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IN THIS ISSUE:

Honeybee Hive Placement 1
Fungicide Applicaiton .. 2
Fungicide Planning 3
GDD and Plant Phenology..................... 4
Bed Moisture Mapping 6
Degree-Day Maps 6
Observations from the Field............................. 7
Grower Updates........... 8

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Effect of Hive Placement on Honeybee Foraging in Cranberry

by Abby Lois, Aidee Guzman, and Christelle Guédot
UW-Madison Fruit Crop Entomology

Pollination services are important both economically and ecologically. In cranberry, most growers use honeybees for pollinating cranberry flowers, averaging $140 to $210 per acre, and thousands of dollars being spent each year on honeybee rentals to ensure cranberry pollination. Past studies in cranberry marshes have reported anywhere from 97% to only 10% of honeybees visiting flowers offsite. In Wisconsin, cranberry marshes are embedded within a mosaic of agriculture and native vegetation and the surrounding landscape may impact honeybee fidelity to cranberry by providing alternative floral resources, while providing native pollinators with the habitat and resources needed throughout the summer.

Growers have reported that rented honeybees tend to fly off the marsh into the woods to forage on other resources, suggesting that the proximity to additional resources may influence honeybee foraging behavior. Also, barriers such as water reservoirs on cranberry marshes may redirect honeybees to forage on cranberry. This study aimed to determine the fidelity of honeybees to cranberry by assessing the effect hive placement and landscape attributes in the vicinity of the marsh have on pollinator foraging.

Methods Overview

Eleven marshes in Central Wisconsin were selected for analysis during the 2015 production season. Each marsh was classified as "high" or "low" woodland according to the land cover data within 1 km of the marsh. Marshes were considered high woodland if more than 60% of the surrounding area contained woodland, and low woodland marshes exhibited primarily open habitat (surrounded by less than 30% woodland land cover).

Three hive locations were determined within each of the eleven marshes: one in the center of the marsh surrounded by only cranberry beds and dikes, the second on the edge of the marsh near the surrounding natural habitat, and the third near a marsh's water reservoir. A pollen trap was mounted on the entrance of each hive and pollen samples were collected for 24hr periods throughout early and peak bloom. Each sample was analyzed for pollen composition.

Results

Surrounding landscape, high or low woodland, had a significant impact on pollen composition. Low woodland hives exhibited the highest proportions of cranberry pollen, near 50%, suggesting that some foraging is still occurring offsite or on dike plant species. Hives in high woodland environments collected lower amounts of cranberry pollen regardless of hive locations (see figure).

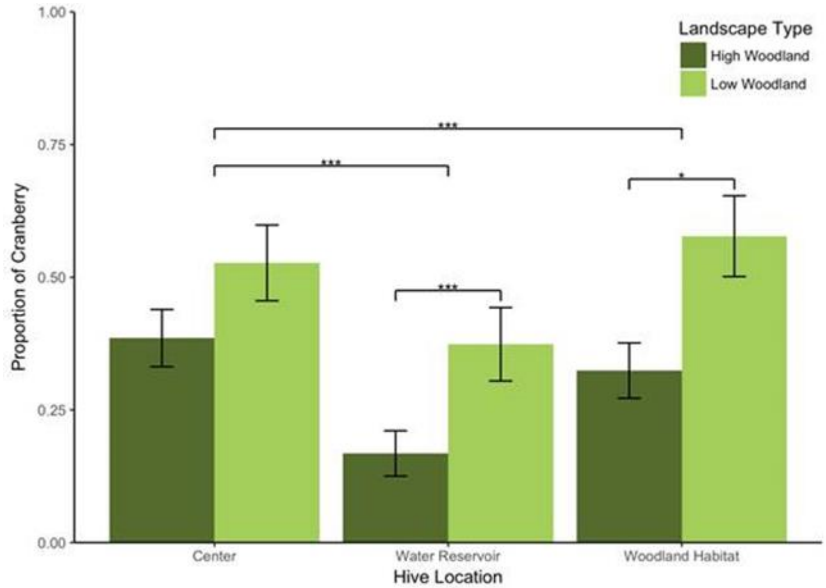
Hives placed in the center of the marsh collected the highest proportions of cranberry pollen in both high and low woodland areas. Hives near woodland habitat on the edge of the marsh collected slightly lower amounts of cranberry pollen as hives in the center of the marsh. Hives bordering water reservoirs exhibited the lowest percentages of cranberry pollen, especially in high woodland environments. Future research will address how we can improve pollination services from honeybees by adding supplemental sugar to hives and the effect of fungicide on honeybee visitation to cranberry.

Recommendation

Based on our results, we encourage you to place honeybee hives near the center of the marsh when possible and away from edges of water reservoirs for optimal pollinator efficiency. Placing hives on edges with natural habitat may be a valid option for those looking to spread hives more evenly throughout the marsh.

Thank you to our collaborators who participated in our study (cranberry growers and beekeepers alike), from letting us work on your marsh to letting us use your bee hives. As always, it was a pleasure working with you and we could not do this without you! And thank you to WCB, CI, and Ocean Spray for funding this research.

Happy Growing Season!



Proportion of cranberry pollen as a function of hive location in two landscape types. *The stars above the horizontal bars indicate level of significance, with three stars representing the most significant differences.*

Fungicides—If Some is Good, More Isn't Always Better

by Patty McManus

UW-Madison and UW-Extension

On page 3 of this issue, Pamela Verhulst provides a valuable cost/benefit summary of fungicides used to control fruit rot. The calculations show that for beds that were rejected in 2016 because of high levels of fruit rot, the cost of a couple of fungicide applications is a small price to pay if it converts the total loss into an acceptable shipment of berries in 2017. As Pamela points out, however, cultural practices to remove "trash" and manage canopy density and wetness are essential and will complement use of fungicides. While I recommend 2 to 3 fungicide sprays where fruit rot is a chronic problem, it is important to keep in mind the costs of using fungicides that go beyond the chemical itself- and more isn't always better. The most obvious of these is the cost of labor, fuel, and wear on spray equipment. These expenses will vary among growers, but need to be factored in to total costs. Below are some other considerations and hidden risks of overdoing it with fungicides:

Diminishing returns. In our fruit rot fungicide trials, we usually focus on product efficacy and optimal spray timing. However, in 2009 and 2010, we tested the efficacy of several fungicide applied 2, 3, or 4 times. We found that spraying effective fungicides reduced fruit rot compared to the non-treated checks, but there was no statistically significant difference among the 2, 3, and 4 spray treatments. This was the case even when fruit rot was quite high—29 to 48%. Most fungi that lead to fruit rot infect during bloom and early fruit rot stages, so additional sprays after that window will likely not pay for themselves.

Phytotoxicity. Chlorothalonil (Bravo, Echo, Equus, others) applied in lower spray volumes (less than 30 gallon/A) and/or during hot weather can injure flowers and fruit. In our trials, we have not seen reduced yields, but some growers have. Mancozeb (Dithane, Penncozeb, others) can reduce fruit color, especially if applied after bloom to developing fruit. We haven't seen problems with other fungicides in our trials, but we usually spray just 2 times.

Fungicide resistance. Overuse, or even moderate use, of fungicides has led to the emergence of fungicide-resistant pathogens in many crops. To date, we have not seen evidence of fungicide resistance in fruit rot pathogens. But with each application of Abound, Evito, Indar, or Proline—the fungicides most at risk for resistance—we are one step closer. So, spray only if truly needed.

Human health. Chlorothalonil (Bravo, Echo, Equus, others) and mancozeb (Dithane, Penncozeb, others) are classified as probable human carcinogens. The greatest risk of exposure is to pesticide applicators. Personal protective equipment (PPE) reduces the risk, and spraying only when truly necessary helps even more.

Pollinator health. While fungicides are not believed to be directly toxic to honey bees and other pollinators, there is mounting evidence that some fungicides, including some used in cranberry production, are harmful to honeybees in slow, indirect ways. A recent study suggested that triazole fungicides (a group that includes the active ingredients of Indar, Proline, and Orbit/Tilt) inhibit an enzyme that honey bees use to detoxify chemicals that naturally occur in plants and agricultural insecticides. This in turn makes it more difficult for bees to extract energy from their nectar- and pollen-based diet. Another study suggested that chlorothalonil in pollen makes honeybees more susceptible to infection by a gut parasite. There are still many questions about the effects of fungicides on pollinators, but the potential risks are another argument to spray fungicides only when truly justified.

FUNGICIDE PLANNING– A COST RATIO TOOL

by Pam Verhulst
Lady Bug IPM, LLC

Many growers experienced fruit rot in 2016. Some growers were caught off-guard because they have never experienced a high level of fruit rot. Fortunately, the University of Wisconsin- Madison and other research facilities have been studying fruit rot for several years.

Fungicide recommendations are determined from research. Researchers collaborate with growers who permit research to be conducted on their cranberry properties. Consultants and growers appreciate this type of research because it represents results found during typical cranberry production, including environmental and cultural impacts. Jack Perry, presents his and Patty McManus' research findings several times throughout the year. You might recall the +++ Fruit Rot tables from Cranberry School or the recent Mini Clinics.

The information from Patty and Jack's research was used to construct the following fungicide table (Table 1). Only consistently highly successful products (+++) were used for this example. Product prices were determined from calculating an average cost (obtained April 2017) from two different suppliers. Actual prices may vary. The intentions of Table 1 are for growers to use as a template for their own personal inputs: Rate, Cost/Gal and Acres.

Table 1

Product	Rate/Acre (oz)	Cost/Gal	Cost/Acre	100 Acre Property	50 Acre Property	3 Acre Bed
Abound	15.5	$206	$24.88	$2,488.48	$1,244.24	$74.65
Indar	12	$273	$25.59	$2,559.38	$1,279.69	$76.78
Abound +Indar	8 + 6	$205.5 + $273	$25.64	$2,564.06	$1,282.03	$76.92
Proline	5	$537	$20.98	$2,097.66	$1,048.83	$62.93
Quilt Xcel	21	$125	$20.51	$2,050.78	$1,025.39	$61.52
Average			$23.52	$2,352.07	$1,176.04	$70.56

A fungicide application will cost, on average, $23.52 an acre. From there, the cost benefit ratio can be determined. In other words, how much the crop is worth, and how much crop needs to be lost to pay for a fungicide application.

Table 2 is an example of one (3 acre) bed at various average yields and price per barrel. Table 2 does not factor in other fungicide application inputs such as; cost of labor, nozzle/ sprayer wear, fuel, etc. Growers should also note that Total Crop does not include any other business inputs. Additional columns can be added to provide growers with a more accurate % Crop. Those inputs have been left out to simplify the example.

Table 2 shows as the yield or price per barrel increases, the % crop decreases. In other words, as the yield or price increases, it becomes more cost efficient to use a fungicide. After adding other various inputs, growers can determine what their economic threshold is. In this general example a grower would have to lose more than 1.5% fruit (to rot) for one fungicide application to pay for itself.

As an integrated pest management consultant, I would not encourage growers to freely spray fungicide once they reach 2% rot. Fungicides are pesticides and with that carry many health and environmental risks (see Patty McManus's article on page 2) Work with consultants, handlers, or UW researchers to determine appropriate thresholds.

Table 2

Acres Treated	Average Yield/Acre	$/bbl	Total Crop	Average Fungicide Application Cost/ Acre	% Crop
3	100	$15	$4,500	$23.52	1.568%
3	200	$15	$9,000	$23.52	0.784%
3	300	$15	$13,500	$23.52	0.523%
3	400	$15	$18,000	$23.52	0.392%
3	200	$20	$12,000	$23.52	0.588%
3	300	$20	$18,000	$23.52	0.392%

In 2016, there were growers that had entire beds rejected, by their handler, due to high Fruit Rot. Two fungicide applications, on a 3 acre bed, will cost around $141. Those two fungicide applications could potentially prevent Fruit Rot pathogens from entering the plants and prevent that bed from later being rejected. A rejected bed could cost as much as $18,000 (300 bbl/ac @ $20/bbl). High yielding Hybrids (400-600 bbl/ac) could cost as much as $36,000. In this example, it is clear that the $141 investment is a risk worth taking.

For 2017, I encourage growers to take a look at their cultural practices along with fungicide options. Trash floods, sanding, pruning, fertility, ditching, efficient irrigation practices and systems are examples to consider as part of your integrated pest management plan.

*Check with your handlers for current pesticide use tolerances and always read the labels.

Linking Growing Degree-Days and Cranberry Plant Phenology

by Elissa Chasen and Shawn Steffan
USDA-ARS and UW Entomology

The progression of plant growth stage throughout the season, or phenology, is determined by a variety of environmental cues including photoperiod and growth units, or degree-day accumulation. Degree-days are a measurement that combines heat and time. They are calculated based on daily high and low temperatures and species specific developmental temperature thresholds. Figure 1 depicts the model we use to determine the degree-day accrual. The sine wave is used to estimate the change in temperature over time. While actual daily temperature may behave otherwise, the use of a sine wave allows us to collect just two temperature data points for each day (the high and low) and approximate how the temperature changed during that day. The degree-day accrual for a given day is equal to the area under sine wave curve that is contained between the species specific developmental thresholds.

While the specific developmental thresholds have not yet been empirically derived for the cranberry plant [1,2], researchers have assumed that the cranberry plant lower threshold is somewhere between 40 and 50 ˚F [1–4]. By correlating degree-days calculated with a range of lower thresholds to cranberry plant development (*cv* ‘Early Black’), DeMoranville [2] concluded that a lower threshold is a better predictor. The lower developmental threshold also likely varies between cranberry varieties.

The phenology of virtually any plant or cold-blooded animal is strongly influenced by ambient heat. Recent examples of the predictability of organismal development in cranberries involved two different insect species [5–7]. Cranberry plant phenology is an important indicator for timing management decisions, such as insecticide, fungicide or fertilizer applications [8,9]. In response to grower interest, we coordinated a group of cranberry-growing ‘citizen scientists’ to study cranberry growing degree-days since 2014. Growers recorded daily high and low temperatures on their marsh and followed a standardized protocol to document cranberry development. This 3-year timespan has allowed us to observe cranberry plant phenology in relation to degree-day accumulation across the major cranberry growing regions of Wisconsin.

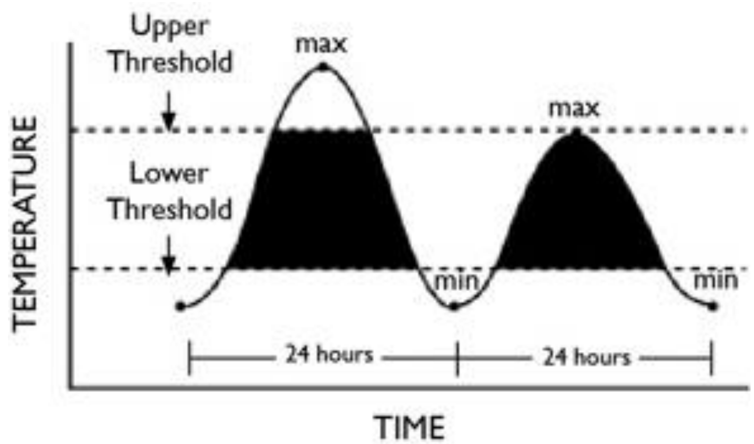


Figure 1. *The sine wave model (above) estimates the daily temperature fluctuation with just the daily high and low temperature. Degree-day accumulation is equal to the black shaded area contained in the sine wave curve between the species specific developmental thresholds.*

Methods:

Each year, daily high and low temperatures for each collaborating marsh were recorded beginning March 1. Degree-days are calculated using a lower threshold 41 ˚F [2] and an upper threshold at 85 ˚F, the double sine method and an intermediate cutoff (UC IPM). Temperature probes are placed at canopy height, outside of direct sunlight, and near the edge of the dike.

Plant phenology recordings were taken by walking transects of the bed 1-2 times per week, and noting the phenological stage at 10 stopping points along the transect. An upright with either one or more of any of the phenological markers counted as that phenological stage. The average number of plants in each stage was noted for each observation day. Plant stages that were recorded include: tight bud, cabbage head, rough-neck, hook, bloom, and fruit-set (see [10] for detailed descriptions). All plant observations were conducted in ‘Stevens’ variety. Grower collaborators were located in Wood, Monroe, and Juneau counties.

Results:

Figure 2 (right) shows each of the noted cranberry plant stages and their corresponding range of degree-days. Note that the dots throughout the figure are the actual data points, while the lines represent the trends in the data.

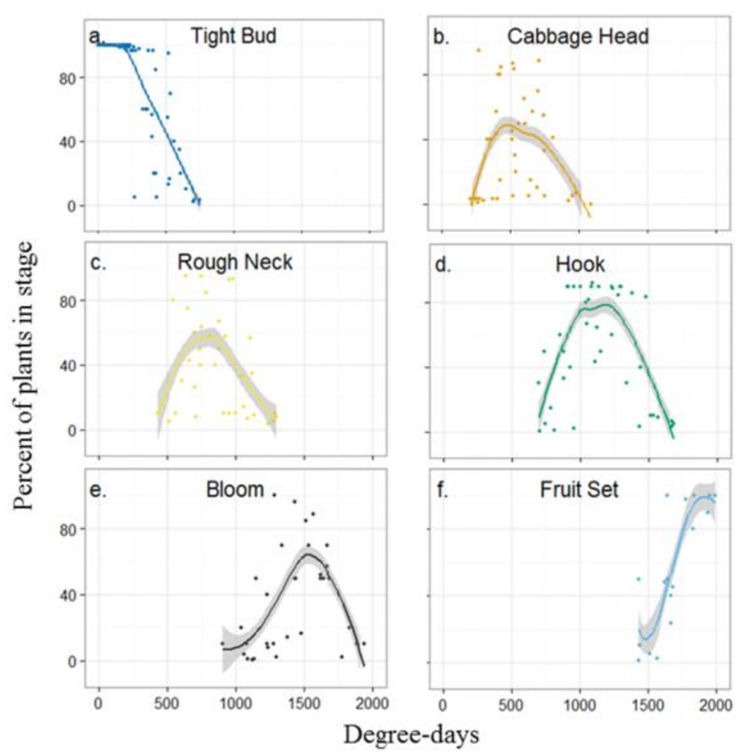


Figure 2. Percent *of each plant growth stage present over time, measured in degree-days, presented individually. Dots represent individual observations while the lines represent trends.*

First, we can observe trends in tightbud development. This is the name of the plant stage when ice comes off in the spring. What we have seen for the last 3 years is that the cranberry plants tended to remain in tightbud for the first 250 degree-days in a year (accumulating DDs from March 1), and have been generally been out of tightbud by 750 degree-days (fig. 2a). At 500 degree-days, half of the plants are typically out of tightbud. Bud-break is influenced by timing of ice-off, spring chilling hours, photoperiod, and degree-days [2], so while our observed degree-day accumulations are important, growers will not be able to predict bud break by only considering degree-day accumulation.

This brings us to cabbage head, when the bud scales begin opening and lose their red pigment. Throughout the last several years of grower observations, we have seen that this stage is present between 250 and 1,000 degree-days and peaks between 500 and 600 degree-days (fig. 2b). Roughneck, when the bud has significant elongation, was observed between 500 and 1,300 degree-days, peaking between 700 and 800 degree-days (fig. 2c).

Hook stage begins when the flower pedicels lengthen and start to droop, making a "hooked" shape. We saw this occurring between 750 and 1,700 degree-days, peaking at ~1,200 degree-days (fig. 2d). Bloom begins when one bud on an upright opens. We saw this beginning at about 900 degree-days and occurring through 1,950 degree-days (fig. 2e). Peak bloom happened ~1,500 degree-days and fruitset began around 1,450 degree-days (fig. 2f).

Discussion:

This preliminary work represents the first in a 2-part investigation looking at the relationship between cranberry insects and their host plant. Our ultimate goal in this work is to correlate our observations of cranberry plant phenology with cranberry insect pest phenology, so that the more apparent plant phenology may be used along with insect degree-days to predict insect life stages. Future work will focus on linking insect DD benchmarks with those of their host plant.

It is important to note that different cranberry varieties will likely have different development thresholds. Given that our lower temperature threshold was quite low, it will tend to be highly conservative, capturing the daily degree-day accumulation for most varieties. However, variety-specific DDs may be important in years with highly variable weather conditions.

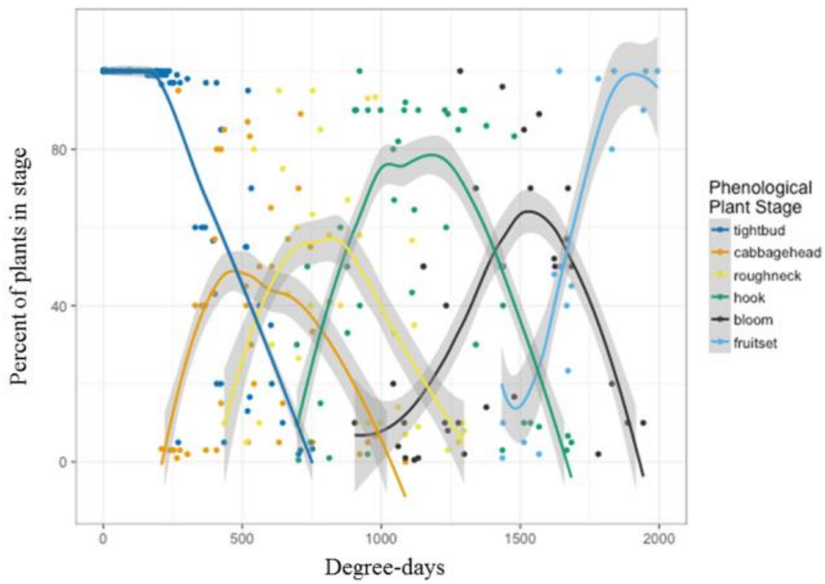


Figure 3. Representation of all plant stages correlated over time, measured in degree-days. Dots represent individual observations while the lines represent trends.

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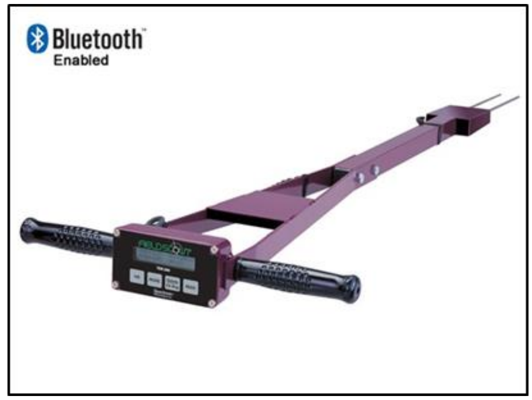
Bed Moisture Mapping w/TDR 300 Field Scout Probe

by Ben Tilberg
Ocean Spray Cranberries, Inc.

The TDR 300 soil moisture meter measures soil moisture using electrical conductivity and displays the measurement in terms of volumetric water content (VWC). VWC is the percentage of a soil column that is occupied by water – the rest of the soil column is made up of solids or air. In general, cranberry bed soils are saturated when the VWC is greater than 30% or 40%. When the VWC drops to around 10%, most of the free water is gone and what water is left is tightly held by the soil so roots can't really use it. This is often referred to as the wilting point so it's recommended that you should irrigate at around 10% VWC (Jeranyama et al. 2012)[1].



This probe works well for reading instantaneous measurements in different areas of the bed. However, when using soil electrical conductivity instruments, reliability depends on the soil texture, the vegetation cover, and the amount of soil organic matter, all of which can impact soil water availability. The more homogeneous the soil is, the better the reliability. When mapping a bed I recommend waiting at least 8 hours after a good rainfall or irrigation (1/4" or more) before taking readings to determine wet vs. dry areas. The instrument can be purchased with several different probe forks but the 2-3" stainless probes work the best for cranberry soils. It's simple to use, stick the probes fully into the soil and press the "READ" button. You'll need to take several readings across your bed within a few hours in order compare readings with a bed. This method may be useful for surveying sprinkler uniformity or in renovation planning.

In 2016, we evaluated a bed with historically high variability in soil moisture. Moisture variability often results in variable plant growth and development, and beds having high variability in soil moisture often have areas of vine overgrowth. Generally, excessive vine growth has a multi-year effect when left unchecked, and is thought to have a significant impact on yield. Our work in 2016 was conducted in an effort to evaluate the applicability of the TDR 300 meter in determining soil moisture variability within cranberry beds with the ultimate goal of providing moisture mapping of bed(s) for use in making moisture management decisions. The figure to the right shows a moisture contour map that was created with the readings from the TDR probe. Readings were collected on 40' x 40' grid across the 4-acre bed over a 4 week period in July and August.

[1]Peter Jeranyama, IRRIGATION WATER MANAGEMENT 2012: Irrigation Water Management 57(www.UMASS.edu)

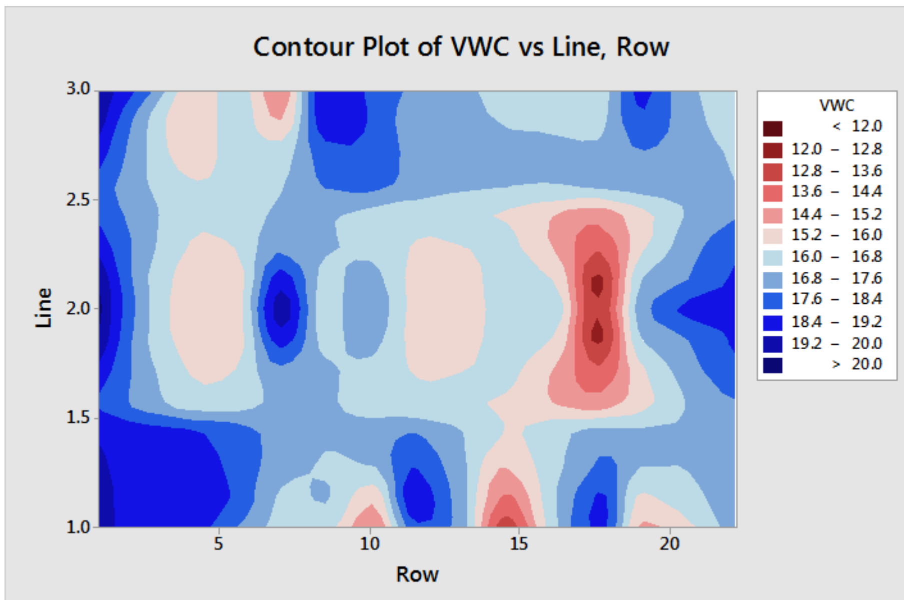


Figure 1. Average volumetric water content values recorded by TDR 300 moisture meter over the course of 4 weeks. Blue and red represent wet and dry areas within the bed, respectively.

Cranberry Plant and Pest Degree Days– May 24, 2017

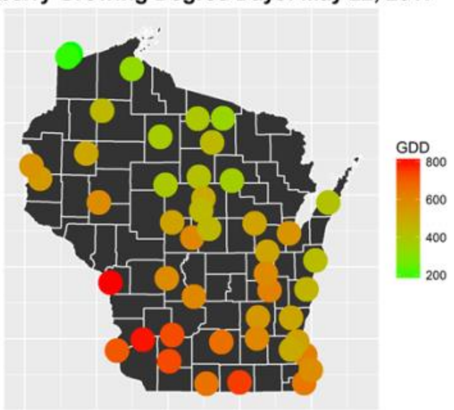
by Elissa Chasen and Shawn Steffan
USDA-ARS and UW Entomology

The maps on the next page show how spring is progressing across Wisconsin. Each of these three organisms has accumulated different amounts of degree-days because each organism has specific temperature thresholds for their development (the range at which development occurs). For the cranberry plant: 41 and 85˚F; sparganothis fruitworm: 50 and 86˚F; and cranberry fruitworm: 44 and 87˚F.

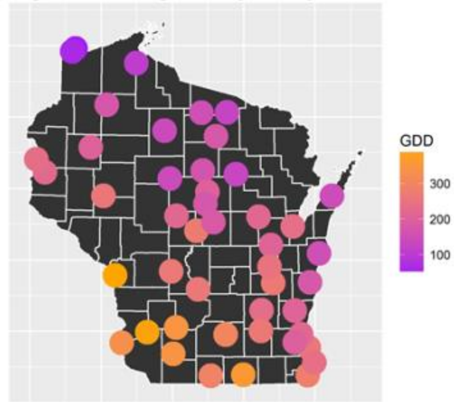
If you want better detail regarding DDs, check out the interactive maps we have posted online. The interactive feature allows you to click on the map locations and this prompts a pop-up that names the location and gives exact degree-days. These are available through the Steffan lab website (http://labs.russell.wisc.edu/steffan/cranberry-growing-degree-days/). Once on the website, follow the link to the interactive maps.

The table on the next page allows for comparison of degree-days over the last three years. We are just slightly behind the DD accumulations from 2016, and this is more pronounced for the northern cranberry growers. These differences in DD accumulation should only amount to a

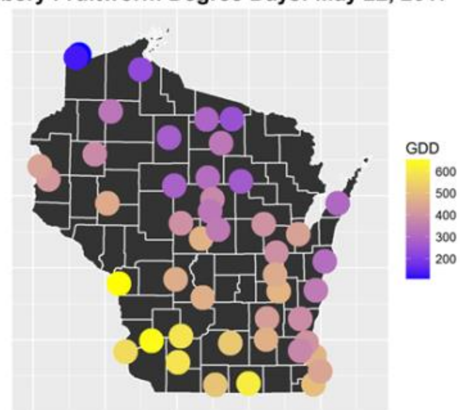
Cranberry Growing Degree Days: May 22, 2017



Sparganothis Degree Days: May 22, 2017



Cranberry Fruitworm Degree Days: May 22, 2017



lag of one to a few days in plant and insect phenology. Sparganothis flight should begin around 600 Sparg DDs and observations from last year show that CFW flight should begin around 960 CFW DDs.

May 22	Cranberry DDs			Sparg DDs			CFW DDs		
	2015	2016	2017	2015	2016	2017	2015	2016	2017
Northern WI (Minocqua)	496.5	460.3	392.2	219.3	196.7	151.8	388.1	354.6	293.8
Central WI (Wisconsin Rapids)	713.5	616.8	602.9	358.9	282.2	273.8	579.3	482.5	474.7

Observations from the Field

by Jayne Sojka
Lady Bug IPM, LLC

Our spring started out strong and then disappeared! On April 6th we saw pussy willows in bloom and ice was coming off the cranberry marshes quickly. Since then, growers had to flood and re-flood because of the cold temperatures. Trash floods in 2017 were critical because 2016 had so much rot and we hope that by flooding, we are able to get the bogs cleaned up of mummy berries, diseased leaves, and berries on the bog floor.


Figure 1

It seems that we see grass as soon as the ice is off our beds! (Figure 1). Some marshes are showing a huge challenge. The best success story I have seen this spring against grass was an application of POAST with crop oil on April 22, 2017. The vines are dormant with a very tight bud yet the grass was emerging. Today the grass has a brown/orange stress (Figure 4) and growth has slowed down or stopped . I understand that surfactants work well because they damage the waxy cuticle, allowing for better uptake of the herbicide, but I feel that there is a safer time to use COC (crop oil) on cranberry vines and in my opinion that time is EARLY! Use it when the buds are tight and vines are dormant.

On May 10th traveling on Hwy 21, I saw my 1st Eastern Tent Caterpillar (Figure 2) This is another sign that I look for in predicting insect hatch on the cranberry marshes. Yes I should put a growing degree day to this scenario so we can use modern technology along with observations! I pay close attention to where these Caterpillars show up first (different growing areas) as those areas will more than likely be the 1st marshes with economic levels of cranberry pests.


Figure 4

By the time of this writing we will be seriously thinking about our 1st insecticide applications or flooding for insect control. REMEMBER to POST, POST, POST!


Figure 2


Figure 3: Fruit Tree Leaf Roller found webbing.

GROWER UPDATES

DuBay Cranberry

Well the brief warm up we had was a nice break from the rain and cold. Hopefully, everyone was missed by the severe weather that followed. I for one would welcome a week without rain. We received a little over 3 inches of rain last week. Since the end of March, we received over 13 inches of rain. With all this rain, our renovation project has been delayed yet again. We are hoping that we can start putting in the drain tile this week, weather permitting of course. Trying to find a window of opportunity to apply our herbicides has also been challenging. We can finally start to see some new growth appearing on our HyReds , Ben Lear, and Mullicas. It sure seems to be a slow start to the growing season by looking at the vines but the weeds are telling me different.

Have a safe and enjoyable Memorial Day weekend, and remember those who sacrificed to protect what we enjoy today.

Dave Hansen
DuBay Cranberry

Saratoga Cranberry Company

There was not as much frost this past week but there was still plenty to do on the good old marsh. We were able to get both the Casaron and the first application of Callisto the week after the second marsh update. We are planning the second application of Callisto this Friday, weather permitting. Our renovation project is going surprisingly smooth. We will finish our second bed of 'Mullica Queen' at the end of the workday today then move on to installing the sprinklers on the next beds so we can start spreading 'Sundance'. As of May 22, 2017 we are sitting at 565 growing degrees days.

Russell Sawyer

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