessary or whether the sample size is sufficient to predict the "scab-risk" of the orchard.



Legend

Incidence of scabbed leaves	Prediction of scab-risk	Scab Management Recommendation
	TOO HIGH: no further sampling needed	**Use Protection Strategy**
	Uncertain: sample 10 more trees	
	LOW: no further sampling needed	**Use Delayed First-spray Strategy**

Chart 2. Sequential sampling chart for determining level of scab risk in an orchard block. Use this chart if sanitation practices will NOT be considered.



Legend

Incidence of scabbed leaves	Prediction of scab-risk	Scab Management Recommendation
	TOO HIGH: no further sampling needed	**Use Protection Strategy**
	Uncertain: sample 10 more trees	
	MODERATE: no further sampling if planning to use sanitation	**Use Sanitation practices, and Delayed First-spray Strategy**
	Uncertain: sample 10 more trees	
	LOW: no further sampling needed	**Use Delayed First-spray Strategy**

Chart 3. Sequential sampling chart for determining level of scab risk in an orchard block when sanitation practices will be considered.

STEP 2: If sanitation practices will **NOT** be considered, refer to Chart 2 (on the next page). If sanitation practices will be considered, refer to Chart 3.

3) PROTECTION STRATEGY

This strategy is designed to maintain a protective fungicide residue barrier against scab infection. A protective fungicide schedule historically has been recommended to begin at green tip, with subsequent treatments timed according to fruit bud stages or a 7-day calendar schedule during the primary scab season. Research has shown that even with over two inches of rain, the 7-day schedule is sufficient if captan, or an EBDC fungicide is used in complete applications at full rate.

If strictly followed, the 7-day schedule may result in fungicide being applied well before it was needed. When seven days have passed since the previous application and no rain is expected, the next protective application can be delayed until just before the next rain is forecast. Of course, the unpredictability of rainfall poses the risk of an unexpected infection period occurring when the trees are not protected. The protective strategy usually requires more fungicide, labor, and equipment-time than a post-infection strategy. It is most effective in orchards with low inoculum and in seasons when weather conditions do not limit preventive spraying.

4) POST - INFECTION STRATEGY

This strategy is designed to apply fungicide when there has been an infection period and trees were not adequately protected with fungicide residue from the last fungicide application. Weather equipment to monitor temperature and hours of leaf surface wetness must be used to determine if conditions were favorable for infection. When an infection period is determined to have occurred, a fungicide with extended postinfection activity (e.g., a sterol inhibiting fungicide or a strobilurin) is applied within the time it is considered to be effective (see Table 13 – Characteristics of Apple Scab Fungicides).

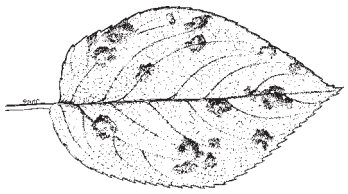
Although a postinfection strategy can reduce the number of spray trips and the amount of fungicide used, especially during a spring with few infection periods spaced widely apart, reliance on the post-infection activity of fungicides may accelerate the development of resistance.

5) COMBINATION PROTECTION/POST-INFECTION STRATEGY

A scab management strategy that incorporates both protectant fungicides and fungicides that have post-infection activity allows for the greatest flexibility in selecting the material(s) best fitting disease and weather conditions at specific times during the growing season. It also allows for the optimal use of fungicides based on their characteristics, spectrum of activity towards other pathogens, and resistance management.

6) CONIDIA SUPPRESSION

If scab lesions develop during primary scab season, the focus switches from ascospore maturation to suppressing conidia production and further secondary infections. It is estimated that each leaf lesion can produce up to 100,000 conidia. Peak conidia production occurs during the first one to two weeks after the lesion is visible. Conidia production is relatively lower after about four weeks but, although parts of the lesion may appear "burned-out" or dead, conidia production usually continues through the summer at low levels. In other words, even though the lesion may look dead, the potential exists for further conidia production.



Orchards should be checked for scab lesions at least once a week, beginning 9 – 17 days after the first scab infection period in the spring. Table 3 (and see footnote 3) gives more precise estimates of lesion development times.

Examine a minimum of 10 extension shoot leaves and 10 fruit cluster leaves on at least 10 trees per block. Check areas of the canopy most likely to have inadequate spray coverage. With large trees, this means the upper canopy, so a thorough inspection may require climbing. In addition to examining foliage, check 50 fruitlets per tree on at least one tree per acre or at least 5 trees per block. There may be

significant risk of secondary scab if 0.5% or more of the fruitlets or leaves have active scab lesions.

Scouting for scab lesions must continue late enough into the season to allow time for lesions to become visible from the season's final primary scab infection period. The ascospore maturity model (Chart 1) provides guidance on when to expect all ascospores to have matured. Combining the estimated date for final ascospore maturation with monitoring of rain, temperature, and leaf wetness allows you to determine when the last infection period occurred. If the season's final ascospores were released in a wetting period that was not long enough for infection, then you can refer back to the previous infection period as the last one of the year. If infections occurred, lesions will generally show in about two weeks.

Two full-rate captan applications 5–7 days apart can reduce conidial inoculum, and is especially effective when temperatures exceed 80°F in the days following application. Because of the need to cover all scab lesions with fungicide, thorough coverage is essential. Relatively high volume, low concentrate applications (no more than 4X) will give the best results. These treatments in summer will also help manage sooty blotch and flyspeck. Another option is two applications of Topsin M, in combination with captan at half the full label rate, where benzimidazole resistance is not a limiting factor.

Two applications of Syllit plus a half label rate of captan is an effective tactic where Syllit has been used sparingly and resistance to it has not developed. Syllit is not effective against summer diseases. Combining it with captan will help manage summer diseases and reduce the chance of a buildup of fungal strains resistant to Syllit.

Other fungicides such as the sterol inhibitor (SI) fungicides (e.g., Nova, Rubigan, Procure) and the strobilurins (e.g., Flint and Sovran) have 'anti-sporulant activity'. ***Using these materials as anti-sporulants must be balanced with serious concerns about developing resistance if they are used in this manner.***