Presentation Summaries
American Cranberry Growers Association
2015 Summer Field Day
Thursday August 20, 2015
Rutgers University

P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Chatsworth, NJ

Parking will be available at the Center’s shop (across cranberry bogs). Transportation for tours will be provided at the Center. Restrooms located at the Center, adjacent to Conference Room.

CRANBERRY BOGS:

8:30–8:45 Opening Remarks
Shawn Cutts, President, American Cranberry Growers Association

8:45–9:05 Virus Observations in the Field-Symptoms and Detection (Bog 8)
James Polashock, Research Plant Pathologist, USDA-ARS

9:05–10:25 Update on Disease Management (Bog 10)
Peter Oudemans, Department of Plant Biology and Pathology, Rutgers University

9:25–9:45 Next Generation Cranberry Hybrids: the 3rd Breeding and Selection Cycle (Bog 10)
Nicholi Vorsa, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

9:45–10:05 Evaluation of Our “Top Ten” Fruit Rot Resistant Selections (Bog 11)
Jennifer Johnson-Cicalese, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

10:05–10:25 Update on Insect Pest Management (Bog 19)
Cesar Rodriguez-Saona, Department of Entomology, Rutgers University; Vera Kyryczenko-Roth, P.E. Marucci Center; and Robert Holdcraft, P.E. Marucci Center

10:25–10:45 Assessing Insect Resistance in Cranberries (Bog 20)
Elvira de Lange, Department of Entomology, Rutgers University

CONFERENCE ROOM:

11:00–11:15 Cranberry Statistics
Bruce A Eklund, State Statistician, U.S. Department of Agriculture | National Agricultural Statistics Service
11:15–11:30 Cranberry Museum
   *Ted Gordon*, Pine Barrens Botanist, Historian

11:30–12:00 Show and Tell
   Cranberry growers

12:00–1:00 LUNCH (Pole Barn)

1:00–1:30 Farm Safety
   *Ray Samulis*, Cooperative Extension Agent, Burlington County Extension, Rutgers University
Virus Observations in the Field-Symptoms and Detection
James Polashock, USDA-ARS

Introduction

Viruses are known to infect all living organisms and cranberry is no exception. Historically, only ringspot disease of cranberry was thought to be caused by a virus. We have shown that cause is indeed a virus that is related to, but distinct Blueberry red ringspot virus. Recently, several new viruses have been found and we are just beginning to examine their potential impact.

_Tobacco streak virus_ (TSV) was first described in cranberry in 2001 as infecting germplasm material sent from New Jersey to Scotland. We confirmed the presence in one of the Rutgers germplasm plots that has since been destroyed. The origin of the germplasm was Wisconsin. Scarred fruit was noted on new varieties in Wisconsin in 2012 (Figure 1). Testing showed affected plants to be infected with TSV. More extensive testing in Wisconsin showed the virus to be widespread in Wisconsin, but also present in Massachusetts and New Jersey. Viral sequence analysis suggests the virus has either been prevalent in cranberry for some time or that divergent virus strains are being introduced into cranberry annually. The scarring is thought to be caused by a ‘shock’ reaction when plants are first infected. The plants appear to become tolerant and later bear normal fruit. Pollen harbors the virus, but thrips may be needed as the vector.

_Blueberry shock virus_ (BlShV) was discovered in some plants with scarred fruit that tested negative for TSV. Symptoms of BlShV infection are indistinguishable from those caused by TSV. BlShV and TSV are in the same virus group and plants infected with BlShV also seem to recover. BlShV in blueberry is transmitted by pollination without the need for another vector such as thrips. This may allow rapid spread in cranberry. To date, the virus has been found in Wisconsin, Massachusetts, NJ, and Oregon.

_Blueberry scorch virus_ (BlScV) has been reported as infecting cranberry in the Pacific Northwest. Infected plants are assymptomatic. This virus has not been described in cranberry in Wisconsin or on the east coast, but it is present in blueberry in New Jersey and can potentially spread to cranberry. This virus is vectored by aphids.

Funky Flower (Figure 2) appears to be caused by a variant of _Blueberry red ringspot virus_. Symptoms are exhibited as two different types of flower distortion. We are examining the viral DNA sequence and the proteome to further characterize the virus and its effects on the plant. Mode of spread is unknown.

_Ampelovirus-_ We have been studying footprint disease of cranberry (Figure 3) and, using ‘next generation’ sequencing, discovered a completely uncharacterized virus. The virus in the Closteroviridae family and appears to be in the genus _Ampelovirus_. Viruses in this group are mealy bug vectored and cause important diseases of grape. Association of this virus with footprint disease has not been demonstrated.
Figure 1. Symptoms of TSV infection in cranberry.

Figure 2. Distorted flowers symptomatic of Funky Flower disease.

Figure 3. Symptoms of footprint disease of cranberry in the cultivar Stevens.
Detection

TSV, BiShV and BiScV are typically detected using ELISA (antibody detection). Antibodies are not available for any of the newer viruses and these are detected using molecular techniques such as RT-PCR.

Conclusions

Virus problems are likely to become more significant in cranberry production. The scope and impact of those viruses described above are unknown. We are coordinating efforts with researchers in other growing regions to begin collecting the required data. Efforts to limit spread are being implemented across the country through virus testing of propagation materials and interstate quarantines. Beds to be used for propagation should be tested as well as vines and planting material procured from other sources.
In the battle against fruit rot two primary objectives were targeted during 2015. The first objective focused on the replacement of chlorothalonil and the search for either new fungicides or improved use patterns of older materials. In this work we have identified one new mode of action (SDHI) and four new products (SDHI, SI and QoI) and two materials that are registered but rarely used (Oso and Mankocide). All of these products are being tested individually to determine efficacy as well as in programs to compare with our standard program (two applications of Indar + Abound followed by two applications of mancozeb). Initial results identified several candidate fungicides however; mancozeb or mankocide will remain our primary broad spectrum replacement for chlorothalonil and Oso will likely be used provide later season protection.

As cranberry yields rise we see increased levels of fruit rot especially near the surface of the canopy. We believe this yield loss is caused by heat stress and specifically overheating of the fruit. Our primary method for cooling the canopy is irrigation, however there are several reasons why over-irrigation can pose problems including increasing disease pressure. In this research we are investigating methods to determine when cranberry fruit begin overheating and what the characteristics of a scald or heat damaging day are. To do this work we are using thermal imaging as well as temperature probes to investigate the patterns of heating. Our second objective is to investigate thresholds for berry tolerance to heating and to establish the targets where cooling of fruit is absolutely necessary.

In this photo we are using an inexpensive cooking thermometer to estimate the internal temperature of fruit. The internal fruit temperature typically exceeds air temperature and factors that affect fruit temperature include:

1. Shading
2. Fruit color (darker is hotter)
3. Cloud cover
4. Relative humidity
5. Sunlight
We have installed miniature temperature probes into cranberry fruit and collected data showing the effect of some of these factors. In the chart below you can see how internal temperature of fruit can be difficult to determine without direct measurement. Based on our preliminary observations 110F is a reasonable threshold for protecting cranberry fruit from damage.
Next Generation Cranberry Hybrids: the 3rd Breeding and Selection Cycle (Bog 10)
Nicholi Vorsa and J. Johnson-Cicalese P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

Genetic improvement of cranberry was initiated in 1929 with a cooperative effort between the USDA and State Agricultural Experiment Stations of New Jersey and Massachusetts. The breeding program was initiated in response to the ‘false-blossom’ disease with the objective of developing varieties which showed resistance to the spread of the disease (based on blunt-nosed leafhopper feeding preference assays), and would produce large crops and superior fruit. Crosses were made in Wisconsin, Massachusetts and New Jersey. Over 10,000 seedlings were planted and evaluated in Whitesbog, NJ. By 1940 1,800 seedlings fruited and 40 selections were made for a second test. From these, ‘Stevens’, ‘Pilgrim’, ‘Wilcox’, ‘Franklin’, ‘Bergman’ and ‘Beckwith’ cultivars were named. Another selection, known as ‘#35’, was likely selected for productivity, but never named because of poor color. These cultivars, e.g. Stevens, represent the 1st breeding and selection cycle of the American cranberry. An additional 182 selections were made during 1945-46 and set out for second round of testing. One selection, BE4, was recently named ‘Willapa Red’, testing well at the WSU Long Beach Cranberry Station.

In 1985, Rutgers University/New Jersey Agricultural Experiment Station established a blueberry and cranberry breeding program. In 1988, 20 crosses were made with the first breeding cycle hybrids Steven, Pilgrim, Franklin and Wilcox, and ‘Ben Lear’, a native selection from Wisconsin. These 20 crosses initiated the 2nd breeding and selection cycle in cranberry. From these crosses, 1466 seedlings were grown out in 5’ x 5’ plots at Haines & Haines, Inc. cranberry farm, Chatsworth, NJ and a replicate subset of 800 at Dubay Cranberry Co., Junction City, WI. The selection criteria in the early 1990’s were largely directed toward the cranberry juice market including traits such as early ripening and high total anthocyanin content (TAcy), as well as good consistent productivity and vegetative establishment vigor. The cultivars Crimson Queen® and Demoranville® were released from these crosses. Subsequently, in the 1990’s the variety #35 (Howes x Searles hybrid) was used in a series of crosses with Stevens, Pilgrim and ‘Lemunyon’, a native New Jersey variety. The next release was Mullica Queen®, a cultivar that originated from a 1997 cross of Lemunyon x #35. Scarlet Knight® was derived from a Stevens x NJS98-37 (a Franklin x Ben Lear hybrid, full-sib of Demoranville) cross made in 1995, and selected for early high color and fresh fruit qualities.

In 2004, a series of 3rd breeding and selection cycle crosses were made between the 2nd generation cultivar Mullica Queen (MQ) and 2nd generation cultivars Demoranville (D), Crimson Queen (CQ), Scarlet Knight (SK) and an unnamed selection NJS98-71 (Pilgrim x Ben Lear), 1st generation cultivars, Pilgrim (P) and Stevens (S), and Ben Lear (BL). Over 1600 progeny were evaluated from these crosses during 2009-2012. In 2013, seventeen selections exhibiting very high yield potential: MQxBL (2), MQxD (1), MQxS (1), PxMQ (3) and NJS98-71xMQ (4), were planted in Bog 10 to be evaluated for productivity, fruit rot susceptibility, season, vegetative vigor, establishment and fruit quality traits, e.g. TAcy, Brix, titratable acidity, phenolics, etc.
Evaluation of Our “Top Ten” Fruit Rot Resistant Selections (Bog 11)  
Jennifer Johnson-Cicalese, Peter Oudemans and Nicholi Vorsa, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers Univ., Chatsworth, NJ

An intensive effort to develop cranberry cultivars with improved fruit rot resistance (FRR) began in 2003. The effort was initiated by screening our germplasm collection under intense fruit rot pressure resulting in the identification of four sources of FRR resistance. Two accessions were highly resistant, Budd’s Blues (BB) and US89-3, and two moderately resistant, Cumberland and Holliston. These accessions were used in crosses amongst each other, and with elite high yielding selections. In 2009, 1624 progeny from 50 crosses were planted in 5’ x 5’ field plots at the Marucci Center, Chatsworth. Once established, the progeny were evaluated for three years under reduced fungicide regimes and severe fruit rot pressure. From these 1624 progeny, the “top ten” were selected based on the best FRR, commercially viable yields, as well as good berry size and color (Table 1). Most of the top ten selections had Budd’s Blues as a parent, a variety that has long been known to exhibit excellent FRR, but has very low yields. We were pleased to see that in these crosses many of Budd’s Blues’ progeny had good yields. For example, one BB x Crimson Queen (CQ) progeny had a 3-yr mean yield of 300 g/ft².

On July 8, 2015, these selections were planted in Bog 11 in 10’ x 20’ plots, 5 replicates of each. Plots of Crimson Queen were also included in this trial as the susceptible control. Once established, this trial will be evaluated for fruit rot, yield and fruit quality, under reduced fungicide input scenarios, i.e. a fungicide trial overlay. Plots will be divided into subplots and receive a number of fungicide treatment regimens to determine minimum amount needed, and optimal timing of fungicides, to achieve commercially acceptable low levels of fruit rot on these FRR selections. These top ten selections were also planted this year in a Wisconsin trial, and will be planted next year in trials in Massachusetts and Washington. Depending on their performance, one of these selections may be considered for potential cultivar release.

Table 1. Progeny with best fruit rot resistance and yield.

<table>
<thead>
<tr>
<th>Selection</th>
<th>Cross*</th>
<th>Rot rating**</th>
<th>Yield, g/ft²</th>
<th>% rotted fruit</th>
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<tr>
<td>CNJ05-64-9</td>
<td>BB X CQ</td>
<td>1.0</td>
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<td>32.6</td>
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<td>CNJ05-64-14</td>
<td>BB X CQ</td>
<td>1.3</td>
<td>300.4</td>
<td>33.6</td>
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<td>CNJ05-64-1</td>
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<td>190.2</td>
<td>29.8</td>
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<td>257.5</td>
<td>22.6</td>
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<td>213.1</td>
<td>21.1</td>
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<td>Stevens</td>
<td>Susceptible</td>
<td>4.1</td>
<td>151.6</td>
<td>87.1</td>
</tr>
</tbody>
</table>

*Resistant parents: BB = Budd’s Blues, CU = Cumberland, 86-45 & 86-46= progeny from Stevens x US89-3 cross. Susceptible, high yielding parents: CQ=Crimson Queen, MQ=Mullica Queen, DE=Demoranville.

**Rot rating scale of 1-5, where 1=0-20% rot and 5=100% rotted fruit.
Update on Insect Pest Management

Cesar Rodriguez-Saona, Department of Entomology, Rutgers Univ.; Vera Kyryczenko-Roth and Robert Holdcraft, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers Univ., Chatsworth, NJ

The continued availability of broad-spectrum insecticides, such as organophosphates and carbamates, for use in cranberries is under threat from the FQPA of 1996. In the last decade, the pesticide industry has experienced a mini-revolution in terms of discovery of novel insecticides that are not only very selective and effective at very low rates but also safe to the environment and human health. Most notable of these recent discoveries include methoxyfenozide (Intrepid), spinoteram (Delegate), acetamiprid (Assail), rynaxypyr (Altacor), novaluron (Rimon), and indoxacarb (Avaunt). These insecticides have proven to be very effective against lepidopteran pests (i.e., chewing caterpillars) such as Sparganothis fruitworm, cranberry fruitworm, spotted fireworm, and blackheaded fireworm. However, they have no control over piercing-sucking insects (order Hemiptera) such as leafhoppers, toad bugs, mirids, etc. In the past 2 years, two insects have increased in population size and seen causing damage to cranberries in New Jersey. These are the cranberry toad bug, Phylloscelis atra, and the mirid Plagiognathus repetitus.

There is concern among cranberry growers of a potential increase in secondary pests, such as the cranberry toad bug and mirids, because of recent changes in pest management strategies (e.g., adoption of new reduced-risk products and decreased applications of broad-spectrum insecticides).

Cranberry Toad Bug

In 2013 we observed damage in cranberry bogs by the cranberry toad bug, Phylloscelis atra, in New Jersey. Although we had seen toad bugs in cranberry bogs in the past we had never seen them causing damage to the vines and fruit. Toad bugs are hemipteran insects (similar to blunt-nosed leafhoppers) but belong to the Family Dictyopharidae (planthoppers) (as opposed to leafhoppers, which belong to the family Cicadellidae). Toad bugs feed only on cranberries. This insect has a single generation per year. It overwinters as eggs. The nymphs appear by the end of June through August, and the adults from August through October. Eggs are laid from September through October. Feeding damage can be noticed in two stages. First stage feeding damage on vines causes closing in (towards the branch) of the leaves on the new growth. Second stage feeding causes changed in color (reddish to brown) of new growth. The damage can be seen from July until harvest. This damage will cause dying of the branch and the berries to shrivel up. Heavy infestation will result in dwarfed berries. Little information is currently available on the ecology, impact, monitoring, and management of cranberry toad bugs.
Mirids
In 2014, we observed damage to cranberries likely caused by an unknown “mirid” bug (Hemiptera: Miridae). These insects are known as true bugs and have piercing-sucking mouthparts to suck juices out the plants. The species has now been identified by Dr. Thomas Henry, from USDA-ARS-Systematic Entomology Laboratory in Beltsville, MD, as *Plagiognathus repetitus* (Hemiptera: Miridae). The insect seems to damage young leaf and flower buds. We observed deformed leaves and flowers in June. This damage appears to cause serious reduction in yield. The damage was likely caused by the nymphs in April-May, as adults were seen in June-July. We know little about the biology and management of this insect at this point. Mirids can be serious pests of other agricultural crops. For example, the tarnished plant bug, *Lygus* spp., is an important pest of cotton causing injury to the flowering buds. As for *Plagiognathus repetitus*, Franklin (1950) writes that in MA it overwinters as eggs and the eggs hatch in early June. Adults were seen in Massachusetts in late June-early July (similar to our observations). The insect is known to occur from Ontario (Canada) to Virginia and is an ericaceous plant specialist. It has been recorded from cranberry, sheep laurel, *Vaccinium* sp., and related plants. Franklin noted that this insect is rarely seen in high numbers; this was not the case in 2014 where we saw high numbers in one farm that had not sprayed broad-spectrum insecticides pre-bloom in several years.

Methods and Results
Cranberry Mirid
Field experiments were conducted to determine the toxicity of registered insecticides on the cranberry mirid. The following insecticides were evaluated: Assail, Sevin, Diazinon, Lorsban, and Imidan. Treatments applied with a compressed CO₂ backpack sprayer on 14 May. Insecticides were applied at 50 gal of water per acre water. Plots were 6 ft × 6 ft and were replicated five times in a complete randomized block design. Plots were sampled from a 4 ft × 4 ft area using a backpack vacuum-sampler on 15 May from the center of each plot (1 ft treated buffer all sides). Samples were evaluated in the lab under magnification. Numbers of nymphs on foliage at time of sampling were counted. All insecticides provided good control against the cranberry mirid nymphs.
In addition, bogs were sampled via sweep-net. Five sweep sets were collected pre-spray on 16 May. Lorsban 4E was applied at 3 pints/acre by airplane on 19 May. Five sweep sets were collected post-spray 22 May. Samples were evaluated in the lab under magnification. Number of nymphs per sweep set was counted. Lorsban provided very good control against the cranberry mirid nymphs.

In conclusion:
- All insecticides tested were effective at controlling the mirid.
- At high level of infestation treat within 1 week after detection.
- Check for mirid nymphs in early spring after removing the water from bogs.
- If needed, use a broad-spectrum insecticide like Lorsban for its control.

**Cranberry Toadbug**
Little is known on the impact of damage by toad bugs on cranberry yield. This information is important for the development of treatment thresholds. We conducted a study to determine whether toad bug feeding impacts cranberry fruit quality and health by characterizing feeding damage. Treatments consisted of 0, 10, 25 or 50 nymphs and were replicated 5 times. Nymphs are the main target of insecticide applications and the cause of most of the early damage to the vines. At the end of the experiment, berries will be harvested by clipping uprights. To characterize damage, the number of dwarfed and healthy berries will be counted. All berries will be weighed. This experiment is on-going and results will be presented at the ACGA winter annual meeting.
Beating the bugs in the bogs: Insect resistance in different cranberry varieties
Elvira de Lange, James Polashock, Nicholi Vorsa, and Cesar Rodriguez-Saona

Insects are a major problem in cranberry production – they are estimated to reduce yield by 1-2% and without spraying, cranberry false blossom, a phytoplasma vectored by blunt-nosed leafhopper, would eliminate commercial cranberry production completely. Spraying chemical pesticides is the most common practice to combat pathogens and herbivorous insects, but beneficial insects, such as honeybees, important pollinators of cranberry, and natural enemies, such as predators and parasitoids, could be affected as well. Therefore, we study the defensive mechanisms that cranberry plants themselves use against insect feeding. We focus on the most problematic insects on cranberry in New Jersey: Sparganothis fruitworm, spotted fireworm, gypsy moth and the above-mentioned blunt-nosed leafhopper.

In the field, we have studied resistance of cranberry uprights and fruits to Sparganothis fruitworm and spotted fireworm. In an experimental bog with ten cranberry varieties – Howes, Early Black, Ben Lear, Stevens, #35, Grygleski, HyRed, Crimson Queen, DeMoranville and Mullica Queen – we put out a large number of cages, in which we introduced larvae of the two insect species. The larvae were weighted before and after feeding on the plants, enabling us to identify on which varieties they grew best – more susceptible varieties – and on which varieties they grew poorly – more resistant varieties.

In the greenhouse, we have assessed resistance of seven cranberry varieties – Howes, Early Black, Potter, Stevens, Franklin, Crimson Queen and DeMoranville – to gypsy moth. We weighted larvae before and 7 days after feeding on the different cranberry plants, to evaluate their performance. Also, we collected the volatiles or aromas that gypsy moth-infested plants emit. A similar experiment was performed with blunt-nosed leafhopper. We evaluated the growth and development of leafhopper nymphs on six cranberry varieties – Howes, Early Black, Potter, Franklin, Crimson Queen and DeMoranville. We selected small nymphs of approximately the same size, allowed them to feed on the plants in small cages, and evaluated their weight and developmental stage – nymph or adult – 20 days later. In addition, we collected the aromas that leafhopper-attacked plants, variety Mullica Queen, emit. Herbivore-induced aromas may be beneficial for the emitting plants, as they can serve to repel herbivores and attract their natural enemies. But they may also be detrimental, as they can guide other herbivorous insects to the plants. We aim to identify specific compounds in the cranberry aroma that are correlated with plant resistance against various pests. This information may help us to reduce insect damage in the cranberry crop.

Dr. Cesar Rodriguez-Saona has previously identified differences in cranberry resistance against insects as a result of plant nutrient status. Recently, Dr. James Polashock reported that thrips seem to attack plants in large numbers right after fertilization treatment. Therefore, we wondered if cranberry plants that have access to abundant nutrients emit aromas that attract herbivorous insects. We subjected six cranberry varieties – Howes, Early Black, Potter, Stevens, Franklin and Crimson Queen – to four different nutrient
levels and collected plant volatiles. Eventually, we aim to assess the attractiveness of these volatile blends to herbivorous insects and their natural enemies.

Elucidating mechanisms of resistance against insect pests in cranberries will help improve insect resistance in existing high yielding varieties, as well as development of novel varieties with improved resistance qualities.
Cranberry Statistics

Bruce A Eklund, State Statistician, USDA- National Agricultural Statistics Service

The US forecast for the 2015 cranberry crop is 8.41 million barrels, up slightly from 2014.

Many growers in Wisconsin reported damage due to cold winter temperatures. Even with the cold damage, most growers reported a normal to slightly better than normal season so far. In Massachusetts, grower comments were mixed. Some growers were optimistic, some were repairing bogs, and others reported problems with insects. Oregon and Washington producers expect 2015 to be a good year due to favorable weather conditions.


[A barrel weighs 100 lbs]

<table>
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<th>State</th>
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