Early season disease management in 2022

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Winter finally came again in mid-January, and we had reasonable snow fall through February and into mid-March, during which came in the form of sporadic snowstorms. Snow cover is consistently over, and while it's still cool in the evenings, we've had considerable bouts of warm temperatures often exceeding 60°F. In the Hudson Valley and Long Island, green tip is presently happening or imminent. The rest of the production areas in NY may still have a week or more before bud break. While we've had some bursts of warm weather and in the coming week, there are cooler days forecasted for the week, which could slow tree development. Overall, the season will be upon us shortly, and we need to consider early season management for apple scab. In 2021, there was a decent amount of rainfall in early to mid-April, but little in May to June, which was characterized by sporadic, but hot (>75°F) heavy thunderstorms and July more so. Still with the drought from 2020 and the lack of rain from tight cluster to petal fall, my unsprayed trees of several different cultivars had only moderate levels of apple scab. Not surprisingly, there were no reports of apple scab control failures in commercial orchards anywhere in NY.

Inoculum reduction recommendations in 2022.

Despite the low levels of apple scab in 2021, the conditions were such that there should be plenty of inoculum for apple scab in 2022. Hence, it will be important to reduce overwintering or "primary ascospore inoculum", which starts the epidemic that we manage all season. Reducing this initial inoculum will delay the epidemic, and in theory, if there is little rain early in the season, it could possibly delay the epidemic to a point in the season where it would be too dry and hot for the apple scab fungus to cause infection. Since we don't know when the next drought season will occur, we should keep suppressing apple scab so that it can't get a foothold in orchards. Moreover, reducing orchard floor leaf litter and fruit drops may greatly reduce the inoculum for other foliar diseases like Marssonina blotch and numerous fruit rot diseases including bitter, black, and white rot. As soon as it is possible to safely get a tractor in the orchard, remove any remaining fruit drops and pruned shoots left on the floor from winter pruning as they may contain bitter rot or black rot inoculum. If orchard floor management was

practiced in the fall with flail mowing or urea sprays, it won't be necessary to repeat the practices this spring. Research out of the University of New Hampshire has demonstrated that there are diminishing returns for practicing inoculum reduction in the fall and spring. Even if the planting is in green tip, inoculum reduction may still provide considerable benefit by reducing inoculum pressure by tight cluster or pink, when tissues are at their greatest susceptibility to apple scab.

The two best options for inoculum reduction are to apply the urea to leaf litter or use a flail mower to shred leaves. These practices hasten decomposition of the leaf litter. In the case of flail mowing, leaves should be first swept or raked from underneath the canopy into row middles as most of the apple scab inoculum is present on litter under the trees. Subsequently, go over the row middles with the flail mower set to scalp the sod. If urea is used, apply 40 lbs. of feed grade urea per acre in 100 gallons of water to the herbicide strip (5% solution). Dolomitic lime applied at a rate of 2.5 tons per acre can be used of in place of urea. Of the various options, applying urea is the simplest approach, but take care to flush the sprayer pumps with water afterwards since the urea is caustic and can corrode a pump over time. As suggested above, the use of orchard floor urea may also reduce inoculum of other diseases (e.g. Marssonina blotch, Bitter rot, and Black rot) as it hastens decomposition of leaf litter, fruit drops and pruned shoots that harbor the pathogens causing foliar diseases, cankers, and summer fruit rots.

Delayed-Dormant copper for fire blight inoculum reduction.

The warm weather at and just after petal fall in 2021 allowed for considerable fire blight epidemics in NY. In 2022, there will likely be an excessive number of cankers in affected orchards. However, a "delayed-dormant" application of copper at silver tip will help reduce inoculum of fire blight in cankers and even overwintering apple scab conidia in buds. Presently, overwintering fire blight cankers are still dormant even in my high inoculum fire blight research orchard in Geneva. As the weather begins to warm (> 60°F) in the coming day/weeks, fire blight cankers could begin to ooze. Now is the time to scout for oozing cankers, especially in the eastern part of the state. It's important to note that cold weather will not kill fire blight bacteria overwintering in cankers; the bacteria will remain inactive, but viable at low (< 32F) temperatures. To mitigate the threat of oozing cankers and reduce both fire blight inoculum and early season apple scab inoculum, make a "delayed dormant" silver-tip application of a high (>15%) metallic copper equivalent (MCE) copper fungicide (e.g. Badge, Kocide, Cuprofix). It may be hard to get into

the orchards at silver tip due to wet fields, so the application can be delayed to green tip. Even at green tip, it is generally still safe to apply high MCE copper products. In the Geneva research orchards, a second application of a high MCE copper fungicide is often made at ¼" green with no consequence.

When to start applying fungicides for apple scab management.

For any fungicide application, it is advisable to use an apple scab forecasting system such as the one in the NEWA system (http://newa.cornell.edu/). This will identify predicted ascospore releases and potential infection events to improve application timing and cost-effectiveness of fungicide investments. The first step when using any apple scab disease forecasting system is to determine the biofix, which is the date at which to start the model based on a biological feature of the host or pathogen. Determining the biofix can be frustrating as the forecasting system will provide them by default, regional extension specialists will release information regarding shooting towers and squash mounts, and finally there are different green tip dates for the many cultivars on the farm. Historically, shooting towers and squash mounts were first used to determine maturity and ejection of ascospores and have the highest level of accuracy. However, these technics are labor intensive and require a high level of skill to do well, and this information is truly most applicable to the orchard from which the leaves were collected. A considerable amount of published research proposed that ascospore maturity could be reliably estimated based on temperature accumulation (degree-days) after 50% flower bud break on 'McIntosh'. This research led to a 'Maturity Model' that would allow any grower to estimate ascospore maturity without the labor intensive and highly technical squash mounts and shooting towers. 'McIntosh' was chosen as most of the region was planted to 'McIntosh' and local populations of the pathogen were well adapted (evolved) to mature and release when 'McIntosh' had green tissue. There is also an evolutionary advantage for ascospores to mature and release at green tip, not prior to green tissue. Individual ascospores in populations that mature and release when there is no green tissue, would just dry up and die and not contribute to the epidemic or survival of the population. Presently, estimations based on the biofix of 50% flower bud break are considered to best capture the peak and tail end of ascospore maturity and release. Despite the intense scientific validation of this model for estimation, researchers routinely found mature ascospores in squash mounts and shooting towers long before bud break. Indeed, in 2019 and 2020, Dr. Acimovic (Virginia Tech) often captured mature ascospores in eastern NY 1-3 weeks before the 50% McIntosh budbreak biofix. To

complicate matters, local populations have likely evolved to mature and release in accordance with the development of newer local varieties as 'McIntosh' is not as widely planted. Perhaps, 'Gala' budbreak should now be used as the biofix? Since we know that ascospores are present before green tip, one solution might be to choose a biofix 1-2 weeks prior to budbreak. Unfortunately, starting ascospore maturity and release simulations early may also end the simulation early, and any potential threat of ascospore release at the end of the epidemic may be missed. Fortunately, ascospores released prior to green tissues won't be able to infect, and if they could, the recommended copper application as silver tip (see above) will afford excellent protection should even the slightest green tissue be available.

With all of this information, what should one do about simulations and biofixes? As green tip approaches, leave your simulation with 50% bud break biofix, but if the weather warns of potential infection or considerable rainfall, temporarily set your biofix back to 10 days earlier and see if the amount of ascospores potentially ejecting increases dramatically. If the simulation increases dramatically, perhaps consider a single-site fungicide or dodine (see the next section). Once you begin to approach tight cluster, ensure that your simulation is back on the 50% bud break biofix to best capture the peak and ensure that the simulation doesn't end too early.

Early season apple scab management.

Once green tip is past, it's advisable to start applying protectant fungicides for apple scab, timed according to infection events predicted by weather conditions. One of the most popular protectant fungicide programs consists of a tank mix of Captan with Mancozeb at half maximal rates for each product (e.g. Captan 80 at 2.5lbs/A & Mancozeb 3lbs/A). The combination is referred as "Captozeb" in the vernacular sense and has excellent residual (Mancozeb) and redistribution (Captan) properties, but has little to no post-infection activity, and must be applied before rains. Re-application is warranted when unprotected tissues emerge 7 days later or when considerable rainfall (> 1") occurs. Regardless of the simulation or biofix used, one should target fungicides applications just prior to predicted large releases of ascospores (> 15% discharge) during weather conditions conducive to infection (Figure 1).

Date	Ascospore Maturity	Daily Ascospore Discharge	Cumulative Ascospore Discharge
Apr 14	10%	0%	7%
Apr 15	12%	4%	11%
Apr 16	14%	0%	11%
Apr 17	16%	<1%	12%
Apr 18	19%	<1%	12%
Apr 19	24%	0%	12%
Apr 20	30%	16%	28%
Apr 21	35%	0%	28%

The Ascospore Maturity model predicts that 95% of the ascospores have matured. At this point, essentially all ascospores will be released after a daytime rain of greater than 1/10 inch with average temperature above 50°F

Infection Events Summary

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Events: Dry Wet

Date (2019)	Infection Events	Average Temp (°F) for wet hours	Leaf Wetness (hours)	Hours > 90% RH	Rain Amount
April 14	no	64	1	5	0.02
April 15	yes	57	14	9	0.65
April 16	no	48	1	0	0
April 17	no	44	8	0	0.02
April 18	no	48	5	7	0.01
April 19	no	54	6	9	0.01
April 20	yes	65	7	15	0.56
April 21	no	-	0	6	0

Figure 1. Output from the NEWA apple scab disease forecasting tool in early May in the Hudson Valley. An ideal time for protecting the crop with a fungicide would be before the predicted ascospore discharge on 4/20. The date of 4/16 would also be an ideal time for selecting a product containing a single-site fungicide, which has post-infection activity. Such an application would also protect against the minor infection on 4/15 (4% ascospore discharge) and the subsequent infection a few days later on 4/20.

As the season approaches bloom or if there is rain for several days after green tip, consider some of the products containing single-site fungicides (e.g. Cevya, Luna Tranquility, Luna Sensation, Flint, Fontelis, Merivon, Syllit, Rally, Rhyme, Inspire Super, Miravis, Aprovia). Many of the products containing single-site fungicides will provide a broader range of activity against other fungal pathogens like powdery mildew and fruit rots, which may cause latent infections at bloom, whereas the “Captozeb” combination does not. Given fungicide resistance

concerns, it's no longer recommended to apply products containing single-site fungicides for post-infection activity. Instead, think of making applications between infection periods. Use disease forecasting to identify periods where substantial ascospore release (> 15% discharge) has occurred and another infection period is predicted soon after. (Figure 1).

For example, apply your selected product containing a single-site fungicide(s) (with 3 lb/A mancozeb) for "next week's" infection within 24-48 hours after the last infection period. It should protect against the next predicted infection and perhaps afford some curative activity if any germinating spores slipped through the fungicide coverage from the previous week. Of the products with single-site fungicides, dodine, sold as Syllit, will likely be your strongest performer for applications between infection periods. However, Syllit may only be applied twice before pink. Another option would be to use Aprovia, Miravis, Sercadis, Luna Tranquility, Cevya, or Inspire Super. As the season progresses into bloom, Luna Sensation or Merivon, which contain quinone outside inhibitor (QoI) fungicides. QoI fungicides are highly effective against mildew and would be good choices for orchards of mildew susceptible cultivars and plantings along the lakes where apple powdery mildew pressure can be high.

Summary

A strong early disease management program should begin with inoculum reduction with urea or flail mowing as soon as orchards can be entered. Prior to applying urea or flailing mowing to reduce leaf inoculum, make sure to sweep the orchard to remove prunings and any remaining apple drops, which may harbor inoculum from many other late season diseases. After orchard floor management, apply copper from bud break "silver tip" to early green tip. This application will help reduce overwintering apple scab and fire blight inoculum and protect against early-season apple scab infections. From green tip to bloom, a program of protectant fungicides (i.e. captan and mancozeb) should be implemented to protect the developing fruit clusters. If there are prolonged wetting periods in the early season, an application of mancozeb (3 lb/A) along with either Aprovia, Cevya, Miravis, Sercadis, Syllit, Luna Tranquility, or Inspire Super may be helpful. As we proceed toward bloom, additional applications of products with single-site fungicides (e.g. Luna Sensation, Merivon) may be needed to manage powdery mildew and other fungal diseases that may begin as latent infections during bloom. Keep track of apple scab ascospore discharge and infection events predicted from local weather on the disease forecasting service of your choice.