scaffolds
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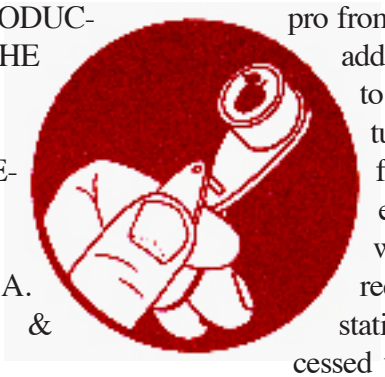
DISEASES

DETAILING THE MODEL



AN INTRODUCTION TO THE RIMpro APPLE SCAB PREDICTION MODEL

(Srdjan G. Aćimović & David A. Rosenberger, Plant Pathology & Plant-Microbe Biology, Highland; acimovic@cornell.edu & dar22@cornell.edu)

Background

❖❖ RIMpro is a proprietary fruit crop management program developed in Europe by Marc Trapman with assistance from many European scientists who, over the past 20 or more years, collected the data required for model development and validation. RIMpro contains modules that address apple scab, fire blight, apple powdery mildew, Marsoninna leaf blotch of apple, grape downy mildew, grape black rot, plus several insect pests and models for crop load adjustment. (The latter is not yet functional in the US.) The focus of this article is the RIMpro model for apple scab ascospore development, release, and infection.

RIMpro is available only via an annual subscription of 200 Euros for an individual connection or 150 Euros per station for networks of 10 or more stations. RIMpro forecasts are driven by a weather forecast system, and the most commonly used in the United States is a Norwegian world-wide weather service identified as "yr.no". (There are currently no options for using other weather forecast networks such as the NOAA forecast that is widely used within the US.) Ground-based weather is fed into RIMpro from NEWA-RainWise stations (for an additional license fee of $55 payable to NEWA for the data feed). The status of pest populations and forecasts for each location are updated several times per hour with the latest weather forecast and with the most recent data recorded from the NEWA stations. The RIMpro program is accessed via computer or smart phone. All the data is stored in "the cloud", a system that allows very rapid access to real-time data. You can find out more about RIMpro by visiting this link: http://www.rimpro.eu/faces/index.xhtml or click on the button "Create a new RIMpro account" to find all information about account types and what you need to subscribe. Furthermore, to allow data flow from your NEWA station to RIM pro you can request a license via this link: http://blogs.cornell.edu/yourenewa/licensing/rimpro/request/

In 2017, Cornell's Hudson Valley Research Laboratory (HVRL) established a partnership

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with the interested eastern New York (NY) apple growers to facilitate commercial introduction of the RIMpro apple scab and fire blight models. Users from 21 NEWA-RainWise stations on commercial farms subscribed to use RIMpro in 2017, and the partnership is continuing in 2018 with 18 eastern NY farms subscribed to this service. The goal of this joint effort is to introduce and evaluate the RIMpro technology in a way that will allow apple growers to become comfortable with using it during the scab and fire blight infection seasons. It is hoped that this new tool will allow growers to time sprays for maximum efficiency while avoiding unnecessary sprays for apple scab early in the season and perhaps for fire blight as well.

While good models for apple scab and fire blight are currently available within the NEWA apple disease modules (http://newa.cornell.edu/index.php?page=apple-diseases), the RIMpro algorithms incorporate some advances (especially for apple scab) that may increase accuracy for predicting both early season scab infection periods and the point at which ascospore inoculum is exhausted after bloom. However, RIMpro will be of benefit only for growers willing to learn the system, properly maintain their NEWA stations allowing accurate weather data recording, and then check the RIMpro outputs on a regular basis as they plan their fungicide applications. As with any of the NEWA models, the pest models are reliable only if the NEWA stations are properly calibrated and maintained because all of these models are driven by the environmental parameters that are recorded into the NEWA network from on-farm weather station.

RIMpro subscribers can, if they wish, join a RIMpro group that then allows them to view the disease predictions for all their subscribed neighbors within this group. This feature is especially helpful if one of the NEWA stations stops working during a critical period because members of the user group can quickly check the outputs from a nearby station. The group formed in easten NY is called ENY Apple FARM Group, and any subscriber in that group can check on the weather conditions and pest development for any of the other 17 stations in the RIMpro user group.

User Guide – It's Simple

When you log into the RIMpro cloud and open the apple and pear scab model in your RIMpro account, you will see a graphic (Fig. 1, next page) under the upper left tab labeled "Scab primary". In this figure, the vertical light blue line on the large central graph shows the current date/time in the day (A). Everything to the right of the light-blue line is an apple scab prediction based on the weather forecast from the Norwegian weather forecast model for the specific GPS coordinates of your farm's NEWA-Rain-Wise weather station. Everything to the left of the light-blue line represents the actual weather data recorded by your NEWA-RainWise station on premises (Fig. 1).

Besides the other informative parameters visible in Fig. 1, by far the most important is the red line or so-called RIM infection value which is read by using the vertical Y-axis scale on the left-hand side of the graph labeled (it ranges from

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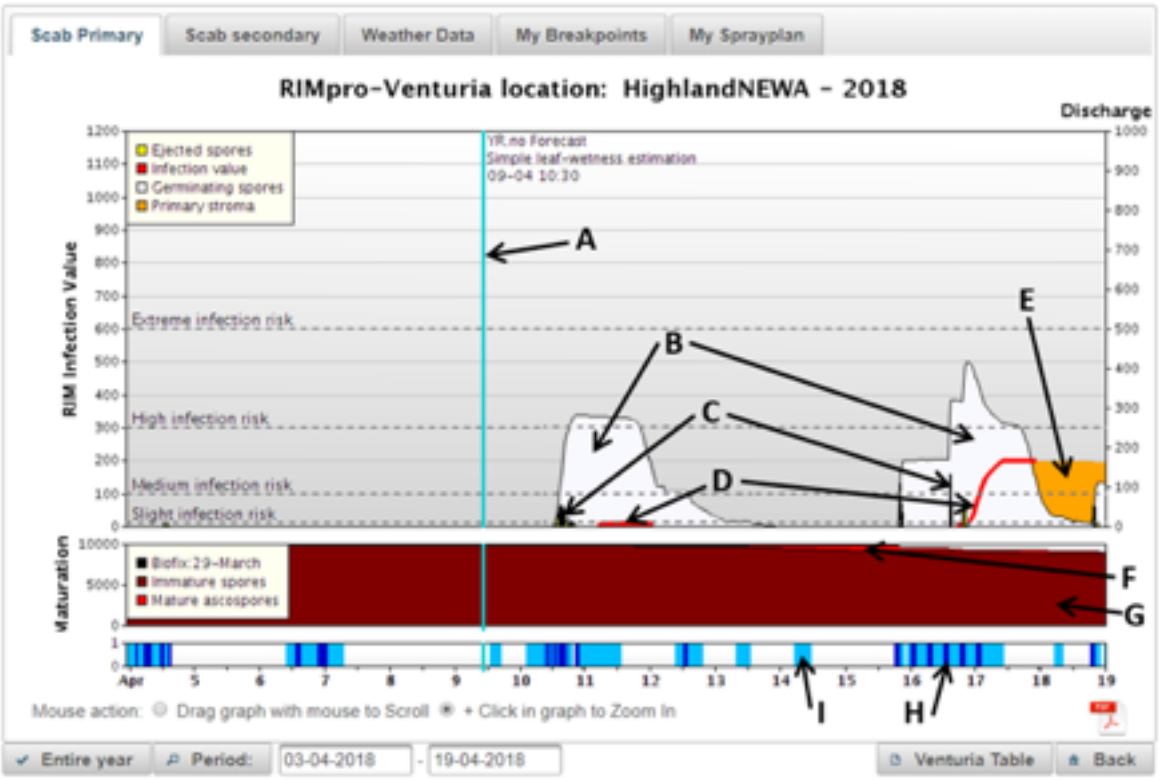

Figure 1. Example of infection prediction in RIMpro apple scab model for Highland, NY on 9 Apr 2018.
(A) Vertical light blue line marks the current date and time within that day.
(B) White camel hump-like areas show germinating spores; i.e., cumulative number of scab spores that germinate over time and are read using the right-side Y-axis scale on that is labeled "Discharge" (from 0–1000 on the image).
(C) Small yellow-black bars, which are seen better when magnified with zoom-in tool below the graph, is the number of ejected spores from leaf litter in the orchard. Each small bar is the number of spores discharged in one hour; to read how many spores were ejected, use the right-side Y-axis scale.
(D) Red line is the RIM infection value which, when divided by 100, is roughly the percentage of the total season's spores that are likely to cause infection in any given infection. Read the RIM infection value(s) using the vertical Y-axis scale on the left-hand side of the graph. A RIM value of 1000 means that 10% of the total season's spores probably caused infections during an infection event.
(E) Orange area is called "Primary stroma" and represents scab lesions were initiated by infection from germinating spores and that are incubating in the leaf or passing through the incubation period, after which scab lesions will be first visible. Incubating infections are worth noting because, if no fungicide was in place before the infection event began, some or all of the incubating infections can still be eliminated by using fungicides with post-infection activity.
(F) Light red at the very top of the middle ascospore maturation graph is the proportion of mature scab spores that are ready for discharge with wetting events.
(G) Dark red is the proportion of immature spores that still need time to mature and remain to be discharged in future wetting events.
(H) The dark blue bars in the wetting graph with dates, at the bottom, are the actual or predicted rain periods.
(I) The light blue bars are actual or predicted wetting periods when no rain is falling but trees continue to be wet after rain. Used by permission of RIMpro B.V.

0–1200 in Fig. 1). RIM values, when divided by 100, are roughly equivalent to the percent of the total season's scab spores that are likely to cause infection in any given infection event.

Infection case scenarios warranting sprays

Hence, the red RIM value curve is the single most valuable indicator showing whether an infection period has occurred or is predicted to occur given current weather forecasts. For example, a

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RIM value of 1000 means that 10% of the total season's spores probably triggered infections during an infection event. In orchards that had little or no scab last year due to good spray programs, RIM values less than 300 are of no economic consequence at the beginning of the season, when there is little green tissue to allow infection, and at the end of the season when leaves are usually holding more fungicide residues. RIM values of less than 300 should not be ignored in orchards with high levels of scab inoculum and should be considered low- to moderate-risk events during the peak period of ascospore discharge between pink and petal fall. If there was even a little bit of scab lesions developing last year on leaves or fruit, even in fall, at the beginning of the season you should spray for predicted events that are at or above 100 RIM value (RIM of 100 is labeled as medium infection risk dashed line in Fig. 1).

The second most important fact to keep in mind when looking at the RIMpro scab predictions is that the white camel-humps, like the one visible as prediction for 10–14 Apr (Fig. 1), which has a flat red line and no orange field after the line, are not significant infection periods. These events only indicate that a spore release and germination event occurred, but weather did not allow spores to complete the infection process. In recent years in the mid- and lower Hudson Valley, the first major scab infection event detected by RIMpro has usually occurred after tight cluster or sometime during transition from tight cluster to the pink bud stage.

Use of RIMpro early in the spring and at the end of scab spore release season may allow the number of fungicide sprays to be reduced. Once RIMpro shows that ascospores have been depleted, if your primary scab control was excellent, there will be no need for additional scab sprays. In the Hudson Valley, sprays for primary scab infections can start later than the traditional recommendation of green tip, which is based on assumptions (1) that the green tissue is exposed and could get infected, and (2) that the first ascospores are mature in leaf litter.

Lastly, even though the scab model shows the 10-day long prediction for scab, based on 10-day weather forecasts from the Norwegian weather forecast model, weather forecasts that extend more than 96 hr into the future are notoriously unreliable. However, 10-day forecast is good for tentative spray planning, especially as it relates to weather fronts that are moving in from the west (Fig. 2). Because weather forecasts, even 48 and 24-hr forecasts, are subject to change, it is wise to check the RIMpro scab prediction model daily so as to pick up changes in predicted weather and scab events.

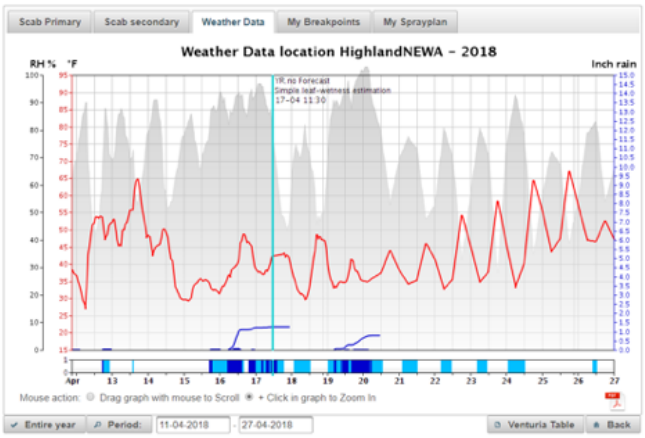

Figure 2. Example of RIMpro's summary of weather conditions from 12–27 Apr accessed by selecting "Weather Data" card. Vertical light blue line marks the current date/time in the day, in this case on 17 Apr 2018. Everything to the right of the light-blue line is a weather prediction based on the forecast from the Norwegian model yr.no which RIMpro uses. Everything to the left of the light-blue line are the actual data recorded by the NEWA-RainWise station on premises. In the large central graph, red line represents actual/predicted temperatures (read the values on the left-hand Y-axis in red, ranging from 15–95°F), dark blue curved line(s) at the graph base are the actual/predicted rain events indicating rain amounts in inches over time (read the values on the right-hand Y-axis in blue, gray background peaks show relative humidity (RH) in % (read the values on the far-left y-axis in black). The small bottom graph with dates indicates the length of periods of rain (dark blue bars) and of wetting afterwards (light blue bars). Used by permission of RIMpro B.V.

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When to spray

The best spray windows are usually between major infection events. In general, the best strategy would be to cover green tissue with a contact fungicide just before a major infection event so as to protect all green tissue that will be exposed to scab spores. After the event passes, a follow-up spray that includes both a protectant and a fungicide with post-infection activity can be used if the infection event was so long that new leaves unfolded, if rains during the event were sufficient to remove all of the protectant fungicide residues, or if spray coverage prior to the infection event was questionable due to windy conditions. If the next infection period is close enough to the first one, the follow-up application will provide protection through this second infection. However, if the next predicted infection period is far away, it is still better to apply a tank-mix of contact and systemic fungicide right after the first infection period, and then wait for that next infection to apply the same concept: apply a contact fungicide before it and apply the contact plus post-infection fungicide tank-mix after the event. Depending on the weather conditions, sprays might be 5–7 days apart during very wet spring, whereas in a dryer year, it may be feasible to allow 9–12 days between sprays.

Parameters RIMpro needs for accuracy

To run correctly, RIMpro scab model requires input of (1) green tip date, which is when 50% of fruit buds are at green tip for your earliest apple scab-susceptible cultivar, and (2) a scab biofix date, which is the date of the first ascospore release detected from leaf litter by using a spore catch or a vacuum spore tower, indicating that spores are mature in leaves. (Cornell's HVRL plant pathology lab routinely determines the biofix date using the vacuum scab spore tower for leaves from three locations in eastern NY). If scab discharge data is not available for your area, the green tip date can be used as the biofix. To determine 50% green tip, we walk across the orchard diagonally and randomly select fruit buds on approximately a dozen trees, tallying how many fruit buds are at green tip, silver tip, or in dormancy, using an approximate sample of 100 buds total per cultivar. ❖❖

ERRATUM: In the April 2 issue, a table in the "2018 Apple Fungicide Update for NY" article listed Aprovia as "Not-Restricted"; in fact, it is a Restricted Use fungicide, and can be used on Long Island, as indicated.

NEW APP

NEW REGISTERED USES FOR APOGEE

(Kerik Cox, Plant Pathology and Plant-Microbe Biology Section, Geneva & Dan Donahue, ENY CHP, Highland; kdc33@cornell.edu & djd13@cornell.edu)

Fire blight and prohexadione-calcium

❖❖ Apogee, manufactured by BASF, is a commercial plant growth regulator for use in apples and pears. The active ingredient prohexadione-calcium is a gibberellic acid inhibitor that reduces vegetative growth and has uses for managing vigor in apple and sweet cherry. In NY, we've traditionally used Apogee to manage growth in vigorous apple varieties and fire blight in apples. Fire blight is caused by *Erwinia amylovora*, a bacterium capable of traveling throughout the tree and initiating a rapid necrotic blight. The potential for spread throughout the plant and speed at which the blight consumes the tree is principally influenced by active growth status. Growth regulators like prohexadione-calcium slow this growth and restrict the spread of the fire blight bacterium from infected tissues. Unfortunately, growers need plantings of young high-density apples to have some active growth for establishment, which reduces the utility of using prohexadione-calcium to manage fire blight. However, newer planting systems, like the narrow fruiting wall, uses tools like prohexadione-calcium to prevent trees from filling canopy space for

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ease of pruning and harvest. Based on research funded through the Apple Research and Development Program (ARDP), horticulturalists and pathologists working together realized that there may be some benefit of early season applications of prohexadione-calcium at pink to manage vigor, bitter pit in 'Honeycrisp', and fire blight.

In the case of fire blight, what might happen with pink applications of prohexadione-calcium? Directly unaffected by the Apogee application at pink, the bacteria, at full bloom, would still wash into the floral cup, get in through the nectaries and start to blight the flowers. If Apogee was applied at pink, would the bacteria be able to spread down the pedicels to the developing fruit cluster? Based on two years of data in inoculated trials on 'Gala' in Geneva funded through the ARDP, we found that Apogee applications at Pink led to a reduced incidence of blossom blight and subsequent shoot blight. The effect can be observed with rates as low 3 oz/100 gal, with a stronger effect at 6 oz/100 gal. The reduced blossom blight is still observed if flowers are left untreated, but inoculated with fire blight bacteria at full bloom. Applying the biological at bloom improved the level of blossom blight control in these treatments. While there was an immediate impact on shoot growth in the early season, plants seemed to recover in shoot growth by September, except in 2016, where we had extreme drought in western NY.

Bitter pit and prohexadione-calcium

Bitter pit (BP) disorder is the visual manifestation of fruit tissue desiccation under the skin, with dark, sunken spots on the fruit surface and corky tissue underneath, and not centered on a lenticel (a characteristic of lenticel breakdown). Considered the result of a localized calcium deficiency, the question of why calcium was deficient in a particular BP-afflicted apple, why a specific grouping of cells desiccates, and at what time in that fruit's development those cells became deficient is not well understood. Calcium is distributed throughout the tree via the xylem, transpiration is the driving force, and water is the carrier. Once outside of the xylem and beyond the influence of the transpiration stream, calcium is relatively immobile. Calcium is a key component in the structural integrity of cell walls, where it serves to cross-link pectin chains, improving strength and reducing elasticity. Calcium is also essential to maintain cell membrane integrity, with cell leakage a consequence if deficient. Small amounts of calcium play an important role in hormonal signaling as well. Calcium is "stored" within a cellular organelle called a vacuole, and studies have shown that this stored calcium can account for as much as 40% of the total calcium in a fruit. So, if cells have all this calcium stored away, how can deficiencies develop near harvest or during storage? Turns out, studies have shown that the calcium transported into the vacuole is rapidly sequestered within more complex molecules, such as chelates, and as such is no longer available to the plant. Free calcium ions in the apoplast (that is, the open space in-between cells) are an important source for structural calcium, but whose concentration are tightly regulated by the plant, possibly a consequence of the signaling role they play. It is conceivable that at specific locations in the fruit, at specific times, calcium in the apoplast may become deficient, resulting in localized pockets of weakened cell wall structure and potentially leaky cell membranes. It should be noted that, as discussed earlier in this article, prohexadione-calcium acts to inhibit the synthesis of the inactive gibberellin GA-20 to an active form, GA-1. Gibberellins are known to inhibit the movement of calcium ions in the xylem; therefore, if GA is reduced in the system, perhaps calcium content in the tree will increase?

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An ARDP-funded study was initiated in eastern New York in 2016 to investigate the hypothesis that competition between shoots and fruits for calcium plays a role in BP development in Honeycrisp. The concept our group explored was that shoots have a natural advantage due to a stronger transpiration stream driven by evapo-transpiration from the extensive area of leaf tissue, as well as a more complete and effective system of xylem tissue. As an example, it is thought that poor development of xylem tissue in the calyx end of the apple contributes to the explanation of why BP symptoms are more likely to be found in the calyx end. Our group was also interested in looking at the status of calcium early in fruitlet development, during the cell division (mitosis) phase. Due to its proven ability to reduce shoot extension, and its mode of action as a GA inhibitor, prohexadione-calcium was selected for testing. Several prohexadione-calcium rates and application timings were evaluated in replicated trials conducted in 2016 and 2017, along with three commercial airblast trials in 2017. Data was collected on incidence and severity of BP, horticultural characteristics of the fruit, terminal and bourse shoot extension, as well as extensive peel mineral analysis. In both 2016 and 2017, our group observed a statistically significant reduction of 45% (2016) and 54% (2017) in BP incidence when prohexadione-calcium (Apogee) was applied at pink stage, at a rate of 6 oz/acre to trees that ranged in size from 100 to 180 gallons per acre tree-row volume, applied at 2X or 3X concentration along with a water conditioner.

2EE label for Apogee

Given potential uses of Apogee at pink in apples and grower requests, we worked with the DEC and BASF to apply for a 2EE label specifying the use of Apogee as early as pink. Presently, Apogee is the only formulation of prohexadione-calcium labeled for use at pink in apples. The 2EE label can be found at the new NYSPAD site: (http://www.dec.ny.gov/nyspad/products?0). At the site, simply type "Apogee" in the product name field and press search. The second result will take you the new 2EE label (Figure 3).

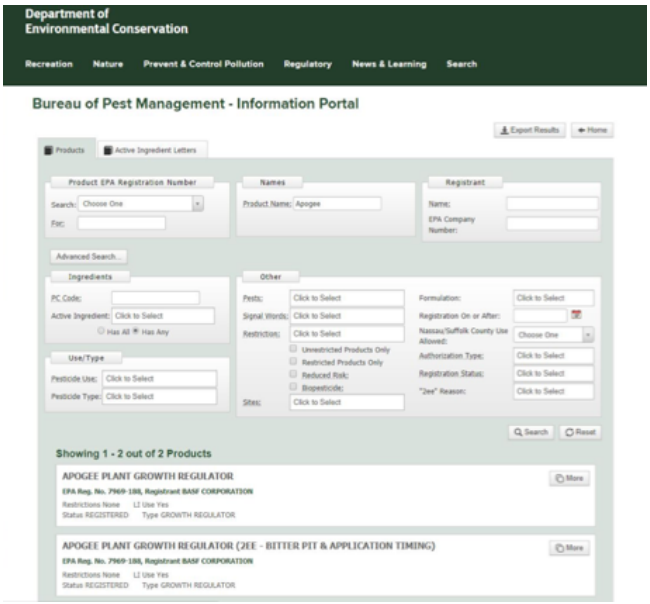

Figure 3. Screen of the NYSPAD system showing the search function to find product labels.

Please follow the 2EE label, and you must have a copy in your possession at the time of application. Here are a few specific considerations when applying prohexadione-calcium at pink stage for bitter pit suppression:

• The 2EE label specifically states to apply at a rate of 6 oz/acre and do not adjust for tree-row volume. The reason for this strict language is that 3 oz/acre at pink was not found to be effective, and 9 oz/acre resulted in a significant reduction in fruit size.

• If suppression of fire blight is NOT a concern, and BP suppression is your target, then limit prohexadione-calcium to a single pink application. For both 2016 and 2017, our results demonstrated that three applications starting at petal fall increase the incidence of BP.

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Data from 2016 indicated that three applications starting at pink did reduce BP incidence; however, the combination was not re-tested in 2017. If multiple applications of prohexadione-calcium are planned, our current recommendation is to start at pink, not petal fall.

• You should see limited vegetative growth suppression with a single application at pink.

• It is strongly recommended that you leave an untreated control somewhere within the treated block. Rating BP, either by formal counts or "eyeball" at harvest is unlikely to provide good efficacy data. Samples of both treated and untreated fruit should be stored together and evaluated after 60 days (or more). Contact Dan Donahue (djd13@cornell.edu) if you'd like some assistance with this evaluation.

• Bitter pit can be a problem in other New York State-grown varieties, especially Cortland and Braeburn, sometimes Golden Delicious and Red Delicious. The 2EE label for BP suppression is restricted to Honeycrisp simply because other varieties have not been tested. Will it work on other varieties? Perhaps, although some have suggested to me that Honeycrisp isn't REALLY an apple…, just kidding, but as they say, your mileage may vary.

So how does it work? The short answer is that the mode of action is not clear. We have collected and are in the process of analyzing additional data not reported here, and work will continue in 2017. At this point, it does not appear that reduction in fruit size and shoot extension are direct factors. Future articles are planned that will address these questions.

Questions or comments on the topic of this 2EE recommendation of the suppression of BP in Honeycrisp should be directed to Dan Donahue (djd13@cornell.edu), and questions about the effects of Apogee on fire blight at pink should be directed to Kerik Cox (kdc33@cornell.edu). Thanks to Ms. Anna Wallis, Dr. Gemma Reig, Dr. Mike Rutzke, Ms. Sarah Elone and Mr. Michael Basedow for their valuable contributions to the ENY Honeycrisp BP project, and thanks to Anna Wallis, Katrin Ayer, and Mei-Wah Choi for their work on the prohexadione calcium and fire blight project. A special thanks for the financial and in-kind support of the NYS Apple Research and Development Program, Cornell Cooperative Extension – Eastern New York Commercial Horticulture Regional Program, the Hudson Valley Research Laboratory, BASF Corporation, and our grower cooperators W.G. Minard, Fino Farms, Crist Bros. Orchards, Yonder Farms, and Forrence Orchards. ❖❖

NATIVE BUZZ

INTEGRATED POLLINATOR MANAGEMENT IN YOUR ORCHARD

(Maria van Dyke, Department of Entomology & Emma Mullen, Dyce Lab for Honey Bee Research, Ithaca; mtv32@cornell.edu & ekm75@cornell.edu)

❖❖ With apple bloom just around the corner, many of you have likely been thinking about the pollinators that will be in your orchards. Honey bees are essential pollinators in apple orchards; however, it's important not to overlook the important contribution of wild bees. In New York, apple blossoms are visited by a diverse community of wild bees, many of them being more efficient pollinators than honey bees. Cornell research has found the more robust the wild bee community in orchards, the better the pollination services. The higher quality visitation behaviors of wild bees improve seed set, fruit grade, and market value of apple. The difference in visitation quality between wild bees and honey bees is because wild bees more often come in direct contact with floral

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reproductive parts compared with honey bees. Honey bees, on the other hand, often work the flowers from the side, avoiding direct contact with stigmata. Wild bees also tend to carry loose pollen on their bodies, which easily facilitates pollination. Honey bees do not carry pollen loosely but instead pack it onto their legs.

How can you assess the bee community in your orchards?

It is valuable for growers to understand the pollination services in their orchards by learning their bee community. Growers can determine whether or not their site contains a robust wild bee population, or if they should rent honey bee colonies to supplement pollination. While historically it was very common to rent honey bees, a recent survey of over 500 New York apple growers found that 60% were open to relying on wild bee pollination alone if they could accurately assess the bee community in their orchards.

The Northeast Pollinator Partnership is a new tool developed by Cornell that allows growers to assess the bee populations in their own orchards, right from the convenience of their smartphones. To try it, visit (https://northeastpollinatorpartnership.org/count-bees/) and follow the instructions on the page. Assessments are simple and consist of performing 5-minute timed counts of the bees visiting blossoms in one square meter area of one tree. For best results, do this survey at three time points on sunny days that are 60°F or warmer. Our lab will analyze the data and return an assessment and recommendations to help you plan for the following year's apple bloom. We can tell you how robust your bee community is, offer advice on habitat management activities, and help you determine if you need to rent more or fewer honey bee hives. Some growers in New York have saved up to $8,000 in hive rentals after learning that they had a sufficient wild bee population to do the job. This smartphone bee survey app puts the power of precision pollinator management in your hands, helping you to understand and integrate the contribution of wild bees and honey bees to your orchard.

How can apple growers actively maintain wild bee communities?

Empire state apple growers have stated that they are willing to make affordable changes to their farm's management that would benefit pollinators. If you are, too, here are three easy ways to support bees on your property:

1. Maintain diverse floral resources along the margins of the orchard:

Leave bushes and forest intact along field margins and refrain from spraying or mowing the field edges. In the orchard, we recommend that you mow the dandelions flowering along the orchard floor. Bees visiting dandelions can be exposed to pesticides applied to protect your apple trees. In the past, there have been recommendations to allow dandelions to flower along the orchard floor throughout the summer, but unless you are running a completely organic operation, this is not advised.

Maintain or plant willow shrubs, red maple, and sugar maple. Studies find these species offer significant food resources to bee species in the weeks leading up to apple bloom. Their presence in your landscape will increase the likelihood that wild bees will be nearby for the start of apple bloom. These shrubs and trees help build up bee populations year after year to encourage the long term support of early spring bees.

2. Provide nesting resources:

Enhance ground-nesting habitat around the margins of orchards. The majority of wild bees visiting apple blossoms are ground-nesting species, so providing nesting sites encourages

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these bees to build populations in your orchard's vicinity. Leave patches of bare ground or create these patches. Ground-nesting bees love sandy and loamy soils that are commonly found throughout New York. Creating some soil disturbance in fallow sites also encourages these bees to initiate new nests.

Enhance stem-nesting sites by leaving dead twigs and grass stems along orchard margins and non-agricultural areas. In addition, you can create a bee hotel to attract stem-nesting bees using paper tube nesting structures that you can purchase online. Just remember that these homemade structures should be replaced every 2–3 years to avoid disease transmission among bees.

Create wood piles and leave areas of thick dead grass and abandoned stone walls to encourage bumble bees to nest near your orchard. Bumble bee queens and carpenter bees are some of our most effective pollinators and fly at cool temperatures.

3. **Revisit your pesticide management program:**

A thoughtfully developed Integrated Pest and Pollinator Management (IPPM) program in your orchard is key. The IPPM approach adds the extra touch of choosing pesticides that pose the lowest risk to bee health. Research shows that wild bee populations are negatively impacted by increasing pesticide use. Recently it has come to light that fungicides are not as benign to bees as was once thought. Some fungicides weaken the immune responses in bees and others synergize with certain insecticides including beekeeping miticides, making them exponentially more toxic for bees. All this new information can be overwhelming, so our pollinator team is developing an easy-to-use pesticide guide for growers to help make the decision making process simpler. The guide will list all the pesticides used in apple production, their toxicity, persistence, and their ability to synergize with other chemicals. In the near future, you will be able to find this pesticide synergy guide on our 'grower resources link' (May 2018) at our Cornell Pollinator Network site (https://pollinator.cals.cornell.edu).

It's important to state that we are not endorsing that growers abandon the use of honey bees, but instead we want to support grower efforts towards a more integrated pollination management program. This more inclusive approach will help to ensure optimal pollination in the face of increasing hive rental costs and difficulties in obtaining hives when needed. Some growers will find that they do not have enough natural habitat or too big of an orchard to rely solely on wild bee pollination. In these cases, renting honey bees or purchasing bumble bees is a great solution. For best results when using rented bees, growers should place 1–2 colonies per acre. Communication with the beekeeper before, during, and after pollination ensures all expectations and concerns are addressed in a timely manner. If you are planning to rent honey bees this spring, consider using (or simply reviewing) our written pollination contract: https://pollinator.cals.cornell.edu/sites/pollinator.cals.cornell.edu/files/shared/Pollination%20Services%20Contract%20Example_2018.pdf. Most importantly, take time to get to know the bees in your orchard and get in touch with us if you have any questions.

Blitzer, E. J., Gibbs, J., Park, M. G. and Danforth, B. N. 2016. Pollination services for apple are dependent on diverse wild bee communities. Agriculture, Ecosystems & Environment 221, pp.1–7.

Park, M. G. et al. 2018. Apple grower pollination practices and perceptions of alternative pollinators in New York and Pennsylvania. Renewable Agriculture and Food Systems. 1–14. https://doi.org/10.1017/S1742170518000145 (Grower Survey Report).

Park, M. G., Raguso, R. A., Losey, J. E. and Danforth, B. N. 2016. Per-visit pollinator performance and regional importance of wild *Bombus* and *Andrena* (*Melandrena*) compared to the managed honey bee in New York apple orchards. Apidologie 47(2), pp.145–160.

Weekly Apple Scab Update for NY (4/23 to 4/28/18)

Below are apple scab predictions for NY apple regions based on the NEWA disease forecast system (http://newa.cornell.edu/index.php?page=apple-diseases). Information is kept concise. Alerts will also be posted to Twitter @FruitPathology with updates occurring throughout the week, which would allow notifications to send to mobile device. The various outputs are explained below.

Week of 4/23/18*	Hudson Valley	Wayne	Niagara	Champlain Valley	Finger Lakes
Infection Predicted	Moderate (4/25)	Not at green tip	Not at green tip	Not at green tip	Low (4/25)
Maturity	16%	-	-	-	4%
Discharge	12%	-	-	-	2%

Output explanations
Infection predicted:

• **Low:** <10% ascospores will discharged throughout the week; Moderate: 10-20% ascospores will discharged throughout the week; High: >20% ascospores will be discharged throughout the week

• **"None"** – no infection predicted for the week; Date: An infection event is predicted for the date listed. If a multi-day infection event is predicted, the first full date of the infection will be listed

Ascospore maturity: The percent ascospore maturity during the predicated infection event. If there is no infection predicted, the maturity for the end of the week is listed.

Discharge: The percent ascospore discharge during the predicted infection event. If no infection predicted, the cumulative ascospore discharge for the week is listed.

UPCOMING PEST EVENTS

	43°F	50°F
Current DD* accumulations (Geneva 1/1–4/23):	82.9	27.1
(Geneva 1/1–4/23/2017):	252.9	114.1
(Geneva "Normal"):	209.3	97.9
(Geneva 1/1-4/30, predicted):	143.7	54.8
(Highland 1/1–4/23):	165.2	59.1

Coming Events:	Ranges (Normal ±StDev):	
Green fruitworm peak catch	96-231	37-109
Green apple aphids present	111-265	38-134
Pear psylla 1st oviposition	40-126	11-53
Pear thrips in pear buds	118-214	50-98
Rosy apple aphid nymphs present	134-244	56-116
Spotted tentiform leafminer 1st catch	118-218	45-102
Spotted tentiform leafminer 1st oviposition	143-273	58-130
McIntosh green tip	99-145	38-63

*all DDs Baskerville-Emin, B.E.

INSECT TRAP CATCHES (Number/Trap/Day)

Geneva, NY

	4/9	4/16	4/23
Green fruitworm	0.0	0.0	0.5*
Redbanded leafroller	0.0	0.0	0.5*
Spotted tentiform leafminer	0.0	0.0	0.0

Highland, NY

	4/9	4/16	4/23
Green fruitworm	1.0	0.0	0.5
Redbanded leafroller	0.0	28.0	8.5
Spotted tentiform leafminer	0.0	0.0	1.5*
Lesser appleworm	0.0	0.0	1.5*

* first catch

PHENOLOGIES

Geneva:	Current	4/30, Predicted
Apple (McIntosh, Red Delicious):	silver tip	green tip
Apple (Empire, Idared):	early green tip	green tip
Pear (Bartlett, Bosc):	early swollen bud	bud burst
Sweet Cherry	early swollen bud	swollen bud
Tart Cherry:	swollen bud	swollen bud
Peach:	swollen bud	bud burst
Plum:	swollen bud	bud burst
Apricot:	swollen bud	bud burst

Highland:

Apple (McIntosh):	30% half-inch green
(Golden Del.):	9 % half-inch green
(Ginger Gold):	45% half-inch green
(Red Delicious):	31% half-inch green
Pear (Bartlett):	39% bud burst
(Bosc):	41% bud burst
Peach:	25-32% bud burst
Cherry:	62-100% swollen bud
Plum:	53% swollen bud

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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