Presentation Summaries
ACGA Winter Meeting Program
Thursday, January 24, 2013

8:00-8:30 Registration and Coffee

8:30-8:40 Welcoming Remarks—Shawn Cutts, President, ACGA
   Treasurer’s Report – Shawn Cutts

8:40-9:00 Transition to Rutgers Plant & Pest Advisory Online
   Jack Rabin, Associate Director - Farm Programs, Rutgers New Jersey Agricultural Experiment Station

9:00-9:25 An Update on Fruit Rot Resistance Breeding and Promising Selections
   Nicholi Vorsa, Jennifer Johnson-Cicalese, Department of Plant Biology and Pathology, Rutgers University

9:25-9:50 Effects of Mid-day Misting on Canopy Temperature and Cranberry Production
   Patrick Burgess, Nick Vorsa, and Bingru Huang, Department of Plant Biology and Pathology, Rutgers University

9:50-10:15 Evaluation of New Insecticides against Lepidopteran Pests
   Cesar Rodriguez-Saona, Department of Entomology, Rutgers University; Vera Kyryczenko-Roth, P.E. Marucci Center; and Robert Holdcraft, P.E. Marucci Center

10:15-10:30 Break

10:30-10:55 Managing Cranberry Beds for Production and Disease Control
   Peter Oudemans, Department of Plant Biology and Pathology, Rutgers University

10:55-11:20 Application of Next-generation Sequencing Technology for Pathogen Identification
   James Polashock, Research Plant Pathologist, USDA-ARS

11:20-11:45 Cranberry Weed Control Update
   Brad Majek, Rutgers Agricultural Research and Extension Center, Bridgeton

11:45-12:00 Update on Research Council Activities and Support of the Research Station
   Joe Darlington, Chair, Research Council

12:00-1:00 Lunch

1:00-1:30 Late Water: The Massachusetts Experience
   Frank Caruso, Department of Plant and Soil Sciences, University of Massachusetts
1:30-2:00 **BOGS Online Grower System, A Decision Management Tool and Record Keeping Program**
   *Brian Wick, Cape Cod Cranberry Growers' Association*

2:00-2:30 **Sparganothis Fruitworm Phenology**
   *Shawn Steffan, Research Entomologist, USDA-ARS, University of Wisconsin-Madison; Cesar Rodriguez-Saona, Rutgers University; Annie Deutsch, University of Wisconsin-Madison; and Vera Kyryczenko-Roth, Rutgers University*

2:30-3:00 **What are the real farm safety hazards on our farms?**
   *Ray Samulis, Burlington County Agricultural Agent, Rutgers University*

3:00 **Adjournment- ACGA Board of Directors Meeting**
AN UPDATE ON FRUIT ROT RESISTANCE BREEDING AND PROMISING SELECTIONS

Nicholi Vorsa and Jennifer Johnson-Cicalese
Department of Plant Biology and Pathology
P.E. Marucci Center for Blueberry & Cranberry Research & Extension,
Rutgers University, Chatsworth, NJ

Fruit Rot Resistance Breeding

A major objective of the Rutgers/NJAES cranberry breeding program is to enhance fruit rot resistance in future varieties. New Jersey cranberry growers face the highest fruit rot disease pressure of all the growing regions, and fruit rot in NJ appears to be increasing in severity and scope. Moreover, fruit rot is also a significant issue in Massachusetts, and has become increasingly a problem in other growing regions, e.g., Wisconsin. Climatic factors in recent years, including record heat during summer and bed flooding, have exacerbated fruit rot pressure. Moreover, fungicides are facing more restricted use due to ‘minimum residue level’ issues, and are subject to potential loss of label.

We have identified fruit rot resistance, to varying degrees, in our germplasm (cranberry gene pool). However, the varieties exhibiting resistance, e.g. Budd’s Blues and Holliston, are either not commercially viable because of poor productivity, i.e. Budd’s Blues, or only show modest resistance, ‘Holliston’ type. Thus the focus of the cranberry breeding program, through breeding and selection cycles, is to develop consistently high yielding cultivars with significantly higher fruit rot resistance, along with superior fruit quality, e.g., TAcy. Progress has been made in these areas. We have identified cranberry accessions with resistance to fruit rot, used them in over 150 crosses, and have now begun evaluating their progeny. In 2009, 1624 progeny, from 50 crosses derived from four sources of resistant germplasm, were planted in field plots, with each family replicated twice. These crosses included parents with the greatest field fruit rot resistance (FFRR) crossed with elite high-yielding selections. In 2011 the final two fungicide applications were withheld from this planting and disease pressure was severe enough to screen for FFRR. In 2012, the plots had only one fungicide application at early bloom. Significant differences were found between families, and within families, in fruit rot ratings and rotten fruit counts. Families with the most resistant parents provided a higher frequency of resistant progeny, indicating potential for improving FFRR through breeding. In addition, there was a good correlation between 2011 and 2012 fruit rot ratings.Moderately high heritability estimates were obtained with offspring-mid-parent regression ($R^2 = 0.52$), indicating additive genetic variance for FFRR. ‘Additive gene effects’ suggests predictable genetic gain for FFRR in cranberry is possible. As mentioned earlier, our most resistant accessions are very poor yielding so we were pleased when we found both good resistance and high yield (> 600b/A est.) in some progenies. A note worthy of mention is that one of the most resistant clones, Budd’s Blues’, was used earlier in crosses in the Rutgers program over 20 years ago in the hope of improving FFRR. Unfortunately progeny from these crosses exhibited poor yields and the prospect of developing high yielding cultivars with FFRR did not seem hopeful. Additional progenies were planted in 2011 and 2012 for genetic studies of resistance, including resistant x highly inbred cranberry lines. The 2012 planting included replicated plots of the best progenies from 2011 results. These plots will be evaluated as soon as they are established. A genetic map of cranberry has provided SSR genetic markers. We are mapping these markers in our best new families segregating for FFRR to
identify genomic regions (QTLs) associated with resistance, and facilitate future progeny screening. A replicated trial of our FFRR material in Washington was well enough established this year to collect data and significant differences were found in fruit rot ratings and counts. Although there was much less disease pressure, our most resistant selections also had the least fruit rot under Washington conditions.

**Promising selections**

In our efforts to improve yield and fruit quality, several new selections are showing exceptional performance. Two selections are from crosses made in 1999. One selection is a result of a Crimson Queen® x N35 cross, from which 138 progeny were evaluated at the PE Marucci Bog 8 planting, and the second, from a N35 x NJS98-34 cross from which 112 progeny were evaluated. A plot each of Stevens and Ben Lear were included as comparisons. Both selections had yields over 500 g/ft², whereas, yields of Stevens and Ben Lear were less than 400 g/ft² (See table 1). Mean berry weight and percent fruit rot is given in Table 2.

Table 1. Yield, total anthocyanin content (TAcy), and soluble solids (Brix) of fruit harvested September 7, 2006 and September 12 and 25, 2007, Chatsworth, NJ.

<table>
<thead>
<tr>
<th>Selection</th>
<th>2006 Yield g/ft²</th>
<th>2006 TAcymg/100g Sept 7</th>
<th>2006 Brix Sept 7</th>
<th>2007 Yield g/ft²</th>
<th>2007 TAcymg/100g Sept 12/25</th>
<th>2007 Brix Sept 12/25</th>
</tr>
</thead>
<tbody>
<tr>
<td>CQ x N35</td>
<td>546</td>
<td>12</td>
<td>7.5</td>
<td>526</td>
<td>15</td>
<td>9.2</td>
</tr>
<tr>
<td>N35 x NJS98-34</td>
<td>561</td>
<td>20</td>
<td>7.3</td>
<td>594</td>
<td>17</td>
<td>7.7</td>
</tr>
<tr>
<td>Stevens</td>
<td>255</td>
<td>5</td>
<td>7.3</td>
<td>357</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>Ben Lear</td>
<td>327</td>
<td>24</td>
<td>8.1</td>
<td>169</td>
<td>24</td>
<td>9.7</td>
</tr>
</tbody>
</table>

Table 2. Mean fruit weight and percent fruit rot of fruit harvested September 7, 2006 and September 12 and 25, 2007, Chatsworth, NJ

<table>
<thead>
<tr>
<th>Selection</th>
<th>2006 Mean fruit wt</th>
<th>2006 % fruit rot</th>
<th>2007 Mean fruit wt</th>
<th>2007 % fruit rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>CQ x N35</td>
<td>2.5</td>
<td>11.2</td>
<td>2.0</td>
<td>1.7</td>
</tr>
<tr>
<td>N35 x NJS98-34</td>
<td>2.4</td>
<td>20.8</td>
<td>2.4</td>
<td>11.9</td>
</tr>
<tr>
<td>Stevens</td>
<td>2.5</td>
<td>26.6</td>
<td>1.9</td>
<td>17.8</td>
</tr>
<tr>
<td>Ben Lear</td>
<td>2.2</td>
<td>29.6</td>
<td>2.1</td>
<td>10.1</td>
</tr>
</tbody>
</table>

These two selections are also planted in replicated variety trials in OR (2010), WA (2011), WI (2009), and BC (2012). In Oregon these selections are performing remarkably well.
EFFECTS OF MID-DAY MISTING ON CANOPY TEMPERATURE AND CRANBERRY PRODUCTION

Patrick Burgess, Nick Vorsa, and Bingru Huang
Department of Plant Biology and Pathology, Rutgers University

New Jersey cranberry growers have been employing mid-day irrigation as a common practice to alleviate heat stress during summer months. A previous study found that proper use of irrigation misting can alleviate mid-day depression of photosynthesis and maintain lower canopy temperature during peak sun hours. Whether canopy cooling and heightened photosynthesis may promote plant growth and physiological activity governing berry production is not well documented. A field study was conducted with the cultivar ‘No. 35’, Bed 7 at the PE Marucci Center, during summer 2012 to investigate whether mid-day misting can promote cranberry leaf and up-right growth, fruit count and weight per up-right, leaf chlorophyll content, as well as carbohydrate accumulation in leaves and fruit.

APPROACH: Canopy temperature and leaf wetness were also continually monitored using automated data loggers with sensors attached to plant up-rights. Treatments included irrigation misting when canopy temperature reached 90 °F, 95 °F, or no irrigation applied (control).

RESULTS: Irrigation at both 90 °F and 95 °F effectively cooled the leaves compared to controls but irrigation at 90 °F was more effective for cooling and had more positive effects on cranberry growth. Leaf temperature was 7-14 °F lower compared to controls when plants were misted at 90 °F and 3-5 °F lower at 95 °F. By mid-September, plants misted at 90 °F had significantly longer up-rights with increased leaf density or greater number of leaves per up-right. Leaf area and chlorophyll content were also significantly higher due to misting at 90 °F which facilitates better light harvesting for photosynthesis. Most importantly, the number of fruits per up-right was higher due to misting at 90 °F with plants having on average 7% more fruits compared to controls. During all sampling days including final harvest, mid-day misting treatment did not have significant effects to fruit weight or carbohydrate production in leaves or fruits. Results from 2012 reflect short term treatment effects from ten weeks of mid-day misting. If cranberry plots are continually misted for several years, the accumulative impact may be more significant. Future research should investigate the effects of mid-day misting on cranberry production for a large-scale commercial growing site over multiple years’ time. The study will be repeated during summer 2013 to confirm results.
EVALUATION OF NEW INSECTICIDES AGAINST LEPIDOPTERAN PESTS

Cesar Rodriguez-Saona, Vera Kyryczkenko-Roth, and
Robert Holdcraft
P.E. Marucci Center

Within the last few years four new reduced-risk insecticides, Assail, Delegate, Rimon, and Altacor, have been registered for use in cranberries. Another insecticide similar in chemistry to Altacor is expected registration soon. Adoption of these new insecticides among New Jersey cranberry growers will require testing their toxicity against major cranberry pests. Studies were conducted to evaluate toxicity of Assail, Delegate, Rimon, Altacor, and other insecticides against spotted fireworm and Sparganothis fruitworm to increase adoption of these reduced-risk insecticides among New Jersey cranberry growers.

RESEARCH OBJECTIVE

Compare the insecticidal toxicity of Assail, Delegate, Rimon, Intrepid, Altacor, and other insecticides on spotted firweworm and Sparganothis fruitworm.

APPROACH

Field and semi-field experiments were conducted in 2011 and 2012 to determine the activity of insecticides with different modes of action on spotted fireworm and Sparganothis fruitworm larvae. Foliar applications of Lorsban, Assail, Delegate, Intrepid, Rimon, Altacor, and an unregistered insecticide were applied to small (4-by-4 feet) cranberry plots. Residual toxicity of these insecticides was evaluated by placing spotted fireworm and Sparganothis fruitworm larvae on field-weathered foliage.

In addition, field studies were conducted in 2012 to compare the toxicity of Altacor and Intrepid against spotted fireworm larvae (pre-bloom application).

RESULTS

Our data show that Altacor is effective against spotted fireworm and Sparganothis fruitworm larvae. Altacor was equally effective as compared with Lorsban, Delegate, and Intrepid. Altacor can be rotated with these insecticides to reduce risk of resistance development.

<table>
<thead>
<tr>
<th>Cranberry</th>
<th>Blackheaded fireworm*</th>
<th>Cherry fruitworm</th>
<th>Cranberry fruitworm</th>
<th>Green spanworm</th>
<th>Omnivorous leafroller</th>
<th>Raspberry crown borer</th>
<th>Sparganothis fruitworm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.066 – 0.099</td>
<td>3.0 – 4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Blackheaded fireworm - use high application rate for moderate to heavy infestations.
ALTACOR® may be applied to cranberry by overhead chemigation. For specific guidance see label section titled APPLICATION BY CHEMIGATION – CRANBERRY.
Field experiment comparing the toxicity of Altacor and Intrepid against spotted fireworm in a commercial cranberry farm in New Jersey
Fairy ring is a unique disease found on cranberry plantings in the Northeastern region. The disease appears as expanding rings of dead vines with a zone of recovery near the center. Recent findings on this disease have shown that by keeping Briar/Loosestrife free of leaf rust, spread of Fairy Ring will be limited. The connection between cranberry and Briar represent a critical link in the disease cycle that, when disrupted, will stop the formation of new rings. Existing rings increase in diameter when the fungus grows among runners and roots located in the organic layers formed during sanding practices. In this fact sheet a discussion of the control of existing fairy rings using the fungicide Indar is presented.

THE PLAYERS

Infection pads are signs of a Fairy Ring infection. The infection pads are shown here on the surface of a dying cranberry runner as seen with 10X magnification. They are sign of the pathogen Thanatophytum sp. When sampling for diagnosis the runners should be collected from the leading edge of the ring with both living and dead uprights. The sample should be taken to a depth of at least six inches.

The rust hyperparasite, Tuberculina is shown here attacking pustules of Puccinia macropora, a pathogen of briar (Smilax). The purple colonies of Tuberculina contain spores that are carried in air currents. A second susceptible rust species was recently been identified: Puccinia minutissima infecting Decadon spp (Swamp Loosestrife)
Treating Fairy Ring on Cranberry

**Timing:** Begin applications at bud break - rough neck stages. Applications made after the onset of hook are much less effective.

**Treatment Area:** Measure 10’ beyond the active edge of the fairy ring and calculate the area of the shape. Shape is often close to circular however the area more irregular shapes may need to be measured using a GPS or GIS system or estimated using additional measurements.

**Fungicide Applications:** Applications should be made in a sufficient volume of water to carry the fungicide to six inches into the soil. Our testing indicates 0.2 gallons/ft\(^2\) is generally sufficient in typical sandy cranberry beds. Muck soils may require higher volumes.

**Fungicide Concentration:** Applications should be made in a sufficient volume water to carry the fungicide to six inches into the soil. Our testing indicates 0.2 gallons/ft\(^2\) is generally sufficient in typical sandy cranberry beds. Muck soils and older beds may require higher volumes.

To calculate rate first measure the total area of the bed and the total area to be treated. If the ratio of treated area to bed area is less than 0.2 then the maximum rate of Indar can be used (Formula 1). If the ratio is above 0.2 then the rate of Indar will have to be adjusted (Formula 2).

**Formula 1 (when treated area (ft\(^2\))/bed area (ft\(^2\)) ≤ 0.2)**

\[
\text{Indar } 2F \text{ fl.oz.} = \text{Fairy ring area (ft}^2\text{)} \times 0.0014
\]

\[
\text{Water (gallons)} = \text{Treated area (ft}^2\text{)} \times 0.2
\]

Combine Indar with the calculated volume of water and apply to the bed at a rate of 0.2 gallons/ft\(^2\).
**Formula 2 (when treated area (ft²)/bed area (ft²) > 0.2)**

Correction = Fairy ring area (ft²)/Exhibit A (ft²)

Indar 2F fl. oz. = (Fairy ring area (ft²) x 0.00028) / correction

Water (gallons) = Treated area (ft²) x 0.2

Combine Indar with the calculated volume of water and apply to the bed at a rate of 0.2 gallons/ft²

**Application:** Applications should be made by applying the calculated volume of diluted fungicide to the area to be treated. This can be done by first determining the flow rate from the pump and then determining the time required to deliver the desired volume.

Applying Indar 2F to a Fairy Ring.

**NOTES:**

DO NOT make applications in less than 0.2 gallons/ft² unless you are certain that the mixture will penetrate the soil to the desired depth.

To calculate desired depth using a soil probe measure the maximum depth where you can identify cranberry roots and/or runners.

DO NOT apply Indar 2F at a lower volume and then attempt to wash it in using irrigation. The fungicide will bind to the surface and not move to the desired depths.

DO NOT apply using chemigation using an excessive wash off time since this will also result in restricted movement downward.
APPLICATION OF NEXT-GENERATION SEQUENCING TECHNOLOGY FOR PATHOGEN IDENTIFICATION

J.J. Polashock
USDA-ARS

Identification of the causal agents of previously undescribed disorders in plants can be difficult.
- The disorder may not be caused by a pathogen
- Many disease-causing organisms cannot be cultured
- Symptoms can vary from cultivar to cultivar and year to year
- Viruses can be unstable and difficult to isolate
- The causal organism may not be present throughout the plant and titer can vary throughout the season.
- 'Universal’ detection methods may not work for all strains of a pathogen

Previously undescribed disorders frequently appear in cultivated plants, especially when the natural range is expanded or new cultivars are planted. The first step in diagnosing any new disorder is to determine if the cause is apparently due to pathogen infection, or some other factor. Careful notes can help in this process, such as the source of the plants, spray and other treatment records, ground preparation and previous use information, weather data, area affected and spread, etc. Genetic mutations can also be the cause and these can be difficult to pinpoint. If the data suggest a pathogen is involved, various methods can be used to isolate and/or identify the causal agent.
- Plants can be cultured and monitored for fungi and bacteria
- Viruses can be isolated and purified
- Phytoplasmas can be detected using molecular methods.

However, all of these methods can be very time consuming and can fail at various steps.

Next-generation sequencing allows a new approach to the identification of unknown pathogens. We now have the ability to sequence the entire transcriptome (i.e. of the genes being expressed in an organism in a given tissue and at a given time). The sequences can then be ascribed to putative functions based on similarities to previously characterized genes. The assumption here is that the causal agent (i.e. the pathogen) is expressing its own genes. Most of the genes detected will be host (plant) genes, but non-host genes should also be present.

We tested this approach in the identification of the casual agent of ‘funky flower’ in cranberry. The transcriptome was sequenced from control and affected cranberry flowers. Over 81,000 gene fragments were identified in each data set. Three genes were identified in the affected plants belonging to a virus in the Caulimoviridae. The closest similarity in the database was to blueberry red ringspot virus isolates from Europe.

Now that a potential pathogen has been identified, Koch’s Postulates must be demonstrated to prove causation. We are now at this step in our efforts to identify the causal agent of funky flower.
Quinstar 4L has been labeled for use in NJ for the past several years under Section 18 Emergency Exemptions, but use has not been allowed by Ocean Spray Inc. due to the lack of a tolerance for Quinstar 4L in Europe for export products. Quinstar 4L now has a full federal label for use on cranberries in the United States. Unfortunately, the European export problem has not yet been resolved.

Herbicide screening in cranberries also identified Quinstar 4L as a potentially useful herbicide for use with good crop safety more than fifteen years ago. Good crop safety has been observed at up to four times the labeled rate when applied to dormant cranberries in early spring or to actively growing and blooming cranberries in late spring or early summer. Experiments conducted to evaluate the control of serious annual and certain perennial cranberry weeds in growers’ bogs have indicated that Quinstar 4L has the potential to control weeds that cannot currently be easily controlled in cranberries. Applied at 8 fl. oz./A (0.25 ai/A), Quinstar 4L has controlled yellow loosestrife also known as swamp candle to some cranberry growers, when applied in early summer after cranberry bloom, near or shortly after the weed blooms. False nutsedge and other annual weeds have been controlled by Quinstar 4L when applied the spring.

Dodder has been an increasing problem in cranberry bogs in recent years, since the cancellation of the Furlo registration for cranberries. Quinstar 4L applied at 8 fl. oz./A (0.25 lb ai/A) plus 1 percent oil concentrate was evaluated for dodder control in cranberries. The herbicide was applied in June after dodder had germinated and begun to attach, in July after attachment, and at both timings. The June application initially controlled dodder, but recovery was evident by August. Dodder bloom was delayed from late July to mid August, but not prevented. The application of Quinstar 4L in July did not control dodder. Two applications of Quinstar 4L, in June and in July was the only treatment that provided season long dodder control. The failure of the July treatment to control dodder strongly indicates timing of the application is critical to obtaining acceptable control. Quinstar 4L, applied earlier in the spring before attachment and at or immediately before dodder germination, followed by a second application in early summer, is likely to provide the best control and need to be evaluated further.
“Late Water” (LW) is a practice used by growers since early in the 20th century, wherein the cranberry bed is flooded for four weeks from mid-April to mid-May after removal of the winter flood earlier in the spring. It was originally used by growers to protect the vines from frost during the period, but it became apparent that there were many other benefits offered by the flood with respect to disease, insect and weed management.

The LW flood is typically applied when the leaves have turned green but the buds are still tight and red. The flood should be at least 30 cm above the vines, a deep flood, to insure that all of the vines in the bed are well-covered by the water. In certain beds, the water will need to be continually pumped to make certain that some of the vines are not exposed to the air. These exposed vines would begin to lose dormancy and grow, thus making them vulnerable to frost injury. Although the flood is usually held for four weeks, if temperatures are significantly above normal (as they were in 2012), algal growth will be a problem, necessitating applications of algicides or removal of the flood. Once the flood has been withdrawn, vines are super-sensitive to frost injury, and growers must take great care that the buds are protected when temperatures approach freezing.

There are many consequences of the LW flood:

1. Bloom is synchronized and berry maturity can be delayed
2. Suppression of fruit rot, improved fruit quality
3. Suppression of cranberry fruitworm, Southern red mite, cutworms
4. Suppression of dewberry, goldenrod
5. Stimulation of growth in established beds, vine expansion in renovated beds

The main downside of the LW flood is a possible reduction of the crop during the year of LW by 5-15%. Extra expense may be incurred if the flood needs to be continually maintained at a deep depth by pumping the water from the holding pond. In unique circumstances, berry shape may be affected for a certain percentage of the crop.

LW should not be held if the following occurred:

1. Vines are stressed at the end of the winter
2. The bed had a big crop during the previous fall
3. The fall was especially mild, thus preventing the normal hardening off of the vines
4. The winter was particularly mild
5. The bed had been sanded during the winter

LW is not used as often as it was 20 years ago in Massachusetts. The practice has the stigma of reducing crops, and growers are wary of this. Currently registered fungicides and insecticides do a superior job of managing fruit rot and fruitworm. It remains, however, one of the best cultural tools for management of these pests by organic growers.
BOGS ONLINE GROWER SYSTEM,
A DECISION MANAGEMENT TOOL AND RECORD KEEPING PROGRAM

Brian Wick
Cape Cod Cranberry Growers’ Association

The Cape Cod Cranberry Growers’ Association created a straight-forward record keeping program in 2010 for tracking pesticide and fertilizer use. This was a MS-EXCEL spreadsheet and served its purpose well. In 2012, the decision was made to add more functionality and mobility to this concept. That vision lead to the creation of the BOGS Online Grower System. BOGS is an Internet-based application that not only has the capabilities of tracking pesticide and fungicide use but also IPM sweep results, soil and tissue test results, water use, sanding, creating work orders and insect pest identification. Also included are the individual cranberry handler pesticide use reports, a delivery report that identifies the earliest a particular section of bog can be harvested based on PHI, pesticide use by bog, contract or date, total fertilizer use for the season and relevant Massachusetts reports such as the state pesticide use and a public drinking water regulatory statute for growers in specific regions. Included are each of the major handler’s pesticide restrictions for different fruit market types, warnings on total pesticide use or rates that exceed label requirements, current EPA registration numbers, re-entry times, pre-harvest intervals and more.

The insect identification tool is specific to Massachusetts cranberry pests, based on the annual University of Massachusetts Cranberry Chart Book. This is a two-part program with the first part designed to help growers identify unknown insects through a series of questions. Answering these questions helps to narrow down the list of possible insects, like a funnel. Color photographs and relevant fact sheets help further confirm the insect. Once the pest has been identified, the second part of the program comes up with possible control options, including cultural and chemical. A further set of questions determines if these control options make sense for the grower’s particular operation. The questions take into account the efficacy of the grower’s chemigation system, past chemical use and a variety of environmental considerations. The goal is to have a tool that can be used in the field to help quickly identify insect pests and/or control options.

The overall goal of BOGS is added mobility, increased efficiencies, regulatory compliance and real-time decision making. There is a yearly subscription fee for use of the system. Much of the work in building this application has come from grant funds. One of the grants we currently have obtained is an education grant funded through the USDA’s Risk Management Education program. The purpose of the grant is to educate more growers on the use of BOGS, helping them become more efficient, complaint and improve their pest and fertilizer management programs. The other component of the grant is to investigate if any other cranberry growing regions would be interested in using BOGS. Visiting with New Jersey growers is a logical first step. Although our regions are different, we also have a lot of similarities. We are curious in determining if there is interest in BOGS, what modifications would New Jersey growers want to see and then decide if it makes sense for both CCCGA and New Jersey growers to pursue the use of BOGS in a different growing region.
SPARGANOTHIS FRUITWORM PHENOLOGY

Shawn Steffan, Research Entomologist, USDA-ARS, University of Wisconsin-Madison
Cesar Rodriguez-Saona, Rutgers University
Annie Deutsch, University of Wisconsin-Madison
Vera Kyryczenko-Roth, Rutgers University

Sparganothis fruitworm, *Sparganothis sulfureana* (SFW), is one of the most significant, consistent pests of the cranberry industry. Controlling SFW has proved to be difficult, partly due to the fact that some of the basics of its biology and phenology remain unknown. A key element of successful pest management is knowing the life history of the pest. This allows growers to refine their control strategies to target the life stages most vulnerable. Phenology models that depict an insect’s development provide the means to track an insect’s growth throughout the year. An insect’s developmental rate is highly temperature-dependent, and degree-days are commonly used to measure this development. In order to quantify degree-days, the upper and lower temperature thresholds for growth must be determined. To these ends, we measured SFW larval growth rates over a wide range of controlled temperatures (44-101°F). Growth rates were then plotted against temperature, and a model was fit to the dynamic. From this model, we were able to determine the lower (48°F) and upper (85°F) development thresholds of SFW larvae. The thresholds were used to generate degree-day (DD) accumulations that were linked to developmental events, such as flight initiation and length, adult lifespan, pre-ovipositional period, ovipositional period, and egg gestation period. These DD accumulations represent key developmental benchmarks, helping to optimize pest management in the cranberry system.
Late Water (LW) is a 30-day spring reflood applied several weeks after the winter flood has been removed and before the plants have lost dormancy (not yet fully green). LW suppresses some insects and Southern red mite (SRM). Fruit rot disease is reduced on LW bogs and keeping quality is improved. LW has also been shown to suppress growth of dewberries (brambles).

**Significant reductions in pesticide inputs may be achieved with the use of late water.**

**FLOOD MANAGEMENT**

*When to use LW:* Late water should be used no more than one year in three. If the previous summer was very sunny and none of the adverse weather conditions listed below are present, the use of LW should be considered for its benefits in insect, mite, disease, and weed control (see below).

*When not to use LW:* To minimize crop reduction, late water should not be used more often than once every three years. Bogs with poor quality water supplies may not be good candidates for late water. Do not use LW if the winter has been unusually cold or abnormally warm (particularly if the fall was also warm). **Do not use LW in the spring following a fall flood.**

Experience has shown that in some years (on average, 1 in 10 years) late water bogs may produce significantly (>10%) lowered yields. Overall, however, this low yield may be offset by higher yields in subsequent years. Costs in the LW year should also be less, particularly if inputs are reduced due to reduced pest pressure, helping to offset any losses. It is not known exactly what factors contribute to these occasional lower yields, but avoiding LW in the conditions listed above should provide some insurance against a large crop loss.

*When to apply the flood:* The flood should be applied in the spring prior to the breaking of bud dormancy. The leaves will be beginning to lose their dormant red color but the flower buds should still be red and tight. Generally, the 30-day LW flood will be applied between April 15th and 20th. If temperatures in late March - early April are warm (5°F per day above normal) or the season is early due to warm winter temperatures, the flood may be applied earlier (up to one week). Do not apply the flood if the buds have broken dormancy. We recommend putting sprinkler heads in place prior to the flood. This allows easy application of algaecide if needed (see below) and ensures that you will be ready if a frost night occurs immediately after flood removal.

*Depth and temperature:* The flood depth should be maintained so that all vines are well covered by water. Shallow floods and/or flood temperatures consistently greater than 65°F should be avoided to prevent injury and crop reduction. Flood water temperatures will generally be cooler if the flood is deep (> 12 inches above the vines). Beds that are severely out of grade may be poor candidates for LW.

*Prevention and treatment of scum:* Algae (scum) often forms in LW floods. Water temperature is a major factor in the development of scum; shallow floods and inland, warmer locations may be more prone to this problem. If your flood is shallow or if you have had scum problems in LW or winter floods, plan to treat using a liquid copper algaecide applied two weeks into the flood period (Algae-Pro, Cutrine Plus, etc; see the Weed section for more information). The material is injected into the sprinkler system running at 20 psi (30 minute injection, you may continue running for 1-2 hours after to disperse the material). Rates are calculated using label information and the number of acre-feet to be treated. To calculate acre-feet, multiply the number of acres by the depth of the flood in feet (take into account variation due to non-uniform flood depth). If you do not use this treatment, you must scout shore ditch edges for the presence of algae and treat with copper compounds as soon as scum is observed. Remember that copper only prevents further algal growth (it doesn't eliminate existing scum), so prompt treatment is necessary. If scum is severe, early withdrawal of the flood may be necessary. If heavy scum is present after the flood, it should be broken up mechanically so that light can reach the vines. Even so, crop reduction may occur when scum is severe.
Late Water Flood Timing

<table>
<thead>
<tr>
<th>Location</th>
<th>Apply the flood around:</th>
<th>Remove the flood:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inland Areas</td>
<td>April 10-15</td>
<td>no later than May 15th</td>
</tr>
<tr>
<td>Coastal Plymouth County</td>
<td>April 15-20</td>
<td>about May 20th</td>
</tr>
<tr>
<td>Cape Cod</td>
<td>April 20 or later</td>
<td>late May</td>
</tr>
</tbody>
</table>

Choose actual application timing based on weather (see previous page) and hold for approximately 30 days.

**Draining:** Release the flood slowly over the top board to protect water resources. The date of flood removal will vary with location and date of application. If air temperatures are unseasonably warm, and flood water temperature becomes too high, the LW flood may need to be removed prior to 30 days. If the flood is removed early, pest management benefits may be affected (see insect management next page).

**MANAGEMENT AFTER LATE WATER:**

**Irrigation:** There should be no need to irrigate (unless protecting for frost) for at least 2 weeks after the LW flood is withdrawn. Always schedule irrigation based on soil moisture status.

**Frost protection:** After removal of the LW flood, cranberry buds are sensitive to frost injury. During LW, the appearance of the terminal bud is arrested at the spring dormant stage. However, internal changes in the bud lead to a loss of frost tolerance despite appearances.

When using LW, frost management should be based on the actual duration of the flood, rather than the appearance of the buds. After more than one week of flooding, appearance of the buds will not be an accurate predictor of tolerance. A one-week flood early in the spring has no impact on frost tolerance -- protect the buds based on appearance. After LW of longer than 1 week, protect the bogs for 27°F (flood duration = 2 weeks) or 30°F (any duration longer than 2 weeks).

**Fertilizer use:** LW bogs respond readily to fertilizer: N dose should be reduced to avoid overgrowth. A 30–40% reduction of N is possible by eliminating the spring application and/or reducing the fruit set dose. Further reductions may have impact on bud development for the following year. Remember, fertilizer applied in the current season has the greatest impact on the following season's crop. The best tactic for a LW bog is to add no fertilizer for at least 2 weeks after flood withdrawal and then add small amounts with close monitoring of response. Generally, no fertilizer should be needed until bloom. Time your applications by the plant’s development. This is especially important when development has been shifted in time by the use of LW. If the LW flood was terminated early (duration of 3 weeks or less), standard fertilizer regimens may be followed.

**Disease management:** Late water is an excellent cultural control strategy against fruit rot.

Processed fruit and fresh fruit Howes, year of the LW flood - Use reduced rates and number of applications of fungicides. Fungicides may be eliminated on processed-fruit beds if keeping quality is forecast to be good. If one application is to be made, apply at 50% bloom. If two fungicide applications are made, apply the first at 10% bloom and the second two weeks later. Reduced fungicide rates should be employed, especially for Howes, which has greater resistance to rot. Experience with Stevens in LW is limited, but generally it has even better rot resistance than Howes.

First year after LW has been held - Fungicide applications and rates can still be reduced without sacrifice in fruit quality.

Second year after LW has been held - Fungicide applications and rates should be increased to a normal schedule. Otherwise, fungal inoculum will increase and may cause significant field and storage rot losses.

New Plantings - Late water held in a newly planted (one or two year-old) bog will help prevent inoculum buildup, as well as helping the vines spread over the surface of the soil. Both of these factors will help reduce the amount of rot during the initial two crop seasons. Late water may also slow down weeds on new bogs (see next page).
Late Water

**Insect and mite management:** Many insects are affected by LW. Emergence is delayed, and when a type of insect does appear, emergence is often synchronous, permitting better management. LW can be used to manage several pest insects:

- **Early season insects** - False armyworm and Gypsy moth may be suppressed. In general, cutworms have not been a problem in recent years on LW bogs. Pre-bloom sprays are seldom needed, but sweep net scouting should still be carried out -- cutworm moths may be attracted to the wet bog just after flood removal as a site for egg laying. If this happens, infestation may be quite severe. In addition, spanworms have sometimes been found on LW bogs.

- **Cranberry fruitworm** - Cranberry fruitworms, that overwinter in the bog in hibernacula (cocoons), have been shown to be greatly reduced by LW. Mortality is higher when the flood is warm (approx. 60°F). Shorter duration (2.5-3 weeks) LW floods appear to have little effect on mortality in the hibernacula; populations are suppressed very little, compared to those on unflooded beds and significantly less than those on beds receiving a 4-week flood (see table below). Monitoring for infestation is important (see the insect section for scouting practice after LW). Fruitworm sprays may be eliminated on LW bogs. Second and third sprays are seldom needed but scouting for eggs should continue as populations may move in from surrounding beds.

Effect of late water duration on cranberry fruitworm mortality. Data based on failure of insect to emerge from hibernacula following flood.

<table>
<thead>
<tr>
<th>Site</th>
<th>Flood length</th>
<th>CFW mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>flooded</td>
</tr>
<tr>
<td>1</td>
<td>2.5 weeks</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>2.5 weeks</td>
<td>45%</td>
</tr>
<tr>
<td>3</td>
<td>2.5 weeks</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>4 weeks</td>
<td>98%</td>
</tr>
<tr>
<td>4</td>
<td>3 weeks</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>4 weeks</td>
<td>94%</td>
</tr>
</tbody>
</table>

**Sparganothis** fruitworm is not controlled by LW. Flight is synchronized making management easier.

**Southern red mite** - Mites can be severely impacted by holding late water. Intense infestations can be essentially eliminated in the year of late water. The mites begin to increase in the second year following the flood, but even then, may stay much below the original infestation level prior to the flood. Generally, LW affords two years of control for this pest.

**Weed management:** While LW may delay weed development and suppress the growth of some perennial weeds, this technique alone does not result in control of most established weeds. LW does not control dodder.

- **Dewberries** (running bramble) - Some success in retarding the growth of dewberries by holding late water has been shown. Sawbrier (*Smilax glauca*) was less affected. LW suppression of dewberries should be followed up with other controls such as hand-wiping, clipping, or perhaps flame cultivation with glyphosate. Fall flooding also suppresses dewberries. However, severe crop loss resulted when LW was used in the spring following a fall flood. Do NOT combine these practices.

**Herbicide use:**

- Do not apply preemergence herbicides prior to a late water flood.

- Low rates of Casoron (up to 40 lb/A) may be applied after the late water flood is withdrawn for the control of **dodder**. Apply herbicide as soon as possible after the withdrawal of the flood (be sure the vines are dry and the soil has drained).

- No other preemergence herbicides should be applied after the flood is withdrawn.

**Bees:** Bees for pollination may be more important on late water bogs due to the fact that the period of flowering is of shorter duration than that for early water bogs. Protect bees from pesticide exposure.