Volume 24

January 20-21, 2016

Holiday Inn Hotel and Convention Center

Stevens Point, WI

Sponsored by:

UW Extension
University of Wisconsin-Extension

Wisconsin State Cranberry Growers Association

Wisconsin Cranberry Research & Education Foundation, Inc.

This publication was compiled and edited by:

Christelle Guédot
Extension Fruit Entomology Specialist
Department of Entomology
University of Wisconsin-Madison

The Proceedings of the 2016 Wisconsin Cranberry School (Volume 24) and the 2015 Annual Report of the Wisconsin State Cranberry Growers Association were published by:

Wisconsin State Cranberry Growers Association
P.O. Box 365
Wisconsin Rapids, WI 54494
(715) 423-2070

For additional copies contact:
Wisconsin State Cranberry Growers Association

Madison, Wisconsin
February 2016

Table of Contents

CRANBERRY VIRUS AND DISEASE ISSUES

LINDSAY WELLS-HANSEN, SARA THOMAS-SHARMA, and PATTY MCMANUS

Department of Plant Pathology, University of Wisconsin-Madison

VIRUSES

Tobacco streak virus (TSV) and *Blueberry shock virus* (BlShV) are associated with berry scarring symptoms in cranberries in Wisconsin and other growing regions. The scarring symptoms associated with TSV and BlShV are identical (Fig. 1), and can only be distinguished when samples are tested for the viruses. We have been conducting experiments over the past three growing seasons to gain a better understanding of the effect(s) of these viruses on cranberry.

TOBACCO STREAK VIRUS (TSV)

Fig. 1. Berries infected with *Tobacco streak virus* (left) and *Blueberry shock virus* (right).

TSV does not negatively impact yield components once plants have 'recovered' from the virus. Berry weight and percent fruit set are significantly decreased in TSV-positive uprights with scarred fruit compared to healthy uprights. This is not surprising, since most berries affected by scarring become shriveled by the time of harvest, and any berries that do not shrivel are stunted and severely deformed. However, recovered, TSV-positive uprights do not differ from healthy uprights in berry weight, number of flowers produced, or percent fruit set, suggesting that there are no negative impacts of TSV on yield. Impacts of TSV on return bloom in recovered uprights in the year(s) following berry scarring symptoms are variable, but research suggests that return bloom is not negatively impacted in the first year following scarring symptoms. Impact in subsequent years is less clear, especially since fluctuations in return bloom in healthy cranberry uprights over multiple years is unknown. Although yield is not negatively affected, it is important to remember that 'recovered' plants remain infected and serve as sources of inoculum for new infections.

TSV is unevenly distributed in infected uprights. Viruses tend to move toward metabolic "sinks" in plants. As these "sinks" change with cranberry development, the distribution of a virus within a cranberry upright changes throughout the growing season as well. For cranberry uprights with scarred fruit, virus distribution is uneven and changes throughout the growing season, while little change in virus distribution is observed in recovered uprights bearing non-scarred fruit. Unfortunately, this means there is no 'safe' time for cuttings to be taken to escape the virus. However, understanding where TSV is located within plants throughout the growing season allows us to avoid characterizing a plant as healthy when it is actually TSV-positive.

TSV is genetically variable. TSV from cranberry is genetically variable within and between growing regions, making it impossible to link TSV in Wisconsin cranberries with a particular source. These findings are consistent with the 2001 report of TSV on cranberry in which isolates of the virus from plants in New Jersey were variable.

The percent of TSV-infected uprights does not increase dramatically from one year to the next. In a 2-year study designed to gain insight into how TSV spreads within and between beds, we investigated the percentage of uprights infected with TSV in affected beds across years as well as the spatial patterns of infected uprights within affected beds. In 2014 and 2015, 1,440 and 960 uprights, respectively, were collected before bloom in two beds. Incidence of TSV (% TSV-infected uprights) does not increase much from year to year within a bed (Table 1). Additionally, TSV-positive uprights are clustered in a bed, but at different scales in beds. These results offer potentially good news because they suggest that once TSV is introduced into a bed, spread seems to occur from foci in a bed rather than from external sources each year.

Table 1. Percent of uprights (cv. Mullica Queen) that tested TSV-positive at two marshes across 2 years.

	% TSV-positive MQ uprights	
Location	**2014**	**2015**
Marsh 1	67	71
Marsh 2	1	2

***BLUEBERRY SHOCK VIRUS* (BlShV)**

BlShV does not negatively impact yield components once plants have 'recovered' from the virus. We have demonstrated that cranberry uprights infected with BlShV 'recover' from berry scarring symptoms in the year following berry scarring, similar to what we have reported for TSV. Uprights which produced *scarred, symptomatic*, BlShV-positive fruit in one year, produced *non-scarred, asymptomatic*, BlShV-positive fruit in the following year. All parts of 'recovered' plants remain infected with BlShV after recovery, including pollen and seeds. As such, it is *possible* that pollen is involved of the spread of the virus. However, since we do not currently know how BlShV spreads in cranberry, DO NOT spray insecticides with the goal of curtailing virus spread. The risk of harming pollinators outweighs the benefits of killing possible insect vectors of BlShV!

In 2015, we evaluated several yield components in cranberry uprights with scarred berries as well as in BlShV-positive, 'recovered' uprights. Experiments were conducted at three marshes, and uprights were separated into three categories: scarred, BlShV-positive (symptomatic); non-scarred, BlShV-positive (recovered), and non-scarred, BlShV-negative (healthy). Results from these experiments are shown in Figs. 2-5. Number of pedicels (flowers) and fruit set was not different between symptomatic, recovered, and healthy uprights,

suggesting that early in the season, flowering and pollination were not negatively impacted by BlShV. Not surprisingly, the number of marketable fruit and the average fruit weight were significantly lower in symptomatic uprights, but there was no difference between recovered and healthy uprights, suggesting that there are no negative impacts of BlShV in 'Stevens' for the yield components tested once plants have 'recovered'.

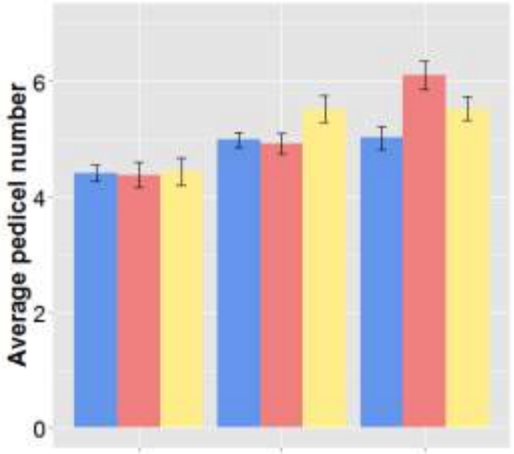


Fig. 2. Average number of pedicels per upright for three categories of uprights collected from three cranberry marshes in Wisconsin in 2015.

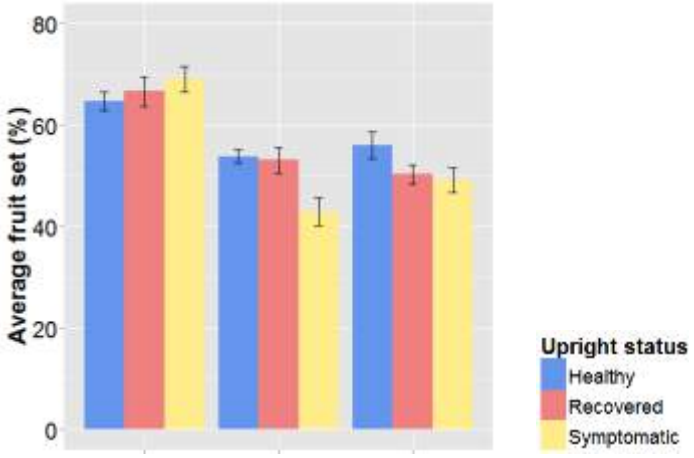


Fig. 3. Average percent fruit set ([no. berries/no. pedicels] × 100) per upright for three categories of uprights collected from three cranberry marshes in Wisconsin in 2015.

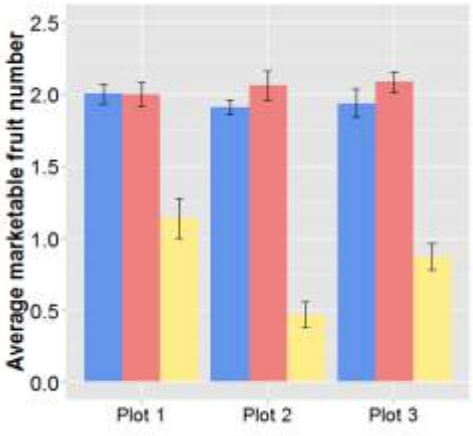


Fig. 4. Average number of marketable berries per upright for three categories of uprights collected from three cranberry marshes in Wisconsin in 2015.

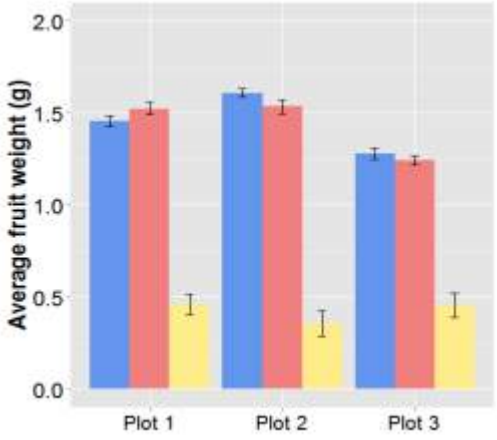


Fig. 5. Average berry weight (g) per upright for three categories of uprights collected from three cranberry marshes in Wisconsin in 2015.

What's next for BlShV research?

- Collect additional return bloom and yield component data on BlShV-infected uprights.
- Conduct genetic studies to determine if the BlShV that occurs in cranberry is the same as the BlShV that occurs in blueberry.
- Determine whether cranberry harbors additional viruses.

Interestingly, the symptoms and epidemiology associated with BlShV parallel those of TSV in cranberry. This coincidence has allowed us to use what we know about one virus to gain a better understanding of the other. While this has been extremely helpful in our research, it is important to remember that this is a coincidence, and not all viruses will behave in this way in cranberry. As such, it is important to obtain virus-free planting material when establishing new plantings.

CRANBERRY FRUIT ROT

Recently, several "reduced-risk" fungicides have become available for use in controlling the cranberry fruit rot disease complex (e.g., Abound and Indar). These fungicides have shown specificity for the fruit rot pathogens they target. As such, it is important to know which pathogen(s) is the target(s) in a particular bed and year. In 2013 to 2015, fruit were collected from defined plots in cranberry beds in Wisconsin and New Jersey to determine the incidence of fruit rot as well as the frequencies of fruit-rotting fungi across years in the same areas within beds. The overall incidence of rotten fruit reached 100% in some plots in New Jersey and was much higher than in Wisconsin, where it ranged from <1 to 37%. Fruit rot incidence varied between sites in Wisconsin, but in general, it remained the same or decreased across years despite no treatment with fungicides. In Wisconsin, the dominant fruit rot species varied among years and between sites, and as such, the pattern of persistence was not clear. However, in New Jersey, the dominant fruit rot species were persistent across years. This suggests that while fungicide recommendations can be made for the following growing season based on the fungal profile of a given location during the current growing season in New Jersey, this may not be the case in Wisconsin.

RED SHOOT

Red shoot is caused by the fungus *Exobasidium perenne*, which is related to the fungal pathogen (*Exobasidium rostrupii*) that causes red leaf spot in cranberry. Symptoms of red shoot manifest as small, spindly shoots that are bright red in color (Fig. 6). Affected shoots also have slightly misshapen, rounded leaves. Uprights affected by red shoot are sometimes mistaken for weeds in cranberry beds, but tracing the spindly shoots to the roots reveals that the shoots are in fact attached to a runner. Red shoot has historically been insignificant, and as such, no control measures have been developed. However, crop scouts have reported an increase in the prevalence of this disease in recent years, particularly in older cultivars such as Stevens, McFarlin, and Searles. In an effort to better understand the importance of red shoot in cranberry, we ask that you monitor your beds for the disease in the coming growing season, and ask scouts or UW for help in diagnosing.

Photo: Jayne Sojka

Fig. 6. Cranberry uprights with Red shoot, caused by the fungus *Exobasidium perenne*. Symptoms include small, spindly shoots that are bright red in color and that have slightly misshapen rounded leaves.

USING DEGREE-DAYS TO MAXIMIZE YOUR PEST MANAGEMENT TOOL BOX

ELISSA CHASEN and SHAWN STEFFAN

Department of Entomology, University of Wisconsin, Madison and USDA-ARS, Vegetable Crops Research Unit, Madison WI

Take home points:

- Insecticide control is limited by many factors: insecticide coverage, insecticide half-life, insect life stage, and plant growth.
- Using degree-day models to time insecticide applications accurately is a powerful tactic that increases the efficacy of each insecticide application.
- Mating disruption operates independently of the limitations that occur with insecticide control. This tool is almost available for use in commercial cranberry production.

Background: Precise and accurately timed insecticide applications can save growers hundreds of dollars per acre. For example, in a study completed in apples, applications made three days early led to 1.4% greater yield damage, and applications made three days late led to 2.0% greater yield damage, than applications made at optimal timing. Optimal treatments were achieved by timing the insecticide applications for adult trap catches of the insect pest, along with the use of a degree-day model (Sjöberg et al. 2015).

Using this relationship between fruit damage and treatment timing, we generate estimates of losses to cranberry growers based on an average per-acre yield of 245 barrels and average per-barrel value of $47.80 (USDA NASS 2013). Properly timed insecticide applications could save growers between $164 and $234 per-acre. Considering that most growers spend between $120 and $160 per acre on insecticides (Clicker Session results, 2015), precise treatment timing is critical to make the most of your insecticide applications.

There are several explanations that make the timing of insecticide applications so critical:

"CHIPs": insecticide Coverage, insecticide Half-life, Insect life stage, Plant growth.

Insecticide Coverage. The amount of pesticide lost due to drift is estimated between 5-65%. In fact, less than 0.1% of the pesticide actually reaches the target insect (R. Groves, personal communication). There are a lot of factors that go into this estimate, including: 1) weather conditions/wind speed, 2) droplet size as a function of nozzle selection, 3) the pesticide's physical properties, and 4) spray practices (Fishel and Ferrell 2010). Increasing carrier volume when possible can significantly increase insecticide coverage. Additionally, the crop canopy obstructs coverage from the understory, which includes a significant portion of the plant biomass.

Insecticide Half-Life. Once an insecticide is applied to the crop, it is subject to environmental conditions that degrade the active ingredient (ai) of the chemical. Figure 1 shows three different insecticides, Altacor (chorantraniliprole), Diazanon and Imidan (phosmet), commonly used in cranberry production and their known half-lives, or DT_{50}, in days. This is the amount of time it takes for the ai to

degrade to 50% of its original concentration. The figure shows that five days after application, the amount of Altacor remaining is less than 15%, Diazanon is 33%, and Imidan, 42%.

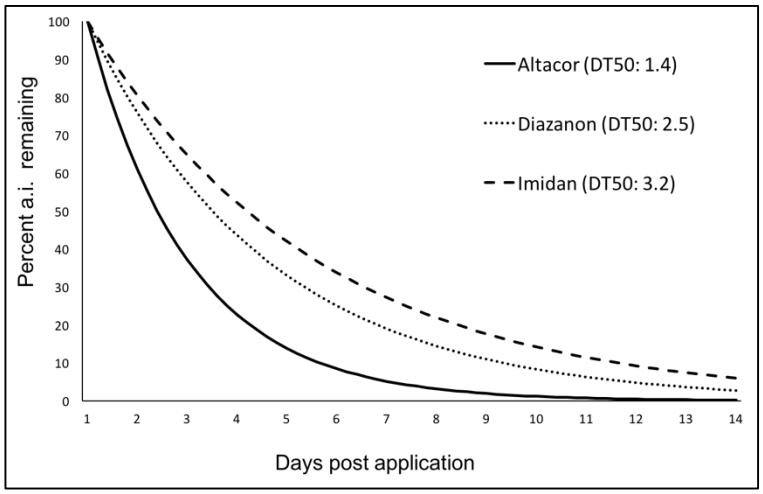


Figure 1. Percent of active ingredient (ai) remaining after application based on the rate of degradation (DT_{50}) of three insecticides (in days).

Plant Growth. Assuming a spherical shape of cranberries, geometric principles dictate that surface area (SA) is related to the square of the berry's radius, such that SA = $4\pi r^2$. This means that while the diameter of a fruit grows approximately linearly, surface area increases exponentially. Because we do not have data specific to cranberries that relates fruit diameter to time, table 1 displays data collected on apple fruit growth relating apple fruit diameter to surface area over a period of fruit growth (Steffan and Redding 2004). Noteworthy in table 1 is the striking increase in relative SA early in the fruit growth. As surface area increases, the amount of fruit that is protected by a previous insecticide application decreases in proportion to the amount of new surface area. This is especially relevant because it is standard practice to apply insecticides to manage cranberry fruitworm when most fruits are just beginning to grow (Averill and Sylvia 2015). If we extrapolate from apple growth, that means that if an insecticide spray covered 100% of the berry on day 1, within two weeks, due to growth of the berry alone, the amount of surface area protected on that berry decreases to less than 10%. This estimate is generous based on what we have already discussed relating to pesticide drift and insecticide half-life.

Table 1. Date and fruit growth (diameter and surface area) of apples (Steffan and Redding 2004).

Date	Diameter (in)	Surface Area (in^2)	Ratio of growth to next time point
5/15	0.20	0.13	11.5
6/1	0.69	1.49	3.1
6/15	1.20	4.52	1.4
7/1	1.44	6.53	1.5
7/15	1.74	9.48	1.7
8/1	2.30	16.62	1.6
8/15	2.87	25.96	

Insect Life Stage. Lastly, insecticides are often limited by the fact that at any given point in time, the targeted pest population exists as multiple life stages, and not all life stages are equally susceptible to the pesticide. One research article compared the mortality of eggs, larvae, adults and pupae of a beetle (red flour beetle) when exposed to four different insecticides (spinetoram, imidacloprid, thiamethoxam, and chlorantraniliprole). None of these insecticides were effective against pupae and efficacy of chlorantraniliprole (Altacor), for example, was greatest for young larvae (nearly 100%), 66% for adults, 64% for old larvae, and there was a 40% reduction in egg hatching (Saglam et al. 2013).

Assuming a similar pattern of efficacy for the cranberry fruitworm, it would likely be most beneficial to target the population when the majority of the population existed as larvae. However, this is complicated by the fact that cranberry fruitworm larvae are protected within the berry. Figure 2 illustrates cranberry fruitworm life-stages (i.e., pupae, adults, eggs, larvae), represented by the percentage of each life-stage at a given time-step. The cranberry fruitworm overwinters as prepupa, and adults begin emerging sometime around the beginning of June with peak-flight occurring during bloom. Adults lay eggs on the berry calyx, and larvae emerge after about five days.

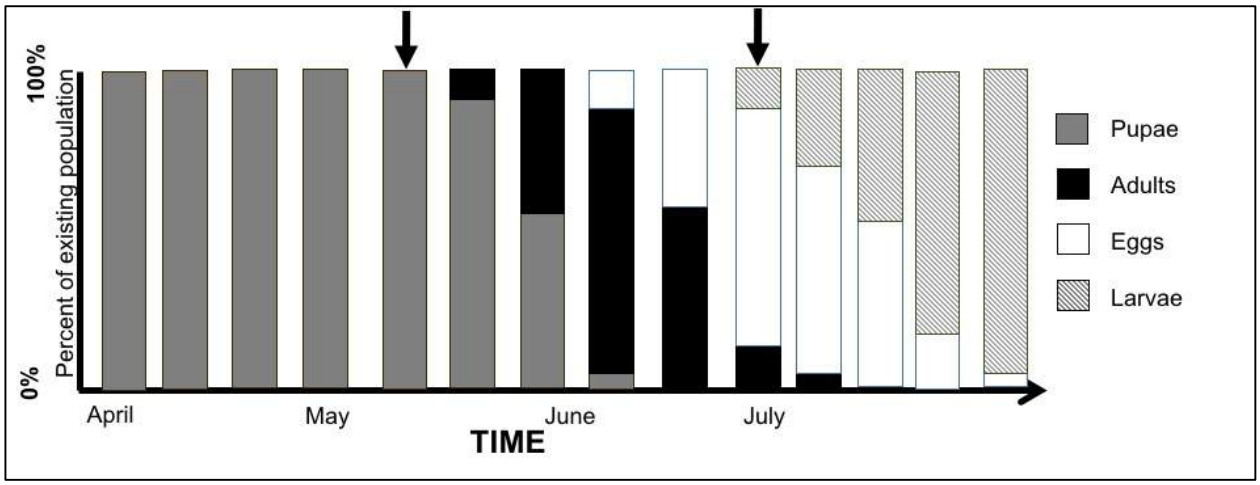


Figure 2. Distribution of cranberry fruitworm life stages present throughout the early part of the growing season. The black arrows represent standard insecticide application timings.

Most growers apply a spring insecticide application, represented by the first black arrow. In the case of the cranberry fruitworm, it is likely that the whole population is protected from this application as pupae, resulting in no mortality. A second application, represented by the second arrow, is timed during bloom to target cranberry fruitworm larvae as they emerge from eggs. At this point in time, the population exists mostly as adults, eggs and larvae. The adults and any larvae that have not yet entered a berry are susceptible to this application, but many individuals are generally less susceptible as eggs. Individuals that emerge from eggs within the next 24-48 hours are also susceptible. The point of this example is to show that there is no time point at which all of the individuals from the population are susceptible to the insecticide application, and the various life stages are differentially affected by the application.

Degree-days. Degree-day models are a tool that take advantage of the fact that insects are ectotherms so their development is temperature dependent. They can be used to predict the most abundant life stage present for a given species so that insecticide applications can be timed accordingly. Laboratory

work conducted in the Steffan lab determined the upper and lower developmental thresholds for Sparganothis fruitworm to be 86 and 50°F respectively. This means that their development only takes places when the temperature is within that range. By keeping track of the daily high and daily low temperature on an individual marsh, one can use the degree-day look up table (http://labs.russell.wisc.edu/steffan/files/2013/11/Degree-day-look-up-table.pdf) to keep track of accumulating degree-day. This, combined with the correlation of accumulated degree-days with life-history benchmarks, (http://labs.russell.wisc.edu/steffan/sparg-developmental-thresholds/), can help to predict the most abundant life stage that is present for sparganothis on your marsh (Deutsch et al. 2014).

There is a large amount of variability in degree-day accumulations from year to year. Figure 3 shows that the range of predicted flight initiations (600 DD) for the Wisconsin Rapids area from 2007-2015 covers almost an entire month. Additionally, within a year, there is variability from marsh to marsh. Figure 4 shows a range of predicted flight initiations from four different marshes in 2015. The difference of five days in figure 4 can make a significant impact on the efficacy of your pest management considering the three day different in the apple example from the beginning of this paper. Figures 4 and 5 demonstrate how important it is to record degree-days each year on your own marsh.

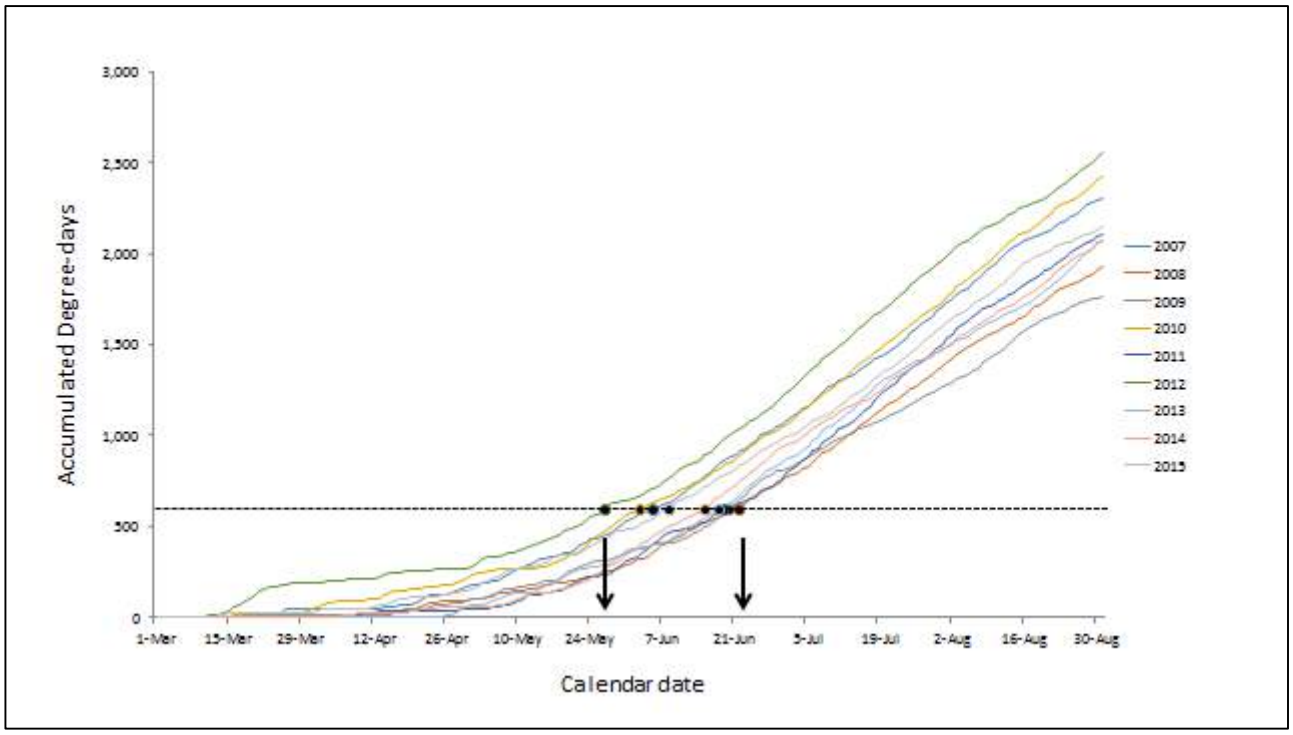


Figure 3. Correlation between calendar date and accumulated degree-days for Sparganothis fruitworm, 2007-2015. The dotted line represents the amount of degree-days for flight initiation (600 DD). Between 2007 and 2015, this covered almost an entire month.

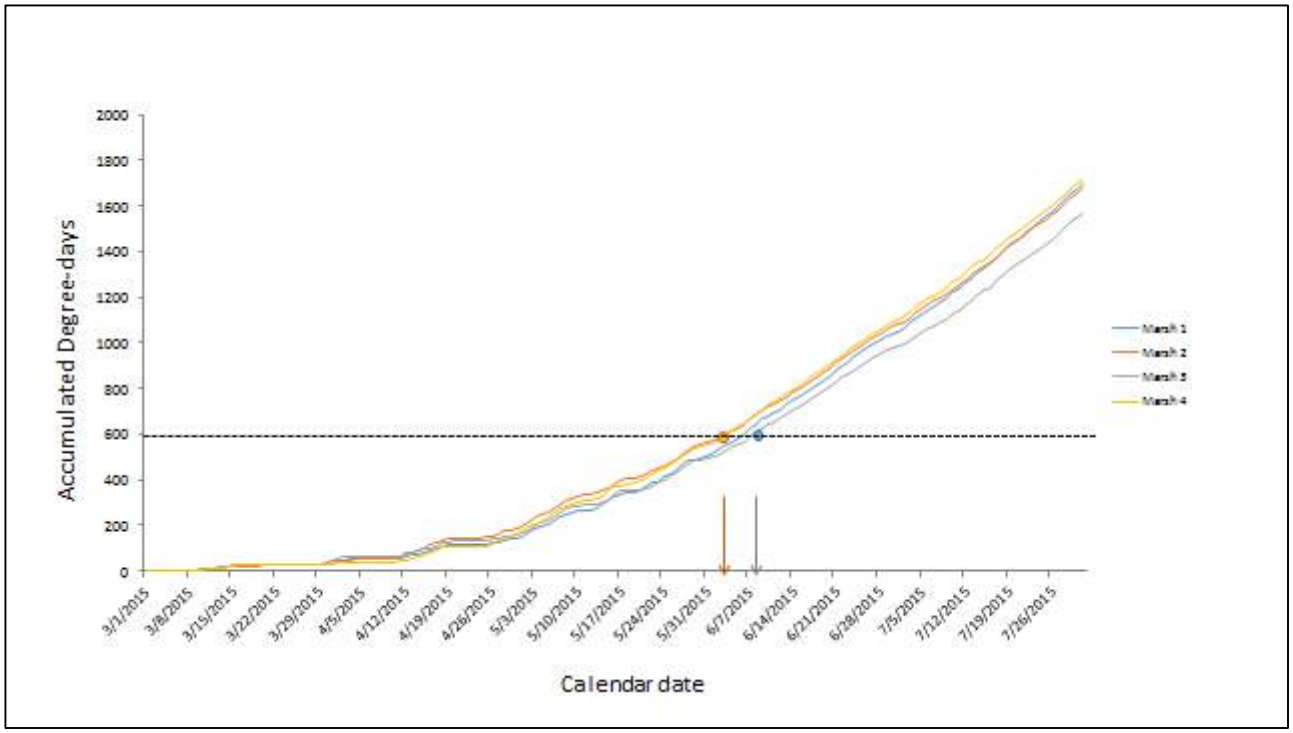


Figure 4. Correlation between calendar date and accumulated degree-days for Sparganothis fruitworm, on four different marshes in 2015. The dotted line represents the amount of degree-days for flight initiation (600 DD). The range of predicted flight initiation between four marshes covered five days.

Mating disruption as an alternative: In the coming years, one of the most effective tools to manage cranberry insect pests will be the mating disruption program that we are developing at the Steffan lab. The premise of mating disruption is to inundate the environment with the female sex pheromone so that males cannot find the female moths, thereby preempting mating and reducing the number of fertilized eggs and larvae. Our 2014 data shows great promise for this to be a powerful pest management tool in cranberry production (Steffan & Chasen, 2015).

The major benefit of mating disruption is that it operates independently of the constraints that are imposed on insecticide applications. The only timing that a pest manager has to be aware of is the beginning of moth flight. The mating disruption pheromone applied shortly before flight begins will continue to provide protection to your marsh for the duration of moth activity over the summer. Over the last year, we have been working on the logistics of mechanizing this application for you so that it can be applied either by drone or by boom sprayers.

Works Cited:

Averill, A., & Sylvia, M. 2015. Insect Management 2015. Retrieved from http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1200&context=cranchart

Deutsch, A. E., C. R. Rodriguez-saona, V. Kyryczenko-roth, J. Sojka, J. E. Zalapa, S. A. Steffan. 2014. Degree-Day Benchmarks for Sparganothis sulfureana (Lepidoptera: Tortricidae) Development in Cranberries. J. Econ. Entomol. 107: 2130–2136.

Fishel, F. M., & Ferrell, J. A. 2010. Managing Pesticide Drift. *UF/IFAS Extension*, *PI232*, 1–16. Retrieved from https://edis.ifas.ufl.edu/pi232

Kar, A., Mandal, K., & Singh, B. 2013. Environmental fate of chlorantraniliprole residues on cauliflower using QuEChERS technique. *Environmental Monitoring and Assessment*, *185*(2), 1255–1263.

Saglam, O., Athanassiou, C. G., & Vassilakos, T. N. 2013. Comparison of spinetoram, imidacloprid, thiamethoxam and chlorantraniliprole against life stages of Tribolium confusum Jacquelin du Val (Coleoptera: Tenebrionidae) on concrete. *Crop Protection*, *53*(January 2016), 85–95.

Sjöberg, P., Swiergiel, W., Neupane, D., Lennartsson, E., Thierfelder, T., Tasin, M., & Rämert, B. 2015. Evaluation of temperature sum models and timing of Quassia amara (Simaroubaceae) wood-chip extract to control apple sawfly (Hoplocampa testudinea Klug) in Sweden. *Journal of Pest Science*, *88*(2), 301–310.

Steffan, S. A. and E. Chasen. 2015. Multi-species mating disruption in cranberries. Wisconsin Cranberry School Proceedings. Vol. 23. Jan 21-22, 2015. Stevens Point, WI. Pgs 47-50.

Steffan, S. A. and M. E. Redding. 2004. Doubling times and half-lives: Considerations for IPM programs under heavy codling moth pressure. Western Orchard Pest and Disease Management Conference. 78th Annual Conference. Jan 14-16, 2004. Portland, OR.

United States Department of Agriculture National Agricultural Statistics Survey (USDA NASS). 2013. 2013 Wisconsin agricultural statistics. http://www.nass.usda.gov/Statistics_by_State/Wisconsin/Publications/Annual_Statistical_Bulletin/bulletin2013_web.pdf

WHAT'S UP AS THE TEMPERATURE GOES DOWN? UNDERSTANDING FROST NIGHT CONDITIONS

BETH ANN WORKMASTER and AMAYA ATUCHA

Department of Horticulture, University of Wisconsin, Madison

SUMMARY

- Be aware of temperature sensor placement and patterns of cooling on your marsh during both advection freeze and radiation frost events.
  - Monitor temperatures as close to the top of the canopy as possible and toward the center of the bed.
  - Plant temperatures (T_{plant}) can be 2-4 degrees colder than the surrounding air.
  - Critical protection time can be lost if you rely on sensor readings from a location away from the vines.
- Consider the effect of the dew point temperature (DP) on the rate of cooling and on T_{plant} relative to the current plant critical temperature.
  - Air temperatures (T_{air}) drop quickly above the dew point – be aware of it relative to 32°F and the stage of plant growth.
  - Cooling rates slow as T_{air} approaches the DP.
  - When T_{air} is near or at the DP, T_{plant} will be close to T_{air}.
- If drier air is present (T_{air} well above DP), consider starting sprinkle irrigation earlier as T_{air} approaches 32°F to compensate for evaporative heat loss.
  - Run a sufficient volume of water to compensate for radiative and evaporative loss.
  - Wind speed affects this, if using during an advection freeze.
  - If irrigation is shut off before end of frost/freeze event, remember ice is capable of conducting heat.

Effective plant protection on frost and freeze nights depends on growers and managers understanding both the nature of the environmental conditions and factors related to the cranberry plant, such as the critical temperatures for plant survival. Here, we will focus on the factors involved on the marsh during advection freezes and radiation frost events, and important considerations for protection decision-making.

Factors involved in freezing events

During every plant-related freezing event there are two main factors going on: the processes of heat transfer and the release or consumption of heat energy involved in changes in the state of water (also known as the latent energy of water). To change the temperature of a substance, energy must be either added or removed. The four major processes of heat transfer in the environment are radiation, conduction, convection, and advection (Figure 1). *Radiation* is energy in the form of waves which are not composed of matter. There are many types of radiation, or electromagnetic energy, and here we will focus on that emitted by the sun, solar radiation, and the portions of that which are absorbed and subsequently re-emitted by the

earth, called terrestrial radiation. *Conduction* is the process of heat transfer by touching, molecule to molecule. Heat moves from a warmer object to a colder one, such that this process is good for moving energy over relatively small distances. Conduction is an important process in the transfer of energy from the ground to the air just above it. *Convection* is the vertical transfer of heat energy by the rising of a warmed mass of fluid (such as water or air) and the sinking of the displaced cooled mass to replace it. *Advection* is the horizontal movement of warm or cool air masses due to air pressure differences (wind) on both local and global scales. Each of these processes are at play to varying degrees during a freezing event out on the cranberry marsh.

As with any substance, energy is either released or consumed as water changes between its three phases – solid, liquid, and gas – more commonly referred to as ice, liquid water (or simply "water"), and water vapor (Figure 2). This energy is called latent heat because it is involved in the formation or breaking of the forces that attract the water molecules. The processes of melting, evaporation, and sublimation all involve the taking away, or consumption, of heat from the environment, while their counterparts, freezing, condensation, and deposition, involve the release of heat to the environment. All of these processes occur without changing the temperature of the water. To do that, the amount of energy required to change the temperature of a given mass of a substance by one degree is called its heat capacity; the heat capacity of liquid water is 1 BTU per pound.

Types of spring and fall freezing events

During the seasons when cranberry beds are not covered with winter ice, there are two general types of freezing events that can occur: advection freezes and radiation frosts.

Advection freeze. An advection freeze is also often referred to as a "wind-borne freeze" because it occurs when a colder (and typically drier) air mass of freezing temperatures moves into a geographic area, displacing the relatively warmer air that was there. Such a weather front movement usually results in a longer period of cold than what is experienced in a frost event. Plant temperatures lose their heat to the moving air and are therefore mostly warmer than the surrounding air at a given time.

It is difficult to protect cranberry vines from an advection freeze. Sprinkle irrigation is used commonly for protection on frost nights (discussed below), a strategy that takes advantage of the latent heat of fusion that is released when that water freezes. However, this method is not useful typically to counteract advection freezes for several reasons. Large amounts of water are required, due to the duration of these events. If the wind speed is much greater than 5 mph, coverage of areas of the beds is compromised. In addition, there is significant risk of increased damage to the plants because the influx of a much drier air mass, coupled with wind, means there will be some evaporation of the applied water. The latent heat of evaporation of water consumes 1080 BTU per pound of water, while the latent heat of fusion of ice formation releases only 144 BTU (Figure 2). This is an imbalance of seven and a half times contributes to the risk of driving down further the temperature of the plants and the air near them. The most

effective method to protect cranberry vines during an advection freeze is a short-term flood. This practice takes advantage of the heat capacity of water. The warmth of the volume of water acts as a reserve of energy to protect the submerged plants. In addition to the costs of time and money to put on such a flood, the main challenge with this protection method is the need to move the volumes of water necessary ahead of the timing of the arrival of the weather front.

Radiation frost. In contrast to the advection freeze, frost events occur when ice forms on objects, like plants, that are cooled to temperatures cooler than the surrounding air. The source of the water for this ice is from the air itself (more discussion on this below). The most common type of frost event is a radiation frost. These events occur on clear cold nights that have little to no wind. As the name implies, radiation is the main heat transfer process at work on these nights. Each day the earth's surface is exposed to the relatively shorter wavelengths (primarily visible light) of solar radiation from the sun. This warms the earth's surface resulting in, among other processes, the re-emission of longer wave radiation, that includes heat energy. It is the loss of this energy from the ground and surrounding objects to the open clear calm night sky that creates the conditions for frost formation. Air inches near the ground that has been warmed by the process of conduction from the ground surface can only temporarily transfer some heat to vines. However, it is the surfaces of objects most directly exposed to open sky, such as the top of the plant canopy, that become the coldest.

Temperature inversions. Another phenomenon that often occurs during a radiation frost event is the formation of a temperature inversion layer at heights well above ground surface. Normally air temperature *decreases* with altitude. An inversion layer forms when warmer air is effectively trapped at heights up to hundreds of feet above the ground, creating a situation where air temperature *increases* with altitude. This occurs because on calm clear nights the atmosphere is very stable and the ground and surface objects radiate heat energy (cool) faster than does the air at increasing altitudes, which only cools by the slower process of conduction. As a result, in a cranberry bed the temperature of the air at canopy level will typically be colder than air at even five to six feet higher (Figure 3). The inversion of temperature will remain until after sunrise and the incoming solar radiation warms the earth's surface again. The implication for cranberry growers is that it is important to know the source of temperature readings on your marsh or those posted in temperature forecasts. If a reported air temperature is not listed or known to be from the canopy level of the cranberry bed, it is safest to assume that it is likely from some height above the ground surface (for example, official National Weather Service readings are taken at six feet above ground).

Cooling rates of objects during a radiation frost. Growers need to be watchful of not only the absolute temperature conditions on the marsh, but one also needs to be aware of the cooling rates of objects (like plant leaves, buds, and fruit) on a radiation frost night. Several factors in the environment influence how fast the temperatures will drop. Characteristics of the physical environment on the ground play a role in the cooling rate of objects, since all objects radiate heat energy and they can affect each other when they are nearby. For example, the shape of the cranberry bed can influence the temperature in the bed, creating pockets of unique

temperature (and even humidity) experience, called microclimates. Energy is re-emitted from the sides of the dike and this can have a warming effect on the air and plant temperatures several feet into the bed. This is why the first flowers to open in the spring are typically on the bed edge. The structure of the cranberry canopy can also create a microclimate due to the way the plant grows and the density of plant material. Air in the middle of the canopy (where fruit is often located) and covered areas closer to the ground will be warmer than the buds and leaves exposed at the top of the canopy. Radiation of heat energy from the soil is affected by the amount of ground cover over it, with barer soil losing energy faster. Wet soil below the surface will lose energy slower due to the heat capacity of water, while the water at the surface is subject to evaporation.

It is important for growers to pay attention to both the absolute temperature and the rate of cooling. The graph in Figure 3 shows that as time overnight progresses, the plant temperature will be colder than the air around and above it. If the grower is watching the temperature recorded at some height (solid black line), then by the time that source approaches a critical plant temperature ($T_{critical}$), the plant temperature (T_{plant}, solid gray line) will already have been below $T_{critical}$ for some time (gray box).

Relative humidity and the dew point temperature. Another important factor that influences the rate of cooling of the air and objects on a radiation frost night is the amount of moisture in the air. The relative humidity (RH) is a measure of how far the air is from saturation. This is a relative measure, expressed as a percentage, because the maximum amount of water vapor the air can hold changes with temperature (see Figure 4). The dew point (DP) is the temperature to which air must be cooled to become saturated (100% RH). Therefore, the DP can never be greater than T_{air}. So, an air mass calculated to have a lower DP is drier than one with a higher DP. In other words, the temperature of the former air mass would have to drop farther before it became saturated with water vapor than would the latter air mass. Therefore, the closer the DP temperature is to the current air temperature, the closer that air is to saturation, and when the DP = T_{air}, the air is saturated. You can look for RH and DP tables online that will illustrate these points.

How close the DP is to T_{air} over the course of a radiation frost night is important because this will have an effect on the cooling rates of both the air and objects. Typically, the predicted low temperature will be very close to the DP. Drier air will cool faster, so initially on a radiation frost night the temperature will drop fairly rapidly. As T_{air} approaches DP, the rate of cooling will decrease. This is because as the air becomes saturated the water vapor in the air will begin to condense into liquid water, that is, dew. Similar to the processing of freezing, the condensation of water is a process that releases heat energy into the environment (1080 BTU per pound, the opposite of what is consumed in evaporation). The release of this energy results in a temporary slowing, or even stopping, of the cooling of the air and of plant tissue. When frost forms (DP is below freezing), this is a process called deposition (Figure 2), which releases 1224 BTU per pound of water (the sum of the specific heat of condensation plus freezing). Therefore, if the DP is predicted to be above 32°F, T_{air} will likely stay above freezing. If the DP is predicted to be

well below 32°F, particular care is in order, as the rate of cooling will be faster than at the DP. Frost protection measures may be necessary, depending on the critical temperatures for the buds or fruit at that time.

Considerations for radiation frost protection. Cranberry beds are protected on radiation frost nights with the use of sprinkle irrigation. As referred to above, this method takes advantage of the heat energy released to the environment (144 BTU per pound of water) as this water freezes on the vines. While this is a very successful protection strategy, there are a couple of factors to consider. First, depending on how far the DP is from the air temperature at the time of irrigation start-up, this initial addition of water into the air may experience some evaporation. Since evaporation is a phase change of water that consumes heat from the environment, the air around the plants may lower in temperature. This may have an effect on the plants, particularly if they are at a stage of development where they are very temperature sensitive. It is also important to run a sufficient volume of water to compensate for any further evaporative, as well as radiative heat losses over the course of the night. If irrigation is stopped, close monitoring is warranted, as once all the free water present is frozen, heat can be lost from the vines first via conduction through the ice and the radiation to the open sky.

Conclusion

Developing the most successful set of freeze and frost event protection practices for cranberry involves an understanding of the range of environmental factors that are on-going at these times. An appreciation for the different processes by which heat moves across and within the marsh, as well as the pattern of temperature changes over both the landscape of your marsh and over the course of freeze or frost event can save critical time and resources for the protection of your crop.

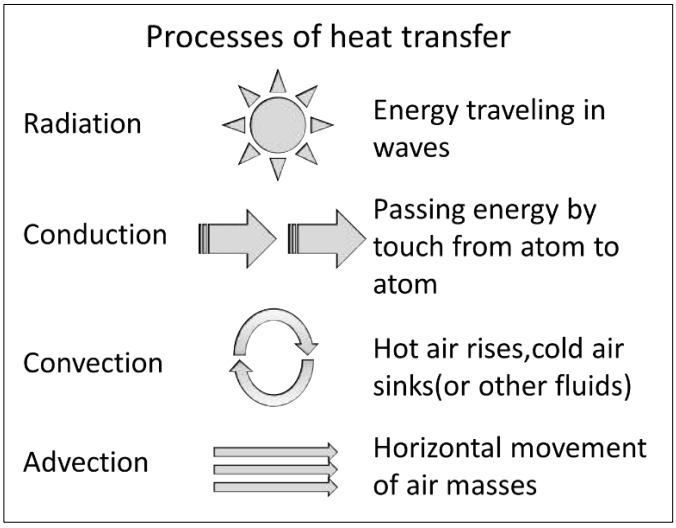


Figure 1. Processes of heat transfer are involved in how different frost and freeze events occur.

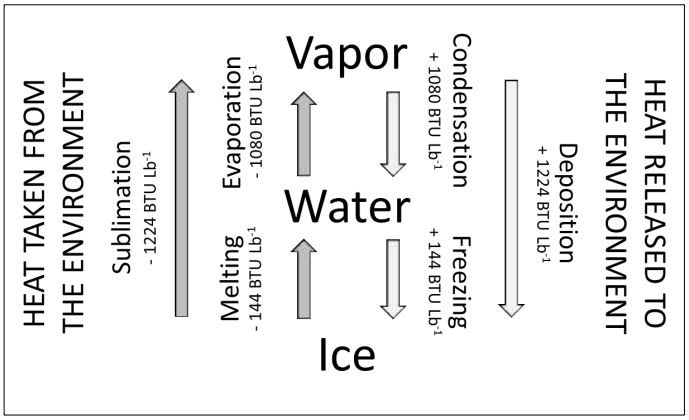


Figure 2. Changes in the physical states of water result in heat energy either being released to or consumed from the environment. Units for the energy amounts listed are BTU (British Thermal Units) per pound (Lb^{-1}) of water.

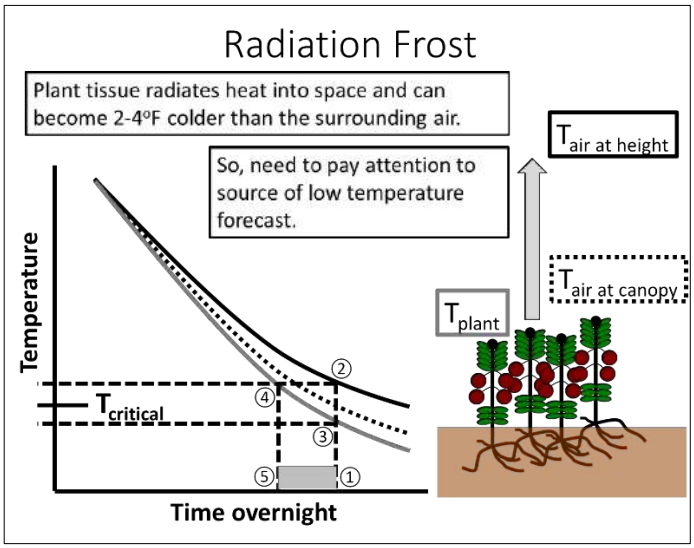


Figure 3. Generalized experience of temperature drop overnight in a cranberry marsh noted at three different locations in a bed: plant at bud or top leaves, the air at canopy level, and the air at a height of several feet above the canopy. If a grower is watching for the time (point 1) where the air temperature recorded at some height (solid black line) drops to a particular point (point 2) approaching the critical plant temperature ($T_{critical}$), it is likely that the plant temperature (T_{plant}, gray solid line) will already have been below $T_{critical}$ (point 3) for some period of time (gray box), compared to reaching that trigger temperature (point 4) at an earlier time (point 5). This difference in time could be critical in the plant's experience of potentially damaging temperatures.

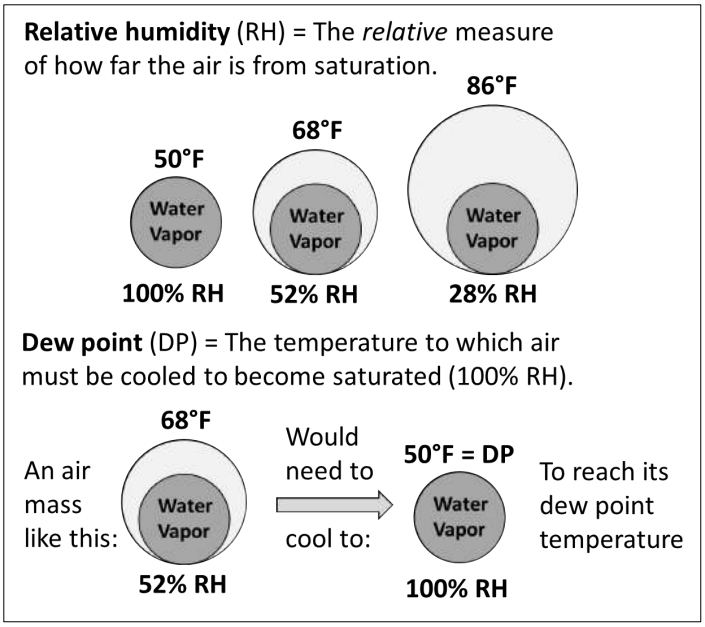


Figure 4. Definitions of the concepts of relative humidity (RH) and dew point (DP). RH is a calculated measure of the moisture content of the air that is considered "relative" because the maximum amount of water vapor the air can hold changes with temperature. What the DP is on a potential frost night is an important factor in the both the prediction of the overnight low temperature and the rate of cooling to be expected.

EVALUATION OF INSECT RESISTANCE IN WISCONSIN CRANBERRY VARIETIES

ERIN MCMAHAN and CHRISTELLE GUÉDOT

Department of Entomology, University of Wisconsin, Madison

Take home points:

There was no overall significant difference in resistance among common Wisconsin varieties. However:

- Sparganothis fruitworm adult populations were lower in the varieties Ben Lear, HyRed and Mullica Queen than in Stevens or GH-1
- Cranberry fruitworm larval populations and damage were higher in beds of Ben Lear and Mullica Queen than in Stevens, GH-1, or HyRed
- In laboratory feeding trials, there was no difference in sparganothis fruitworm performance among any of the tested varieties

This is a report on the results of a three-year study that assessed commonly grown Wisconsin cranberry varieties for insect resistance. Wisconsin's cranberry industry is interested in ways to improve sustainability and reduce the use of broad- spectrum insecticides, which create risks for human and environmental health and can impact fruit marketability to national and international markets. The integrated pest management (IPM) strategy of host plant resistance (HPR) can help control pest populations by utilizing the natural defenses of certain plant varieties. HPR has been used in crops worldwide to suppress insect populations, yet this strategy has not been widely researched in cranberry.

Promisingly, a handful of resistance studies have indicated that some cranberry varieties may be more resistant than others to insect feeding ([1,2]) However, the varieties and insect pests used in these studies are uncommon in the state of Wisconsin, which is the world's leading producer of cranberries. More research is required in varieties and insects important to Wisconsin cranberry production.

The objective of this research was to assess possible resistance in the varieties Stevens, Ben Lear, GH-1, HyRed, and Mullica Queen towards the three most economically important insect pests in Wisconsin cranberry: sparganothis fruitworm (SFW), blackheaded fireworm(BHFW), and cranberry fruitworm (CFW).

Resistance was assessed through the following studies:

1) Evaluation of field population densities of the target pests in the five cranberry varieties
2) Measurement of growth and development rates of SFW feeding on these varieties in the laboratory

Objective One: Field Population Density Study

Methods

Adult Population Densities

This study was carried out in the summers of 2013 and 2014. We used five different sites in commercial marshes in central Wisconsin, and used beds of five varieties at those sites: Stevens, Ben Lear, GH-1, HyRed and Mullica Queen. In each study bed, we placed four pheromone traps baited with commercially available, species-specific pheromone lures; one trap with a pheromone bait for SFW, one with a bait for BHFW, a third with a bait for CFW and a fourth control trap with no lure. Each study bed was adjacent to at least one other bed of the same variety, so that traps could be placed between the beds to minimize the likelihood of moths flying in from other varieties.

The traps used female sex pheromone lures so they attracted only male moths. Each week we collected and replaced traps and counted the number of moths in each. Counts were averaged for all weeks of the first flight for both years and compared across varieties.

Fruit Damage and Larval Population Densities

Using the same study beds used in the adult trapping, plus the adjacent bed of the same variety, we walked 100 meter transects along the bed edges, collecting all prematurely red, damaged berries within the width of meter. A separate transect was walked for each of three weeks in both 2014 and 2015. Damaged berries were returned to the lab, counted, and dissected, and the larvae found inside were counted and identified to species. The three weeks were averaged for each bed for both years, and the average berry counts and larval populations were compared across varieties.

Results

Adult Population Densities

We found a significant difference in adult SFW populations among varieties. Populations of SFW were significantly lower in beds of Ben Lear and Mullica Queen than in Stevens or GH-1. HyRed had significantly lower SFW populations than Stevens (Fig. 1) There were no significant differences between populations of BHFW among varieties, although there appears to be a non-significant trend of lower populations in GH-1(Fig. 2). There were no significant differences in CFW populations among varieties (Fig. 3).

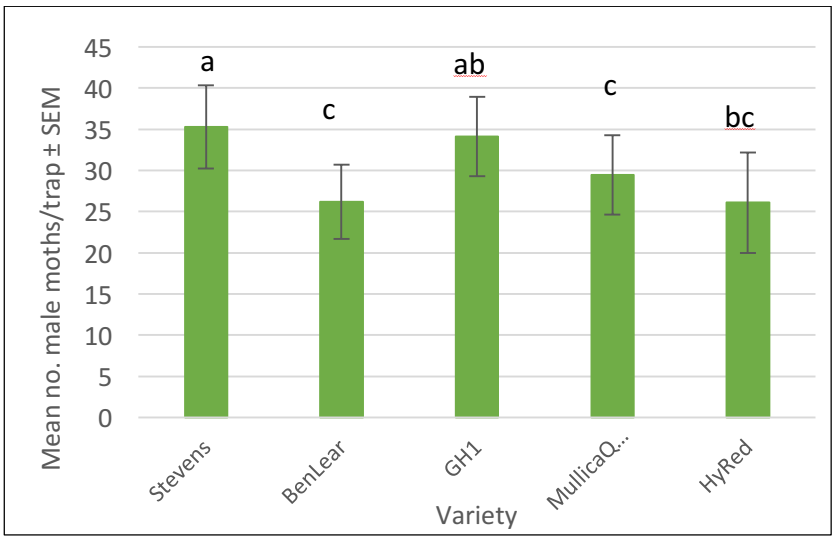


Figure 1. Average number of male SFW moths per trap for all weeks of the first flight for both seasons. Black bars indicate standard error and letters indicate significant difference

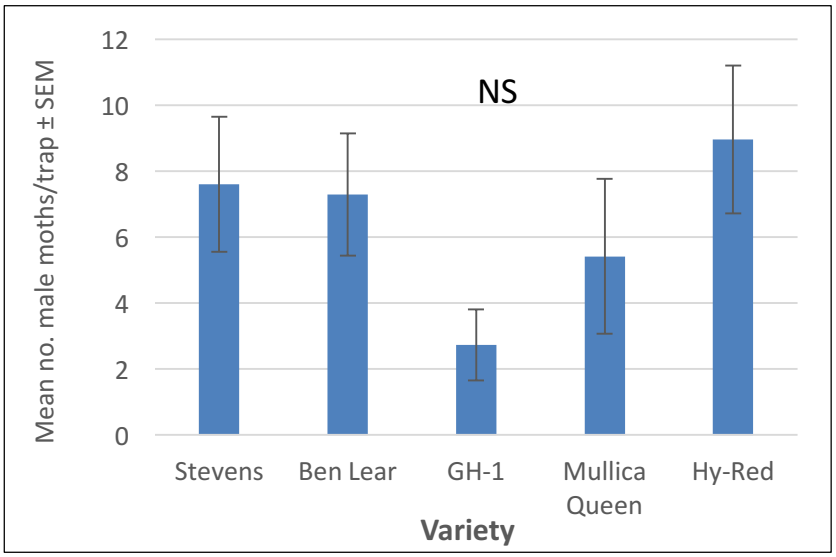


Figure 2. Average number of male BHFW per trap for all weeks of the first flight for both seasons. Black bars indicate standard error and NS indicates no significant difference.

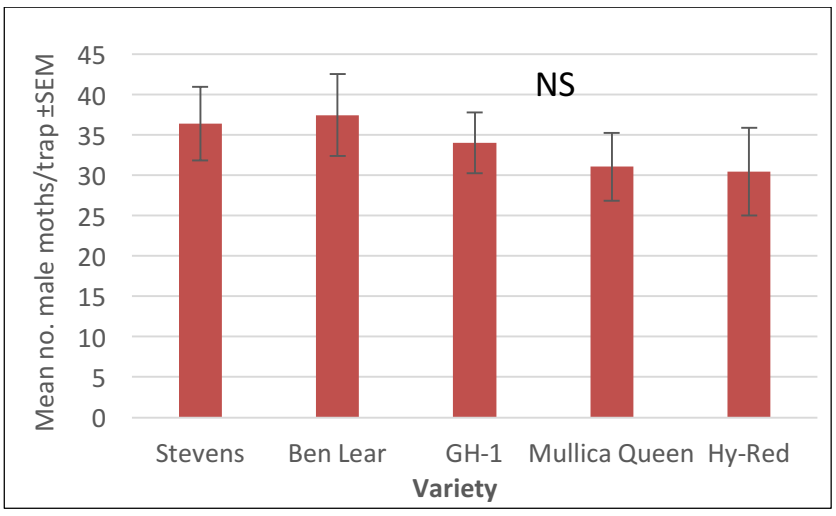


Figure 3. Average number of male CFW per trap for all weeks of the single flight for both seasons. Black bars indicate standard error and NS indicates no significant difference.

Larval Population Densities

The number of damaged berries was significantly higher in beds of Ben Lear and Mullica Queen than in Stevens or GH-1 and there were significantly higher numbers of CFW larvae in beds of Ben Lear and Mullica Queen than in GH-1 (Fig. 4). 99.5% of all larvae found were CFW, so larval populations of SFW (the other species that inhabits berries) could not be assessed.

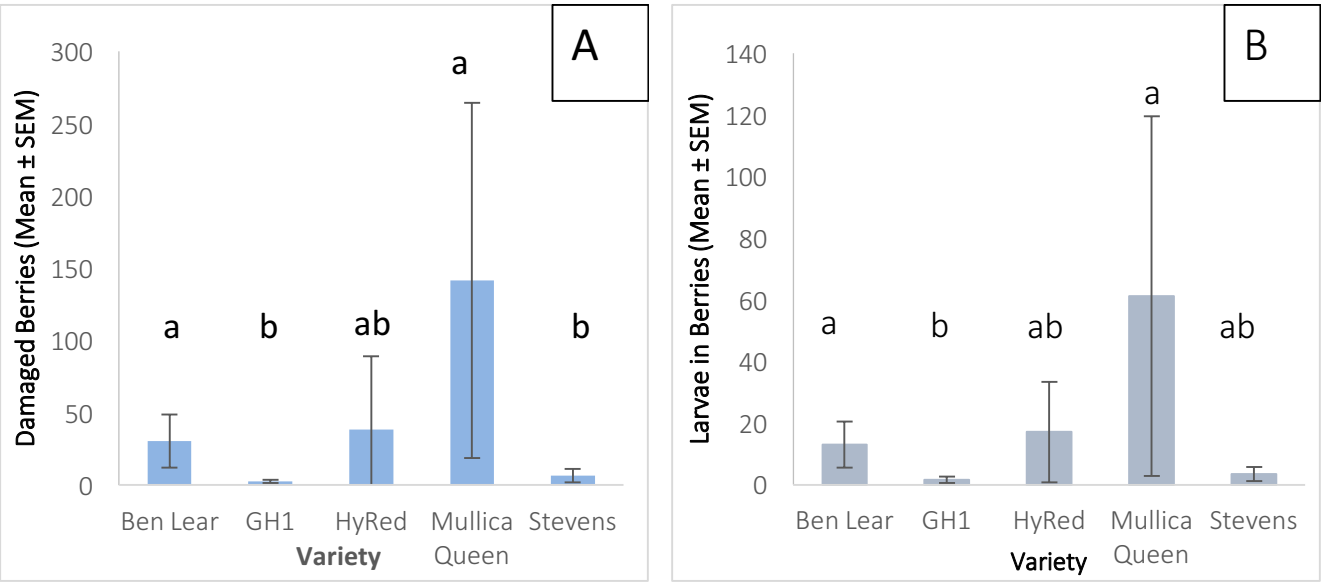


Figure 4. Average (± SEM) A) damaged berries and B) larvae collected per bed for each variety for both years combined. Three weeks of sampling were averaged for each study bed, then all beds of the same variety were averaged and both years averaged. Letters indicate significant difference.

Objective Two: Development Rate Study

Methods:

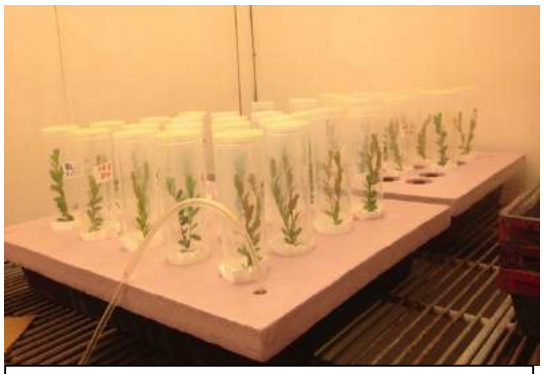


Figure 5. Experimental hydroponic system setup.

Cranberry plants of the five varieties (Stevens, Ben Lear, GH-1, HyRed and Mullica Queen) were grown in a greenhouse on the University of Wisconsin campus. SFW larvae were acquired from a colony that was started with field-collected larvae in 2013, and reared in a laboratory incubator on a wheat germ diet. The experiment was set up in a hydroponic system that consisted of a foam board with holes placed on top of a tray containing water. Two clipped uprights of the same variety were inserted into each hole and the bases submerged in water (Fig. 5). 20 replicates of each of the five varieties were set up, and a newly hatched SFW larvae was added to each replicate. Each replicate was enclosed in a plastic vial to prevent the larva from escaping. Larvae were allowed to feed undisturbed and fresh plant material was added as needed. Survival rate,

larval weight at 16 days, pupal weight, and days to pupation were recorded. Measurements were averaged for each variety and compared across varieties.

Results

Larval survival rates did not differ significantly among varieties. At 16 days, larvae feeding on Ben Lear were significantly heavier that those feeding on Stevens or HyRed, and larvae feeding on Mullica Queen were heavier than those feeding on HyRed. However, by the time the larvae pupated, there was no longer a significant difference among varieties. There was also no difference in time to development of the insects among varieties (Fig. 6). The size of the pupae impacts the egg-laying capability of the adults, and time to development impacts the survival of the larvae in the field. Therefore, no significant difference in these measurements indicates no meaningful difference in resistance among the varieties tested.

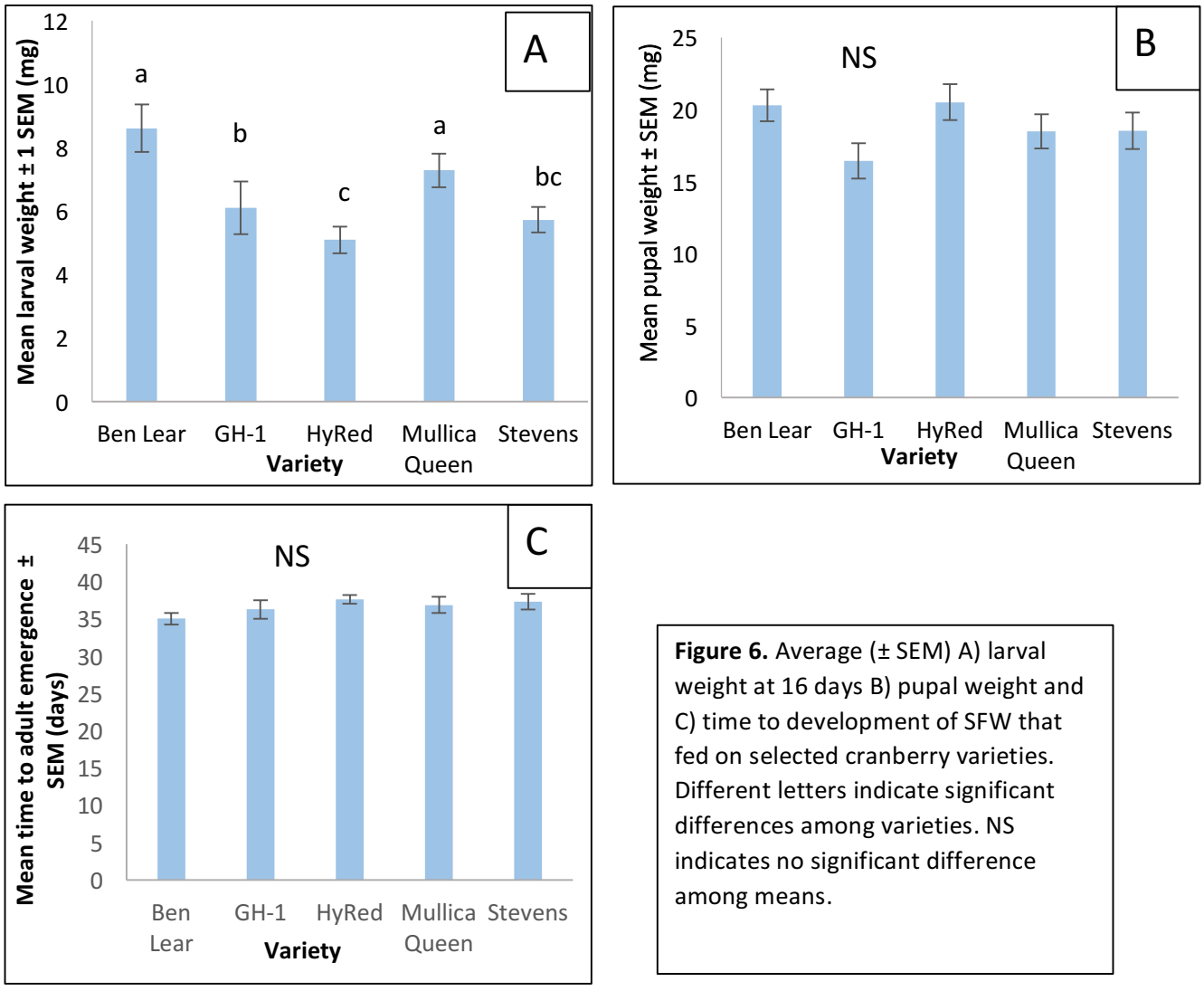


Figure 6. Average (± SEM) A) larval weight at 16 days B) pupal weight and C) time to development of SFW that fed on selected cranberry varieties. Different letters indicate significant differences among varieties. NS indicates no significant difference among means.

Overall summary of findings and discussion

The table below summarizes the results of this research (Fig. 11)

Sparganothis Fruitworm	
Adult Field Populations	Stevens & GH-1 > Ben Lear, Mullica Queen & HyRed
Larval Field Populations	No data
Development Study	Larval Weight: Ben Lear & Mullica Queen > Stevens, GH-1, HyRed No other differences
Cranberry Fruitworm	
Adult Field Populations	No difference
Larval Field Populations	Ben Lear & Mullica Queen > Stevens, GH-1, & HyRed
Blackheaded Fireworm	
Adult Field Populations	No difference
Larval Field Populations	No data

In our laboratory studies, we found no difference in SFW development on different varieties. Therefore, there is no evidence that there are chemical of physical properties of these different varieties that cause resistance, although other studies have demonstrated a difference in chemical composition among varieties ([1,2]). However, we did see differences in field populations, which may be due to phenological differences among different varieties. For example, there were significantly more damaged berries and CFW larvae in beds of Ben Lear and Mullica Queen than beds of GH-1 or Stevens. Ben Lear and Mullica Queen both develop and ripen earlier than the other two varieties, and their larger size may make them preferable to egg-laying CFW females. Future research could measure the exact degree days of developmental stages of each different cranberry variety, and compare them to established degree days for SFW and CFW life stages ([3]). Other factors such as variation among locations, bed ages and density, and natural enemy populations could also cause population differences.

Overall, there was no single variety that stood out as being resistant across all insect pests. It is uncertain whether higher SFW adult populations in Stevens and GH-1 translate to greater larval damage since we found very few SFW larvae. **Mullica Queen and Ben Lear** may host higher CFW populations so we urge growers to **keep an eye on these varieties.** Continued research into host plant resistance with other varieties and pests in this under-studied crop can possibly contribute effective management strategies to growers' toolboxes.

Literature Cited

1. **Neto, C. C., C. A. Dao, M. R. Salvas, W. R. Autio, and J. E. V. Houvel**. **2010**. Variation in concentration of phenolic acid derivatives and quercetin glycosides in foliage of cranberry that may play a role in pest deterrence. J. Am. Soc. Hortic. Sci. 135: 494–500.

2. **Rodriguez-Saona, C., N. Vorsa, A. P. Singh, J. Johnson-Cicalese, Z. Szendrei, M. C. Mescher, and C. J. Frost**. **2011**. Tracing the history of plant traits under domestication in cranberries: potential consequences on anti-herbivore defences. J. Exp. Bot. 62: 2633–2644.

3. **Deutsch, A. E., C. R. Rodriguez-Saona, V. Kyryczenko-Roth, J. Sojka, J. E. Zalapa, and S. A. Steffan**. **2014**. Degree-day benchmarks for *Sparganothis sulfureana* (Lepidoptera: Tortricidae) development in cranberries. J. Econ. Entomol. 107: 2130–2136.

A SYNTHESIS OF RECENT RESEARCH REGARDING THE SPRING FLOOD IN WISCONSIN: KNOWNS AND UNKNOWNS

JANET VAN ZOEREN[1] and SHAWN STEFFAN[1,2]

[1]*Deptartment of Entomology, University of Wisconsin, Madison*

[2] *USDA-ARS, Vegetable Crops Research Unit, Madison WI*

Approximately half of Wisconsin's cranberry growers replace a spring insecticide application with a 1- to 2-day spring flood. Despite the potential for this flood to be a highly cost-effective alternative to chemical insect controls, growers need to know whether the flood can reduce pest pressure without causing damage to the cranberry plant. Over the past five years, research in the Steffan Lab has addressed these concerns, specifically looking at: 1, the efficacy of flooding at suppressing key cranberry pests, 2, the effects of flood waters on the cranberry plant's physiology, and 3, the mechanism through which flooding reduces pest moth populations.

Does flooding suppress key pests?

In 2011, a large-scale field study was set up on 11 commercial cranberry marshes across central Wisconsin (Steffan et al. 2012). On each marsh several beds received a spring flood ("Flood"), while other beds received a spring insecticide spray ("Spray") but were not flooded. In total, 23 Flood beds were compared to 23 Spray beds. Throughout moth flight, populations of Sparganothis fruitworm, cranberry fruitworm, and black-headed fireworm were monitored using pheromone-lured P2 sticky traps.

Following the flood, there were significantly fewer black-headed fireworm trapped in the Flood compared to the Spray beds. Sparganothis fruitworm and cranberry fruitworm trap-catch was equivalent in Flood and Spray beds. Overall, these results indicate that flooding is a highly effective method of pest suppression for these three moth species, and that the flood is as effective, or in the case of black-headed fireworm, more effective than a conventional insecticide application.

Does flooding damage the cranberry plant?

During the summer of 2011, plant physiological characteristics were also measured in these 23 flooded and 23 sprayed beds. The metrics of plant health used were: chlorophyll content, upright length, number of hooks and flowers / upright, and harvestable yield. In the flooded beds, water temperature and dissolved oxygen content of the water was measured both at the beginning and the end of the flood.

On average, dissolved oxygen at the beginning of the flood was around 8.2 ppm, and had dropped off by the time the water was removed to around 7.7 ppm. In general, as temperature increased, dissolved oxygen decreased. Only a few beds had dissolved oxygen levels below 5 ppm, and these tended to be older beds with greater biomass of submerged organic materials.

Microbial activity within submerged detritus uses some of the available oxygen in the water, thereby reducing dissolved oxygen levels.

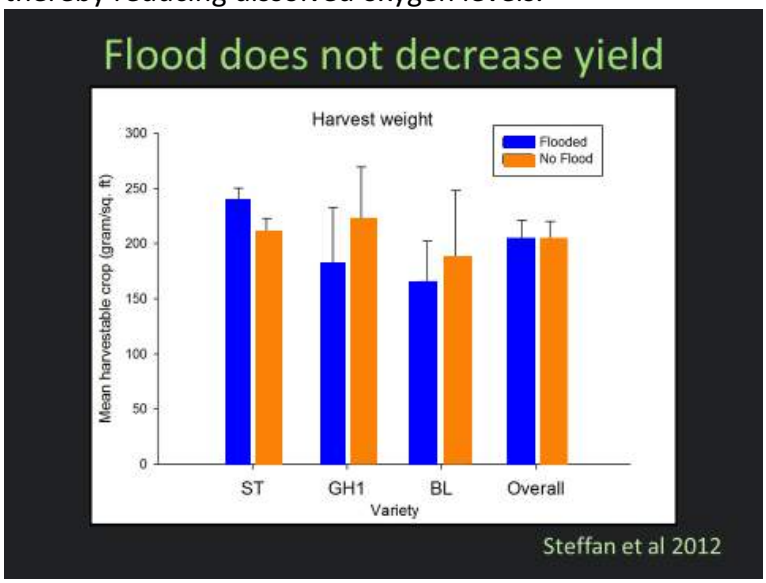


Figure 1. Average harvestable yield in Stevens, GH1, Ben Lear and across all varieties, comparing Flood (blue) with control (orange) beds.

Early on, it did appear that the flood had stressed the cranberry plants. One week after the flood, chlorophyll was significantly lower than in the control (Spray) beds, and after four weeks, there were fewer flowers / upright in the flooded beds. However, although statistically significant, these differences represented only slight reductions in floral count. In fact, the difference between flower-set in sprayed beds (4.16 flowers / upright) compared to flooded beds (3.83 flowers / upright) amounted to a decrease of only 0.3 flowers per upright. Most importantly, by the time berries were harvested there was no difference between yield in flooded (204.3 grams / ft^2) compared to sprayed beds (203.0 grams / ft^2). This was true not only overall, but also when different varieties were separated out, with Stevens, Ben Lear, or GH1 all showing no difference in yield between Flood and Spray beds (Fig. 1).

These results suggest that in field-relevant conditions, there are no season-long detrimental effects of flooding on the cranberry plant. In the greenhouse, we decided to further investigate the submergence tolerance of cranberries across a gradient of temperature. We were able to directly manipulate both water temperature (cold vs. warm conditions) and submergence duration (0 hrs., 48 hrs., and 96 hrs.), and continued monitoring dissolved oxygen. We assessed upright length at 7-weeks following submergence.

There was no difference between upright length for plants submerged for 0, 48 or 96 hours, as long as dissolved oxygen stayed above 5 ppm (40% saturation). Because water temperature is tied to dissolved oxygen, in some of the trials with warm water, upright length was decreased following longer submergence. However, this effect was only seen when temperatures were warm ***and*** dissolved oxygen was low.

In summary, based on these data, we recommend that growers who use the spring flood carefully monitor dissolved oxygen on their marsh. As long as dissolved oxygen stays above 5 ppm (40%), and temperatures are relatively cool (depending on dissolved oxygen, 80°F could be worrisome), there seems to be no detrimental effect

on cranberry plant health of flooding for as long as 96 hours.

How does flooding suppress pests?

These results show that flooding can remove pest species without damaging the plant, but does not explain the mechanism through which this takes place. Previous research has suggested that, at least for Sparganothis fruitworm, caterpillars can withstand a longer flood duration than the cranberry plant, suggesting that suppression does not take place through simple drowning (Teixeira and Averill 2006). However, native naturally occurring biological control agents have the potential to provide highly efficient pest control. These include generalist predators (i.e. spiders, which may eat whatever prey they come across) and specialist parasitoids (often wasps, which tend to specialize on a single pest species). These predators and parasitoids have been observed in Wisconsin cranberry marshes (Singleton 2010), and have the potential to consume significant numbers of cranberry pests (Marucci and Moulter 1992). We hypothesize that the pest suppression provided by flooding is in fact due to an increase in biological control following the flood; in order to determine if this is the case we investigated the population dynamics and interactions of pests, predators, and parasitoids in cranberry beds following either the spring flood or a spring insecticide application.

During the summer of 2014, field investigations took place on six flooded and six sprayed beds on a single commercial cranberry marsh in central Wisconsin. Arthropod communities were sampled in the beds seven times: one pre-treatment sampling event in mid-May, five sampling events in the weeks following treatment, and one the week following an insecticide application that was applied to all beds in early July. Samples were taken each week with pitfall traps, sweep-netting, and pheromone-baited traps. Pitfall traps targeted active insects in the understory, while sweep-netting targeted insects in the canopy. The pheromone-baited traps sampled for Sparganothis fruitworm, cranberry fruitworm, and black-headed fireworm.

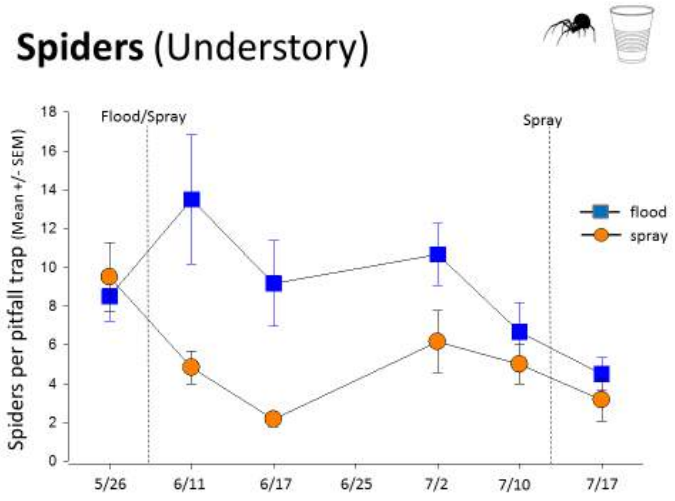
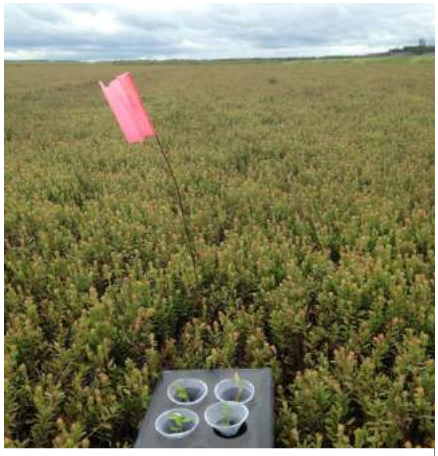


Figure 2. Number of spiders caught in pitfall traps by week, showing more spiders in flooded beds (blue squares) than in sprayed beds (orange circles).

There were more generalist predators (Fig. 2) and parasitoids caught in the "Flood" beds than in the "Spray" beds. This suggests that predators and parasitoids thrive following the flood, although it's unclear if the flood directly helps them, or if the difference is due to the absence of an insecticide spray in the "Flood" beds. Similar to the results from 2011, flooding was as (or more) effective than the spray at suppressing Sparganothis fruitworm, cranberry fruitworm, and black-headed fireworm.

These results show that the flood corresponds to an increase in natural enemy populations, but does not directly address whether these predators are in fact suppressing pest populations. In order to investigate this more fully, in the summer of 2015 we studied the predation and parasitism rate of Sparganothis fruitworm on marshes using a spring flood, compared with those spraying an insecticide. Specifically, we addressed egg predation rates, egg parasitism rates, and larval parasitism rates.



Larval parasitism sentinels

Egg predation and egg parasitism sentinels consisted of eggs, attached to a piece of corrugated plastic, with a roof to prevent rain or sun damage to the eggs. For predation sentinels, the plastic was in contact with cranberry uprights to allow predators access to the eggs, while for parasitism sentinels predators were excluded from the eggs. Larval parasitism sentinel traps consisted of four Sparganothis caterpillars, each on cut cranberry upright, in a plastic water vial with a funnel to catch the caterpillar if it fell from the upright. Egg and larval parasitism sentinels were put out in the field for 4 days each, then reared out in the laboratory to see whether a pest caterpillar emerged, or if a parasitoid had consumed the caterpillar and would instead emerge. Additionally, we collected some wild larvae from a single Flood marsh, using sweep netting and visual inspection for webbed uprights, which were also reared out in the lab.

Egg predation rates varied from 0% - 100%, with significantly more egg predation in Flood compared to Spray marshes. However, this difference was found both before and after the actual flooding event, and the percent of eggs consumed decreased equally following both the spring flood and the insecticide application (Fig. 3). Because most of the marshes that used the flood in 2015 had also flooded 4-5 out of the past five years, while most of the marshes that sprayed insecticides in 2015 had sprayed 4-5 out of the past five years, the higher rate of pest egg predation in Flood marshes may be indicative of a carry-over effect. This suggests that several years of flooding, instead of spraying in the spring, can have a positive effect on biological control of pest moth eggs on the marsh.

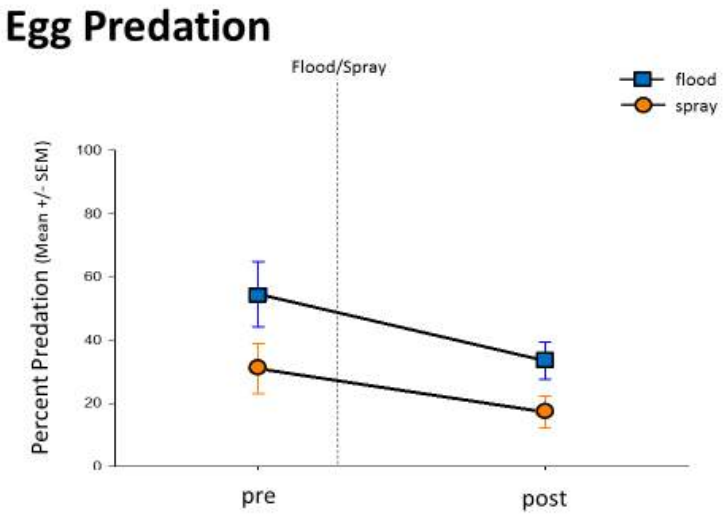


Figure 3. Percent egg predation on marshes before and after a spring flood (blue squares) and insecticide spray (orange circles). Predation is greater both before and following treatment in the Flood condition.

Unfortunately, both egg and larval parasitism sentinels found

0% parasitism rates, indicating that no caterpillars had been attacked by parasitoids. There are several possible reasons these sentinels were not parasitized – the trap itself may have been distasteful to the parasitoids, either in terms of how they smelled or looked, the traps may have been placed in the field at a time when parasitoids were not looking for caterpillars to parasitize, or the laboratory reared eggs and larvae may not have been appealing to the parasitoids. It seems unlikely that these numbers represent a true lack of parasitoids present on the marshes, due to previously reported high numbers of both egg and larval parasitism in Sparganothis fruitworm (Marucci and Moulter 1992). Furthermore, when rearing out the wild caught caterpillars from this study, a parasitism rate of 33% was found, indicating that larval parasitoids were present, but simply were not detected in the sentinel traps. Future research into the species and life histories of these parasitoids could provide valuable information regarding how to increase their efficacy.

Overall Messages

Through these studies, we have shown that pest moths can be controlled by the spring flood equally as effectively as they are by a conventional insecticide application. Additionally, there is no evidence of a detrimental effect of this flood on the cranberry plant itself, as long as flood waters are removed before dissolved oxygen levels approach 5 ppm. The flood has a positive effect on populations of natural enemies, with more spiders and parasitoid wasps found in beds following the flood rather than a conventional insecticide application. This increased generalist predator density following flooding does translate, over a long term, to an increase in egg predation on the marsh. The effects of flooding on parasitism rates were not specifically addressed, due to trap failure. However, it is likely that the large number of parasitoids in flooded beds would translate to an increase in the number of caterpillars killed due to parasitism. For this reason, flooding is most likely to be a highly effective pest control strategy on marshes where predators and parasitoids are abundant. These natural enemies represent a highly cost-efficient tool in the cranberry growers IPM toolbox, which can further be sustained and nurtured through flooding in the spring, instead of applying an insecticide. Therefore, the spring flood is shown to be an effective method to control pest moths, while concurrently maintaining healthy populations of beneficial predators and parasitoids.

Literature Cited

Marucci, P.E. and H.J. Moulter. 1992. Biological control of *Sparganothis* fruitworm on cranberries in New Jersey, Part II. Cranberries. 56 (4): 11-15.

Singleton, M. 2010. Biological impacts of insecticide use in the Wisconsin cranberry industry. M.Sc Thesis, University of Wisconsin.

Steffan, S.A., M. Singleton, J. Sojka, J. Zalapa, T. Dittl and R. Harbut. 2012. Early-season flooding for insect pest control. Wisconsin Cranberry School 2012 Proceedings. 20: 24-28.

Teixeira, L.A.F. and A.L. Averill. 2006. Evaluation of flooding for cultural control of *Sparganothis sulfureana* (Lepidoptera: Tortricidae) in cranberry bogs. Environmental Entomology 35:670-675.

Discovery and Virulence-Screening of Native Nematodes in Wisconsin Cranberries

SHANE FOYE and SHAWN STEFFAN

Department of Entomology, University of Wisconsin, Madison and USDA-ARS, Vegetable Crops Research Unit, Madison WI

Three of Wisconsin's most damaging cranberry pests include *Sparganothis sulfureana* Clemens (Lepidoptera: Tortricidae), commonly known as the sparganothis fruitworm, *Acrobasis vacinii* Riley (Lepidoptera: Pyralidae), commonly known as the cranberry fruitworm, and *Systena frontalis* Fabricius (Coleoptera: Chrysomelidae), commonly known as the red-headed flea beetle. In an effort to control these cranberry pests in an environmentally friendly and economically effective manner, cranberry growers may seek to supplement their pest control programs with entomopathogenic nematodes (EPN). These specialized nematodes infect insects, and release a specific, symbiotic bacterium that ultimately kills the host (Kaya and Gaugler 1993). The EPN use the dead host, henceforth cadaver, for nutrients and a place to reproduce. Although EPN are virulent towards a wide variety of pests, they are considered safe for humans, as well as beneficial arthropods (Lynch and Thomas 2000).

Many EPN species forage by cruising through the soil, following chemical exudates and other cues given off by their hosts (Grewal et al 1994). Other EPN ambush their hosts, by waiting at the surface of the soil for the pest to move near their location, and particular EPN use a combination of foraging and ambushing (Grewal et al 1994). Considering that each species of EPN has a specific relationship with a different bacterium, and that EPN vary in terms of their foraging habits, it is understandable that some EPN tend to be more or less successful on different hosts, and in different environments.

In the state of Washington, EPN have been used to successfully control the black vine weevil in cranberry operations; however, efforts to control cranberry pests using commercial EPN formulations have not been as successful in Wisconsin (Booth et al 2002). It is possible that commercial EPN have been relatively unsuccessful in Wisconsin because the EPN currently available from distributors do not have the ability to find or kill local pests. Another possibility is that the EPN currently available from distributors are not adapted to the cold climates and low pH of the cranberry marshes in Wisconsin. In order to find a superior EPN for the biological control of damaging, local cranberry pests, scientists at UW-Madison have looked for EPN in locations that contain wild cranberry populations in central and northern Wisconsin.

Three lines of EPN have been recovered to date, and efforts are underway to identify them (Fig. 1). After applying molecular methods, one of the three EPN lines has been identified as *Oscheius tipulae* (Rhabditida: Rhabditidae), a nematode named due to its association with cranefly larvae. The molecular process that yielded the result required the use of a standard Quiagen DNeasy ® kit to extract nematode DNA, a generic nematode PCR procedure to amplify the ITS region of the EPN genome, and the use of GENBANK to compare our extracted and amplified DNA, which was sequenced using Sanger Sequencing at the UW-Madison's Biotechnology Center. Until the other two species can be identified, the lines are being referred to by the colors of their cadavers, which are red and grey.

Figure 1. Individuals from the three nematode lines. The red nematode is pictured on the left, the grey nematodes are pictured in the center, and *Oscheisu tipulae* is on the right. The images were taken at 20x.

All three EPN lines were recovered from Jackson County during August 2015. The samples were taken by collecting mossy substrate and topsoil surrounding wild cranberry plants on public land, and placing the samples in plastic bags. The EPN were removed from the soil using a standard bioassay (Lacey and Kaya 2007). Briefly, six late instar waxworms were placed in each bag, and left for a week in the dark at room temperature (Fig. 2). Waxworms are often used for this test because a wide variety of EPN attack waxworms, they are cheap, and readily available.

Cadavers were identified by examining any color changes that might indicate the presence of a nematode infection. The cadavers were collected approximately two weeks after the baiting process began, and were washed by dipping them into distilled water. The clean cadavers were each placed inside of a modified White trap, which consisted of a large, glass Petri dish, on top of platforms with moistened filter, with a pool of water below the platform (Fig. 3). As EPN emerged from the cadaver, they fell into the water, and were collected for analysis and virulence screens (Kaya and Lacey 2007). One unusual aspect of this project is that the EPN required an additional week to emerge, which is not typical of most EPN, which kill waxworms in about a three days, and emerge in about a week.

Figure 2. Waxworms in a bag of moss collected from wild cranberry habitat.

Figure 3. A waxworm cadaver in a modified White trap. The cadaver is positioned atop a piece of filter paper placed on a glass platform, with water below the platform.

Preliminary attempts to evaluate the effectiveness of the three lines as biocontrol agents for sparganothis fruitworms are currently underway. Sparganothis fruitworms were chosen as the primary target for screening because colonies of these insects are easy to maintain, and larvae were readily available at the start of the experiment. Five fruitworms were placed in Petri dishes, lined with two pieces of filter paper (Fig. 4).

Each dish received a dose of 0, 50, 100, or 200 EPN of the same species, suspended in 2ml of water. Each dosage was repeated in three dishes, for a total of 15 larvae per dose. Dishes were stored in cabinets at room temperature. Sparganothis fruitworm pupae were also tested in the same way. Three days after the insects were treated with the EPN, the dead insects were removed, and dissected to ensure that they were killed by EPN. The experiment was repeated two more times.

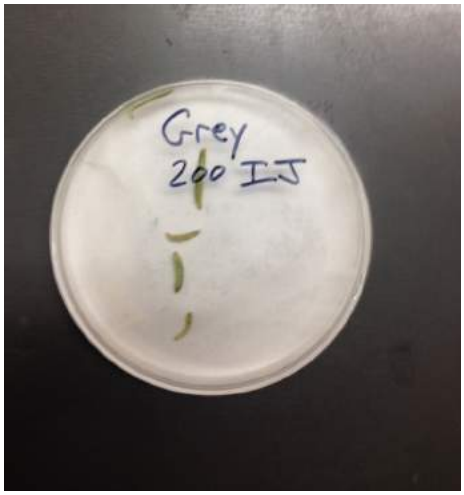


Figure 4. An example of sparganothis fruitworm larvae in a Petri dish used for biocontrol efficacy screens.

Although this procedure is a helpful first step that allows scientists to determine whether or not it is possible for EPN to target particular hosts in a sterile environment devoid of competitors, this simplified design does not strongly reflect the field capabilities of the EPN. After confirming that EPN can in fact kill Sparganothis larvae, the experimental design was modified by using larger Petri dishes, and filling them partially with autoclaved sand. Heat-treated cranberry leaves and twigs were also added, to recreate the environment at the bottom of a commercial bed. The five fruitworm larvae per dish were treated with a 200 EPN/2 ml dose of a single EPN species, henceforth referred to as a "high" dosage, and distilled water was added to moisten all of the sand. Dishes were left at room temperature on the benchtop for five days, and dead larvae were dissected to see if they had died from EPN or some other cause.

While biocontrol evaluations were taking place, preliminary attempts were made to identify the symbionts of these EPN. The EPN were surface-sterilized with an 8% bleach solution, then washed with water to remove the bleach, and finally pelletized by centrifugation. The water was removed, and the EPN were resuspended in a buffer that would protect the bacterial cells from lysing. This step was necessary because the EPN were then destroyed with a plastic mortar. The liberated bacteria were then diluted using a standard serial dilution protocol, and plated on an ampicillin-resistant growth medium, that would restrict the growth of environmental contaminants, and only allow the type of microbes commonly found in EPN to grow.

At the low dose, in the sterile Petri dish screen, red killed on average 64% (± 12.1 SE) of the fruitworms, which was significantly more sparganothis fruitworm larvae than either grey, which averaged 37% (± 8.7 SE), or *O. tipulae*, which averaged 32% (± 11.4 SE) at the low dosage ($p<0.001$). At the highest dose, red and *O. tipulae* were similarly effective, with red killing approximately 90% of the larvae (± 4.1 SE) and *O. tipulae* killing 88% (± 6.2% SE). Both were more successful than grey, which killed 67% (± 14.8 SE). Approximately 98% of the larvae survived the control treatments. In the realistic screen, where only the high dose was tested, differences were not detected between any of the EPN, although red EPN began inducing mortality on the third day of the trial, whereas *O. tipulae* required at least four days to induce mortality, and the grey EPN seemed to be equally effective on days three through five. Red killed on average 80% of the larvae (± 6.2 SE), grey killed on average 73% of the larvae (± 4.3 SE)

Pupal infections were sporadic for all EPN lines. Red infected 20% of the pupae at the high dose, and approximately 13% at the moderate dose. Tan infected 20% of the pupae at the moderate dose, and 14% at the high dose. Grey infected none of the pupae at any dose. Although it is unlikely that these EPN would be applied to target pupae in the field, it is worth noting that there is a chance that larvae that survive exposure may be infected as they progress into the pupal stage.

The species identifications of the bacteria extracted from the EPN are forthcoming. Although the identities of the bacteria remain unknown, it is worth noting that the red nematodes, which have the highest mortality rates at low doses, contain about five colony-forming units of bacteria per nematode, whereas *O. tipulae* had only two and the grey nematodes had approximately one per nematode. This finding suggests the amount of bacteria per nematode may make the nematode more lethal. The validity of this "payload hypothesis" will depend in part on whether or not the microbes are in fact species shown to be pathogenic towards insects.

Overall, the red EPN appears to show the greatest amount of potential for biological control purposes. It has high mortality even when EPN numbers are low, and it can kill hosts in a more realistic setting. This EPN has killed a cranberry fruitworm larva that was residing inside a hibernaculum, suggesting that "red" might be a double-duty pest control option. In an effort to determine the host range of red, this EPN has been exposed to mealworms, waxworms, and german cockroaches at a rate of 200 EPN /2 ml, and although the infection rates are variable, this EPN can kill juvenile members of each group. Red may therefore be capable of persisting on alternate hosts after it kills off the pest, although these results may suggest red could indiscriminately target hosts, which might lower efficacy if by chance the nematodes encounter other benign insects in the field. Insects that spend extended periods of time underground are most susceptible to EPN attack. Therefore, red-headed flea beetle should be highly susceptible to these nematodes. Red-headed flea beetles were collected last fall, and as soon as their eggs hatch in the spring, tests similar to the ones performed on the fruitworms will be conducted on the beetle larvae. Considering the broad host range of the red nematode, we expect red will be most successful against the flea beetles, and that grey might be the least successful.

In conclusion, it is worth mentioning a few remarkable attributes regarding about the EPN encountered so far in this study. *Oscheius tipulae* was previously thought to invade cadavers killed by other nematodes, and steal resources from the original occupants; however, a growing body of evidence suggests this nematode can kill insects (Torrini et al 2015). For example, a close relative of *O. tipulae* that was recovered from a karstic cave, is capable of killing various Diptera. The study noted that it took over five days for the *Oscheius* nematode to kill a waxworm, which supports observations made in our study. One similarity between our study and the other studies that suggest *Oscheius* nematodes can kill insects is that these studies are all examining areas with low insect abundance, low nutrient levels, and low numbers of other EPN. These environments typically don't support kleptoparasitism, because there aren't enough nutrients to support diverse nematode communities, or the energy-intensive positions high up on the food chain. We therefore suggest that *Oscheius tipulae* is a facultative kleptoparasite, that will steal cadavers when dead cadavers are present, but when cadavers are scarce, it is capable of securing its own insect hosts. Plans to address this hypothesis in the upcoming field season are in progress.

Another strange component of this study is that the grey EPN actually did better in the realistic screening process than in the sterile conditions. Morphological attributes may be responsible for this difference, or perhaps this EPN is exploiting some component of the more detailed terrain. It is also possible that the host behaves differently in a more realistic setting, which might give grey an unexpected advantage. As shown in Figure 1, grey has a larger cuticle than the other nematodes, perhaps enabling it to traverse rugged terrain better than the other two nematodes.

References:

Booth SR, Tanigoshi LK, and Shanks, CH Jr. 2002. Evaluation of Entomopathogenic Nematodes to Manage Root Weevil Larvae in Washington State Cranberry, Strawberry, and Red Raspberry. Environmental Entomology 31(5): 895-902.

Grewal PS, Lewis EE, Gaugler R, and Campbell JF. 1994. Host finding behavior as a predictor of foraging strategy in entomopathogenic nematodes. Parasitology 108: 207-21.

Kaya HK, and Gaugler R. 1993. Entomopathogenic Nematodes. Annu. Rev. Entomol. 38: 181-20.

Kaya HK, and Lacey L. 2007. Field Manual of Techniques in Invertebrate Pathology: Application and Evaluation of Pathogens for Control of Insects and other Invertebrate Pests, Edition 2. Springer Science & Business Media.

Lynch LD, and Thomas MB. 2000. Non target effects in the biocontrol of insects with insects, nematodes and microbial agents: the evidence. Biocontrol News and Information 21: 117-130.

Torrini G, Mazza G, Carletti B, Benvenuti C, Roversi PF, Fanelli E, De Luca F, Trocoli A, and Tarasco E. 2015. Oscheius onirici sp. n. (Nematoda: Rhabditidae): a new entomopathogenic nematode from an Italian cave. Zootaxa 3937: 110-119.

ROOT GROWTH PATTERNS IN CRANBERRIES

AMAYA ATUCHA and BETH WORKMASTER

Department of Horticulture, University of Wisconsin, Madison

Root systems of plants present two primary functions: uptake of water and nutrients, and anchorage. However, secondary functions such as storage, production of growth regulators, interaction with soil microorganisms, and propagation can have a significant impact on the plant's performance. Some of these functions are linked to differences in root morphology and anatomy, which is why using branching order of roots as a way to understand how root processes affect the entire plant can be a very powerful approach.

Root branching systems refer to the most distal root tips as first-order roots, which are the newest roots and the most rapidly cycling portion of the root system. First order roots are thinner, have a higher content of nitrogen, and higher respiration rates than higher order roots, all of which imply that first order roots are more active in nutrient uptake than higher order roots (Pregitzer et al., 1998, 2002; Pregitzer, 2002). Moreover, studies in trees have shown that mycorrhizal associations, which are responsible for higher water and nutrient absorption, are more common in first order roots than in higher order roots (Peterson et al, 1999; Brundrett, 2002, Guo et al. 2008). On the contrary, second and higher order roots present secondary development, which is characterized by an increase in root diameter and the presence of new layers of tissue which act as a barrier to water and nutrient absorption (Peterson et al., 1999; Taylor & Peterson, 2000). Hence, secondary development present in second and higher order roots, represent a change of root function from absorption to transport (Wells & Eissenstat, 2003).

Timing of root growth is of foremost importance to adjust and target production practices (e.g., irrigation, fertilization, agrochemical applications, disease control, etc.) to periods of active root growth, when uptake rates are highest. Early studies of root growth in fruit crops led to the generalization that roots grow in a bimodal pattern, with root flushes typically occur in spring around bloom time and in the fall after harvest. However, new techniques developed for studying *in situ* seasonal root growth patterns have shown there is a great variability on the timing of root flushes from one year to the next (Eissenstat et al., 2006).

The main objective of this study is to characterize cranberry root growth dynamics and root morphological traits, and develop a root phenology model to increase production efficiency and sustainability.

Methods

The study was established at two marshes in the Tomah-Camp Douglas area. In each marsh 2 bed of 'Stevens' and 2 beds of 'GH1' were selected, and four minirhizotron tubes were installed in each bed in a diagonal transect along its length, for a total of 16 tubes at each marsh. Root images data was recorded from April 2015 to January 2016, using an I-CAP video minirhizotron system (Bartz Technology Inc., Santa Barbara, Calif.). Data analysis was

performed using WinRhizotron software (Regent Instruments, Quebec, Canada) and JMP statistical software (SAS Institute Inc., Cary, N.C.).

Results and Discussion

New root production started in May 2015 for both cultivars and continued until January 2016 (Fig 1.). During the spring months of May and June, new root production accounted for 4% of the total new root production of the year. A significant increase in root production was observed after bloom (beginning of July), with a peak in late September for GH1 and 1st week of October for Stevens. Root production during the 1st week of July (post-bloom) and the 1st week of October (harvest) accounted for 80% of the new root production of the year. Post harvest root production was not negligible and accounted for 16% of the total root production of the year. Even though these results represent only one year of data, it is important to highlight that new root production in cranberries occurred primarily between fruit set and harvest, which means the initial stages of upright growth, bloom, and fruit set are mainly supported by reserves.

Median lifespan of cranberry root was 40.5 days when data from both cultivars was pooled together (Fig. 2). Based on survival probability analysis, 75% of roots in cranberry died within 77.5 days after appearance. Valenzuela-Estrada et al. (2008) reported that medium root lifespan for other *Vaccinium* species ranged between 115-155 days. It is possible that practices such as flooding during harvest time could shorten lifespan of cranberry roots, however we have no data to support this hypothesis.

Root production by root order was not significantly different between Stevens and GH1 (p>0.05) (Fig. 3). First order roots accounted for 90% and 85% of the total root production for GH1 and Stevens, respectively. Second order roots accounted for 9% and 12% of the total root production for GH1 and Stevens, respectively. Finally, 3rd order roots production accounted 1% and 3% of the total root production for GH1 and Stevens, respectively. Root diameter was significantly different among root orders (p<.0001)(Fig. 4). Average root diameters were 0.23, 0.35 and 0.54 mm for 1st, 2nd, and 3rd order roots respectively.

Cranberry root production concentrated mostly in the top 5 cm of soil (Fig. 5). In GH1, 75% of all new roots produced during 2015 were located in the top 5.5 cm of soil, while for Stevens 75% of all new roots produces during 2015 were located within the top 3.5 cm of soil (p<0.0001).

Conclusions

During this first season of data collection, we observed a first flush of root production right after fruit set, and new root production continued until January probably due to the mild fall we experienced in 2015. The highest rate of root production happened during the month of September, which corresponds to the cessation of vegetative growth on the above ground portion of the plants. After this final root flush, roots were still active until January, which might suggest that more attention should be paid to soil moisture levels during fall given that roots are still up taking water and nutrients.

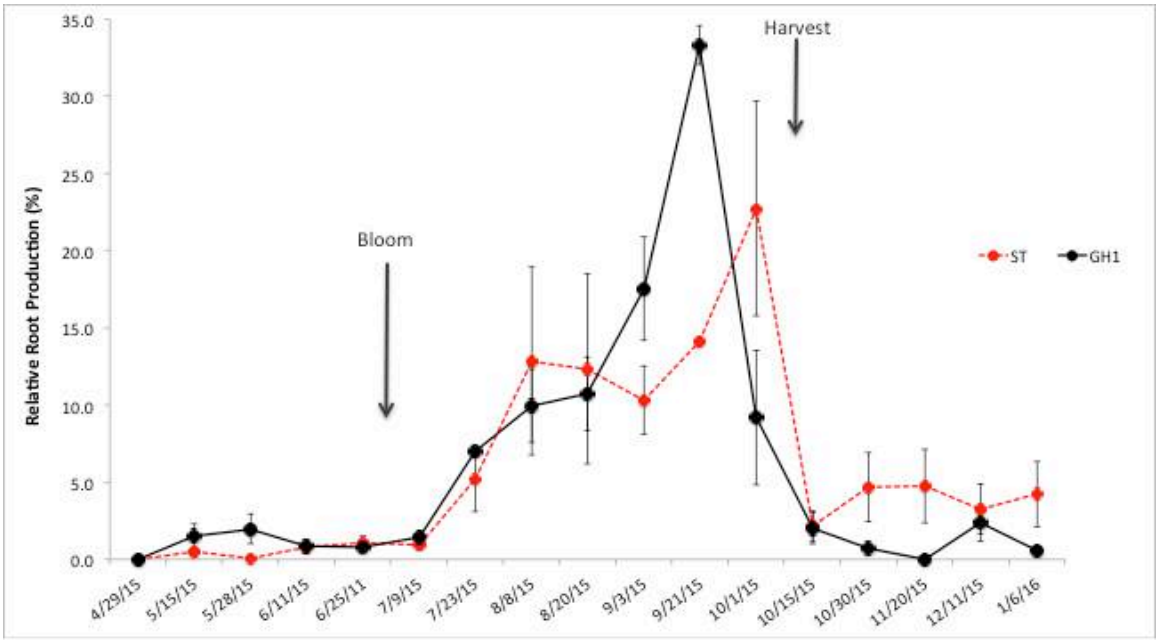


Figure 1. Cranberry root production (%) relative to total new root production during 2015 for 'Stevens' (ST) and GH1 varieties.

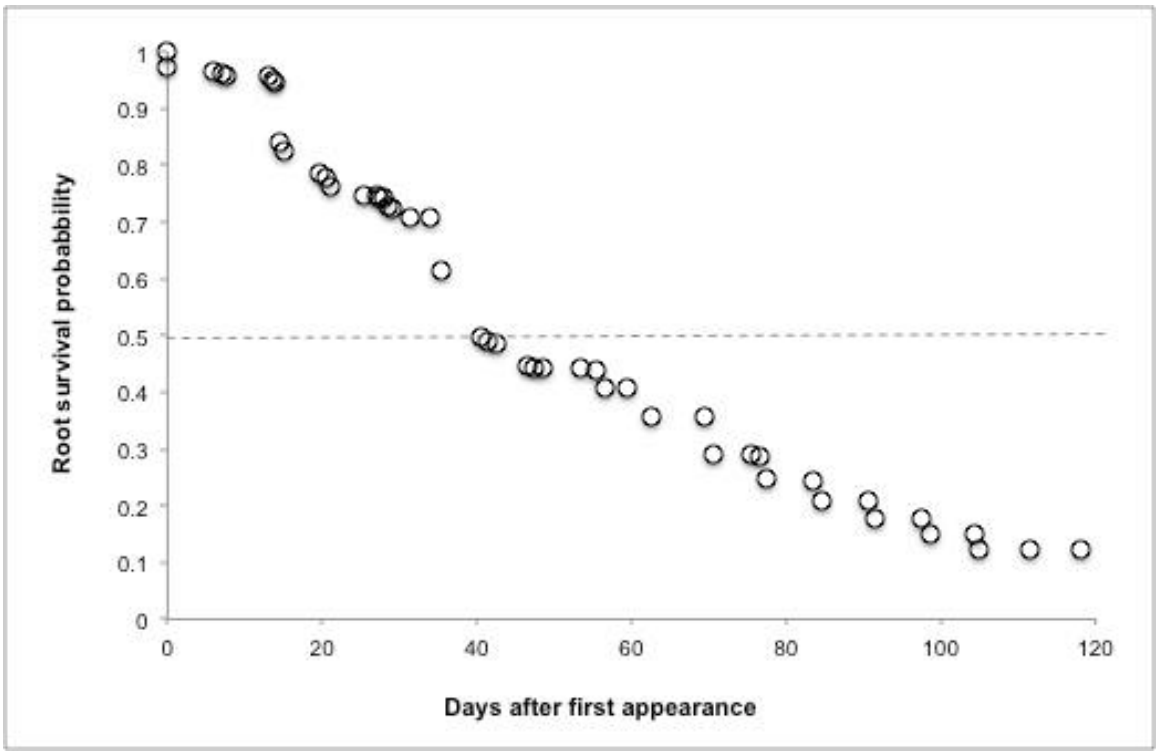


Figure 2. Cranberry root survival probability for all new roots observed during 2015.

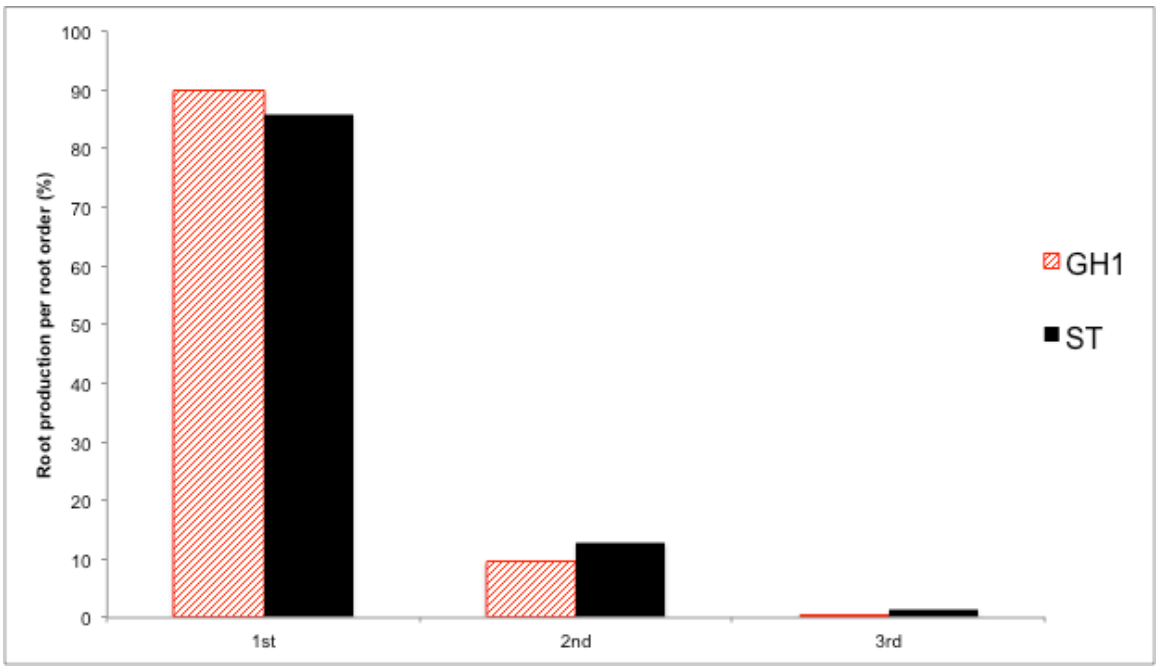


Figure 3. Cranberry root production (%) per root order relative to total new root production during 2015 for 'Stevens' (ST) and GH1 varieties.

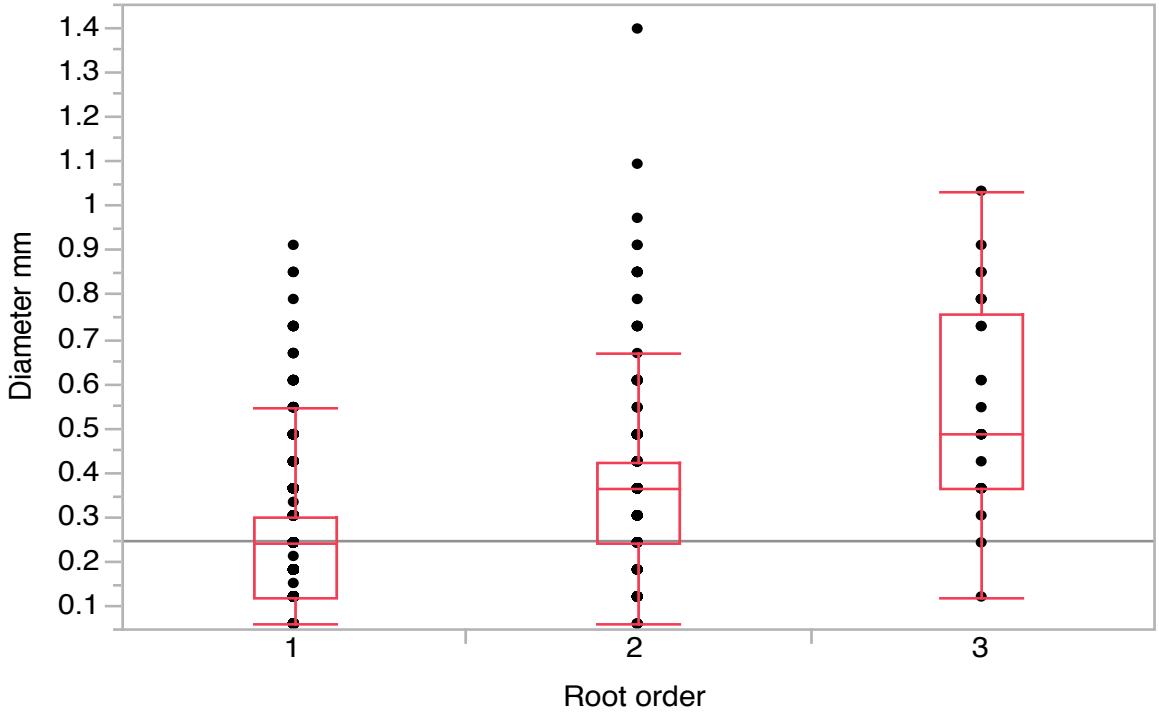


Figure 4. Average root diameter (mm) per root order for cranberry roots. First, second, and third order cranberry roots had an average diameter at birth of 0.23 mm, 0.35, and 0.54 mm respectively.

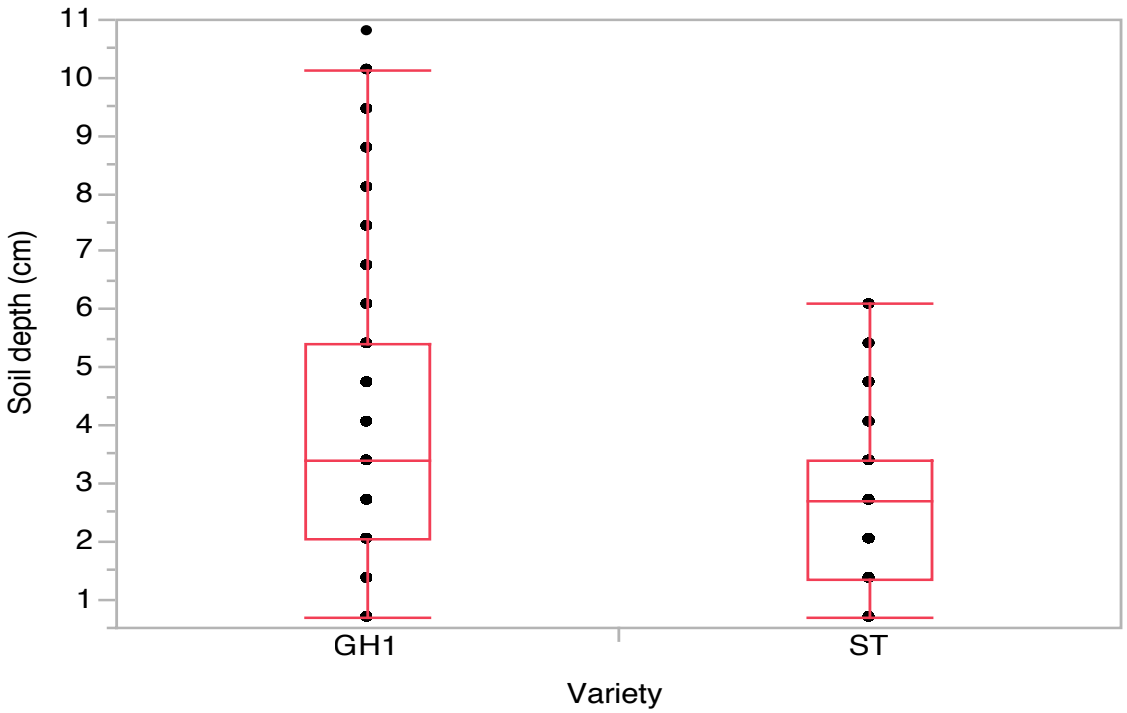


Figure 5. Root distribution in the soil profile (cm) for new roots of 'Stevens' (ST) and GH1 varieties. Cranberry roots of GH1 variety presented 75% of new roots in the first 5.5 cm of soil, while 75% of new root production in Stevens was concentrated in the first 3.5 cm of soil.

Literature

Brundrett MC. 2002. Coevolution of roots and mycorrhizas of land plants. New Phytologist 154: 275–304.

Eissenstat, D.M., A.N. Lakso, D. Neilsen, D.R. Smart, T.L. Bauerle, L.H. Comas, and G.H. Neilsen. 2006. Seasonal patterns of root growth in relation to shoot phenology in grape and apple In: Retamales, J.B., Lobos, G.A. Acta Horticulturae 721. Proceedings of the Fifth International Symposium on Mineral Nutrition of Fruit Plants, pp. 21-26

Guo, D., Xia, M., Wei, X., Chang, W., Liu, Y. and Wang, Z. (2008), Anatomical traits associated with absorption and mycorrhizal colonization are linked to root branch order in twenty-three Chinese temperate tree species. New Phytologist, 180: 673–683.

Peterson CA, Enstone DE, Taylor JH. 1999. Pine root structure and its potential significance for root function. Plant and Soil 217: 205–213.

Pregitzer KS, Laskowski MJ, Burton AJ, Lessard VC, Zak DR. 1998. Variation in sugar maple root respiration with root diameter and soil depth. Tree Physiology 18: 665–670.

Pregitzer KS. 2002. The fine roots of trees – a new perspective. New Phytologist 156: 267–270.

Pregitzer KS, Deforest JL, Burton AJ, Allen MF, Ruess RW, Hendrick RL. 2002. Fine root architecture of nine North American trees. Ecological Monographs 72: 293–309.

Taylor JH, Peterson PA. 2000. Morphometric analysis of *Pinus banksiana Lamb*. root anatomy during a 3-month field study. Trees-Structure and Function 14: 239–247.

Valenzuela-Estrada, LR; Vera-Caraballo, V; Ruth, LE and Eissenstat, DM. 2008. Root anatomy, morphology, and longevity among root orders in Vaccinium corymbosum (Ericaceae). American Journal of Botany 95(12): 1506-1514.

Wells CE, Glenn DM, Eissenstat DM. 2002. Changes in the risk of fine-root mortality with age: a case study in peach, Prunus persica (Rosaceae). American Journal of Botany 89: 79–87

Our cranberry toolbox – Present and future of the cranberry screening program

JACK PERRY[1], JED COLQUHOUN[1], PATRICIA McMANUS[2], and CHRISTELLE GUÉDOT[3]

[1]Department of Horticulture, [2]Department of Plant Pathology, [3]Department of Entomology

University of Wisconsin-Madison

The spring 2015 weather was somewhat typical. April weather was rather normal - warming temperatures and ample, periodic rains. However May was cooler than normal and with more rain than average. The remainder of the growing season was as expected although the summer overall was cool – there were only a few days in which the daily high temperature exceeded 90 F. As a result of these growing conditions and diligent pest control efforts by growers, testable infestations of insects and diseases were sometimes difficult to source.

For selected graphs in this text, the following performance rating scale parameters are used to evaluate the efficacies of fungicide, insecticide and herbicide products/treatments.
"-" inadequate control; "+" - 70 – 79 % control; "++" - 80 – 89% control; "+++" + 90 control

Fungicide Efficacy Trials: The 2015 fungicide trial objectives were to: 1) Evaluate registered and four candidate fungicides for early rot, fruit rot and cottonball management; 2) Evaluate the number of fungicide applications required for acceptable disease maintenance. Evaluated products included Bravo, Evito, Dithane, Indar, Abound, Proline, Tavano, Oso, Regalia, Orbit/Tilt and four experimental fungicides. Seven fungicide trials were conducted – three for cottonball disease, two for fruit rot and two for early rot. Twelve products, thirteen treatments and two applications/treatment was the standard testing format. Application schedules were: (two applications/schedule) - early rot - 50% bloom + 10 days; fruit rot - late bloom /early fruit set + 10 days; cottonball - 10% and 50% bloom. Two of the cottonball trials had testable disease pressure, two of the trials had good fruit rot pressure and one of the early rot trials had testable disease pressure. Early rot is a disease primarily in one to four year old new plantings. Since there have been relatively few new plantings of early rot susceptible varieties in Wisconsin in recent years this disease complex has become less prevalent. Most growers typically apply one or two fungicide maintenance applications - this diligence on their part combined with less-than-conducive weather conditions have resulted in fewer disease testing opportunities. Two recently registered bio-fungicides, Tavano/Oso (Certis) and Regalia (Marrone), and the conventional fungicide Proline (Bayer) were the targeted products. Standard commercial fungicides were included for comparison.

Table 1 Fungicide effectiveness (in 2015 and in a historical perspective) for Diseases Control

	Early Rot	Fruit Rot	Cottonball
Bravo	++	++	-
Dithane	+	++	-
Abound	++	++	++
Indar	+++	+	+++
Abound + Indar	+++	+++	+++
Proline	+++	+++	+++
Evito	++	++	+++
Tavano/Oso	???	++	+
Regalia	+	+	+

Tilt/Orbit	-	-	+++
Experimental #1	+++	+++	+++
Experimental #2	+++	+++	+++

(Tested rates/acre - Bravo WeatherStik 6SC 6.6 pt , Dithane 75DF 6 lb, Abound 2.08SC 15.5 oz, Indar 2F 12 oz, Abound 15.5 oz, Indar 12 oz Abound + Indar 8 oz + 6 oz, Proline 4SC 5.7 oz, Evito 4SC 5.7 oz, Tavano/Oso 5%SC 6.5 oz, Regalia 5%EC 32 oz, Tilt/Orbit 3.6EC 6 oz)

For cottonball control Tilt/Orbit, Indar, Indar + Abound, Evito, Proline and two of the candidate fungicides were highly efficacious. Tavano, Regalia and one of the candidate fungicides did not provide acceptable cottonball control.
For fruit rot control, Indar + Abound and Proline provided stellar disease control. Bravo, Dithane, Abound and Evito provided acceptable control. Tavano and Regalia were moderately effective.

Reducing fungicide applications to save $$ Due to the current depressed economics of cranberry production and the relative light disease pressures there is consideration to reduce the number of fungicide applications to save costs. To address this concern three trials were conducted in 2015. Treatments in these trials consisted of two applications vs one application vs no applications of Bravo, Abound + Indar (1/2 rates), Proline and Regalia were the tested products/treatments.

Table 2 Efficacy of Number of Applications Treatments

	% Control Fruit Rot 2 Applications	**% Control Fruit Rot 1 Application**	**% Fruit Rot 0 Application**
Bravo	90.3	88.7	21.3
Proline	94.4	92.2	21.6
Abound + Indar	93.7	91.8	18.9
Regalia	82.5	73.3	23.2

In this objective, four fruit rot trials had moderate, testable disease pressures. In these trials the disease controls provided by one application of Bravo, Proline and Abound + Indar were not significantly different from those provided by two applications of the respective products. Regalia required two applications for acceptable disease control.

2016 Fungicide Objectives: The 2016 objectives are threefold – 1) continue to monitor disease control performance of registered and candidate products, 2) investigate the potential for using less fungicide through reduced rates and/or reduced application schedules and 3) test the value of adding surfactants to fungicides. With these results we should be able to develop disease control programs that are not reliant on Bravo (potential to be banned by European Union) and programs that decrease the risk of fungicide resistance.

Insecticide Efficacy Trials: The objectives of the 2015 insecticide trials were to: 1) Evaluate registered and four candidate insecticides for the control of our main insect pests; 2) Evaluate foliar vs. soil applications of insecticides against flea beetle. Fifteen insecticide trials were conducted targeting seven insect pests: tipworm, cranberry fruitworm, sparganothis fruitworm, span worm, blackheaded fireworm, flea beetle, and leaf hopper. Sixteen products, twenty treatments and one to two (pest dependent) applications/treatment was the standard testing format. All of the trials had testable insect pressures. Two recently registered bio-insecticides, Grandevo and Venerate (Marrone), and two recently registered

conventional products, Closer and Venom, were the targeted products. Standard commercial insecticides were included for comparison.

Table 3 Insecticide Effectiveness (in 2015 and in a historical perspective) for Insect Control

	Tip Worm	Cranberry Fruitworm	Sparg fruitworm	Span worm	Fire Worm	Leaf Hopper	Flea Beetle
Grandevo	--	++	++	++	+	--	--
Venerate	--	++	++	++	+	--	--
Venom	--	+	+	+	+	++	+++
Closer	--	--	--	--	--	--	+
Altacor	++	+++	+++	++	+++	+++	+++
Assail	+	+++	++	+++	++	+	+++
Belay	++	+++	++	+++	++	+	+++
Delegate	--	+++	+++	+++	++	--	--
Diazinon	+	++	+	++	++	++	+++
Imidan	+	++	+	++	++	++	+++
Intrepid	--	+++	++	+++	+	--	--
Lorsban	++	++	++	++	++	++	++

(Tested rates - Grandevo 30G 3 lb, Venerate 94L 8 qt, Venom 70SG 4 oz, Closer 2.2SC 5.7 oz, Altacor 35WG 4.5 oz, Assail 30SG 6.9 oz, Belay 2.1SC 4 oz, Delegate 25WG 6 oz, Diazinon 4EC 3 qt, Imidan 70WP 4 lb, Intrepid 2F 16 oz, Lorsban 4E 3 pt)

Altacor was highly effective for the control of all tested insect pests. Belay, Assail, Imidan and Diazinon were also effective across-the-board. Most of the worm-specific products, Intrepid, Delegate, Confirm, Venerate and Grandevo were efficacious for the control of fruitworms, blackheaded fireworms and loopers. Neither, Closer nor Venom provided commercially acceptable insect control. Three of the four candidate insecticides demonstrated good control efficacy on all pest insects.

Flea Beetles Flea beetles are a recent pest control challenge that has received considerable concern from growers and crop consultants. Although flea beetles rarely cause economic losses, they are easily controlled with a number of registered foliar-applied insecticides (Table 4). Are we going to have to learn to live with them? Yes, probably. Why are they a "new" problem? The reduced use of organo-phosphate insecticides and milder winter are contributing factors to enhanced flea beetle populations. Flea beetles are easily controlled with insecticides.

Table 4 Effectiveness of foliar-applied insecticides (2015 and historical perspective) for flea beetle control

Product	Flea Beetle Control
Actara	+++
Assail	+++
Belay	+++
Lorsban	++
Diazinon	+++
Imidan	+++
Altacor	+++
Orthene	++
Sevin	++
Delegate	++
Confirm	--
Intrepid	--

A project was conducted to investigate the potential for watered-in soil incorporation of insecticides for the control of the soil phase (larvae) flea beetles.

Table 5 Effectiveness of soil-applied vs foliar-applied insecticides (2014 and 2015) for flea beetle control

Treatment	% CONTROL
Altacor 4.5 oz Pre Bloom Soil	9
Altacor 4.5 oz Post Bloom Soil	10
Altacor 4.5 oz Foliar	94
Belay 12 oz Pre Bloom Soil	7
Belay 12 oz Post Bloom Soil	88
Belay 4 oz Foliar	92
Assail 5.3 oz Pre Bloom Soil	18
Assail 5.3 oz Post Bloom Soil	68
Assail 5.3 oz Foliar	89

Neither pre-bloom soil applications of labeled rates of Altacor, Belay and Assail nor post-bloom soil applications of Altacor or Assail were adequately effective for the later-season flea beetle adult control (Table 5). Although a post-bloom soil application of an accelerated, high rate (12 oz/a) of Belay did provide excellent control, this treatment is likely cost prohibitive. It should be noted that both Belay and Assail are on most handlers' "Do Not Use" lists because of the potential threat to bees. Foliar applications of all three products effectively controlled flea beetle adults in this trial.

2016 Insecticide Objectives: For 2016 the objectives are twofold – 1) continue to monitor the insect control performances of registered and candidate products, and 2) assess the value of adding surfactants to insecticides.

Herbicide Efficacy Trials: Wisconsin cranberry marshes are becoming more and more weed free. There are still some areas with weed problems but the opportunities to find sites with weed infestations in large enough patches for trials are getting difficult to find due to the effectiveness of registered tools. The objectives of the 2015 herbicide testing program were threefold: 1) Target weeds that are escaping our current herbicide arsenal. Of primary interest are maples, leatherleaf, northern St Johnswort and dewberry. 2) Continue to evaluate and display the benefits of using alternative herbicide types to prevent the development of weed resistance via commercial production systems. 3) Evaluate candidate herbicides for potential uses in cranberries.
Ten herbicide trials were conducted in 2015. After years of failed attempts we may have found a solution to controlling maples and leatherleaf. Glyphosate products applied via wick wipers control maples but the kill-time is slow. Glyphosate has not been effective in the control of leatherleaf. Combinations of glyphosate with other products, labeled and not labeled for uses in cranberries, have not been particularly encouraging. In 2014 and 2015 two trials were conducted using glyphosate plus companion products and/or experimental surfactant systems. The results of combining glyphosate with a silicone surfactant provided good, rapid control of maples and leatherleaf. Effective control of northern St Johnswort and dewberry continue to be elusive. Both weeds were controlled with the glyphosate plus a silicone surfactant. However because of the low growing stature of these weeds it is difficult to apply to the weeds and avoid contact with the cranberries*. Keep in mind that many glyphosate labels do not allow a surfactant to be added to a wiper application – read and follow the label of the product you're using!!*

Future for Cranberry Pesticides & Cranberry Pesticides at Risk
In registration process are 3 new insecticides, 3 new herbicides and 5 new fungicides.
Of the pesticides registered for uses in cranberries the following are at risk for registration uses.

Table 6 Cranberry Pesticides at Risk

Bravo	Export residues
Evito	Export residues
Proline	Export residues
QuinStar	Export residues
Belay	Threat to bees
Assail	Threat to bees
OP Insecticides	Threat to the environment

Spray Adjuvants & Surfactants An adjuvant is any non-pesticide material added to a pesticide spray mixture to enhance the pesticide's performance. Examples of adjuvants include surfactants, oils, compatibility agents, buffering and conditioning agents, de-foaming agents, deposition agents, drift control agents, and thickeners. Adjuvants are designed to perform specific functions, including buffering, dispersing, emulsifying, spreading, sticking, and wetting. Adjuvants also can reduce

evaporation, foaming, spray drift, and volatilization. Because adjuvants have no pesticidal properties, they are not required to be registered by the Environmental Protection Agency.

Surfactants are specialized adjuvants that are stickers and spreaders = wetting agents. They wet the foliage, spread out evenly and stick the herbicide to the leaf. *Caution*: too much surfactant can cause excessive runoff. Types of surfactants are 1) non-ionic surfactants (NIS), 2) crop oil concentrates (COC), 3) vegetable oil concentrates (VOC) crop derived seed oil and 4) silicone surfactants.
Cranberry herbicides that benefit from a surfactant are Callisto, Poast, QuinStar, Select Max and some glyphosate products. The allowable type of surfactant is listed on each product label. Yet to be determined, there may be some benefits to using surfactants with some insecticides and some fungicides.

2016 CRANBERRY SCHOOL GROWER SURVEY RESULTS

[1]CHRISTELLE GUÉDOT and [2]MATT LIPPERT

[1]Department of Entomology, University of Wisconsin, Madison
[2]University of Wisconsin-Extension, Wood County, Wisconsin Rapids

Results of the live survey of growers present in the room at the 2016 Cranberry School are presented below. The survey was conducted using Turning Point 5 (Turning Technologies, LLC) software and clicker hardware. Growers were provided with clickers to allow for live anonymous responses to be collected. Questions were displayed on screens and respondents were allowed to select answers. After all responses were collected, the polling was closed, and the results of the survey were displayed on the screens. The "count" column indicates the number of growers that responded and the "percent" column indicates the % of respondents. Thank you for participating!

1) How often do you typically flood your beds for cold protection in the fall before you make ice?

		Responses	
		percent	count
1-2		97%	65
3-4		3%	2
>4		0%	0
	Totals	100%	67

2) Do you think you had yield reduction in the 2015 harvest due to cold damage during fall of 2014?

		Responses	
		percent	count
Yes		37%	28
No		63%	47
	Totals	100%	75

3) At what plant stage do you apply the first doses of fertilizer during the season?

		Responses	
		percent	count
Before bud break		25%	17
Rough neck		46%	31
Full bloom		28%	19
After fruit set		1%	1
Pea size fruit		0%	0
	Totals	100%	68

4) At what location(s)do you primarily monitor marsh temperatures?

	Responses	
	percent	count
By my house	11%	13
On the dike	5%	6
At canopy level, middle of the bed	28%	32
At canopy level, by the edge of the bed	55%	64
At the reservoir	1%	1
Totals	100%	116

5) I would consider cycling sprinkle irrigation on and off during frost protection as a way to save fuel and money.

	Responses	
	percent	count
Yes	46%	34
No	54%	40
Totals	100%	74

6) I track growing degree days with the temperature data from my own weather station/thermometers.

	Responses	
	percent	count
Yes	29%	21
No	71%	52
Totals	100%	73

7) I gauge how hardy buds are after ice-off in the spring by the color of the plant's leaves.

	Responses	
	percent	count
Yes	27%	20
No	73%	53
Totals	100%	73

8) On our marsh a second flush of bud break and bloom in August is:

	Responses	
	percent	count
Minimal	96%	74
Moderate	4%	3
Common	0%	0
Totals	100%	77

9) Do you use a method of yield prediction?

	Responses	
	percent	count
No	17%	13
Yes, based on visual assessment of my bed	61%	46
Yes, based on bud count per square area	20%	15
Yes, based on bud count and bud size per square area	3%	2
Totals	100%	76

10) If yes to the previous question. When do you use this method?

	Responses	
	percent	count
Fall	40%	24
Spring before bud break	28%	17
Spring at Bloom	32%	19
Totals	100%	60

11) Have you ever noticed bees foraging less on cranberry following the application of:

	Responses	
	percent	count
A fungicide	2%	1
A fertilizer	2%	1
An insecticide	41%	19
More than one of the above	54%	25
Totals	100%	46

12) Have you used the fungicide Proline (prothioconazole)?

	Responses	
	percent	count
Yes, good results	27%	18
Yes, fair to poor results	6%	4
No, have not used it.	67%	45
Totals	100%	67

13) Do you use fungicides on new plantings to prevent leaf drop from early rot and establishment of other fruit rot pathogens?

	Responses	
	percent	count
Yes, always	26%	19
Yes, but only on certain varieties	19%	14
No	55%	40
Totals	100%	73

14) Do you cut back on fungicides after the bed fills in?

	Responses	
	percent	count
Yes, we stop treating after about 3-4 years	18%	13
Yes, we cut back after about 3-4 years, but we are afraid to not spray at all	13%	9
No, we treat established beds the same as new beds	28%	20
No fungicides used	41%	29
Totals	100%	71

15) If you have used chlorothalonil (Bravo, Echo, Equus) have you seen crop injury (e.g. flower burning, red flecks on fruit) associated with its use?

		Responses	
		percent	count
Yes, we use it and have seen injury at least in some years		24%	17
We use it but, no, we don't see injury		24%	17
We don't use it		53%	38
	Totals	100%	72

16) Are you confident that you can identify berry scarring associated with viruses?

		Responses	
		percent	count
Yes		38%	27
No		63%	45
	Totals	100%	72

17) You've heard all about TSV and blueberry shock viruses. But have you had blueberry scorch virus confirmed in samples from your marsh?

		Responses	
		percent	count
Yes		1%	1
No, and we did have samples tested		6%	4
Had samples tested, don't remember		6%	4
No, but we did not have samples tested		87%	61
	Totals	100%	70

18) We have seen the fungal disease red shoot on our marsh

		Responses	
		percent	count
Yes		5%	4
We have seen abnormal "red shoots" but not sure if this disease or not		49%	38
No		46%	36
	Totals	100%	78

19) Do you know what FRAC and IRAC codes are on pesticide labels?

		Responses	
		percent	count
Yes		19%	13
No		81%	57
	Totals	100%	70

20) How would you rate your farm safety program?

		Responses	
		percent	count
Very good		34%	22
Good		35%	23
Needs work		22%	14
What safety program?		9%	6
	Totals	100%	65

21) Which topic is the biggest safety concern for you?

	Responses	
	percent	count
Tractors/ Equipment	31%	22
Safety in the shop	18%	13
Chemicals	24%	17
Personal Protective Equipment	21%	15
Other	6%	4
Totals	100%	71

22) Do you have the required written safety policies and posters?

	Responses	
	percent	count
Yes	78%	57
Some	19%	14
What required safety policies and posters?	3%	2
Totals	100%	73

23) What topic(s) would you like more information about?

	Responses	
	percent	count
Lock out/ Tag out	21%	20
Hazardous chemical and spills	49%	47
Basic electrical safety	19%	18
Exits and emergencies	11%	11
Totals	100%	96

24) Of these weeds below, which is your worst enemy?

	Responses	
	percent	count
Northern St. Johnswort	22%	17
Dewberry	24%	18
Those darn trees (maples, willows, etc.)	37%	28
Perennial grasses	13%	10
How dare you ask- I don't have weeds!	4%	3
Totals	100%	76

25) Do you feel that your weed pressure impacts cranberry yield?

	Responses	
	percent	count
No impact	17%	13
Yes, by 10% or less	70%	53
Yes, by 11 to 25%	9%	7
Yes, by greater than 25%	4%	3
Totals	100%	76

26) For your weed control program in 2015, did you:

	Responses	
	percent	count
Use pre-emergent herbicides only	3%	2
Use post-emergent herbicides only	8%	6
Use pre- and post-emergent herbicides	87%	67
I didn't use any herbicides	3%	2
Totals	100%	77

27) Do you feel that having more relatively new herbicides, such as Callisto and QuinStar, impacted the amount of herbicide you use?

	Responses	
	percent	count
I use less herbicide now than in the past	45%	35
I use more herbicide now than in the past	13%	10
I'm not sure it depends on the year	42%	33
Totals	100%	78

28) When considering surfactants with your pesticides:

	Responses	
	percent	count
I use the same surfactant product every year, if possible	46%	33
I use whatever the dealer delivers with the pesticide	46%	33
I'm not concerned about which surfactant brand I use	8%	6
Totals	100%	72

29) Are you concerned about the development of herbicide-resistant weeds on your marsh?

	Responses	
	percent	count
Very concerned	27%	19
Somewhat concerned	63%	45
Not at all concerned	10%	7
Totals	100%	71

30) Weedar 64 herbicide is not currently registered in Wisconsin cranberries. If the Weedar 64 Special Local Needs label for wiper applications was made available again in Wisconsin, would you use it?

	Responses	
	percent	count
Yes, most definitely	38%	29
Maybe	49%	37
No	13%	10
Totals	100%	76

31) Do you wick-wipe weeds with glyphosate?

	Responses	
	percent	count
Yes, every year	75%	59
Yes, but not every year	16%	13
No, we don't wick-wipe weeds	9%	7
Totals	100%	79

32) Which of the following best describes how you keep track of degree-days?

	Responses	
	percent	count
Yes, at my own marsh	24%	18
Yes, using a local weather station	11%	8
Yes, using resources from the USDA Cranberry Entomology Lab.	24%	18
I don't keep track of degree days.	39%	29
What are degree-days?	3%	2
Totals	100%	75

33) Rate your understanding of degree-day models:

	Responses	
	percent	count
I feel competent in using them	23%	17
I need some clarification to use them most effectively	49%	36
Unsure how to use	14%	10
What are degree day models?	0%	0
No interest in using degree day models	15%	11
Totals	100%	74

34) The most economically important insect pest on your marsh in 2015 was:

	Responses	
	percent	count
Sparg.	14%	11
Cranberry fruitworm	53%	41
Black-headed fireworm	6%	5
Red-headed flea beetle	10%	8
Cranberry girdler	1%	1
Tipworm	13%	10
Other pest species	3%	2
Totals	100%	78

35) What was the main yield reducing pest of the 2015 crop?

	Responses	
	percent	count
Insects	27%	19
Disease/Rot	20%	14
Weeds	13%	9
More than one of the above	41%	29
Totals	100%	71

36) Was your crop in 2015:

	Responses	
	percent	count
Up from 2014	36%	28
Down from 2014	46%	36
Similar to 2014	18%	14
Totals	100%	78

37) In 2015 we reduced these inputs:

	Responses	
	percent	count
We didn't	43%	49
Number of bee hives	10%	11
Labor	17%	20
Fertilizers	10%	12
Herbicides	9%	10
Fungicides	5%	6
Insecticides	6%	7
Totals	100%	115

38) Was your insect pressure in 2015:

	Responses	
	percent	count
Up from 2014	9%	7
Down from 2014	22%	16
Similar to 2014	69%	51
Totals	100%	74

39) How many honeybee hives per acre did you bring in during 2015?

	Responses	
	percent	count
0	6%	4
1-2	38%	27
3	35%	25
4-7	20%	14
8 or more	1%	1
Totals	100%	71

40) How many bumblebee colonies per acre did you bring in during 2015?

	Responses	
	percent	count
0	72%	53
1-2	22%	16
3-5	7%	5
6-8	0%	0
More than 8	0%	0
Totals	100%	74

41) How many insecticide sprays did you apply in the 2015 growing season?

	Responses	
	percent	count
0-1	4%	3
2-3	64%	51
4-5	31%	25
6 or more	1%	1
Totals	100%	80

42) Was your number of insecticide spray in 2015?

	Responses	
	percent	count
Up from 2014	4%	3
Down from 2014	24%	18
Same as 2014	72%	54
Totals	100%	75

43) How much do you spend each year on insecticides per-acre?

	Responses	
	percent	count
$0-40/acre	9%	4
$41-80/acre	23%	11
$81-120/acre	38%	18
$121-160/acre	21%	10
$161 or more	9%	4
Totals	100%	47

44) Do you add sugar water to your bee hives to increase cranberry pollination?

	Responses	
	percent	count
Yes	7%	5
No	75%	52
Why would I do this?	6%	4
More research should be conducted before I implement this	12%	8
Totals	100%	69

45) How many sprays were specifically for cranberry fruitworm?

	Responses	
	percent	count
0	9%	6
1	42%	29
2	49%	34
3	0%	0
4 or more	0%	0
Totals	100%	69

46) How many sprays were specifically for sparganothis fruitworm?

	Responses	
	percent	count
0	30%	20
1	42%	28
2	25%	17
3	3%	2
4 or more	0%	0
Totals	100%	67

47) How many sprays were applied specifically for blackheaded fireworm?

	Responses	
	percent	count
0	55%	39
1	42%	30
2	3%	2
3	0%	0
4 or more	0%	0
Totals	100%	71

48) How many sprays were specifically for tipworm?

	Responses	
	percent	count
0	72%	50
1	19%	13
2	7%	5
3	1%	1
4 or more	0%	0
Totals	100%	69

49) How many sprays did you apply last year specifically for flea beetle?

	Responses	
	percent	count
0	55%	41
1	24%	18
2	14%	10
3	7%	5
4	0%	0
Totals	100%	74

50) Are sprays directed at beds or dikes?

	Responses	
	percent	count
Beds	75%	46
Dikes	0%	0
Both	25%	15
Totals	100%	61

51) Were the sprays foliar or soil drench applications?

		Responses	
		percent	count
Foliar		94%	49
Soil drench		0%	0
Both		6%	3
	Totals	100%	52

52) Where do flea beetles spend the winter?

		Responses	
		percent	count
Mostly in the dikes		41%	27
Mostly in the beds		39%	26
Off-marsh sites		20%	13
	Totals	100%	66

53) Do you typically flood in the spring (mid- to late-May) for insect control?

		Responses	
		percent	count
Yes		46%	35
No		54%	41
	Totals	100%	76

54) Are you in favor of a durable, effective pheromone-based disruption system for cranberries?

		Responses	
		percent	count
Yes		58%	43
No		12%	9
I don't know		30%	22
	Totals	100%	74

55) If yes to the previous question what proportion of your annual insect control budget would you be willing to spend on a mating disruption system that reliably controlled cranberry fruitworm and black-headed fire worm?

		Responses	
		percent	count
20%		46%	30
40%		31%	20
80%		9%	6
None of the above		14%	9
	Totals	100%	65

56) What proportion of your insect control budget would you be willing to spend on a mating disruption system that reliably controlled only cranberry fruitworm?

		Responses	
		percent	count
20%		57%	39
40%		22%	15
80%		3%	2
None of the above		18%	12
	Totals	100%	68

57) What % of your insect control budget would you be willing to spend on a mating disruption system that reliably controlled Sparganothis fruitworm?

		Responses	
		percent	count
0%		25%	18
20%		55%	39
40%		7%	5
80%		0%	0
None of the above		13%	9
	Totals	100%	71

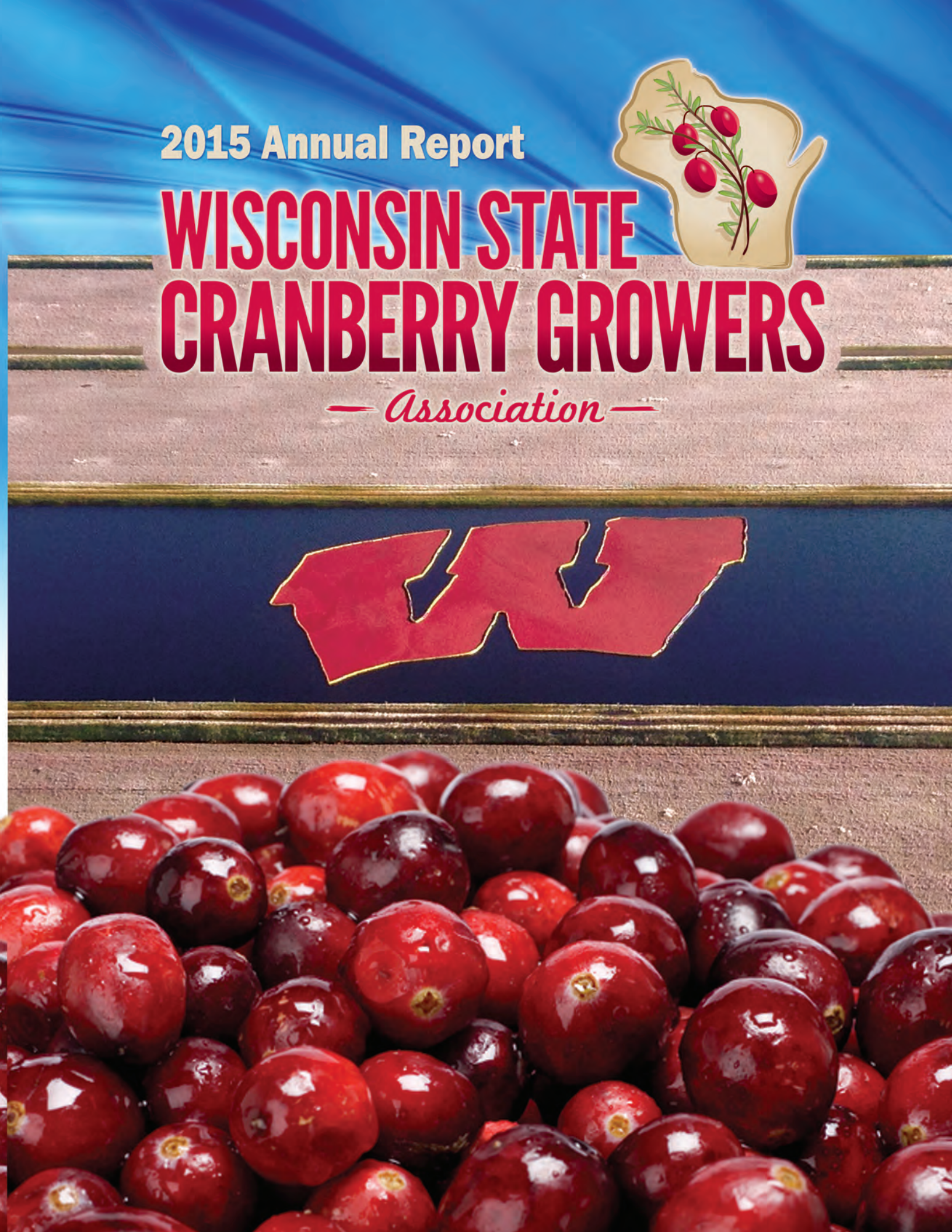
58) Your decision of whether or not to use a late-water spring insect control flood is based mainly on:

		Responses	
		percent	count
Weather forecasts		23%	17
Water availability on the marsh		21%	15
Pest insect densities		14%	10
Other factors		42%	31
	Totals	100%	73

2015 Annual Report

WISCONSIN STATE CRANBERRY GROWERS

Association



ANNUAL MEETING

January 20, 2016

Agenda

1:00 PM — Call to Order

Minutes from the 2015 Summer Meeting
- Tyler Walker, Secretary

Election of Directors
- John Stauner, Chair - Nominating Committee

Report of the President
- Mark Mahoney

Report of the Executive Director
- Tom Lochner

Special Presentations:

WSCGA Public Policy Program Strategies, Tactics and Action

WSCGA Communications Programs – Setting the Stage for a Positive Image for Cranberry Growing in Wisconsin
- Kris Naidl, Laughlin Constable
- Kathryn Whitlock, Laughlin Constable

Report of Committees

Other Business

2:30 PM — Adjourn

WSCGA Summer Meeting Minutes – August 5, 2015

Wisconsin River Cranberry Company Nekoosa, WI

The 2015 Wisconsin State Cranberry Growers Association Summer Meeting was called to order by President Mark Mahoney on Wednesday - August 5, 2015 at 1:30 p.m. at Wisconsin River Cranberry Company in Nekoosa, Wisconsin. Mark Mahoney welcomed the growers in attendance, and thanked the host marsh staff and WSCGA staff, including Tom Lochner, Susan DeRouchey, Crystal Johnston, and Tod Planer for coordinating the Summer Field Day event, along with the WSCGA Education Committee members. A recognition plaque was then presented to Bill Wolfe, owner of Wisconsin River Cranberry for hosting this year's Field Day event.

Royalty - The Cranberry Festival Royalty group from Warrens, WI was introduced by Mark Mahoney. Members introduced themselves and shared information about the upcoming Warrens CranFest. Members included:

- Princess Olivia Engel
- Princess Tatiana Briggs
- Queen Brielle Lueck

Special Guests - Mark Mahoney introduced special guests attending the event and in the audience, including:

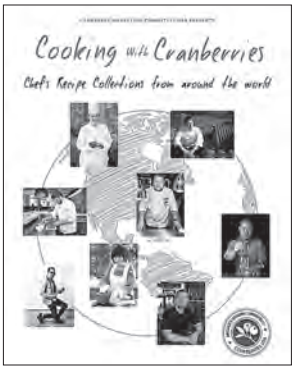
- Jeffrey Lyon, Wisconsin DATCP Deputy Secretary
- Juli Speck, Wisconsin DATCP
- Dan Smith, Wisconsin DATCP
- MaryAnn Lippert, Wisconsin Dept. of Administration
- Dan Baumann, Wisconsin Dept. of Natural Resources
- Katherine VandenBosch, UW Madison CALS Dean
- Nancy VanderMeer, Legislator

Secretary's Report - Mark Mahoney referred to the 2015 Winter Meeting Minutes printed on pages 54-55 in the Summer Field Day Meeting Program Book. Nodji VanWychen moved and David Amundson seconded a motion to waive reading of the January 21, 2015 Meeting minutes, and to approve minutes as printed. Motion carried.

WSCGA Board Members - Mark Mahoney introduced to the audience each member of the WSCGA Board of Directors, including:

- Tom Gardner, Vice President
- Tyler Walker, Secretary
- John Stauner, Treasurer
- David Amundson
- Nicole Hansen
- Mike Moss
- Karl Pippenger
- Carl Salzwedel

Marsh Recognition - Mark Mahoney noted that each year at the Field Day event, the WSCGA recognizes marsh milestone anniversaries. In recognition of the 75th anniversary of the Gottschalk Cranberry marsh in Wisconsin Rapids, President Mahoney made a plaque presentation to Guy Gottschalk and daughter, Fawn Gottschalk, and indicated the Gottschalk Cranberry would be the host of the 2020 Summer Field Day Meeting, in honor of their 80th year marsh anniversary.



Executive Director's Report - President Mahoney invited Tom Lochner to present his Executive Director's report to the members. Lochner thanked Bill Wolfe and his crew at Wisconsin River Cranberry for hosting the Summer Field Day meeting and the WSCGA staff of Susan De Rouchey, Crystal Johnston and Tod Planer for the event support. He also expressed his appreciation to the UW Extension faculty, to Matt Lippert, and to the other members of the Education Committee for their leadership and participation in providing the mini-clinics. Lochner also thanked the WSCGA Associate Members who were exhibiting, as well as the on-site vendors and Baum's Mercantile, and the WSCGA Grower Members in attendance for their support.

Lochner provided a short summary and brief remarks on four primary topics of interest to Wisconsin Growers:

- Legislative – state budget, UW projects and positions;
- Water – ground water and high capacity wells;
- Pollination – restrictions on use of pesticides;
- Research – WSCGA's capital campaign goal of $750,000 for a long-term sustainable research facility.

Leadership Class Introductions - Mark Mahoney introduced Greg Fanning of the WCREF Cranberry Leadership Development Committee. Fanning introduced members of the WCREF Leadership Development Committee, who worked together to plan the third-year sessions for the Cranberry Leadership Development Program (CLDP). In addition to Fanning, committee members include: Nodji Van Wychen, Fawn Gottschalk, Jeff Hopkins, Jenna Van Wychen, and Amy Gebhardt. Next, Fanning asked members of the third leadership class to join him at the front of the room for introduction of: Justin Henry, David Bartling, John Duckart, Gabriella Liddane, John Moss, Beth Oemichen, Mike McElroy, Jeff Peterson, Cardell Potter, Adam Smedbron, Theo Olson, and Danielle Faber.

Mark Mahoney then invited Jon Field, the NRCS District Conservationist and Cranberry Liaison from Juneau County to say a few words. Field indicated that Nutrient Management planning work continues and cranberry growers are asked to work with their local NRCS / USDA office representatives going forward. He also indicated the next deadline for the EQIP program applications is October 2.

Old Business - None

New Business – Mark Mahoney announced that Jim Peterson, the industry icon known to many as "Mr. Cranberry" is planning to retire after 48 years with Ocean Spray Cranberries at the end of August. In recognition of his many cranberry industry contributions, WSCGA and the Board of Directors provided Jim Peterson with a fishing pole, as a gift of appreciation, to enjoy in his retirement. President Mahoney also presented a plaque with special recognition to Jim Peterson, featuring a certificate granting lifetime permission for Peterson to fish on more than 50 WSCGA owner member marsh properties. Jim Peterson noted that it seemed fitting to announce his retirement at Wisconsin River Cranberry, since Bill Wolfe's father, Lloyd Wolfe, originally hired Jim Peterson at Ocean Spray Cranberries 48 years ago in 1967.

Adjournment - There being no further business, Mark Mahoney entertained a motion to adjourn. David Amundson made a motion to adjourn the meeting. Tom Gardner seconded the motion. All were in favor and motion carried.

President's Message – Mark Mahoney

Welcome to the WSCGA 2016 Winter Meeting and Trade Show. The next two days provide a great opportunity to catch up with growers, take advantage of the educational opportunities, and show support for Associate Members by stopping by their booths.

Thank you to everyone that has worked so hard to put this event together. It is the efforts of many including the WSCGA staff, education committee volunteers, sponsors, presenters, and others that make these two days a success. Your commitment to the industry is evident and serves us all well.

With each New Year we are provided an opportunity to look individually and at our businesses with a fresh perspective and choose if we want to change our approach moving forward. Whether or not we choose to make changes about how we proceed, one thing I strongly believe is that when we move forward together we are stronger and more effective than if we choose go at it alone.

The WSCGA takes action for the growers, moving forward working together. The WSCGA is a solid organization with a highly talented staff and committed grower and associate members that are willing to volunteer their time on the board, committees, grower panels, meeting with legislators, and by taking any other action that benefits the membership, Wisconsin growers, and the industry.

A great example of what happens when any industry works together, the WSCGA has always worked hard and will continue to work hard on the behalf of its membership as we continue to face new challenges.

Thank you for your continued support and membership. Enjoy the meeting.

From the Executive Director – Tom Lochner

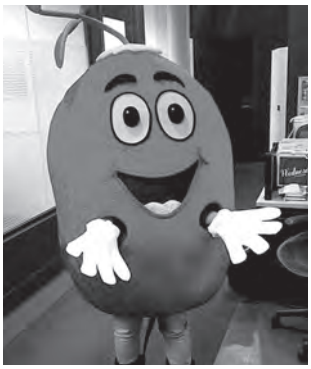
This past year has been, as always, a challenging year for the industry and the WSCGA. The end of the year saw a flurry of activities that will need continued work in the coming years. Threatened cancellations of important pest control products or significant restrictions on their use will be in front of us. Grower returns are always a challenge and building markets and increasing prices to profitable levels will be the highest priority for everyone in the industry.

We also see dramatic changes proposed for the University of Wisconsin and the research and Extension programs that are a major part of the success of the industry here in the state. Maintaining the integrity of the team that has been assembled to work on your behalf will be a priority for WSCGA as well.

But even with the problems we face, I have to remain positive about where we are headed.

First of all, I have been able to spend time with the third class of the Wisconsin Cranberry Leadership Development Program. As was the case with the previous two groups, the class is a great source of energy for those of us who have had the opportunity to work with them. The individuals are genuinely interested and enthusiastic about the industry, its future and taking on leadership roles in helping to positively impact that future.

I also have the opportunity to work with a number of committees that are also dedicated to the organization and the industry. They give freely of their time to develop and implement programs for



WSCGA. They, too, show a genuine enthusiasm for the future of cranberry growing in Wisconsin.

There is then the members who commit resources and support for WSCGA. The decision to invest in WSCGA is directly connected to the return we provide. Our commitment is to make sure we do justify that trust.

I also have the pleasure to work with a great staff and team of consultants who are dedicated to the industry and our members. Whether it involves a legislative issue or communications opportunity there are people who are creative in solving member problems.

And finally, I get to work with boards of directors who challenge you to be your best. They provide great leadership and common sense to make sure that we keep our eyes on our mission, to serve you the WSCGA Member.

WSCGA Annual Report

The Wisconsin State Cranberry Growers Association was formed in 1887 to serve the state's newly emerging cranberry industry. Some 128 years later, the organization continues to work to meet its mission of providing quality programs for members to enable the industry to prosper.

WSCGA is organized as a non-profit, non-stock corporation governed by a nine-member Board of Directors. The board is advised by a number of committees and working groups on topics ranging from Public Policy to Promotion, Grower and Public Education. The association employs professional staff and consultants. The board, committees, staff and consultants work together as a team to develop and implement programs and policy for the organization.

The 2015 annual report highlights activities by the association on behalf of its membership throughout the course of the year. These successes are due to the hard work of the grower and associate members who volunteer their time and talent to work with the Association's professional staff and contractors to advance the mission of the organization. We hope all growers and members of the industry will thank those who continue to work on their behalf and to join the WSCGA in these efforts.

THE TEAM – WSCGA Board of Directors 2015

Mark Mahoney, President
Mark joined the board in 2011 and is part owner of Owen Rock Cranberries in Adams County, which served as the host site for the 2012 Summer Meeting, Field Day and Trade Show. He serves on the Public Policy and Environmental Affairs Committee, Administration Committee, Personnel Committee, and Research Committee. He was elected Vice President in 2012.

Tom Gardner – Vice President
Tom is part of Gardner Cranberry and Hay Creek Cranberry located near Pittsville. Tom joined the board in 2012. He serves on the Public Policy and Environmental Affairs Committee, and is Chair of the Nominating Committee.

Tyler Walker - Secretary
Tyler works with his family at Walker Cranberry Company in the town of Cranmoor, west of Wisconsin Rapids. He was elected to the board in 2011. He serves on the Public Policy and Environmental Affairs Committee and the Nominating Committee. He also serves on the Wisconsin Cranberry Research and Education Foundation Cranberry Leadership Development Committee.

John Stauner, Treasurer
John owns and operates James Lake Farm near Three Lakes, Wisconsin. John was elected to the board in 2008 and Treasurer in 2012. He chairs the Administration Committee, while also serving on a number of working groups.

David Amundson
David's family operations, Wisconsin Moss Company and Amundson Cranberry, are located outside of Babcock where he farms with his wife, Jill. David was elected to the board in 2009, served as Vice President in 2011, and as President in 2012-13.

Nicole Hansen
Nicole is part of Cranberry Creek Cranberries in Juneau County. She was elected to the WSCGA Board in 2009. She served as Vice President in 2010. She chairs the Research Committee, serves on the Education Committee, and represents the cranberry industry on the Board of Directors of the National Institute for Sustainable Agriculture. In 2013, Governor Walker appointed her to a seat on the citizen's board that oversees the Wisconsin Department of Agriculture, Trade and Consumer Protection.

Mike Moss
Mike, his wife, Diane and his family own and operate Elm Lake Cranberry, west of Wisconsin Rapids. Mike has served on the WSCGA board since 2007, and as president in 2010 and 2011. He serves as President of the Wisconsin Cranberry Research and Education Foundation, and on the Administration, Personnel and Research Committees.

Karl Pippenger
Karl is part of the team at Cranberry Lake Cranberries in Phillips and owns and operates his own small cranberry marsh, "Pip's Cranberries". He participated in the 2013-14 Wisconsin Cranberry Leadership Development Program. He joined the board in 2015.

Carl Salzwedel
Carl and his family own and operate Salzwedel Cranberry near Warrens, Wisconsin. Carl was elected to the board in 2009. He is a member of the Public Policy and Environmental Affairs Committee, and has served as the WSCGA on the Cranberry Museum, Inc. Board of Directors.

WSCGA Committees

Public Policy and Environmental Affairs Committee

The committee is responsible for the development of recommendations on policy related to environmental issues as well as other state and federal regulatory and legislative actions that arise as part of the public policy advocacy program. The committee also makes recommendation on disbursements from the restricted account for water and wetlands.

Public Policy and Environmental Affairs Committee Members:

Bill Hatch, Chair
Mike Bartling
Tom Gardner
Bryan Heuer
Gary Jensen
Randy Jonjak
Bill Klouda
Greg Knorr
Mark Mahoney
Bill Metcalf
Jim Peterson
Fran Podvin
Dan Rayala
Andy Reitz
Russ Rifleman
Gary Roberts
Carl Salzwedel
Scott Schultz
Craige Scott
Clare Searles
Ben Tilberg
Ryan Walker
Tyler Walker
Luke Weiland

Administration Committee

The committee advises the WSCGA Board on the internal operations of the association. Its major responsibility is development of a recommendation for an annual budget for the WSCGA.

Administrration Committee Members:

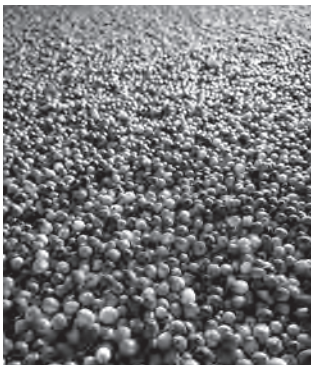
John Stauner – Chair
Bob Duckart
Greg Fanning
Bill Hatch
Mike Moss
Fran Podvin
Russ Rifleman
Scott Schultz

Education Committee

The main emphasis of the WSCGA mission is education, both of growers and the general public on cranberry growing. A large portion of this responsibility is assigned to the Education Committee, making it one of the key committees in the association. The committee meets with UW Extension faculty and others during the year to review and plan the various education programs for the association including the Wisconsin Cranberry School, early season workshops and the Summer Meeting and Field Day.

WSCGA Education Committee Members:

Christelle Guédot – Chair
Jim Bielmeier
Danielle Faber
Steve Hahn
Nicole Hansen
Jason Hatch
Leroy Kummer
Penny Langer
Matt Lippert
Tod Planer
Andy Reitz
Jayne Sojka
Nodji Van Wychen
Pam Verhulst



Public Relations Committee

The committee is responsible for developing and implementing communication and promotion projects to generate a positive image of the industry in the state. That responsibility includes working with the media to tell the industry's story and working with other groups to help promote the state's largest fruit crop.

WSCGA Public Relations Committee Members:

Nodji Van Wychen – Chair
Stephen Brown
Amy Gebhardt
Mike Gnewikow
Fawn Gottschalk
Ed Grygleski
Doug Rifleman
Jim Peterson
Jessica Rezin
Scott Schultz
Mary Smedbron
Bill Wolfe

Research Committee

The Board of Directors established the committee to provide growers with a forum to discuss research needs with University of Wisconsin research faculty and the cranberry research community on a national basis. The committee works cooperatively with the Wisconsin Cranberry Board, Inc. (WCB), The Cranberry Institute (CI), and others to identify grower research needs, coordinate projects to avoid duplication and to help establish priorities.

WSCGA Research Committee Members:

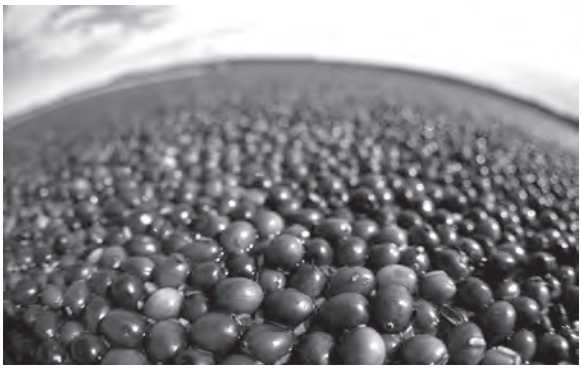
Nicole Hansen – Chair
Suzanne Arendt
Steven Bartling
Stephen Brown
Danielle Faber
Mike Gnewikow
Ed Grygleski
Jeff Habelman
Leroy Kummer
Mark Mahoney
Mike Moss
Ben Ryner
Carl Salzwedel
Scott Schultz
Jayne Sojka
Pam Verhulst
Andy Walker

Associate Member Committee

The Associate Member Committee (AMC) provides input on topics including Associate Membership benefits, Summer & Winter Trade Shows, WSCGA *NEWS* advertising, Program Book & Buyers Guide publication advertising, sponsorships and member surveys. Committee members are polled for input on topics related to membership related topics and inquiries. The group meets prior to the Summer Meeting & Trade Show for an on-site visit and event planning.

Associate Member Committee Members:

Tom Altmann
Amy Boson
Gary Derber
Derek Johnson
Jay Dombrowski / Kathy Ziehl
Paul Roberts
Dawn Ruiter
Jay Weidman



WSCGA Staff

Tom Lochner, Executive Director

Tom Lochner was named the first WSCGA Executive Director in 1988. Since then, the association has grown into a well-respected voice for the Wisconsin cranberry grower. The association has expanded its education, communications and public policy programs. It also took on the responsibility of providing administrative services to the Wisconsin Cranberry Board, Inc. to enable it to implement its research, education and promotion programs. In 2004 the WSCGA also assisted the Cranberry Museum, Inc. develop and operate the Wisconsin Cranberry Discovery Center in the Village of Warrens.

As the chief staff person, Tom represents WSCGA in interactions with University Research and Extension faculty and administration, as well as with Federal, State and local governmental organizations. He is also responsible for coordinating the activities of staff and various consultants who assist with communications and public policy programs. He serves as a liaison with industry groups, such as the Cranberry Institute and the USDA Cranberry Marketing Committee. He also serves as the lead spokesperson for the organization, giving presentations to groups across the state.

Over the course of his career, Tom has worked with the board and committees on growing the programs and membership of the association. He believes in a team approach to program planning and development. This approach has resulted in active committees, an engaged and high performing board, and high grower participation in WSCGA programs.

Alex Skawinski

Alex Skawinski joined WSCGA in December 2015. As the Administrative Assistant, she is responsible for keeping the office in Wisconsin Rapids up and running smoothly. Her responsibilities include the Associate Member programs, the Associate Member Committee, and working with the WCREF Development Fund Committee to plan and hold the annual Cranberry Open Golf Outing and the Sporting Clay Shoot.

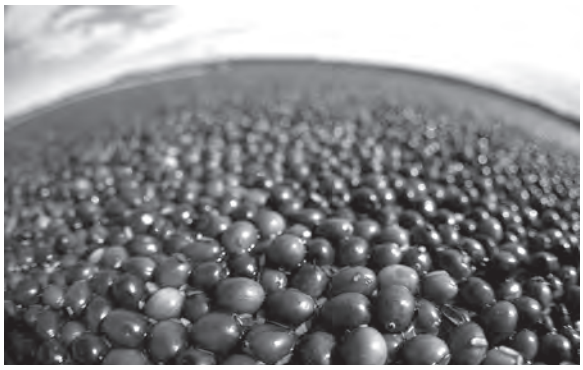
She also manages the annual Trade Shows for WSCGA, which are premier events in the industry. For the Winter Trade Show, she coordinates exhibit space registrations, including online booth registration via Booth Boss, as well as sponsorships and booth upgrades. At the Summer Trade Show, participation is also high on the part of exhibitors.

Alex works with Crystal Johnston on the Cranberry School registration, coordinating the publication of the WSCGA *NEWS*, and keeping the WSCGA website up-to-date and fresh with event information and resources. While new to the team we are excited about having Alex on board to work with all of our members to advance the mission of the association.

Crystal Johnston

Cris joined the staff at WSCGA in 2005 as a part-time bookkeeper. Her main responsibility is to keep the financial records for the association. She also assists as a back-up for staff support and assists at meetings and WSCGA events. This past year, Cris took on additional responsibilities as Clerical Assistant. She now manages the databases for the membership, the assessment forms and filings for the Wisconsin Cranberry Board, Inc. and serves as the office manager in purchasing supplies and equipment for the association.

She also serves as the bookkeeper for the Cranberry Museum, Inc.



Association Consultants

Tod Planer, Farm Conservation Planning Coordinator

Upon his retirement as the Wood County Extension agent in 2002, Tod began a second career as a contractor for the WSCGA. In that role, he helped to develop and implement Whole Farm Conservation Plans for cranberry growers. Early efforts included tail water recovery pilot projects and nutrient management. They evolved to evaluating a suite of conservation practices and their applicability to cranberry farms. Through these evaluations and pilots, Technical Standards were developed to allow growers to be eligible for NRCS cost-sharing programs.

In the past three years, he has been working on energy conservation and alternative energy generation on cranberry farms. This has resulted in support of pilot projects on wind, solar and hydro generation.

Dewitt, Ross and Stevens, Legislative Counsel

DeWitt Ross & Stevens is a full service law firm with experienced attorneys in virtually all areas of practice. Throughout the firm, there are attorneys who have developed expertise in niche areas but still understand the big picture.

The Government Relations team of DeWitt Ross & Stevens is the largest lobbying group in Wisconsin. Because they are located directly on Madison's Capitol Square, often times WSCGA strategize with Legislative Counsel Ron Kuehn and Jordan Lamb, and later head to the Capitol for meetings with legislators and other key policymakers.

Ron Kuehn began his career at Dewitt Ross & Stevens upon graduation from the University of Wisconsin Law School in 1971. Early in his career, he directed his practice into business law and, after a few years, expanded to government relations. Today, he exclusively works in state and federal government relations as the leader of the DeWitt Ross & Stevens, and Wisconsin's largest government relations practice group. Ron has been representing WSCGA since 1988, when the industry faced the most significant challenge to the rights of growers to access water. Throughout the years, Ron has worked for WSCGA on issues ranging from environmental to property taxes to transportation.

A key component of the ongoing governmental relations program is establishing relationships through regular communication with legislative and agency leadership, as well as with the grower community. These efforts over the past 20 plus years have positioned the industry so that it is able to respond to challenges, as well as initiate regulatory and legislative changes to help growers businesses.

Jordan Lamb's expertise in environmental regulation is a particular asset to WSCGA and our members, as they navigate the interplay between state and federal regulations and running a successful business. Jordan was closely involved with the creation and implementation of the Great Lakes Compact in Wisconsin on behalf of Wisconsin agriculture. She also was a major voice for us in the development of the State non-point source pollution program and the rewrite of NR151 and ATCP50. She played a major role in the development of Wetland Reform Legislation in last session of the Legislature and in developing protocol for dealing with floodplain issues with FEMA, DNR and county zoning offices. She has provided leadership on issues related to groundwater, drainage, artificial and navigable waterbodies to name a few.

Broydrick and Associates, Federal Legislative Counsel

Founded in 1981 by Bill and Cynthia Broydrick, Broydrick & Associates is a premier lobbying firm today. The Broydrick Team consists of some of the best and brightest public affairs experts around, who bring experience from the private and public sectors. With offices located in Washington D.C. and Milwaukee, Wisconsin they bring a unique blend of local, state and federal savvy to their clients.

Bill Broydrick served as former Congressman Les Aspin's press secretary, managed Congressman Robert Cornell's campaign and became former Wisconsin Governor Patrick Lucey's senior administrative assistant. In 1978, Bill was elected to the Wisconsin State Assembly and, in 1993, led the Office of Legislative Affairs where he served as a consultant to the Department of Defense.

In 1981, Bill founded Broydrick & Associates, directing its rise to a nationally known firm with offices in Washington, D.C. and the Midwest. He has developed a vast network of contacts and offers strategic planning and grassroots organization.

Broydrick and Associates have been focused on assisting the WSCGA as we work to enhance cranberry research on a national basis. Their past work secured funding for three USDA Agricultural Research Scientists who focus on cranberry. This funding has placed two programs at UW Madison to research cranberry insect pest problems and cranberry genetic improvement. Currently, they are assisting the organizations to secure funding for improvements to research facilities in Massachusetts and Wisconsin.

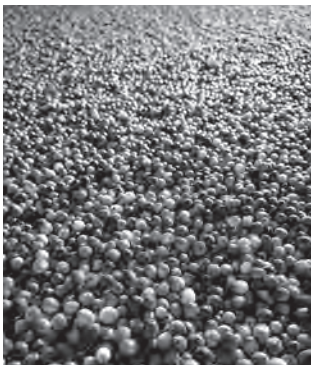
Laughlin Constable, Communications and Public Relations

Laughlin Constable (LC) is a multi-faceted and full service agency. The team from LC provides services to WSCGA. The team is made up of a group of talented and creative public relations professionals with a wide variety of backgrounds. LC provides access to expertise for communications and public relations programs for WSCGA.

Evan N. Zeppos, APR, has more than three decades of professional achievement and experience as a public relations counselor. With experience in both the private and public sectors, he is recognized as a leading expert in public relations and has a unique blend of national, state and local involvement on major issues management and public relations challenges and opportunities. A Milwaukee Magazine survey of local public relations professionals ranked Zeppos as the top communications professional in the metropolitan Milwaukee area. He has also earned national accreditation from the Public Relations Society of America and is a member of its Counselors Academy.

Kris Naidl joined Zeppos in 1994 and began working with the WSCGA. Her work has been recognized through the receipt of 15 Paragon Awards from the Southeastern Wisconsin Chapter of the Public Relations Society of America (PRSA), including a Best of Show Award for her strategic communications work to affect change in state regulations.

Prior to joining LC, Naidl was Assistant Director of Community Relations at the largest



substance abuse prevention agency in Wisconsin. She also held positions as Copy Editor and Writer at a southeastern WI magazine, and worked for a state legislator.

Mikaela Balfany is an Account Executive at Laughlin Constable and works on a variety of projects including strategic planning, writing, media and community relations, social media outreach, special event planning, website development, and more.

Prior to joining Laughlin Constable in 2013, Balfany was the Public Relations Specialist for the YMCA of Metropolitan of Milwaukee. She also served as a Public Relations Account Executive at Zeppos & Associates, where she worked with WSCGA since joining the firm in 2008. A graduate of the University of Wisconsin-Madison, Balfany holds a bachelor's degree in journalism.

Katie Whitlock is an Account Executive at Laughlin Constable where she works on a variety of projects, including strategic planning, news writing, publicity, media and community relations, social media management, special event promotions and more. She has been with Laughlin Constable for four years and previously worked on clients including Wisconsin Dept. of Tourism, Plum Creek, Wisconsin Veteran's Museum and others.

Whitlock is a graduate The University of Findlay in Findlay, Ohio, where she earned a Bachelor of Arts in public relations and a minor in marketing.

WSCGA Program Activites – 2015

Public Policy Advocacy

Policy Statement of WSCGA Public Advocacy Program

The WSCGA's Public Policy Advocacy Program strives for state and federal legislative outcomes that allow Wisconsin growers to farm in an environmentally and economically sustainable manner. Public Policy Program position statements and activities are weighed against this goal:

> Wisconsin cranberry growers support legislation, rules and policies that balance the conservation of important natural resources and the stewardship of resources by growers against the economic needs and benefits of cranberry growing in Wisconsin.

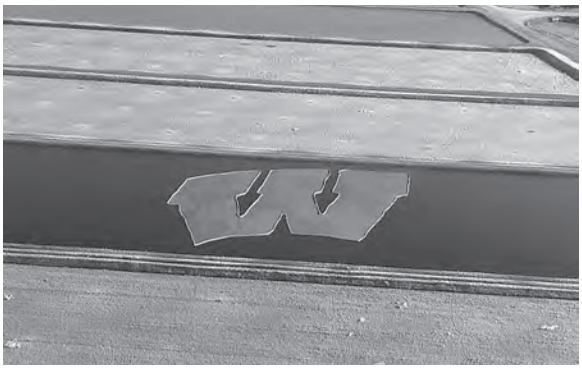
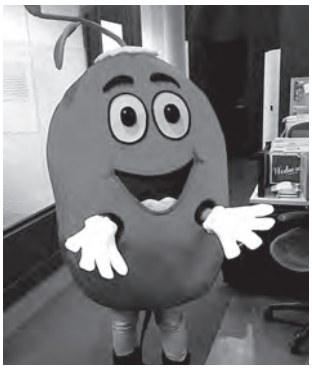
The following are priority areas for the WSCGA Public Policy Advocacy Program:

Environmental Policy and Regulation

The greatest threats – and opportunities – for the industry in public policy are in the area of environmental regulation. Whether it pertains to water access and quality, wetlands or the use of chemicals for crop production that growers use, WSCGA members expect their association to represent their interests.

Water Access

An abundant and high quality water supply is the key to the success of cranberry growing in Wisconsin. As such, the highest priority for the WSCGA is to maintain and protect growers' ability to access surface and groundwater for their farming operations. Conducting normal farming operations


to maintain and enhance water use and conservation must be protected and must continue to be allowed with limited regulation.

Water Quality
Cranberry farming practices face increasing scrutiny as to their impacts on water quality. WSCGA has lead efforts with UWEX, USDA NRCS, DNR and DATCP to address Best Management Practices to protect water quality. Maintaining the definition of return flow from irrigated agriculture as a non-point source is a priority for the WSCGA. Changes to the state water regulatory program need continuous monitoring. TMDL development for cranberry waters and the Statewide Nutrient Management Strategy are also priorities for WSCGA.

Federal/State Linkage
In many cases with environmental regulation, there is a strong and important relationship between Wisconsin and federal laws and regulation. This is the case with the Clean Water Act and floodplain regulation. As changes take place in federal programs, they impact the state as the delegated authority to administer those programs. At the same time, attempts to reform or revise state regulatory programs require federal approval. WSCGA and its Legislative Counsel continue to be vigilant in these areas.

With these identified priorities, WSCGA staff and leadership will closely communicate with the WSCGA Legislative Counsel to evaluate issues as they arise, assess risk and threats to the industry, and then determine the level of activity that is required to meet the organization's goal and mission.

WSCGA State Government Relations Issues - 2015

The WSCGA state advocacy program and its legislative counsel from DeWitt Ross & Stevens in Madison was very active in calendar-year 2015. This state legislative session, which began in January 2015, will continue until about April of 2016, when the Wisconsin State Legislature will adjourn. The following is a list of issues addressed by the WSCGA during calendar year 2015. These are exclusively state government relations issues involving the Wisconsin State Legislature, state agencies or local units of government in Wisconsin.

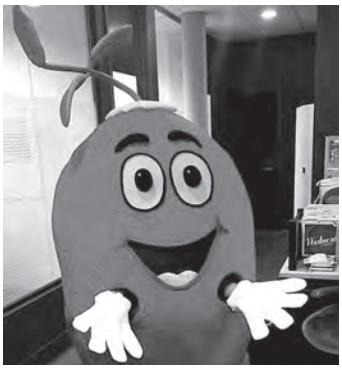
Adverse Possession

The Wisconsin Legislature is still grappling with possible changes to Wisconsin's adverse possession law. It is anticipated that these issues will be successfully addressed during the remainder of the session. Adverse possession is, of course, a real estate law concept that relates to one landowner eventually securing "ownership" of another landowner's property by openly and adversely using that property, fencing it, or constructing something on the property. Agriculture is supportive of adverse possession as a principle of law. It has been very useful in resolving disputes between public and private landowners and private and private landowners.

At the time of this writing, the legislation, which would amend or terminate adverse possession real estate law in Wisconsin, is still being debated. It is anticipated that a resolution of the legislation that is satisfactory to agriculture will be reached.

Drainage District Legislation

Drainage districts exist in Wisconsin, in large part for the purpose of creating an efficient structure for drained lands to be used in production agriculture. At the time of this writing, we have been negotiating



drainage district law changes that we expect to be addressed during the spring session of 2016. At the moment, these negotiations have proven to be successful inasmuch as all of the concerns that we have with amendment of existing drainage district law have been addressed by the proposed legislation. Our primary focus has been the protection of the right of a drainage district to remain in a "suspended" status. One or more districts within the area of the Wisconsin cranberry community participates in a suspended status that is quite satisfactory to the cranberry growers and other farmers and landowners within the district. The original draft of the bill would have terminated this ability to remain suspended and forced termination of the district.

Elk Damage Abatement

Wisconsin has had an elk reintroduction program in the northwest area of Wisconsin (the Clam Lake area) for a substantial number of years. This year, Wisconsin has reintroduced elk into an area largely located in Jackson County. Jackson County also contains a substantial number of cranberry farms. Despite the cranberry community's objections, this reintroduction of elk occurred and is now producing anticipated elk appearances on cranberry farms with some damage resulting. We have, however, reached arrangement with the Wisconsin Department of Natural Resources to secure funding for the construction of elk damage abatement fences around cranberry farms within elk areas. This project has just begun and it is anticipated that bids will be announced in the relatively near future for construction next spring on cranberry farms that anticipate or have already experienced elk damage.

High Capacity Wells

The Wisconsin agriculture community continues to work with the Wisconsin State Legislature on new legislation that will clarify Wisconsin's high capacity well permitting program. Senator Rob Cowles (R-Green Bay) and Representative Scott Krug (R-Nekoosa) are working on legislation to provide regulatory certainty to those who seek a new high capacity well or desire to reconstruct or repair an existing high capacity well, while also putting into place mechanisms to address particularly sensitive areas in Wisconsin in terms of groundwater pumping. The work on this legislation will continue into 2016.

Implements of Husbandry

Senator Jerry Petrowski (R-) and Representative Keith Ripp (R-Lodi) continue to refine the initial comprehensive implements of husbandry (farm implements) weight limit legislation that was originally passed in 2014 (2013 Wisconsin Act 377). In April 2015, the Governor signed 2015 Act 15, which clarified issues related to towed and attached IOH, that IOH with rubber tracks can legally operate on a highway and other technical changes that improve the application of the law to Agricultural commercial motor vehicles. Currently, the legislature is reviewing Senator Petrowski and Representative Ripp's additional clean-up bill that will further clarify the application of the IOH weight limits and the function of the no-fee permit system.

Producer-Led Water Quality Initiatives

As a part of the 2015-17 biennial budget bill, the State Legislature created a new grant program at DATCP called the "Producer Led Watershed Protection Grant Program." This program provides an additional $500,000 in funding over the biennium for water quality abatement activities. The new grant program is specifically for farmers within a watershed to design and lead their own water quality activities.

DATCP is authorized to award grants totaling up to $250,000 each year to qualified groups consisting of at least five agricultural producers that wish to voluntarily conduct nonpoint source water pollution



abatement activities in their watersheds. There are several statutory conditions that must be met for farmers to be eligible to receive these grants.

It is expected that the emergency rule for this grant program will be issued by the end of February 2016 and the first request for grant proposals will be issued at the beginning of March 2016. Because of the timing of this rule in this biennium, it is anticipated that the first set of grant awards will be made in April of 2016.

Accordingly, farmers who are interested in seeking funds for a voluntary producer-led water quality project should begin forming their producer group and identifying their collaborative partner in anticipation of the spring request for grant proposals.

Taxation of Revenue Derived from Agriculture

We are in the third year of a transition into a state income tax credit for revenue derived from agriculture. As a part of a state budget bill agreement reached with agriculture, the Wisconsin Legislature did not expand that credit to the anticipated 5.5 to 0% level, but instead used a tax credit for the income derived in 2015 to be only 4.0%. What this means is that income derived from farming during 2015 will pay at a rate of 3.75% instead of the full 7.75% that income from other sources other than manufacturing pay.

The reason for this agreement was to allow the state to have the revenue necessary to terminate the alternative minimum tax in Wisconsin. Next year, the state income tax credit for income derived from agriculture in 2016 will be 7.5%. This means that on 2017 farm tax returns, the remaining income tax due from farm income will only be 0.25%.

Road and Bridge Projects Affecting Agriculture

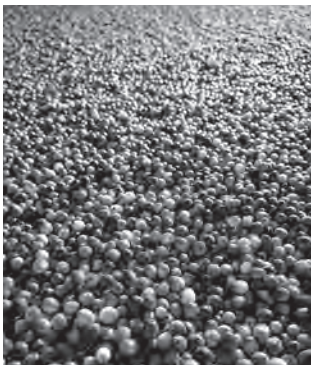
This year, as in past years, we dealt with several issues related to DOT-planned projects that would either interfere with seasonal cranberry activity, or temporarily affect water bodies upon which cranberry growers rely. These issues typically arise from road construction during harvest periods that can interfere with transport of fruit to processing; or dewatering projects necessitated by bridge or road construction adjacent to cranberry farms. Both the DOT and Wisconsin legislators who are interested in agricultural issues have been very cooperative in adjusting construction and dewatering projects to accommodate grower needs. This was once again true during 2015.

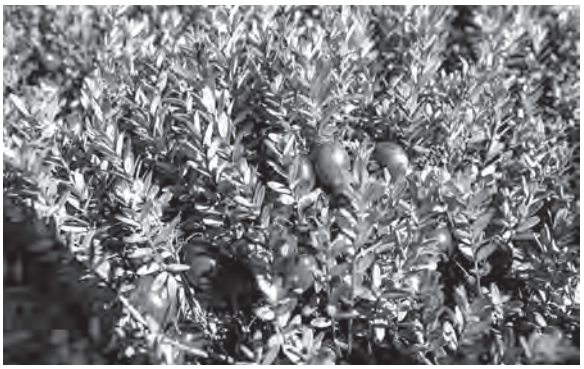
Wood County Floodplain Ordinance – Model for Cranberry Counties

The WSCGA has worked for five years with the Wisconsin Department of Natural Resources (WDNR), the Federal Emergency Management Agency (FEMA), county governments and stakeholders to develop a floodplain ordinance for cranberry counties that protects cranberry farming while also providing a mechanism for recordkeeping and floodplain management that meets state standards. This year, Wood County was the first county to adopt the model FAD-C ordinance, creating flooded agriculture district for cranberries. The ordinance generally provides a mechanism for existing cranberry farms to certify their existing farm boundaries and also creates a process to obtain a floodplain permit for new development activities (*i.e.*, cranberry farming development *outside* of the boundary of an existing farm.) The WSCGA will continue to work with growers and counties to seek similar ordinances in all cranberry-growing counties.

Pollinator Protection Plan

This year the Wisconsin DATCP undertook the preparation of a plan to protect pollinators in Wisconsin.





The plan included both managed and native pollinators and included efforts to develop BMPs for beekeepers, habitat development for native pollinators and for on farm activities. WSCGA participated in the working group tasked with the development of a draft plan. The group met to identify problems and opportunities and to better understand issues with pollinators and land management. A draft plan has been developed which will be the subject of public comment in the coming year. WSCGA has already provided comments with concerns about the plan. We will continue to work with DATCP on the plan with the goal of enhancing pollinator populations without placing undue restrictions on farming practices for our growers.

UW Extension Mission Statement

Wisconsin's cranberry growers work closely with UWEX Specialists to grow a high quality crop in the Badger state. Leadership in UW Extension proposed a significant change to the mission of UWEX to allow it to grant degrees and certificates. WSCGA joined all of agriculture to oppose this change citing concerns that resources of faculty would be stretched to meet the new program at a time when budget restraints threaten the delivery of quality services to growers. The proposal was approved by the Board of Regents despite these concerns. WSCGA will continue to monitor the program and proposed changes in UWEX Structure to oppose threats to support for programs essential to our industry.

Pesticide and Fertilizer Fees

The Wisconsin DATCP is conducting a review of the fees farmers pay on pesticides and fertilizers which are used to fund various programs at the agency. Of primary concern is the Agricultural Chemical Cleanup Fund. This fund is used to provide financial support to businesses or individuals to address contamination of areas from pesticide storage, mixing, loading, etc. Over time the revenue generate by the fees has exceeded need for clean-up. This has resulted in fund balances that have been "raided" and returned to the general fund and are used for purposes other than those intended.

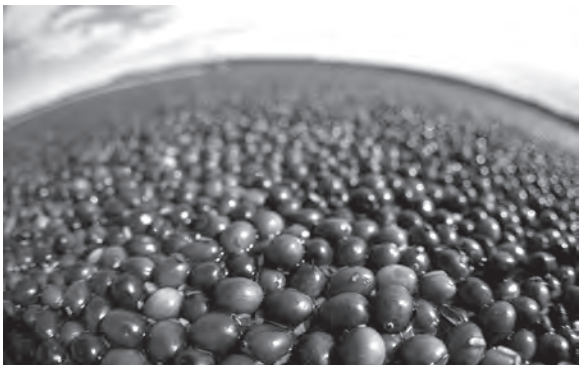
WSCGA is participating in a working group to review all of the programs and funding and to make recommendations to the DATCP. WSCGA is working to reduce fees and funds for clean-up to avoid continued raids while at the same time providing adequate funding to meet needs for site clean-up in the future.

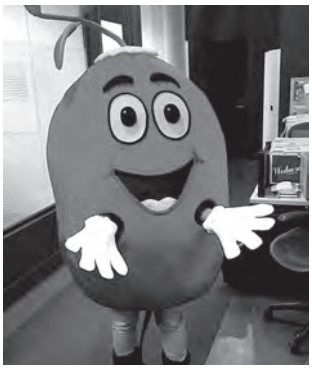
WSCGA Federal Governmental Issues – 2015

The WSCGA Federal advocacy program was very active in calendar-year 2015. Federal activities include working with agencies on issue's and members of congress and the Congressional Cranberry Caucus. The following is a list of issues addressed by the WSCGA during calendar year 2015. These include work by Broydrick and Associates on behalf of WSCGA and direct activities by WSCGA with other state and national groups.

Research Funding

In 2015 WSCGA was able to secure an increase in the budget for the USDA ARS Cranberry Research Program of $750,000. We are working with ARS to utilize the funds to support ongoing efforts to establish a facility dedicated to research on cranberry growing here in the state.





Pest Management Tools

WSCGA has adopted a general policy to support the development of a toolbox of management practices for growers to use in their farming operations. These practices include cultural – such as flooding for pest control or sanding – as well as the use of chemical control options. The chemical control options may include new, softer pest specific compounds and traditional broad spectrum control. The organization encourages integrated use of these tools by growers through IPM.

As a result WSCGA advocates to continue registrations for pesticides as long as their judicious use does not present an environmental or food safety risk. The association works with the Cranberry Institute and other organizations to monitor proposals by EPA and others that impact grower use of pest control products and strategies. During the past year the WSCGA was active on a number of proposals.

Bravo – WSCGA supported efforts to re-establish a workable MRL for Bravo to continue to be able to ship fruit into the EU. These efforts included letters of support for the new tolerance, meetings with USDA trade Staff to stress importance of compound to industry and participation in task force established by the US Cranberry Marketing Committee.

Lorsban (chlorpyrifos) – In late 2015 the EPA proposed to revoke all tolerances for this important insecticide. The action was the result of a court case involving drinking water in the Pacific Northwest, unrelated to cranberry usage of the product. EPA was seeking comments through a public comment period that would include information on usage patterns.

Data showed that over 54% of the acreage in Wisconsin was treated with chlorpyrifos in 2014. Maintaining the registration was deemed by the WSCGA to be important to Wisconsin growers. WSCGA participated in an industry working group to prepare comments and a strategy to place the case for continued use on cranberry before the agency. Comments were filed on behalf of Wisconsin growers on January 5, 2016. A response from EPA is expected in early 2016.

Label Restrictions for Pollinator Protection – in August the WSCGA filed comments on a proposal by EPA to place language on a number insect control products to prohibit tier use during bloom. The language was broad enough that it could have left growers with limited options once bloom began. The association comments pointed out the management practices of Wisconsin growers to work with beekeepers to avoid applications which would impact pollinators. WSCGA suggested language to clarify when the prohibition applied and the potential impact on organic growers. WSCGA also encouraged EPA to allow state's the flexibility to meet state-specific needs through expedited responses to requests for Section 18 and 24c registrations and uses.

Pesticide Applicator/Certification Program – The EPA also proposed major changes to the Pesticide Applicator Training and Certification Program. WSCGA worked with the Wisconsin DATCP to file comments asking for modifications to the proposal, many of which were unworkable for the state. Some of the proposed changes included the elimination of open book tests, requiring certification every three years (now 5) and making significant changes to the content of the training program which could not be accomplished with the current resources. The proposal would also require action by the Wisconsin Legislature and formal rule making by the DATCP to become effective. WSCGA encouraged EPA to give the states the needed flexibility to continue the program which has been effective and successful in Wisconsin.

USDA Purchases of Cranberry Products

WSCGA has been a leader in efforts to encourage USDA to use its authority under Section 32 to purchase cranberry products for school lunch programs and other feeding programs that the agency supports. The association has worked with other groups to secure letters from members of the Congressional Cranberry Caucus and written directly to USDA requesting action. More than $30 million in purchases were announced by USDA this year as a result of this industry wide effort.

Nutritional Labeling

The US FDA sought comment on a proposal to develop a Recommended Daily Allowance for added sugar and to have the information posted to nutritional labels on products. WSCGA joined with other cranberry groups to present comments in opposition to the proposal based upon the potential impact to growers as well as the lack of scientific rationale for the proposal.

Communications & Marketing Highlights from 2015

The WSCGA Communications Program is developed as part of a team effort with the Public Relations Committee and the team at LC. The overall objective is to create a positive public perception of cranberry growing in Wisconsin. In 2015, the program shifted to promote consumption of cranberry products emphasizing their taste, versatility and health benefits. By developing a positive image of cranberry growing and public support for the needs of a prosperous industry, WSCGA is able to achieve success in the public policy arena, as well as secure support for research, extension and other programs.

Grocery Store Sampling

To help increase awareness among consumers of cranberries and how they can be used in everyday cooking, Laughlin Constable worked with six different Festival Foods stores throughout the Fox Valley to sample cranberry recipes the weekend of the Fourth of July. In order to appeal to holiday shoppers, the recipes were picnic-style food and drinks, including a vodka and cranberry juice cocktail and a cranberry broccoli deli salad. The cranberry samples were popular with shoppers and helped push sales of both products over the busy holiday weekend.

Wisconsin Athletic Sponsorships/Events

WSCGA uses grants from the Wisconsin Cranberry Board, Inc. for radio sponsorships with the Milwaukee Brewers Radio Network and UW Badger Sports Properties. The team at Laughlin Constable helps coordinate the effort and produce the radio scripts. As part of the UW sponsorship, WSCGA is also given various opportunities to sample cranberries and cranberry products at UW events, including two football games, a men's basketball game, the CrazyLegs Classic run, the Spring Family Fun Day and the spring football game.

A special thank you to Butch Gardner and Badger State Processing for providing sample packets of dried cranberries, Andy Reitz of Mariani Packing for supplying Cranberry Honey bars and Jim Peterson of Ocean Spray Cranberries for supplying juice for sampling.

Branding

Because of the increased event presence and sampling opportunities, Laughlin Constable assisted WSCGA with the creation of a pop-up tent and banners that would help to brand the space and create attention for Wisconsin Cranberries. These were used at Badger Football and Basketball games, CrazyLegs, the Berry Health Benefits Symposium and more.

Additionally, Laughlin Constable helped to create a new cranberry mascot that could further draw attention to the brand. The new mascot, which made its debut at the Wisconsin State Fair, is a more modern and much more wearer-friendly update to the old mascot. To generate some additional attention for the new mascot, a naming contest was held on Facebook for fans of Wisconsin Cranberries to get involved. The winning name? Ruby.

WISCONSIN CRANBERRIES

Made With WISCONSIN CRANBERRIES

Lastly, Laughlin Constable continued to build off of last year's effort to develop a brand identity for the cranberry industry in Wisconsin through the creation of the general "Wisconsin Cranberries" logo and the "Made With Wisconsin Cranberries (MWWC)" logo. This year, the MWWC logo was officially launched when the O&H Danish Bakery came on board as the first partner. The launch included a traditional media push, as well as Kringle giveaways on social media, and various other cross-promotional opportunities. Habelman Bros. Company also came on board as a partner and already uses the Wisconsin Cranberries logo on its Naturipe packaging. As the Association's marketing partners grow, both consumer facing logos will continue to be used more.

Wisconsin State Fair

For more than a decade, Laughlin Constable has coordinated media efforts for the WSCGA booth at the Wisconsin State Fair. The 2015 effort featured the now year-old mini marsh built specially for the Fair, which includes a flooded marsh on one side and real vines on the other.

After hearing negative feedback from fair-goers about the absence of food in 2014, Laughlin Constable worked with WSCGA to bring back limited food sales. Products for sale included two flavors of Cran-on-a-Stick – traditional and coconut, the now-famous Cranberry and White Chocolate Chunk Cookies, plus single-serve bottles of cranberry juice cocktail and PACt water.

In addition, other Fair promotional efforts included media drops to radio and TV stations on site, media interviews, social media ads, and a Charlie and the Chocolate Factory-style contest, which challenged fair-goers to find the "Golden Ticket" in their Cran-on-a-Stick to win cranberries for a year.

Web and Social Media

Laughlin Constable manages the WSCGA's website and social media accounts, including Facebook, Twitter, Pinterest and YouTube, on an ongoing basis. This includes reviewing and updating the website to keep it fresh and relevant. Laughlin Constable also works to make sure there is consistently new content on the WSCGA's social media channels and coordinates sponsored posts to boost engagement. With the addition of paid Facebook posts in 2015, WSCGA's fan engagement grew exponentially. The WSCGA's presence on social media continues to help communicate industry news, build and maintain relationships with partners and loyalists, and introduce more fans to cranberries and how they can be enjoyed year-round.

Berry Health Benefits Symposium

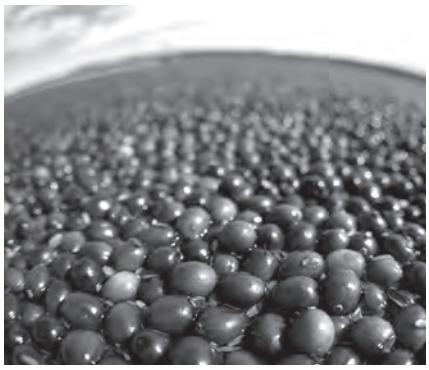
The National Berry Crops Initiative held its 2015 Berry Health Benefits Symposium in Madison in October. The event hosted hundreds of berry health researchers and berry producers from around the world. WSCGA had a booth on site where attendees could learn about the cranberry industry. In addition WSCGA sponsored the event's Wisconsin Cranberry Discovery Tour held on the final day of the event, which Laughlin Constable helped to coordinate. About 60 people joined the tour, where they were able to see a traditional harvest, a fresh fruit harvest and a receiving station. The event was successful in educating an important group of researchers and product manufacturers on the importance of the cranberry industry in Wisconsin and the role it plays worldwide.

Fall Harvest Media Relations

Each year, Laughlin Constable assists with the WSCGA's media efforts surrounding the annual cranberry harvest. This year's media strategy focused on generating media interest in several different key news items: the announcement of crop projection figures; the national Berry Health Benefits Symposium being held in Wisconsin; a Mexican food buyers tour of Wisconsin's cranberry country; and a visit from the UW Chancellor to the marshes. Laughlin Constable also helped to coordinate additional harvest photo, tour and information requests from media, including interview requests from NPR, Upworthy, NBC and many other local, regional and national outlets. The media relations effort resulted in more than 62 million impressions.

UW Harvest Promotion

In addition to WSCGA's sponsorship of UW Athletics, this year Laughlin Constable assisted the Association in helping to leverage the UW partnership to create interest in and buzz surrounding the cranberry industry and how it works together with the University. The effort was threefold, and included a visit from UW Chancellor Rebecca Blank to the marshes to help strengthen the relationship between UW and the cranberry industry; the creation of a giant Motion W out of cranberries, photos of which were used on social media and framed and presented to the chancellor; and collaboration with UW Communications and the Chancellor's Office to create social chatter surrounding the UW vs. Rutgers football game.



Research Programs – 2015

Research Coordination and Administration

Although the WSCGA does not have a direct research program it does provide administrative services to the Wisconsin Cranberry Board, Inc. Under this agreement WSCGA provides the needed administrative services for the WCB. This allows WCB to maximize its investment in research, education and promotion programs on behalf of the Wisconsin growers. WCB is able to hold down administrative costs by sharing these expenses with the association.

As part of this service the WSCGA also works with other cranberry groups to coordinate research activities to avoid duplication, create synergies and partnerships to maximize the investments by growers.

Education Program Highlights - 2015

Education is a major component of the WSCGA Mission. The organization's Education Committee works throughout the year to present programs for growers on improving management practices with the goal of allowing growers to operate their farms in an economically sustainable manner.

Wisconsin Cranberry School

The 2015 Wisconsin Cranberry School was held at the Holiday Inn Hotel & Convention Center in Stevens Point, WI. With more than 400 registrants, the event provided educational sessions, an interactive grower management session, and a forum for growers and related affiliates to exchange ideas and best practices in the cranberry industry. The School is the signature education event for the WSCGA.

The annual program is sponsored as a collaborative effort by the Wisconsin Cranberry Research & Education Foundation (WCREF), the Wisconsin State Cranberry Growers Association, and UW-Extension.

A Pesticide Applicator Training and Certification (PAT) session with information and exam was provided on-site as a one-stop convenience to growers by Wood County Extension, and facilitated by Matt Lippert.

A legislative counsel update presentation was made by Jordan Lamb from DeWitt, Ross & Stevens of Madison, and a communications and public relations presentation was provided by Mikaela Balfany of Laughlin Constable, Milwaukee. A popular session utilizing live CLKR technology provided growers with insights into industry management practices. A range of questions were posed to the audience; growers responded with their respective answers on the hand-held device, and could see an immediate summary of the results, which showed the percentages for each answer of each question.

Presentations by session speakers covered a diverse array of topics, from plant and insect phenology to cranberry variety improvement research, from cranberry virus and disease issues to the cranberry genetics and genomic program, from soil moisture monitoring to nutrient management and honeybee hive location research. There were also update research sessions on cranberry varieties and their resistance to insect pests, carnivorous arthropods activity after spring floods, fungicide applications effect on bee fidelity, pheromone mating / moth birth control in cranberries, cranberry pesticides update reports, and problematic weed management strategies.

Additional sessions provided information on truck maintenance, welding tips / techniques / equipment, safety on the marsh and around the shop, how to maintain stored diesel fuel quality, and opportunities for adopting new technologies in cranberry farming. A grower panel session focused on irrigation decision-making tools for growers.

At the Thursday, January 22 Cranberry School luncheon, WSCGA Board President Mark Mahoney presented two special anniversary awards to UW guests. The first award, in honor of the 125th anniversary of the UW Madison College of Agricultural & Life Sciences (CALS) was presented to Katherine (Kate) Van den Bosch, Dean of the College of Agricultural Sciences at UW-Madison. A second award was presented to Irwin Goldman, Dean of the School of Horticulture at UW Madison. Both organizations were recognized for the "125 years of Positive Contributions to the Citizens of the State of Wisconsin, and to the Agriculture and Cranberry Industry."

Nutrient Management Training Sessions Held April 15-16

In mid-April, about 50 people attended the Nutrient Management training sessions held at two locations and co-sponsored by the WSCGA, USDA / NRCS and UW Extension.

The full-day workshop in Wisconsin Rapids was designed to help cranberry farmers write their own nutrient management plans to meet DATCP requirements. Wisconsin DATCP also requires that farmers complete a department-approved training course at least once every four years to maintain their qualification.

Half-day nutrient management sessions were held in Tomah and Wisconsin Rapids, for those seeking refresher training on the topics.

Presentations were provided by Patrick Murphy, Jon Field, and Tom Frederickson from the NRCS, along with Leroy Kummer from Ocean Spray Cranberries and Amaya Atucha from UW Extension. Since the start of the program more than 400 growers have participated in the training to become qualified to write a nutrient management plan for their farm.

Early Season Grower Workshops Held April 22

The WSCGA and UWEX co-sponsored two early season grower workshops – one at Beltz Cranberry in Warrens, and the other at Elm Lake Cranberry in Wisconsin Rapids on Wednesday, April 22. More than 125 participants attended the two workshops, available to growers at no charge.

These events are held each spring to update growers on new management practices and strategies for the growing season, review of winter impacts on crop, new crop production tools available, and informal discussions on the 2015 growing season. Topics included Bravo restrictions / possible replacement options, growing degree day calculator, virus research updates, weed management strategies, pollination, cold hardiness and root physiology.

A demonstration of an Unmanned Aerial Vehicle (UAV) was provided by Brian Luck of UW Extension. Updates and presentations were provided by UW researchers Amaya Atucha, Jed Colquhoun, Jack Perry and Beth Workmaster. Crop consultants also provided observations from the field.

Summer Meeting, Field Day and Trade Show

The 128th Summer Annual Meeting, Field Day and Trade Show was held at the Wisconsin River Cranberry in Nekoosa. With beautiful summer weather and a great turn-out, this year's event was hosted by Bill Wolfe and his marsh staff. An estimated crowd of nearly 1,000 people attended and participated in the event. Marsh bus tours were held from 9:00 a.m. - 2:30 p.m. There were also 3 mini sessions for growers to attend and 87 on-site exhibits. More than 800 lunches were served between 11:00 a.m. and 1:00 p.m.

WSCGA NEWS

Each month members of the WSCGA are provided with up to date information on the cranberry industry, news, activities and anything that would be of interest to the growers of Wisconsin's number one fruit crop. WSCGA coordinates the publication of the newsletter and solicits articles from a cross section of organizations and individuals. The *NEWS* is distributed in both print and electronic form with over 500 people on the subscription list.

Weather Forecasting

The Wisconsin Cranberry Board, Inc. has provided funding for weather forecasting services for decades. WSCGA administers the program for the industry. Working with forecasters from Great Lakes Weather Services daily forecasts are available online and via a toll free number. The forecasts are specific to cranberry farms and are an important tool for growers as they make decisions about management practices such as frost protection. The forecasts are available April 15 through October 31.

Associate Member Programs

The WSCGA has an active program for the businesses that support the industry in the state. Associate Membership in WSCGA allows these companies to participate in a wide variety of marketing opportunities. The most popular are the Winter and Summer Trade Shows, Advertising programs in the WSCGA *NEWS* and the Summer Meeting publications. Associate members are also actively involved in industry events such as the annual Cranberry Open Golf Outing and the Sporting Clays Shoot.
A committee of the Associate membership works with WSCGA Staff to develop and conduct these programs. Highlights for 2015 include:

Winter Trade Show

The event conducted in conjunction with the Wisconsin Cranberry School and the WSCGA Winter Meeting, the 2015 Trade show was held on Wednesday, January 21 at the Holiday Inn Hotel and Convention Center in Stevens Point WI. The 2015 show included 94 exhibitors at the event – including 8 new exhibitors. In addition to the Expo Room and Main Hallway, exhibitor booth space was provided in the commons area adjacent to school session meeting rooms. All exhibitors are Associate Members of the WSCGA.

This was also the first year the WSCGA offered online trade show registration AND membership payment via credit card for all WSCGA new and renewing members. Paying for WSCGA

membership and trade show booth online saves time for exhibitors, and allows them to select their own booth location. Nearly 60% of exhibitors registered for the Trade Show via Booth Boss, a vendor-contracted online registration system. About 18% of Associate Members paid WSCGA membership online via credit card in the first year this service was offered.

Also new in 2015, Marshfield Clinic – National Farm Medicine Center provided a free skin cancer screening clinic for all event participants. After providing only an age range, residence zip code and category of occupation information, booth visitors received a free analysis of any skin concerns with 8 doctors and dermatology specialists from Marshfield Clinic. Free skin care products and sun hats were provided to booth attendees.

Trade show time was also increased for Cranberry School attendees, after the morning Opening Session. For maximum flexibility, the extra time allowed school registrants to visit exhibits prior to the start of the Cranberry School from 8:00 to 9:00 am, during scheduled breaks, and during the 3 designated lunch times. Trade Show exhibitors provided samples, demonstration, shared new materials, exhibited on-site equipment, and introduced new products and services.

Summer Trade Show

The 2015 Summer Trade Show was held in conjunction with the WSCGA Summer Meeting and Field Day at Wisconsin River Cranberries in Nekoosa, WI. The trade show include both indoor and outdoor booths with 87 total booth spaces occupied for the event on August 5.The Summer Trade Show is the largest grower event held by the WSCGA.

WISCONSIN STATE CRANBERRY GROWERS Association

WSCGA MISSION:

The mission of the Wisconsin State Cranberry Growers Association is to enable the cranberry industry in Wisconsin to prosper through the provision of grower information, responsible environmental stewardship, sound governmental policies and effective public communications.