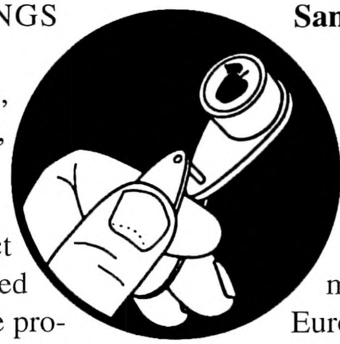
scaffolds Update on Pest Management and Crop Development
FRUIT JOURNAL
April 8, 1996 VOLUME 5 Geneva, NY

COUNT DOWN

FIRST THINGS FIRST
(Art Agnello, Entomology, Geneva)



❖❖ Since nearly all of the insect and mite control decisions we are faced with are in some way related to the process of estimating the size, distribution and behavior of pest populations, it can be useful to go over some of the assumptions behind our trapping, sampling and threshold techniques. The following is adapted from the "Population Monitoring" section of Cornell Cooperative Extension Information Bull. 231, "Biology and Management of Apple Arthropods":

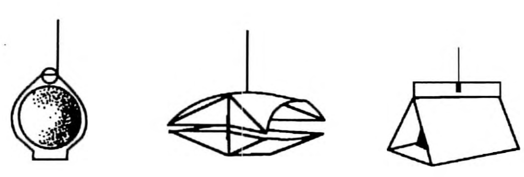
Trapping

Insect trapping is used to determine a biofix, to provide an index of population trends, or to indicate population levels.

• Visual traps rely on visual cues to attract insects (e.g., red spheres for apple maggot, white cards for tarnished plant bug).

• Pheromone traps rely on chemical cues to attract insects (e.g., many moth pests of crops: obliquebanded leafroller, spotted tentiform leafminer, codling moth, oriental fruit moth).

• Physical traps collect insects by obstructing them (e.g., double-sided tape placed around branches to trap San Jose scale crawlers).



Sampling

Insect sampling is conducted to learn about a population in a certain location. A *population* is all the members of a specific group. It can be general or specific, such as all the mites in an orchard, all the adult mites in an orchard, or all the adult European red mites in the orchard. A *sample* is a portion of the population that you examine and use to make a best guess about the rest of the population. For example, to estimate the number of mites per leaf for all the leaves in an orchard, you could sample 50 representative leaves, examine all the mites on them, and from that sample make a best guess.

To take a *representative* sample, first be sure that the sample is truly representative of the population of interest. For instance, you cannot take all the sample leaves from a single tree or only from border trees if you are interested in all the trees in the block. Second, select samples *randomly* so that any one leaf has the same chance of being examined as any other, and that you don't just happen to choose leaves that look bronzed, those that look healthy, or those that are easiest to reach.

A sample is a *random variable*. Simple examples of random events or observations are rolling a pair of dice or flipping a coin. The labels used to describe the result of such an event (e.g., the number showing on the dice) are called random variables. We can describe random variables by setting a likelihood or *probability* for each possible outcome. For example, the probability of obtaining a 6 with any roll of a single die is 1 in 6, and the probability of obtaining heads with a coin toss is 1 in 2.

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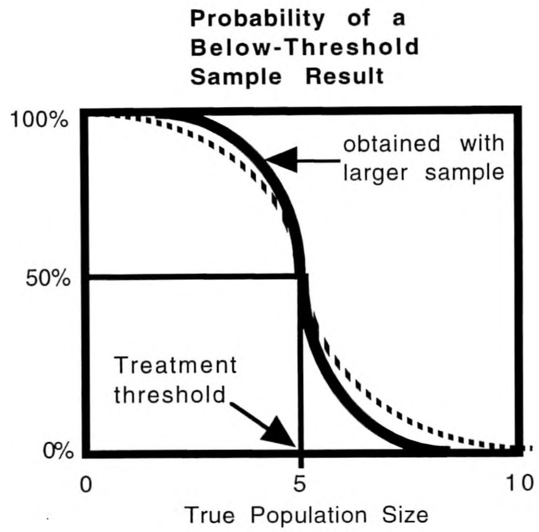

The result of a sample of insects or mites is also a random variable. For example, if we use a sample of 50 leaves to estimate the average number of mites per leaf, this estimate is a random variable that will differ somewhat each time we take a sample. If random variables are analyzed statistically, they can help in understanding insect and mite populations in an orchard.

Random variables are important in making pest control decisions. We sample insect populations to estimate their average, or *mean*, size. Each sample of a given population will vary, but if they are representative they will be close to some average value. Because any estimate of pest population size using a sample is a random variable, there is always some uncertainty about the population's true size. Despite this uncertainty, the estimate of population size is more likely to be close to the true size than far from it, if you have taken a representative sample. If you are sampling a population that is in reality greater than some treatment threshold, your sample may tell you it is below threshold. All is not lost, however. If the sample is truly representative, this problem is more likely to occur when the true population size is *very* close to (that is, slightly above or below) the threshold. This means that, although there is a chance your sample will lead you to make a management error (such as no treatment when the population is actually above threshold), there is less likelihood of this happening as the true population size gets further from the threshold.

For example, if your threshold is 5.0 mites per leaf and the true (but unknown to you) mite population in the orchard is exactly 5.0 mites per leaf, there is a 50% chance that a sample taken using our ERM sampling procedure will indicate that the population is below threshold. If the true population is slightly higher, 5.2 mites per leaf, the chance of a wrong conclusion drops to approximately 40%. If it is actually 6.0 mites per leaf, it drops to less than 10%, and at 7.0 mites per leaf it drops to zero; that is, at some point when the actual population is above, but still relatively close to, the threshold, you will *never* estimate it to be below threshold. Because thresholds are only general guidelines, the consequences of making a decision error with a population only marginally greater than threshold are not likely to be too serious. Also, the greater the number of samples, the greater the precision of your estimate.

Samples are either fixed or sequential, which refers to their size — for example, the number of

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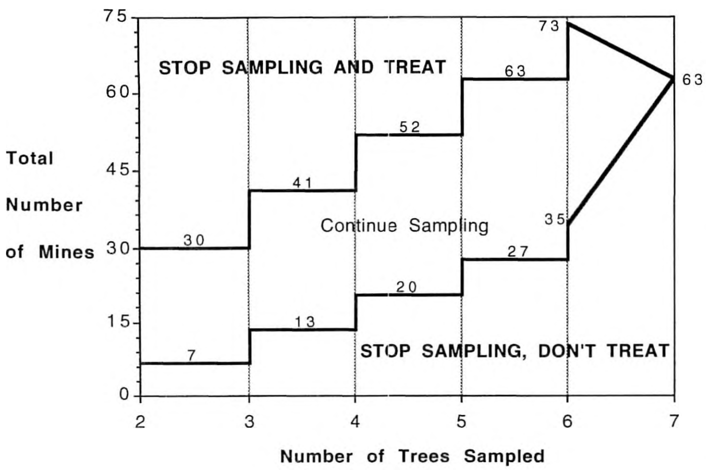
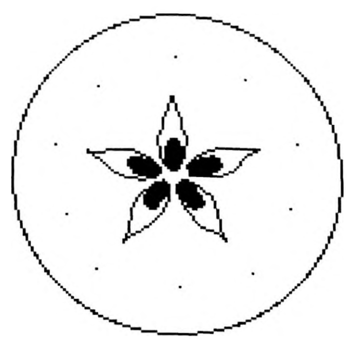


leaves you must examine to reach a conclusion. A *fixed* sample is more basic and generally conservative. This means that, although you may take more samples than you actually need to make a decision, you will never take too few. A *sequential* sample is a more advanced technique used when there is greater familiarity with the insect's biology (specifically, its distribution in particular field situations). The information from each sequential sample is used to determine whether more samples are needed. This is more time efficient because it allows a rapid decision to be made in extreme cases, such as when populations are extremely high or low. When taking a sequential sample, keep in mind that nearness to the edge of the "Continue Sampling" band has *nothing* to do with how close the population is to the threshold. It merely shows how close *you* are to being able to make a decision based on the number of samples you have taken so far.

The presence/absence method is a refinement of the sample and observation process. In special cases of mites and small insects (such as ERM on apple leaves), the number of mites per leaf is mathematically related to the number of leaves on which one or more mites are present. By taking numerous samples of leaves and recording whether mites are present and the number of mites per leaf, a table of correlations can be constructed and used for a sequential sampling procedure. The grower or scout can use the number of leaves containing any mites, without actually counting them, to make a decision about the need for treatment.

Threshold

The most common estimate we make from samples of insects is whether enough insects are present in the true population to justify taking action. This *action threshold* is based on a comparison of the costs of control versus the probable economic loss if no action is taken. Action thresholds are the result of a complex process to gather enough information about a pest-crop relationship to predict if and when to take control measures. Behind a threshold are generalizations about the pest's feeding and reproductive behavior, rate of growth, most susceptible stage of growth, population trends, and the type of injury and costs and benefits of preventing it. As such, it can only serve as a guideline for action in most situations; thus thresholds are usually constructed to be conservative, but many rely on information that is rarely given much thought in practice. For example, a grower will probably not try to estimate the market price of apples or the packout expected from a specific block when deciding whether to spray for leafrollers, although the action threshold may have been set with some attention to these factors. Action thresholds should always be regarded as management aids, not immovable laws, and they do not replace common sense.❖❖



DISEASES

SCAB

APPLE SCAB UPDATE

(Dave Rosenberger, Plant Pathology, Highland)

Apple scab ascospore maturity, Highland, NY

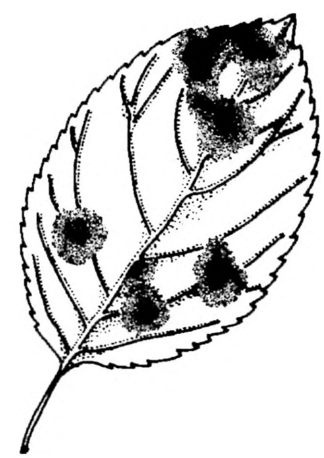
	Immature	Mature	Discharged	Tower shoot
4/3	91%	9%	0%	0 spores

❖❖ Leaf litter on the orchard floor was kept moist by snow cover through most of the past winter and by numerous rains during March. As a result, development of apple scab ascospores has proceeded without the disruptions sometimes caused by drying of the leaf litter during late winter and spring.

No spore discharge was detected on April 3, but the presence of 9% mature ascospores while trees are still dormant suggests that scab pressure at the Green Tip to Half-Inch Green bud stages will be above average this year if rains allow for regular spore releases. With the ascospore assessment methods that I use, economically significant ascospore discharges usually occur soon after we detect a mean of 17% mature spores from the 20 randomly selected pseudothecia used for each squash-mount assessment. Spore maturity will advance very quickly if we have several days of warm temperatures.

Where scab was a problem last year, growers should be ready to apply a protectant fungicide beginning at Green Tip. (Copper applied for fire blight or Marshall Mac canker counts as a fungicide and works just as well as a mancozeb spray for controlling scab). In "clean" commercial orchards, there is probably little risk of significant scab infection until after Half-Inch Green, even in years like this one when spore maturity is relatively advanced at bud break. But defining a "clean" orchard is difficult. Drs. Gadoury and MacHardy developed a method for calculating predicted ascospore dose (PAD) by carefully observing leaves and recording the incidence of apple scab in late September or early October. In the absence of such careful observations, one can only guess whether or not an orchard is really "clean". Late-season scab can appear quite suddenly on the underside of leaves during or after harvest, and under-leaf scab will usually go unnoticed unless one specifically goes looking for it. With the early ascospore maturity that is developing in the Hudson Valley this year, the "guessers" may want to be more cautious than usual when it comes to omitting early scab sprays.

In early spring, the level of ascospore maturity often varies greatly from leaf to leaf. For the squash mounts made on April 3, five of the 20 pseudothecia examined had >15% mature spores (15,17, 18, 36, 40%), five pseudothecia had 1–13% mature spores, and eight pseudothecia had no mature spores. Ascospore maturity one year ago (31 March 1995) was identical to our count for April 3 this year. Last year, four of 20 pseudothecia had >12% mature spores (46, 37, 34, and 12 %), six pseudothecia had 1–5% mature spores, and 10 pseudothecia had no mature spores. In 1995, McIntosh at the Hudson Valley Lab were at Green Tip on April 3, whereas this year trees were only at silver tip.❖❖



NEW TOOLS

NEW STONE FRUIT FUNGICIDES

(Wayne Wilcox, Plant Pathology, Geneva)

❖❖ Two new sterol inhibitor fungicides have received federal labels for control of stone fruit diseases during the past year. One of them, Elite (tebuconazole), is not yet registered in New York and probably won't be for this season. The other, Indar (fenbuconazole), recently received New York registration.

Both are excellent materials. Indar, in particular, has provided outstanding control of brown rot for the last 3 years in our sour cherry trials in Geneva, even when we inoculate fruit and really turn up the disease pressure. For instance, under the most severe evaluation regime last summer, 80% of the unsprayed fruit were infected; fruit sprayed with 2 oz/100 gal of Nova had 59% infection; fruit sprayed with 2 lb/100 gal of captan had 25% infection; fruit sprayed with 12 oz/100 gal of Rovral had 19% infection; and fruit sprayed with 0.8 oz/100 gal of Indar had 3% (!) infection. These same relative differences occurred in the 1993 and 1994 trials as well. We've found Indar to be about 50–60 times as active as Nova against brown rot on an ounce-for-ounce basis of active ingredient in both laboratory and field tests (of course, Nova isn't that great against brown rot anyway). Indar is also two or three times as active as Orbit in lab assays of active ingredients, although these assays are not always perfect reflections of what happens in field.

Those of you who actually read the fine print may note that the Indar label states that the material "is a protectant fungicide". Don't be misled. Indar does provide excellent residual (protectant) activity against brown rot following a spray application, but it is a locally systemic, sterol inhibitor fungicide. Therefore, it won't wash off in the rain, but it won't redistribute either. So, as with other SIs, excellent coverage is critical. The potential for resistance is always a concern with SIs, but the high activity against brown rot of the newer materials (Orbit, Indar, Elite) is one of the best anti-resistance strategies going for them, provided folks don't start cutting rates. Limiting their use to a couple of preharvest sprays (and perhaps an occasional shot during bloom if really needed) is also a good anti-resistance measure.

Indar is labeled on apricots, cherries, nectarines, and peaches (but not plums or prunes). In addition to brown rot, it is labeled for control of cherry leaf spot and peach scab. It's also given us decent control of cherry powdery mildew in our trials.❖❖

STORM FRONT

APPLE SCAB RESISTANCE TO STEROL INHIBITOR FUNGICIDES?

(Wayne Wilcox & Wolfram Köller, Plant Pathology, Geneva)

❖❖ Fundamental and applied research into the development of SI fungicide resistance by the apple scab fungus has been under way in our programs for almost 10 years. For some time now, we've been discussing the general phenomenon in various grower and consultant forums from a theoretical perspective, based on real data from baseline (wild, unsprayed) scab populations and from a single resistant population in Nova Scotia. Our ultimate goal has been to relate these findings to what might happen in commercial apple orchards, and suggest rational anti-resistance strategies. New data from last year suggest that, to borrow terminology from the National Weather Service, we are probably somewhere between a resistance "watch" and a resistance "warning" in our commercial industry. That is, we have not reached the stage where resistance is imminent, but we appear to be moving in that direction if we don't watch out. The threat is real, and should be treated as such.

Review of SI Resistance Development. By now, everybody should remember that the development of resistance to SI fungicides is fundamentally different from the development of resistance to

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fungicides such as Benlate. We've made the point that Benlate (or Topsin) resistance is an "all or nothing" type, where a very small subpopulation of the pathogen is completely immune to the fungicide (regardless of rate) before it is ever sprayed, whereas the vast majority of individuals are fully susceptible. Thus, with each spray, the vast majority of susceptible individuals are controlled; however, the immune subpopulation survives, multiplies, and quickly dominates within the orchard. At this point, control failures occur suddenly, and the immune pathogen *isolates* (individuals) are easily detected and defined.

In contrast, resistance to the SI fungicides is of the "shades of gray" type, wherein there is no distinct immune subpopulation. Instead, fungicide sensitivity is distributed along a so-called "normal" (or bell-shaped) curve, where most individuals have "average" levels of sensitivity, a few are somewhat more and somewhat less sensitive than average, and fewer still are much more or much less sensitive than average. Thus, at lower fungicide exposure rates (caused primarily by low rates in the tank and poor spray coverage), a few of the least sensitive members of the population slip "through the cracks". It is important to note that these individuals are not immune to the fungicide; it's just that below certain rates, they are only partially inhibited (e.g., labeled rates of Rubigan and Nova give about 50% control of "resistant" isolates in greenhouse tests vs. nearly 100% control of sensitive isolates). Thus, resistant isolates are able to grow and reproduce more actively than the more sensitive individuals under certain spray regimes, and can gradually start to dominate the population. As this happens, disease control begins to diminish.

Real World Examples. Because there is no distinct immune subpopulation of the pathogen, it is difficult to define "sensitivity" and "resistance" to the SIs. The fact that a given isolate might be resistant to a 4 oz rate but sensitive to an 8 or 10 ounce rate makes the definition even more tricky. The way we have defined resistance is to compare unsprayed baseline (wild) scab populations with the scab population from the Nova Scotia orchard, where the disease was no longer adequately controlled by Baycor (one of the first SIs used in Europe, roughly equivalent to Rubigan and Nova at current rates). What we found was that isolates making up only 2% of the baseline populations (i.e., the least-sensitive 2% fraction at the edge of the bell curve) made up 40% of the population in the Nova Scotia orchard. Then, last year, we received samples from a Michigan orchard where SIs gave poor control for no apparent reason; these same types of isolates (least-sensitive 2% fraction in baseline populations) also made up 40% of the population in the Michigan orchard. So, now we are able to define resistance on a practical level; i.e., these are the types of isolates that survive and preferentially reproduce under typical spray regimes. And, apparently, we *start losing* commercial levels of control once they reach a 40% "threshold" level in the orchard population.

Using this information, we've reviewed monitoring data from seven NY orchards in 1991, and compared them with monitoring data from seven NY and Michigan orchards in 1995. In 1991, there was no detectable difference between populations in the seven commercial orchards (0 to 4 years of previous SI use) and baseline populations. However, in the three different NY orchards examined in 1995, resistance levels were 12, 20, and 20% (remember, 2% = baseline, 40% = threshold for commercial control problems). In the four Michigan orchards examined, resistance levels were 16, 24, 24, and 42% (the latter being the one with poor control, mentioned earlier).

Anti-Resistance Strategies. We've also used this definition of resistance to evaluate several anti-resistance strategies in a 3-year orchard experiment here at Geneva. Without going into all of the gory details, conclusions are: (1) We got poor control and were able to drive up resistance pretty significantly by applying 1.5 fl oz/100 gal of Rubigan (= 0.75 oz/100 of Nova) alone on a loose schedule. (2) When we added 12 oz/100 gal of mancozeb to this rate, we got less scab, but resistance levels were still elevated

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when we examined those scab lesions that did develop. (3) When we used Rubigan at 3 fl oz/100 gal (= 1.5 oz Nova/100 gal) alone, resistance levels went down, but control was still suboptimal. (3) When we added mancozeb to this rate, resistance levels went down and control was best.

Bottom line is, the anti-resistance strategies we've been preaching for years (maintain full SI rates, tank mix with a protectant, get good coverage, don't cheat on the intervals) really do work. Or, conversely, not following them really can get you in trouble. We weren't making it up.

So what does it all mean? First, we should view these developments as a warning rather than an alarm. They point out that resistance really can develop, particularly if you start cutting corners and playing games. Our standard anti-resistance strategies are not fool proof, but they're IMPORTANT. ALL of them.

Plenty of people got too much scab last year, and it's always tempting to blame these problems on resistance. And it's always possible that this could be true, at least in some instances. However, we haven't heard of a lot of problems where people actually followed the rules (or as one consultant said, "the 4-spray program was more like a 2- or 3-spray program"). Evaluate your own situation honestly.

Second, remember that the basis for each of these anti-resistance recommendations boils down to one simple concept: IT'S ALL A NUMBERS GAME. You want good SI rates both in the tank and on the tree (coverage), so that you reduce the PERCENTAGE of scab isolates that are able to withstand a spray (remember, sensitivity is rate-dependent). You want good spray timings and a tank-mixed protectant to reduce the absolute NUMBER of scab isolates that might potentially be insensitive (you want 2% of a thousand, not 2% of a billion). So, when it's been 3 weeks since the last SI + mancozeb spray and you finally get an infection period, then you can't get back in for 2 or 3 days to put on another spray, think about what happens: there's not enough mancozeb from the first spray to do any good, and the mancozeb in the second spray's too late to have any effect, so the SI is really acting alone. If the rate is inadequate (tank or coverage), control will suffer and you add pressure for resistance development. Some of this happened last year.

Conclusion. The SIs are very useful tools for apple disease control programs in this part of the country. They will eventually wear out. If you want them to last as long as possible, you've got to take care of them. "Full" rates (at least 3 fl oz/100 of Rubigan or 1.5 oz/100 of Nova, which are by no means even approaching excessive) and reasonably tight schedules are expensive, but as the man says, "You can pay me now, or pay me later".

Speaking of "reasonably tight schedules": remember that we have always discussed the 4-spray program in terms of a minimal program for orchards that had good control of scab the previous year. MANY western NY orchards did NOT have good control last year; even if using an SI program, these orchards should have an effective protectant fungicide program in place like they did in the "good old days"—i.e., prior to the first infection period—BEFORE initiating SI sprays at tight cluster or pink. The nice thing about scab is that you can clean it up in just one year if you want to.❖❖

PHENOLOGIES

Geneva:
All - Dormant
Highland:
Apple (McIntosh)- early green- tip

PEST FOCUS

Highland: **Pear psylla** egg laying increasing; **Redbanded leafroller** 1st catch (4/8)

HARD COPY

YOU MADE ME LEAVE YOU

❖❖ This is the last issue that will be mailed to any of last year's subscribers (and there are quite a few) who failed to return a resubscription card, for which we've been extending the grace period since the deadline date of 18 March. We're not just being picky here; since state extension funds (read "tax dollars") are used to support this publication, we have to have tangible documentation each year that the recipients of our mailings have actually requested it. If you've lost the card we mailed, send another postcard bearing your forthright testimonial requesting a 1996 subscription (as well as your mailing address). If you're not sure whether you returned it, you probably didn't, but you can always do nothing and find out for sure.❖❖

UPCOMING PEST EVENTS

	43°F	50°F
Current DD accumulations (Geneva 1/1 - 4/8):	48	14
(Highland 1/1 - 4/8):	137	39

Coming Events:	**Ranges:**	
Green fruitworm 1st catch	41–143	9–69
Pear psylla adults active	2–121	0–49
Pear psylla 1st oviposition	25–147	1–72
Redbanded leafroller 1st catch	32–480	5–251
McIntosh at silver tip	56–137	17–58

INSECT TRAP CATCHES (Number/Trap/Day)

Geneva NY

	3/29	4/1	4/8
Green fruitworm	-	-	-
Pear psylla	-	-	-

HVL, Highland NY

	3/29	4/1	4/8
Green fruitworm	0.1*	2.2	0.4
Pear psylla (eggs/bud)	0.01	0.2	0.5
Redbanded leafroller	-	-	0.2*

*=1st catch

(Dick Straub, Peter Jentsch)

NOTE: Every effort has been made to provide correct, complete and up-to-date pesticide recommendations. Nevertheless, changes in pesticide regulations occur constantly, and human errors are possible. These recommendations are not a substitute for pesticide labelling. Please read the label before applying any pesticide.

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