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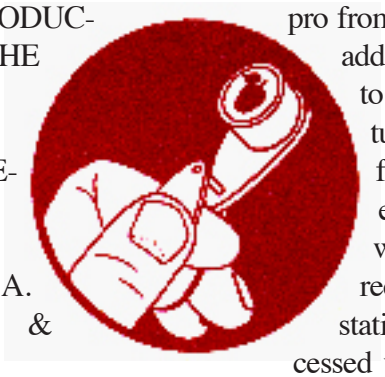
DETAILING THE MODEL



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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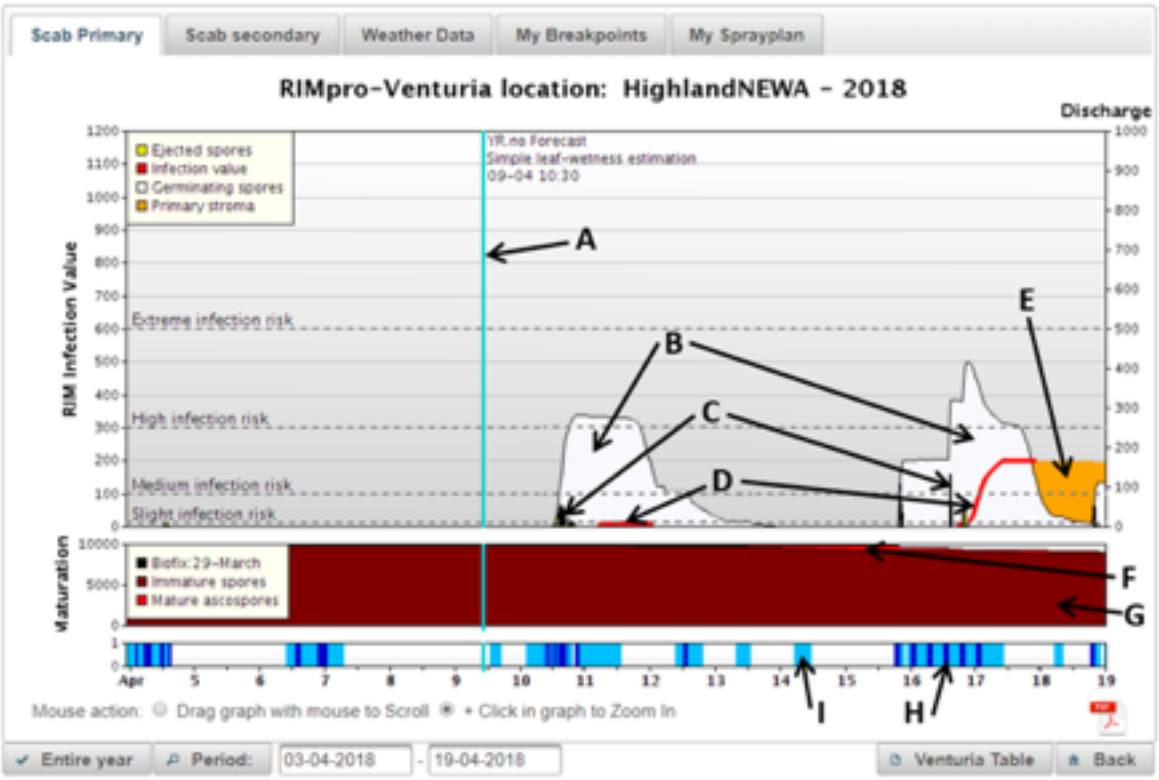

Figure 1. Example of infection prediction in RIMpro apple scab model for Highland, NY on 9 Apr 2018.
(A) Vertical light blue line marks the current date and time within that day.
(B) White camel hump-like areas show germinating spores; i.e., cumulative number of scab spores that germinate over time and 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.

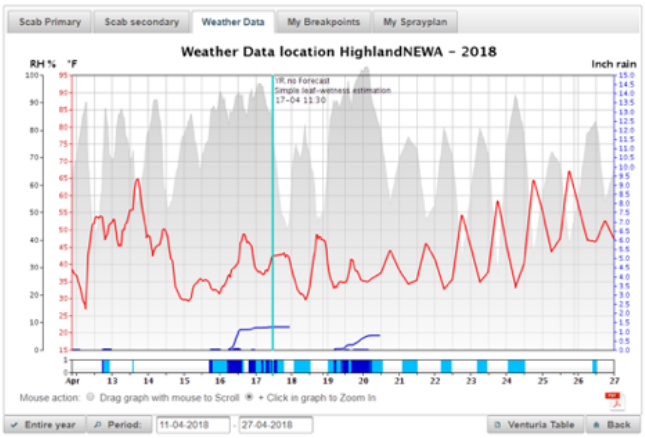

Figure 2. Example of RIMpro's summary of weather conditions from 12–27 Apr accessed by selecting "Weather Data" card. Vertical light blue line marks the current date/time in the day, in this case on 17 Apr 2018. Everything to the right of the light-blue line is a weather prediction based on the forecast 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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