Tracking Fire Blight: Fighting Disease with Disease Forecasting

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While we can see insects, weeds and other kinds of pests, the microbes that cause disease usually can't be seen. We see the impact of diseases, symptoms such as cankers, rots, wilts and other damage, but that is long after the microbes have arrived and infected. To manage diseases effectively, we need to know when they will start to build up to dangerous levels before infection, then stop them. Using traps, pheromones or other insect pest management monitoring tools won't work for microbes. Instead we monitor those elements that drive pathogen growth and infection, particularly the weather. Weather data, particularly temperature, rain and humidity can be used to predict plant disease risk. To do this, weather data are entered into models that calculate risk. To get a good disease risk estimate, we need good weather data and a good model.

Fortunately, there are good fire blight models that can forecast pathogen growth and the risk of infection in apples. Knowing the risk of fire blight enables more accurate and effective spray decisions. Forecast models for streptomycin or other sprays are not the whole answer to fire blight management. Other tactics are required as described in "An Annual Fire Blight Management Program for Apples: An Update" in *Fruit Notes*, Spring 2015, but using a forecast model is a critical component. Fire blight models give growers a way to "watch" bacteria build up in an orchard without actually seeing them. Increasingly, pest management models, automated weather collection and weather forecasts, plus related treatment recommendations come bundled in computer-based decision support systems (DSSs).

In this article, we look at some common DSS options used for fire blight in the Northeast. These include NEWA (the Network for Environment and Weather Applications) managed by the New York State IPM Program, Ag-Radar managed by the University of Maine Extension, and the commercial product SkyBit (ZedX, Inc.). We will look at how each of these decision support systems work, and compare their performance at the University of Massachusetts Cold Spring Research and Education Center at Belchertown, MA in 2014.

Weather Data and Forecasts

There are basically two ways to collect weather data for a fire blight model: purchasing on-site equipment, or subscribing to a site-specific weather monitoring and forecast service that does not require an on-site weather station, so-called "virtual weather". While having a physical weather station on your property rather than using a virtual one may seem more reliable or accurate, this is not the case. Comparisons of virtual weather data to onsite weather stations used for disease forecasting indicate they perform equivalently (Gleason et al., 1997; Magarey et al, 2006; Cooley et al, 2011).

Weather station equipment. The most efficient weather station equipment is electronic and automated (Figure 1), recording data which is then routed to a computer that runs pest management models, such as a fire blight model. Alternatively, data may be downloaded to a computer manually, but it is more convenient to automate that process. Typically, weather data are collected at regular intervals and used in forecast model calculations.

There are several manufacturers of electronic weather stations, but stations need to be matched to the computer system and model that will process the weather data in a given DSS. NEWA is set up to accept data from Rainwise (Trenton, ME; http://www.rainwise.com) and Onset (Bourne, MA; http://www.onsetcomp.com/corporate) weather stations. NEWA also uses data from publically available stations at airports. Other weather stations, such as Davis (Hayward, CA; http://www.davisnet.com/weather/index.asp) and Spectrum Watchdog (Aurora, IL; http://www.specmeters.com/brands/watchdog/), cost less and are integrated with pest management software that can be run on individual personal computers, but we have not evaluated these

Figure 1. Electronic weather station.

DSSs.

The Rainwise and Onset stations used by NEWA generally cost from approximately $2,000, depending on the manufacturer and sensors purchased. Electronic weather stations require regular maintenance, need to be calibrated annually, and over time require repairs and sensor replacement. In our experience, parts costs for a station average $100 to $200 per year, though there is a wide range. Some stations function for several years with no replacement parts, others have required replacement parts within a year of being set up.

Weather stations should be calibrated annually, at least, to maintain data quality. Weather stations do not provide quality control; they simply report values. The accuracy of disease risk forecasts depends on the accuracy of weather data, so the level of quality control for weather data makes a difference to how good a disease forecast is. When a weather station fails, it may be immediately clear if the data are being monitored for quality. However if data are not being monitored, errors may go undetected for some time, leading to inaccurate risk forecasts.

In our experience, stations may break down for periods of a few hours to a week or more. NEWA automatically monitors weather stations, and if a weather station stops transmitting data the person in charge of the station is notified by email. However, detecting inaccurate data is more difficult. We have had cases where critical data such as temperature or the length of a wetting period has been inaccurately measured for long periods, leading to inaccurate disease forecasts. Maintaining continuous high-quality data from onsite weather stations requires significant effort and technical knowledge of the equipment.

Weather forecasts. On-site stations only provide weather observations. Weather forecasts are arguably more important for effective disease management, since chemical treatments generally are most effective if applied before infection. This is particularly true of fire blight management. While streptomycin is active within a 24-hour window after infection, it is most effective as a preventive treatment. In addition, post-infection chemical treatments are more likely to select for resistant strains of a pathogen than preventative treatments. In practice, users need to combine both past and forecast weather to evaluate risk and determine the need to spray.

DSSs that use on-site weather stations must also incorporate forecasts from some source. NEWA, for example, uses data from the National Digital Forecast Database, NDFD (http://www.nws.noaa.gov/ndfd/).

Site-specific virtual weather. Rather than setting up a weather station in an orchard, growers or consultants can subscribe to a service that generates virtual weather data for that orchard. Virtual data are created by combining different sources of actual weather observations (e.g. National Weather Service) with proprietary mathematical techniques which basically interpolate from the actual observations to estimate weather for locations distant from weather stations. In addition to being a substitute for station observations, site-specific virtual weather forecasts can be made.

The most popular virtual weather subscription in the Northeast is SkyBit, which sells E-Weather service products. SkyBit offers an "AgWeather IPM Apple Disease Product" that includes virtual weather data and predictions of fire blight risk, as well as other diseases. Users can begin a subscription by calling in the geographic coordinates and elevation of an orchard and a starting date for the service. Alternatively, users can subscribe online (http://www.skybit.com/). Within one day, users will begin receiving weather and disease products via email or fax. Growers have the option of calling in a bloom date to improve the accuracy of the fire blight model used to make disease predictions, or may simply rely on the model's bloom estimate.

Table 1. Risk level ranges for NEWA, Ag-Radar and SkyBit.

System	Risk Ratings
NEWA	**Low** - bactericides probably unnecessary. **Caution** - check the 5-day forecast, expect infection if warm weather continues (60°F or higher) and a wetting event occurs. **High** - expect infection if there is a wetting event, even a heavy dew. **Extreme** - the blossoms should be protected with streptomycin.
Ag-Radar Eastern Fire Blight Model	**No FB Infection** **Infection Risk** **Severe Infection Risk!**
Ag-Radar CougarBlight	**Low** **Caution** **High** **Extreme!** **Exceptional!**
SkyBit	**-** not active **++** infection

A subscription service can be activated only for those months when decisions will be made for pest control. Virtual stations require a subscription fee of approximately $200 to $400 for a growing season, depending on the length of time and types of products purchased. They come with quality control as part of the service.

Fire Blight Models

Models that analyze weather data to estimate fire blight risk follow generally understood relationships between the bacterial pathogen *E. amylovora*, the seasonal growth of apple hosts, and weather. As early as the 1950's, the plant pathologist William Mills at Cornell recognized a relationship between warm, humid weather and blossom blight, and suggested that streptomycin should be sprayed on blossoms when temperatures above 65º F and rain or high humidity were predicted. In the next 60 years, this basic approach has been significantly refined.

The primary focus for fire blight management is preventing blossom infections. Open flowers give *E. amylovora* a way to get into the tree where they produce toxins and destroy tissue (Figure 2). During the bloom

Figure 2. Pistils (green) and anthers (yellow) of an apple flower. Bacteria must be washed down the pistils to the base of the flower to infect (Photo: Penn State Univ. Extension)

Table 2. Comparison of different weather data sources for fire blight models.

System	Weather Record Source	Weather Forecast Source	Model
NEWA	On-site electronic weather station	Natl. Digital Forecast Database	CougarBlight
Ag-Radar Eastern Fire Blight Model	SkyBit virtual weather	SkyBit virtual forecast	MaryBlyt modification
Ag-Radar CougarBlight	SkyBit virtual weather	SkyBit virtual forecast	CougarBlight
SkyBit	SkyBit virtual weather	SkyBit virtual forecast	MaryBlyt modification

period, fire blight models estimate the reproduction of fire blight bacteria carried into open flowers, primarily by insects. Reproduction is driven by temperature, and heat unit accumulation is well correlated with fire blight infection potential. From 60º F to 70º F the bacteria grow slowly. They grow moderately between 70º F and 75º F, and rapidly between 75º F and 93º F. When temperatures are between 82º F and 90º F bacterial populations can explode, going from a few cells on each flower stigma to millions in a matter of hours. This rapid bacterial growth makes fire blight epidemics "appear out of nowhere".

Reflecting this explosive growth potential, fire blight models estimate bacterial populations based on degree **hours** or hourly heat units, NOT degree **days**. When sufficient heat has accumulated, the models estimate that there are enough bacteria in flowers to infect. A couple of days with temperatures in the 70's and 80's easily reach model thresholds. A single stigma in an apple blossom can support a million *E. amylovora* bacteria, far more than the minimum needed for infection.

Once the population of *E. amylovora* on pistils is high enough to cause infections, bacteria must be washed down to nectaries at the bottom of the flower, where they can move inside apple tissue. That requires water, such as rain. Other sources of moisture, such as heavy dew or the amount of water in a high volume orchard spray application may be sufficient to initiate infection, though this has not been definitively demonstrated.

CougarBlight and MaryBlyt. Two forecasting models or variants based on them are widely used in the Northeast: CougarBlight developed by Tim Smith in Washington state; and MaryBlyt originally developed by Paul Steiner in Missouri and Maryland, and modified by Alan Biggs in West Virginia. In addition to predicting blossom infections, MaryBlyt also predicts when the first appearance of different types of fire blight symptoms will occur, including blossom blight, shoot blight, canker blight and trauma blight. CougarBlight is a "blossom blight only" model. Both models require input on tree development, particularly open flowers, and environmental data, specifically temperature and rain. CougarBlight also asks for the history of fire blight in an area to adjust infection thresholds. If blight is in an area in the current growing season or was active the previous year, thresholds are lower than if there has been no blight in an area within

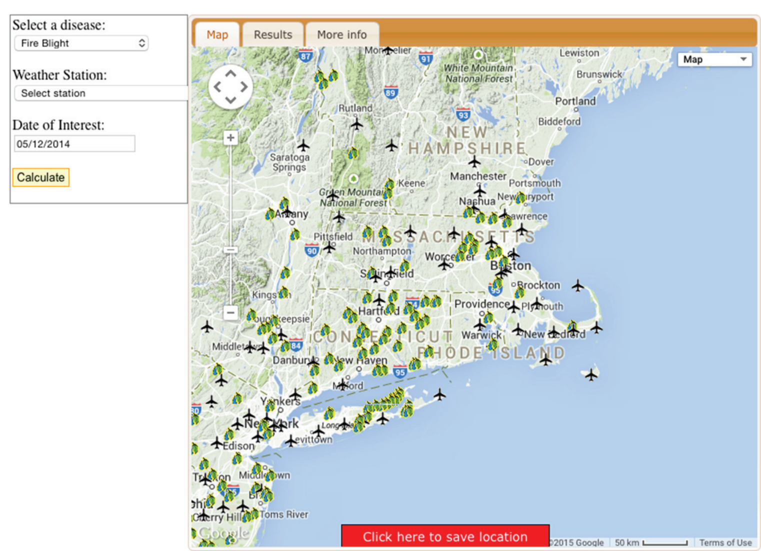

Figure 3. NEWA screen showing weather stations (leaf symbols) and airport weather (plane symbols) in New England and northeastern New York. A Belchertown, MA weather station is selected to run CougarBlight on May 12, 2014

Map | Results | More info

Fire Blight Risk Predictions for Belchertown

Blossom blight predictions using the Cougarblight model begin at first blossom open.

First blossom open date: 5/10/2014

First blossom open date above is estimated based on degree day accumulations or user input. Enter the actual date for blocks of interest and the model will calculate the protection period during bloom more accurately.

Orchard Blight History: Fire blight occurred in your neighborhood last year.

The orchard blight history above is the NEWA default. Select the actual blight history for your orchard and the model will recalculate recommendations.

Blossom Blight Summary - Cougarblight

	Past	Past	Current	Blossom Blight 5-Day Forecast (Forecast Details)				
Date	May 10	May 11	May 12	May 13	May 14	May 15	May 16	May 17
4-day DH	-	161*	457*	464*	540	491	276	313
Risk Level	-	Caution*	High*	High*	Extreme	High	Caution	High
Wetness Events								
Rain Amount	NA	0.04	0.00	0.09	0.00	0.00	0.65	1.11
Rain Prob (%) Night|Day			-|-	-|-	-|-	-|-	-|-	-|-
Dew	NA	Yes	No	No	Yes	Yes	Yes	No
Leaf Wetness (hours)	NA	6	0					

- *Low* - bactericides probably unnecessary, check the 5-day forecast for warm weather (60°F or higher) and wetting events.
- *Caution* - check the 5-day forecast, expect infection if warm weather continues (60°F or higher) and a wetting event occurs.
- *High* - expect infection if there is a wetting event, even a heavy dew.
- *Extreme* - the blossoms should be protected with streptomycin.

Figure 4. NEWA asks for the date of first bloom, and whether fire blight occurred last year, or is occurring in the current season. It then gives the risk of fire blight on each day. Here it shows "High" risk currently, and based on weather forecasts predicts risk will be High or Extreme for the next three days.

the past year.

These models can be run using daily high and low temperatures, and some simple tool such as a rain gauge to collect wetness data. For MaryBlyt, data may be entered into a personal computer on a day to day basis. CougarBlight does not require a computer, but simple calculations and a set of tables that indicate heat units and risk, though using a spreadsheet version of the model simplifies the process. Both MaryBlyt and CougarBlight are available on line. MaryBlyt 7.1 can be downloaded from West Virginia University's Kearneysville Tree Fruit Research and Education Center, http://www.caf.wvu.edu/kearneysville/Maryblyt/ . It runs only on the Windows OS. CougarBlight is available from the Washington State University Chelan-Douglas Extension site, where there are links to Excel spreadsheets in Fahrenheit and Celcius, http://county.wsu.edu/chelan-douglas/agriculture/treefruit/Pages/Cougar_Blight_2010.aspx . These sites also have excellent discussions of fire blight and its management, and instructions on use of the models.

It is easiest to use both models with automated weather data collection and forecasts. Both models have been adapted to different DSSs. In the Northeast, the most commonly used pest management DSSs that have fire blight models are NEWA, Ag-Radar and SkyBit.

NEWA. NEWA uses the CougarBlight model. Growers in Northeastern states can purchase a weather station and link to NEWA (http://newa.cornell.edu/). NEWA may also be used without a weather station in the orchard if there is a NEWA site nearby. But keep in mind, the further from an orchard a site is, the more difference there will be in weather and therefore in estimated fire blight risk. This difference can be the determining factor of whether or not conditions are met to allow blossom infection. (Figure 3)

Using NEWA to track fire blight risk is relatively easy. On the NEWA site, the orchard location, the crop and the disease of interest need to be identified through a series of selection steps. In the example here, a weather station at the UMass Cold Spring Orchard in Belchertown, MA has been selected to evaluate the risk of "Fire Blight" on Apples on May 12, 2014. NEWA automatically tracks weather data, so users do not need to enter it. Clicking the "Calculate" button will generate a table showing "Fire Blight Risk Predictions" for the location, in this case, Belchertown.

NEWA will ask you to enter the date of first bloom. This should always be the date that the first flowers of any variety in the orchard open. Since bloom is critical, and one day can make a big difference in fire blight risk, monitor trees closely for the beginning of bloom. (Figure 4) NEWA will also ask for "Orchard Blight History" as one of three options:

- No fire blight in your neighborhood last year.
- Fire blight occurred in your neighborhood last year.

Blossom Blight Summary - Cougarblight								
	Past	Past	Current	Blossom Blight 5-Day Forecast Forecast Details				
Date	May 10	May 11	May 12	May 13	May 14	May 15	May 16	May 17
4-day DH	-	161*	457*	-	75*	188*	269*	313
Risk Level	-	Caution*	High*	-	Low*	Caution*	Caution*	High
Wetness Events								
Rain Amount	NA	0.04	0.00	0.09	0.00	0.00	0.65	1.11
Rain Prob (%) Night|Day ?			-|-	-|-	-|-	-|-	-|-	-|-
Dew ?	NA	Yes	No	No	Yes	Yes	Yes	No
Leaf Wetness (hours)	NA	6	0					
Streptomycin Spray Date: 5/13/2014								

Figure 5. The predicted impact on fire blight risk of a streptomycin spray applied on May 13 to the Belchertown orchard as estimated by NEWA.

- Fire blight is now active in your neighborhood.

This is a way of estimating inoculum levels. We recommend that growers be conservative and not use the lowest level, "no blight in the previous year".

The NEWA CougarBlight model shows past, current and forecast risk on one of four levels by day. In this example, risk is currently High. Based on the 5-day weather forecast for Belchertown, NEWA also predicts that fire blight risk will be High on May 13 and for the next 2 days. Based on this, this grower should apply a streptomycin spray as soon as possible.

NEWA also shows the effect of a streptomycin spray on fire blight risk (Figure 5). If streptomycin is applied on May 13 in the example, the forecast risk for the next 3 days ranges from Low to Caution, returning to High on May 17. A second streptomycin application may be needed at that time, depending on actual weather on May 13 through May 16.

The NEWA model can indicate when symptoms from a possible infection should first appear (Figure 6). In this example, to find out when symptoms from a May 12 infection should show up, lower down on the same page the "Infection Event Date" can be entered, and the first date of predicted symptom appearance will be calculated. In this example, symptoms from a May 12 infection should begin to show on May 25.

The same section of the NEWA screen also allows users to estimate when an infection occurred by entering a date when symptoms were first seen. In the example, suppose symptoms were seen on some trees for the first time on May 28. That date

Infection Event Date: 05/12/2014

Shoot Blight Infection for Belchertown

Fire blight symptoms on infected shoots show up when about 90 to 100 degree days base 55F have accumulated after an infection event.

Infection event:
May 12

Degree Days (base 55 BE) 5/12 through 5/25:
95

Check for symptoms starting on May 25

Symptom Occurrence Date: 05/28/2014

Shoot Blight Infection for Belchertown

Fire blight symptoms on infected shoots show up when about 90 to 100 degree days base 55F have accumulated after an infection event.

Symptom Occurrence Date:
May 28

Approximate Infection Date:
May 15

Degree Days (base 55 BE) 5/15 through 5/28:
94

Figure 6. NEWA predictions for first symptom appearance from a user-entered Infection Event Date (top), and estimate of the Approximate Infection Date from user-entered Symptom Occurrence Date (bottom).

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E-WEATHER SERVICE                                      AGWEATHER IPM APPLE DISEASE PRODUCT
For: MA-BELCHERTOWN-HORTRESCENTER                                     Date: Tue May 13, 2014

                                     APPLE SCAB         FIRE BLIGHT        SOOTY BLOTCH
              WEATHER                  140414             140512              ------
       TMX TMN  PREC ARH LW        ASM AW  TW   PW     ADH AW  TW  PW       ALW      PW
Date   F   F     in   %  hr         %  hr  F           65F hr  F            hr
==== === === ===== === ==        ==== == === ==      ==== == === ==       =====    ==
BASED ON OBSERVATIONS
0501  65  44  1.01  88 24         2  50  47 ++      -   -   -  -         -        -
0502  63  47  0.00  56  8         2  58  48 ++      -   -   -  -         -        -
0503  64  44  0.00  58  0         3   0   -  +      -   -   -  -         -        -
0504  58  48  0.00  58  0         3   0   -  +      -   -   -  -         -        -
0505  61  47  0.00  56  0         4   0   -  +      -   -   -  -         -        -
0506  61  41  0.00  50  0         5   0   -  +      -   -   -  -         -        -
0507  65  36  0.00  45  0         6   0   -  +      -   -   -  -         -        -
0508  64  42  0.00  67  0         8   0   -  +      -   -   -  -         -        -
0509  58  53  0.11  87 23        10  23  56 ++      -   -   -  -         -        -
0510  78  58  0.55  78 20        14   8  65 ++      -   -   -  -         -        -
0511  77  54  0.00  39  5        19  13  63 ++      -   -   -  -         -        -
0512  83  50  0.00  47  0        26   0   -  +    170   0   -  -         -        -
BASED ON FORECASTS
0513  60  49  0.00  61  0        31   0   -  +    170   0   -  -         -        -
0514  69  46  0.00  68  0        37   0   -  +    188   0   -  -         -        -
0515  71  58  ----  79 10        46  10  64 ++    225  10  64 ++         -        -
0516  71  61  ----  83 22        55  22  66 ++    225  22  66 ++         -        -
0517  67  57  ----  86 24        63  46  64 ++    225  46  64 ++         -        -
0518  67  53  ----  74 24        70  70  62 ++    225  70  62 ++         -        -
0519  63  48  ----  70 11        75  81  61 ++    225  81  61  +         -        -
0520  63  47  ----  71  0        80   0   -  +    225   0   -  -         -        -
0521  65  47  ----  70  0        84   0   -  +    225   0   -  -         -        -
0522  66  48  ----  69  0        87   0   -  +    225   0   -  -         -        -
=========================================================================================
*********  IMPORTANT:  Check the dates at the top of each column.  *********
 Green Tip Date    - is used for Apple Scab
 Blossom Date      - is used for Fire Blight
 Petal Fall Date   - is used for Sooty Blotch

 ASM = Apple Scab Maturity Percentage
 ADH = Accumulated degree-hours from blossom date up to a max of 225.
 ALW = Accumulated leaf wetness hours from petal fall date.
 AW  = Accumulated wetness hours for the most severe event.
 TW  = Average temperature during the most severe event.
 PW  = Pest Wait/Watch/Warning:  - = not active
                                 + = active but no infection
                                ++ = possible infection & damage

******  ATTENTION: Please report your biofix dates (1-800-454-2266) ********
Please call 1-800-454-2266 to report your biofix dates for Green Tip,
Blossum, and Petal Fall. Your product will NOT be correct unless these
dates are reported accurately. Thank you.
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Figure 7. SkyBit apple disease information for the UMass Cold Spring Orchard delivered on May 13, 2014.

is entered in "Symptom Occurrence Date", and NEWA estimates an approximate infection date of May 15.

SkyBit. As described above, SkyBit uses virtual weather stations to provide weather to its fire blight model, a modification of Mary-Blyt. In the example from Belchertown last year, we show the data received in an email for May 13 (Figure 7). Information is arranged in columns. The first column is the date. Columns 1 to 5 give weather information: maximum temperature (TMX F) and minimum temperature (TMN F), the amount of rainfall in inches (PREC in), relative humidity (ARH %), and the number of hours leaves were wet (LW hr).

The remaining columns give information for three apple diseases: apple scab, fire blight and sooty blotch. There are four columns of fire blight information. The number at the top of the column, 140512, is the blossom date, May 12, 2014. Growers need to supply the bloom date to SkyBit by calling a toll free number.

The first FIRE BLIGHT column shows accumulated degree hours over 65°F (ADH 65F), starting at bloom. The second FIRE BLIGHT column is the accumulated wet hours during the most severe infection event (AW hr). The third column shows the average temperature during the event (TW F). The fourth column indicates fire blight risk (pest wait/watch/warning, PW) as one of three levels:

- A minus symbol (-) meaning no risk or not active
- A single plus symbol (+) indicating blossoms are open and the minimum number of degree hours have been accumulated but infection has not occurred
- A double plus symbols (++) indicating risk of infection is high.

In the example, SkyBit indicates risk of infection on May 15. Based on this, an application of streptomycin would be recommended on May 14. SkyBit is relatively simple. It is not interactive, does

Range of open blossom dates for common apple cultivars	CougarBlight Heat Units, Inches Rain, & Leaf Wet Hours	I - No active FB within one mile this year or last two years	II - FB active within one mile of orchard within last two years, but not this year	III - FB active within one mile of orchard this year.	Dates blossom blight (& shoot blight) symptoms apparent if infection occurred
Early King Bloom Mon, May 12	307 HU, 0.0", 0 hrs	Low	Low	Low	
Tue, May 13	312 HU, 0.0", 0 hrs	Low	Low	Low	
Wed, May 14	340 HU, 0.0", 0 hrs	Low	Low	Low	
Thu, May 15	405 HU, 0.12", 9 hrs	Caution	EXTREME!	EXCEPTIONAL!	June 2, (June 12)
Fri, May 16	121 HU, 1.88", 24 hrs	Low	Caution	HIGH	June 3, (June 13)
Sat, May 17	139 HU, 0.0", 11 hrs	Low	Caution (if dew)	HIGH (if dew)	June 3, (June 14)
Sun, May 18	122 HU, 0.0", 0 hrs	Low	Low	Low	
Mon, May 19	68 HU, 0.0", 0 hrs	Low	Low	Low	
Tue, May 20	96 HU, 0.0", 0 hrs	Low	Low	Low	
Wed, May 21	126 HU, 0.0", 0 hrs	Low	Low	Low	

Figure 8. Ag-Radar output for the CougarBlight model at the UMass Cold Spring Orchard for mid-May, 2014.

If blossom infection occurred May 15, blossom blight would be noticeable by June 2, and shoot blight by June 12.		
Range of open blossom dates for common cultivars.	FBP = Fire blight bacteria potential. 100% = minimum threshold level for infection. % FBP, Inches Rain, Leaf Wet Hours, & Avg. Temperature	In absence of rain, 3 or more hours of leaf wetness is counted as possible dew conditions for adequate wetting, which may overstate risk on such days. See Cougarblight model for additional comments. Eastern Fireblight Model Infection Requirements: 100% EIP (>=198 cumulative degree hours > 65F), + > 0" rain, or > 0.1 inch rain on previous day, + Average temp. on wetting day >= 60F
Early King Bloom Mon, May 12	86%, 0.0", 0 hrs., 68F	No FB infection
Tue, May 13	58%, 0.0", 0 hrs., 56F	No FB infection
Wed, May 14	70%, 0.0", 0 hrs., 58F	No FB infection
Thu, May 15	102%, 0.12", 9 hrs., 66F	INFECTION RISK
Fri, May 16	106%, 1.88", 24 hrs., 65F	INFECTION RISK
Sat, May 17	59%, 0.0", 11 hrs., 62F	No FB infection
Sun, May 18	48%, 0.0", 0 hrs., 57F	No FB infection
Mon, May 19	48%, 0.0", 0 hrs., 56F	No FB infection
Tue, May 20	45%, 0.0", 0 hrs., 61F	No FB infection
Wed, May 21	68%, 0.0", 0 hrs., 61F	No FB infection

Figure 9. Ag-Radar output for the Eastern Fire Blight model (MaryBlyt) at the UMass Cold Spring Orchard for mid-May, 2014.

not predict symptom development, or the impact of a streptomycin application.

Because NEWA and SkyBit use different sources of weather data, and different models, the output from the two systems may differ. In our example, NEWA predicted a high risk of infection on May 12 and 13, and extreme risk on May 14, while SkyBit did not predict any risk until May 15.

Ag-Radar. Ag-Radar (http://extension.umaine.edu/ipm/programs/apple/pestcasts/) currently uses virtual weather data purchased from SkyBit, but could use data from any source that provides automated delivery of quality-controlled data to run versions of both CougarBlight and MaryBlyt. (Ag-Radar calls its version of Maryblyt "The Eastern Fire Blight Model"). Ag-Radar works best when growers provide observed dates for first open bloom. These dates are then entered into the system to influence model estimates.

The Ag-Radar CougarBlight fire blight risk assessment for mid-May 2014 is similar to SkyBit's (Figure 8). Risk of infection is low until May 15, at which time it increases. Like NEWA, the Ag-Radar implementation of CougarBlight uses three levels to estimate the amount of initial inoculum though the prompts are different:

- No active fire blight within 1 mile of the orchard in last two years.
- Fire blight was present within 1 mile of the orchard within last 2 years, but not currently active in the area this year.
- Active fire blight cankers within 1 mile of the orchard this year.

Ag-Radar gives users the accumulated degree hours for the previous four days ("Heat Units"), inches of rain, and hours of leaf wetness. It also estimates dates for the first appearance of blossom symp-

File Edit Options Help
Save Print Copy Paste Save Screen as Image View Graph Add or Mo

Inputs

Date	Phenology	Max Temp (F)	Min Temp (F)	Wetness (in)	ra	Avg Temp (F)	EIP	BHWTR	BBS
5/9/2014	PK	57.6	53.5	0.03		55.6	-	-	-
5/10/2014	PK	79.0	58.3	0.38		68.6	-	-	-
5/11/2014	PK	76.6	53.5	0.04		65.0	-	-	-
5/12/2014	BL	85.2	54.5	0.00		69.8	97	+ - - + M	-
5/13/2014	BL	66.5	48.8	0.00		57.6	97	+ - - - L	-
5/14/2014	BL	72.4	45.5	0.00		59.0	121	+ + - - M	-
5/15/2014	BL	75.7	59.4	0.12		67.6	170	+ + + + I	-
5/16/2014	BL	66.7	62.4	0.05		64.6	73	+ - + + H	10 a
5/17/2014	BL	68.3	51.8	1.44		60.0	85	+ - + + H	16 a
5/18/2014	BL	67.3	43.1	0.00		55.2	61	+ - + - M	19 a
5/19/2014	BL	66.1	42.3	0.00		54.2	12	+ - - - L	22 a
5/20/2014	BL	73.8	48.5	0.00		61.2	36	+ - - + M	30 a
5/21/2014	BL	77.3	46.9	0.00		62.1	73	+ - - + M	39 a
5/22/2014	PF	61.9	52.8	0.53		57.4	-	-	42 a
5/23/2014	PF	65.6	51.8	0.49		58.7	-	-	46 a
5/24/2014	PF	64.8	50.8	0.05		57.8	-	-	50 a
5/25/2014	PF	72.8	47.5	0.02		60.2	-	-	56 a
5/26/2014	PB	78.1	52.9	0.06		65.5	-	-	67 a
5/27/2014	PB	79.3	49.7	0.05		64.5	-	-	77 a
5/28/2014	PB	51.5	46.6	0.02		49.0	-	-	77 a
5/29/2014	PB	69.9	40.2	0.00		55.0	-	-	82 a
5/30/2014	PB	72.6	48.5	0.07		60.6	-	-	88 a
5/31/2014	PB	66.3	49.0	0.00		57.6	-	-	92 a
6/1/2014	PB	76.2	43.2	0.00		59.7	-	-	100 a
6/2/2014	PB	81.2	53.2	0.00		67.2	-	-	-
6/3/2014	PB	86.7	55.9	0.04		71.3	-	-	-

Fiugre 10. MaryBlyt output using data from an on-site weather station at the UMass Cold Spring Orchard for mid-May to early June, 2014.

toms and the first shoot blight symptoms.

Ag-Radar also lets users choose the Eastern Fire Blight Model (EFB) based on MaryBlyt (Figure 9). In this example, the EFB infection risk estimate is similar to that of CougarBlight, with an "Infection Risk" on May 15 and 16. The model reports Fire Blight Bacteria Potential (FBP) as a percent of the minimum number of degree days needed for infection. In addition, inches of rain, leaf wetness hours and average temperature are given.

The Bottom Line

Any of these systems are useful in guiding growers in making a streptomycin applications and in some cases scouting for fire blight symptoms. To successfully manage fire blight, the important thing is to use one of them.

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