Weather Data Source and Apple Scab DSS – Do They Make Different Recommendations?

Jon Clements
University of Massachusetts Extension
Daniel Cooley
Stockbridge School of Agriculture, University of Massachusetts Amherst

In the Northeast it is not possible to produce apples commercially without timely fungicide sprays to control apple scab. Decision Support System (DSS) models allow more targeted and potentially better scab control with fewer fungicide applications than a calendar spray schedule during the primary phase of apple scab infection. There are basically two elements that go into a DSS: weather data, and a computerized system that analyzes the data and provides user output. These basic elements vary. This raises the question, does the type of weather station, or whether it's an actual station or virtual data, or the location of a weather station, or the processing and output in the DSS itself, make a difference in predicting infection periods? To attempt to answer that question, we compared six configurations of different weather data sources, different weather station locations in an orchard, and different DSSs during the 2020 season at the UMass Cold Spring Orchard in Belchertown, MA.

Weather data was collected from four on-site weather stations at the orchard. Weather stations included two RX3000 and one U30 weather station from Onset Computer Corporation (onsetcomp.com), and one Rainwise weather station (rainwise.com). All stations were located over grass cover in relatively open areas in the orchard. Two stations (the Onset U30 and the Rainwise) were situated within 100 ft. of one another near a central block in the orchard. The other two were farther apart, one (South) at 617 ft. elevation near the center of the orchard, and the other (North) at 712 ft. approximately 0.25 miles northeast of the South station (Figure 1 and Table 1). We also looked

Figure 1. Weather station sites, Cold Spring Orchard, Belchertown, MA.

Table 1 – Information on the six configurations compared for apple scab forecasts at the UMass Cold Spring Orchard, 2020.

Configuration	Station	DSS	Location			
			Site	Latitude	Longitude	Elev. Ft
NEWA-OU	Onset U30	NEWA	A1	42º 15' 11.2"	72º 21' 35.2"	627
NEWA-RW	Rainwise	NEWA	A1	42º 15' 11.4"	72º 21' 35.3"	627
NEWA-ORX-N	Onset RX3000	NEWA	North	42º 15' 25.7"	72º 21' 31.0"	712
NEWA-ORX-S	Onset RX3000	NEWA	South	42º 15' 14.2"	72º 21' 39.9"	617
RIMpro-RW	Rainwise	RIMpro	A1	42º 15' 11.4"	72º 21' 35.3"	627
RIMpro-MB	Virtual Meteoblue	RIMpro	A1	42º 15' 11.4"	72º 21' 35.3"	627

Apple Scab Infection Events (March 1 - June 21)

Start Date & Time	End Date & Time	Wet Hours	Temp Avg. (F)	Rain (in.)	Combined Event
June 11 11:01 AM	June 12 10:00 AM	8	67	0.21	Yes
May 23 2:01 AM	May 23 10:00 AM	8	64	0.01	
May 15 12:01 AM	May 16 4:00 AM	18	56	0.55	Yes
April 30 5:01 AM	May 2 3:00 AM	33	50	1.18	Yes
April 26 2:01 PM	April 28 8:00 AM	42	39	0.42	
April 13 4:01 AM	April 13 11:00 PM	18	56	1.44	Yes
April 2 7:01 PM	April 4 1:00 PM	36	42	0.36	Yes
March 28 5:01 PM	March 31 11:00 AM	55	40	0.96	Yes
March 13 12:01 AM	March 13 5:00 PM	16	45	0.82	Yes

Dry conditions last 229 hours at download — Download Time: 6/21/2020 23:00

7 infection periods

Figure 2. Primary scab infection periods for a single configuration at the UMass Cold Spring Orchard, 2020 as listed in a NEWA table.

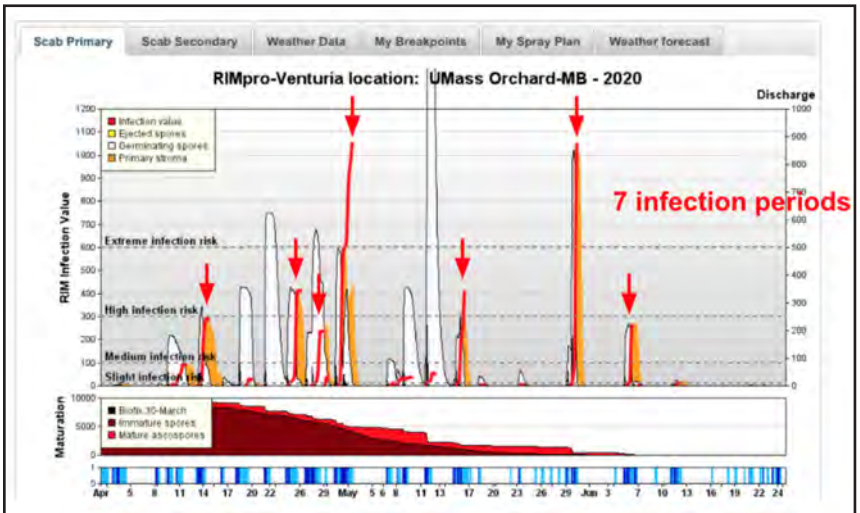

Figure 3. Primary scab infection periods for a single configuration at the UMass Cold Spring Orchard, 2020 as shown in RIMpro output by red lines that exceed 100 RIM Infection Value.

at a "virtual" weather data from a private company (meteoblue.com) which provides estimated weather data using interpolation from actual data. All stations collected temperature, wetness, and precipitation data, required to run the primary apple scab infection model.

We compared two DSSs, the Network for Environment and Weather Applications (NEWA; newa.cornell.edu) and RIMpro (rimpro.eu). The two DSSs use models based on the basic modified Mills Table for primary apple scab infection events, though they differ in terms of modifications and actual algorithms used to calculate the infection. NEWA uses an 'all or none' output to the user for a given wetting period, indicating it either was or wasn't an infection. RIMpro uses a unique calculation of the relative risk of scab infection, the relative infection measure or RIM value.

Each DSS provides output that indicates infection periods in a different format. NEWA provides a list of infection periods in a table format (Figure 2), as well as daily indications on a chart. RIMpro provides a graph that indicates infections when a red line exceeds a certain 'RIM' value (Figure 3). In this study, we used a RIM value of 100 as the threshold for an infection. These infection periods were summed for each of the six configurations and are shown in Table 2.

All apple scab primary infection periods were evaluated in each system as graphically illustrated in Figure 4. Each cell in the table represents a day. Red color-filled cells with an 'x' in them are scab infection periods. Yellow color-filled cells indicate when a grower would probably apply a fungicide spray to manage an infection, a potential spray. Potential sprays were determined using two simple rules: 1) apply a preventive fungicide spray before every infection event; 2) apply a post-infection (kickback) spray following infection periods with wetting that extends more than 48 hours, and/or when ascospore maturity development increases available ascospores by more than 1%.

We first looked at four configurations at the same site, A1. Primary infections ranged from three events

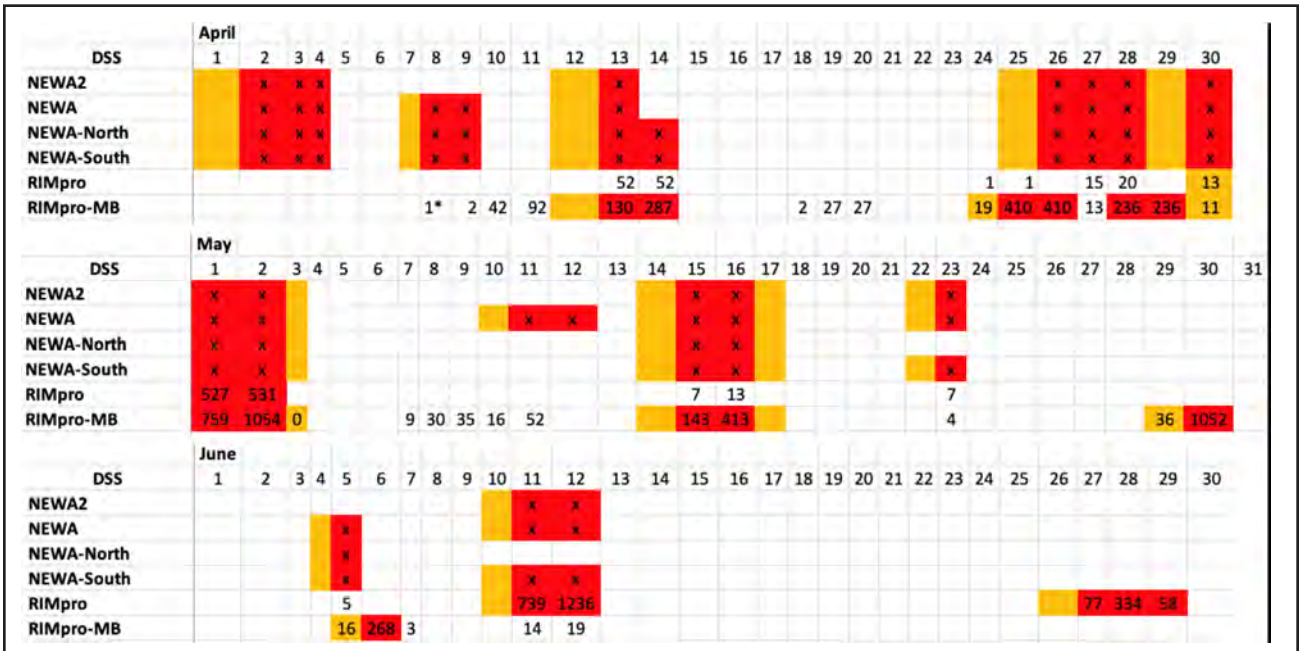

Figure 4. Grid showing primary infection periods (red blocks with an 'x' or RIM value) and potential fungicide sprays (yellow blocks).

for the RIMpro-RW configuration, to ten infections for the NEWA-OU configuration, with NEWA-RW and RIMpro-MB, each showing 7 infections (Table 2). Spray events ranged similarly. This pattern suggested that either weather station site or the DSS used, or both, could contribute to the differences. Comparing each of the two configurations using the same DSS, NEWA or RIMpro, at site A1, there were big differences within each pair, indicating stations can cause differences. Comparing the one pair using the same station but a different DSS, there are also differences. So either or both of these factors, DSS and station, can create differences in scab recommendations.

One pair of configurations, NEWA-ORX-N and NEWA-ORX-S, used the same station hardware and DSS, but were at sites in the orchard that were about 0.25 miles and 85 ft. elevation apart. The infection events and potential sprays differed between these sites, not a surprise. They also differed from events and sprays in the other configurations.

Finally, looking at the three configurations with the same number of infection events, 7, they differ in terms of station, DSS and site, and potential sprays are similar, ranging from 7 to 9. This suggests that any configuration yields similar management decisions. However, in the context of the other data, it is clear there are differences across configurations. The similar results in these three configurations may happen because the variability introduced by the different components cancels out.

The differences we saw are concerning and could result in a grower taking inappropriate management actions, resulting in undesirable outcomes, such as a scab outbreak or making more fungicide applications than necessary. This of course was a preliminary comparison. We need to do further comparisons, and perhaps more importantly, link recommendations from each configuration to actual fungicide applications, to get a better idea of how to best configure a DSS system in orchards. It is clear, however, that significant differences exist between configurations, and these may translate to either overapplication of fungicides or worse, apple scab outbreaks.

Table 2 - Total number of apple scab primary infection periods and potential fungicide sprays during the primary apple scab season by the six DSS configurations.

Configuration	Infection Periods	Potential Sprays
NEWA-OU	10	12
NEWA-RW	7	8
NEWA-ORX-N	7	9
NEWA-ORX-S	9	11
RIMpro-RW	3	3
RIMpro-MB	7	7

Figure 5. Early apple scab infections on a young apple leaf.

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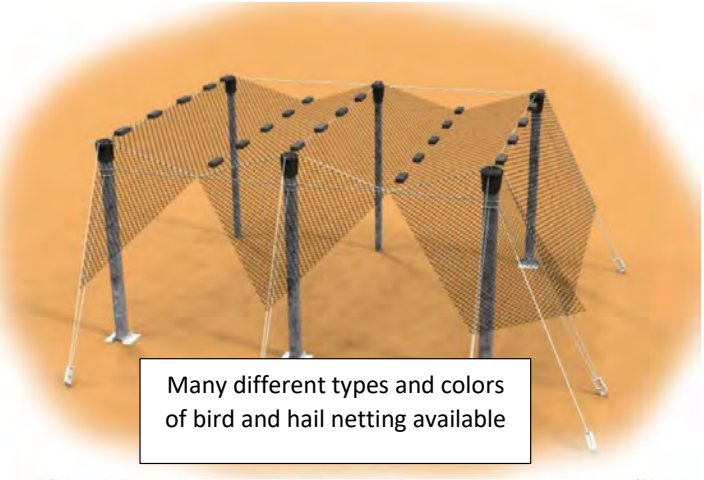

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