‘OrchardWatch’ Weather Monitoring Grid at UMass Cold Spring Orchard

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‘OrchardWatch’ is our vision to use remote sensors in an effort to gather as much environmental and visual data as possible at the UMass Orchard in Belchertown, MA. While we, and many growers, collect weather data to help manage orchards and other crops, it is usually limited to a single site on a farm. As a result, pest management and other decisions are made based on what’s happening at that weather station. Conditions around an orchard may be quite different from that one site. For example, a block surrounded by trees may have a longer wetting period than one on the top of an open hill because it takes longer to dry. This may make a difference in terms of managing apple scab and other diseases. Another scenario: degree days may vary significantly enough that insect development will also be slower or faster in different blocks. In general, we are asking the question, do environmental conditions vary enough from place to place that management decisions could be made targeting relatively small sections of an orchard, rather than the whole farm or large blocks?

This is basically what precision agriculture does, treating relatively small parts of a farm individually based on differences in things such as soil texture and fertility. However, much of the effort to develop precision ag methods has been focused on large agronomic crops and the large farms that grow them, rather than so-called “specialty crops”, including apples and other fruit, grown on smaller farms. We want to explore whether it’s feasible to use precision agriculture, particularly for pest management, in New England orchards.

In order to figure it out, we have installed a total of nine “weather stations” over the past 8 months (September 2019 through April 2020) using Onset Computer Corporation hardware and their Hobolink software to monitor “weather” conditions across 50 acres of the UMass Orchard. (Special thanks to Jim Krupa, Research Technician, for assistance with all the installations.) We are calling this our “Weather Monitoring Grid”, a major component of a larger project, OrchardWatch. OrchardWatch involves significant web-based communication and data collection which can be shared between researchers, growers

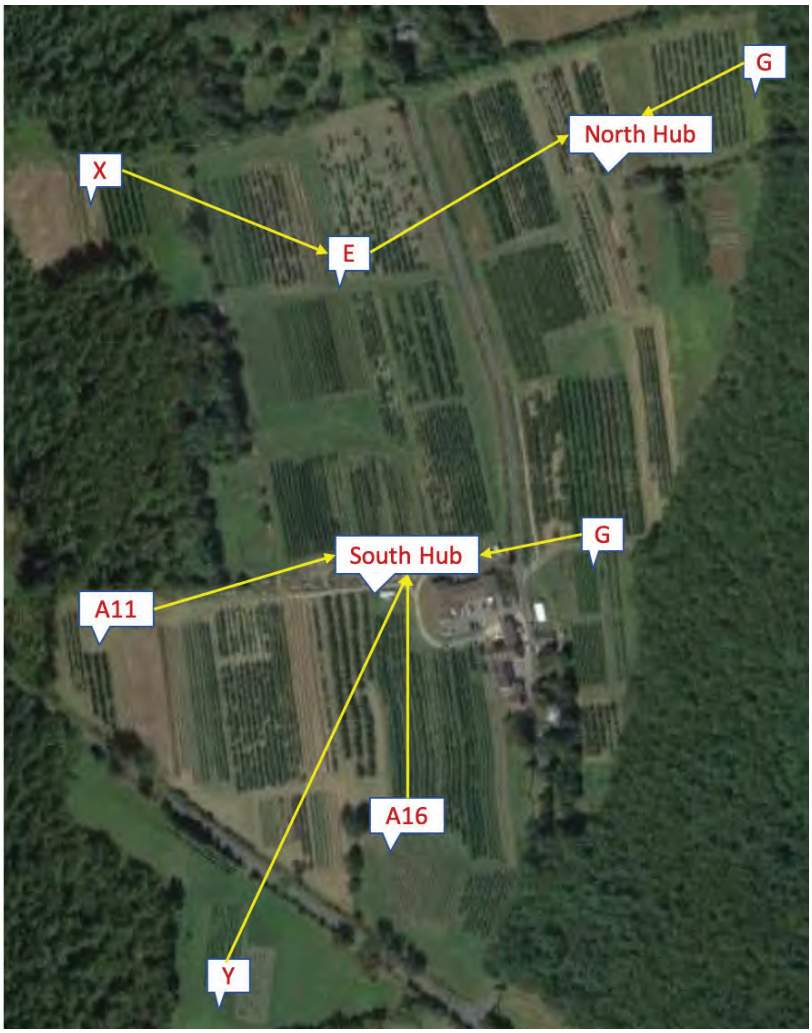

Figure 1. Orchard Watch Weather Monitoring Grid at UMass Cold Spring Orchard, Belchertown, MA.

Figure 2. Four sites at the UMass Cold Spring Orchard showing the Onset RX3000 base station (North Hub, top left), and three different remote stations or "motes" (G, top right; Y, bottom left; X, bottom right).

and the public. The Weather Monitoring Grid consists of two Onset RX3000 logging base stations dubbed "OrchardWatch-North" and "OrchardWatch-South", plus seven Onset Hobonet Field Monitoring System "motes." The nine sensor locations vary in terms of elevation, surrounding terrain and the type of trees, and other crops, being grown. For example, one mote is at the highest point in the orchard surrounded by newly planted trees, and another is at one of the lowest areas with mature trees surrounded on three sides by woods.

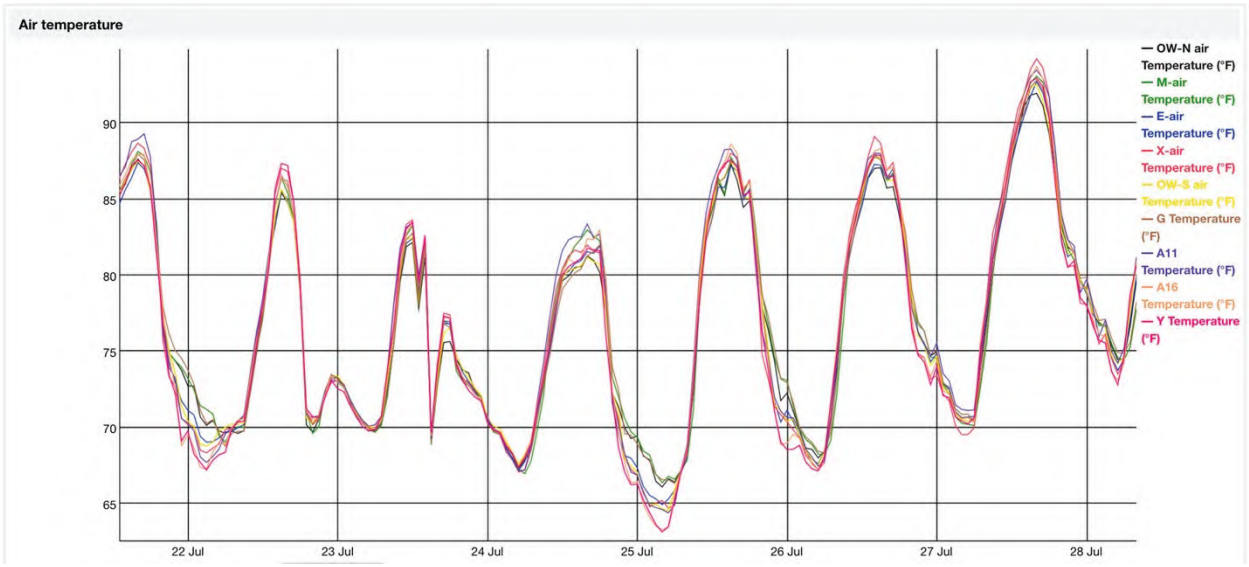

Figure 3. OrchardWatch-Air Temperature for 7 days. Note that there is not a lot of difference in air temperature over time by orchard location. The highest temperatures by site (July 27) ranged from 92.9 to 95.3 F; the lowest temperature (July 25) ranged from 62.7 to 66.2 F. Degree days base 50 F accumulated over the 7 days was very uniform, ranging from 535 to 540.

At each of the nine locations, the Weather Monitoring Grid measures the following environmental conditions:

- Air temperature, relative humidity and dew point at six feet (degrees F.)
- Rainfall (inches)
- Wetness (%)
- Solar radiation (W/m2)
- Wind speed (including gusts) and direction
- Soil temperature (degrees F.)
- Soil moisture (volumetric, m3/m3)

These weather data are logged every 5 minutes and reported to the Hobolink cloud service (hobolink.com) every 10 minutes via cellular data transmission.

We have begun to compare the measurements from the different sites. A very preliminary analysis shows that for air temperature, there isn't much variability between sites. For seven days at the end of July 2020, the average temperature was less than 1ºF, ranging from 76.4 to 77.1ºF. Accumulated degree days base 50ºF, useful for predicting insect development, had virtually no differences, ranging from 535 to 540. On the other hand, soil moisture varied significantly. One site, A11, was particularly dry, with soil moisture content usually below 20%. At the other extreme, sites E and the South Hub were above 40% for most of the week. We will continue to analyze different data with the general goal of determining whether management decisions in different parts of the orchard might differ.

The Hobolink site provides public data access: OrchardWatch-South: https://hobolink.com/p/28ce970fb2430a7eb547758bc6f4aa95 OrchardWatch-North: https://hobolink.com/p/bd2fa7ebce71003581f2f184ee0b6c12

We have also launched an OrchardWatch website at orchardwatch.wordpress.com with links to the data.

Both the North and South sites are also on NEWA, the Network for Environment & Weather Applications: http://newa.cornell.edu/index.php?page=weather-station-page&WeatherStation=ma_beow http://newa.cornell.edu/index.php?page=weather-station-page&WeatherStation=ma_bown

Future plans include installing cameras at each location to capture real time orchard phenology and sky conditions. Cameras might even be able to see pest activity as if one were actually scouting in the orchard. We will investigate machine learning and statistical analysis tools to help develop and improve upon various models such as disease, pest pressure, tree growth and health, etc.

For more information and/or to request weather data, contact Jon Clements (jmcext@umass.edu), Daniel Cooley (dcooley@umass.edu), or Paul O'Connor (proconnor@umass.edu).

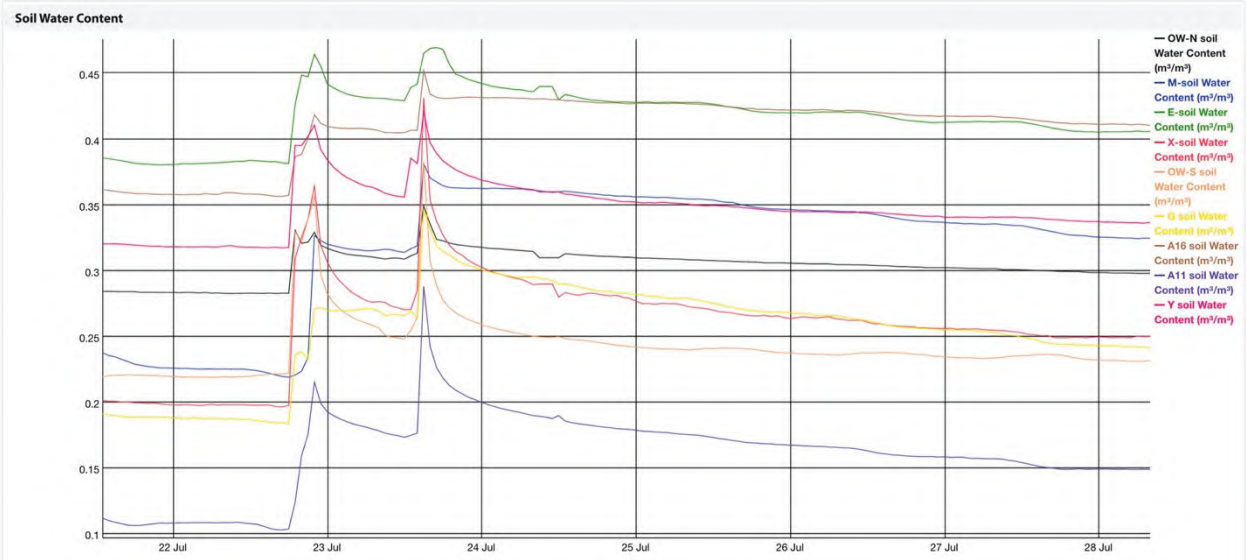

Figure 4. OrchardWatch-Soil Moisture Content for 7 days. Soil moisture (water content) varies considerably over time by orchard location. It is dry at A11, generally below 20%, and initially near 10%. At E, soil moisture is high, generally over 40%.

Acknowledgements

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