

2018 Annual Winter Meeting of the American Cranberry Growers Association



Rutgers University
EcoComplex
Bordentown, NJ

Thursday
January 18, 2018

RUTGERS

New Jersey Agricultural
Experiment Station

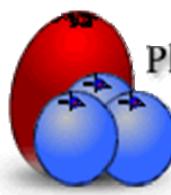
100 YEARS



THE CRANBERRY SUBSTATION, WHITESBOG, 1922



THE CRANBERRY SUBSTATION, PEMBERTON, 1930



Philip E. Marucci
Blueberry and Cranberry
Research and Extension Center
100 years 1918-2018

ACGA Winter Meeting Program

Thursday, January 18, 2018

Rutgers EcoComplex, Bordentown, NJ

8:00-8:30 Registration and Coffee

8:30-8:45 Welcoming Remarks—***Shawn Cutts, President, ACGA***
Treasurer's Report—***Shawn Cutts***

8:45-9:00 **Cranberry Statistics**
Bruce Eklund, National Agricultural Statistics Service, Trenton, NJ

9:00-9:25 **Cranberry Institute – An Update**
John Wilson, Cranberry Institute, Carver, MA

9:25-9:50 **Potential New Varieties with Enhanced Fruit Rot Resistance**
Jennifer Johnson-Cicalese and ***Nicholi Vorsa***, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

9:50-10:15 **Identifying and Implementing Methods for Improving Berry Quality Parameters**
Peter Oudemans, Professor, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

10:15-10:30 **Break**

10:30-10:40 **Introduction of Timothy Waller first recipient of the William S. Haines sr. Research Endowment**
Melissa McKillip, Vice Dean for Advancement, Office of Philanthropy & Strategic Partnerships, School of Environmental and Biological Sciences, New Jersey Agricultural Experiment Station

10:40-11:05 **Understanding the Role of Flowers in Fungal Infections Leading to Cranberry Fruit Rot. William S. Haines Senior Research Endowment**
Timothy Waller, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ

11:05-11:30 **Assessing Soil Health using Next-generation Sequencing Technology**
James Polashock, Research Plant Pathologist, USDA-ARS; P.E. Marucci Center, Chatsworth, NJ

11:30–12:00 **BOGS – a Tool for Record Keeping**
Brian Wick, Executive Director, Cape Cod Cranberry Growers' Association

12:00-1:00 **Lunch**

1:00-1:25 Carolina Redroot Control with Pre-emergence Herbicides and Effect on Fruit Yield and Quality

Thierry Besancon, Weed Science Extension Specialist, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

1:25-1:50 Management of Cranberry Insect Pests: Leafhoppers and Toadbugs

Cesar Rodriguez-Saona, Professor, Department of Entomology, Rutgers University, New Brunswick, NJ; Vera Kyryczenko-Roth, and Robert Holdcraft, P.E. Marucci Center, Chatsworth, NJ

1:50-2:20 Farm Safety with Pesticides

George Hamilton, Professor, Department of Entomology, Rutgers University, New Brunswick, NJ; Patricia Hastings, Program Associate, Pest Management, Rutgers University, New Brunswick, NJ

2:20 Adjournment- ACGA Board of Directors Meeting

New Jersey Agricultural Statistics

Bruce Eklund, State Statistician
NJ Field Office
National Agricultural Statistics Service
503.308.0404
Bruce.eklund@nass.usda.gov

USDA's National Agricultural Statistics released the 2016 Non-citrus Fruits and Nuts Final Summary noon June 27, 2017. New Jersey growers were third nationally in acres harvested and production. New Jersey growers were second nationally in barrels produced per acre, and average price received.

https://www.nass.usda.gov/Publications/Reports_By_Date/index.php

NASS released the forecast for the 2017 crop August 10 at 590,000 barrels. This would be down ten percent from the 2016 final estimate. The national forecast is 9,050,000 barrels, down, down six percent from last year's final. Thank you to New Jersey producers who contributed to an excellent participation rate for the survey producing these results. There is not yet updated 2017 data. One can find cost of pollination information including cranberries at the above link. Look for the release on December 21 2017. Thanks in advance for completing the 2017 Census of Agriculture.

Cranberry Institute – An Update

John Wilson, Cranberry Institute
Carver, MA

The Cranberry Institute (CI) continues to focus on three main areas: 1) supporting cranberry health research; 2) supporting cranberry horticultural research along with the search for newer and safer agricultural chemicals; 3) communications – promoting the health benefits of cranberry in addition to keeping consumer information about cranberry as honest as possible. The purpose of my report is to provide an update on CI activities in the horticultural area.

Previously, I reported that the cranberry industry has had a few new pesticides rejected by EPA over their concern with possible chemical “contamination” of harvest water. EPA estimates chemical concentrations in cranberry harvest water based on a conservative “water model” used for rice. Since environmental modeling is a specialized field, the CI decided to contract with Waterborne Environmental to work with us as we try to get EPA regulators to better understand cranberry culture and grower stewardship practices. We are in the process of contacting individual growers in various parts of the country to discuss how they manage water. This information will be presented to EPA (by June 2018) with the intention of developing a less restrictive water model for cranberry.

In 2017, the cranberry industry provided research awards totaling over \$990,000 – a four year high. We are again seeking new research proposals this year. Funding organizations have already told the CI that due to the smaller 2017 crop and a possible volume set-aside, research money will likely be reduced this year.

Meanwhile, the CI continues to pursue new chemical registration for cranberry. Movento (spirotetramat) has finally been approved in the US. We started this project in 2008 – it was first registered in Canada in 2012 and finally approved in the US 2017. In addition, we are close to approving a new fungicide for cranberry. At the IR-4 meeting last September, we received approval to collect residue data for another new fungicide on cranberry.

Success in pursuing MRLs is mixed. For the older chemistries like quinclorac and carbaryl, the process is a struggle. For the newer products like spirotetramat and prothioconazole, we have had more success.

We appreciate the cooperation of NJ growers and the ACGA in providing support and advice on a number of CI initiatives.

Latest Generation Cranberry Varieties with Enhanced Fruit Rot Resistance

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

Cranberry fruit rot results in substantial economic losses to New Jersey cranberry growers. The cranberry growing season during the last few decades has exposed the cranberry to higher and longer episodes of heat stress, exacerbating fruit rot. All major cultivars currently grown in New Jersey require a comprehensive fungicide schedule. However, even with comprehensive fungicide programs the cranberry crop can still experience high levels of fruit rot. Cranberry varieties adapted to warmer growing seasons and with higher levels of fruit rot resistance offer at least a partial solution for improving the quality of the New Jersey cranberry crop. It is likely that fruit rot severity will increase with higher growing season temperatures. Furthermore, the loss of label of effective fungicides are a constant threat, as well as issues of fungal resistance to currently effective fungicides. A major focus and objective of the Rutgers' cranberry breeding program since 2004 has been the development of commercially viable varieties with enhanced fruit rot resistance. The program is initiating the 3rd and 4th breeding and selection cycle this spring.

Multiple diverse sources of fruit rot resistance (FRR) have been identified and used in numerous crosses: highly resistant Budd's Blues and US89-3, and moderately resistant Cumberland and Holliston. Resistance has been shown to be highly heritable (i.e. resistance is passed on to progeny), and we have identified progeny with both improved resistance and high yield. A 2007 planting of 1600 progeny, derived from 2005 and 2006 crosses, was evaluated in 2009-2013 under severe fruit rot pressure, and the best progeny were selected. These selections were then planted in replicated plots (2014, 4 reps, 5' x 5' plots), and evaluated again under reduced fungicide regimes (e.g. 1-2 fungicide applications) in 2016 and 2017.

Several selections continued to exhibit exceptional performance. For example, several Budds Blues x Crimson Queen progeny had yields comparable to Mullica Queen (362, 359, 348g/ft² vs. 362g/ft²), yet half as much rotted fruit per square foot sample (19%, 21%, 22% vs. 46%). In two progeny from a cross combining two resistance sources, Budds Blues x Cumberland, the yields were slightly less, although comparable to Stevens in this trial (234, 202g/ft² vs. 265g/ft²), but percent of rotted fruit was even further reduced (13%, 13% vs. 57%). Berry size and fruit chemistry were also evaluated; berry size in the higher yielding selections was close to 2.0g/berry and early October total anthocyanin values were within an acceptable range of 30 to 54mg/100g fruit.

These selections have been planted in large replicated plots at the Marucci Center and are also being tested in Wisconsin and British Columbia. These trials will evaluate the varieties under reduced fungicide regimes. The next step will be to plant these varieties in large grower plantings and begin increasing them for commercial release.

Concurrent with the evaluation of 2nd breeding cycle selections, the best 2nd cycle selections were used in 2012-2017 crosses, to hopefully further genetic gain for both productivity and fruit rot resistance. Nearly 5000 progeny have been planted in field plots, and two years of evaluations of

1000 progeny from 2012 crosses (CNJ12) have identified new promising selections which combine multiple sources of resistance. We plan to rapidly establish the best of these in larger replicated plantings also.

We are also continuing our work on identifying and testing genetic markers for resistance, to allow for FRR screening at the seedling stage. And in 2018, crosses will continue to be made to combine resistance with other desirable horticultural traits. Although this has been a time-consuming process, with the first of these FRR crosses being made 13 years ago, we believe we have made progress and anticipate releasing fruit rot resistant cultivars with acceptable yields under greatly reduced fungicide inputs.

Acknowledgements

Support: Karen DeStefano, Sue Vancho, James Polashock and Lab, Richard DeStefano and Crew, Peter Oudemans and Lab

Funding: USDA-SCRI-2008-51180-04878, USDA-NIFA-2013-67013-21107, Cranberry Institute, New Jersey Blueberry & Cranberry Research Council, New Jersey Agricultural Experiment Station Project 12160.

Identifying and Implementing Methods for Improving Berry Quality Parameters

Peter Oudemans, Professor, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

As the market for cranberry becomes more focused on creating ingredients such as the SDC and less focused on juices the definition of fruit quality changes. The class of fruit considered culs includes fruit: a) with symptoms of rot due to reduced skin integrity; b) outside of the optimal size range for SDC production; c) with too low or too high TACY levels; d) with firmness ratings below an optimum; e) with shapes incompatible with manufacturing standards; f) contaminated with excessive foreign materials. The first four factors can be influenced by disease management practices that occur during the growing season.

Our research program targets two major causes of fruit quality reduction. The first is caused by excessive fruit heating and is controlled with irrigation. The second, fruit rot, is controlled by fungicides along with various cultural practices. The challenge is that excessive irrigation can lead to increased fruit rot must be optimized to achieve suitable fruit quality. In this presentation I will cover our research progress for these two areas.

First, I acknowledge the support of the NJ Cranberry Research Council, Ocean Spray, and the Cranberry Institute for funding this research. Also, Christine Constantelos, Tim Waller, Dave Jones, Tim Jensen, John Jensen and Dan Flath provided excellent support for this project.

Fruit Heating: Fruit heating or scald has been variously attributed to excessive heat, over watering, and solar radiation. Our objectives are to identify the major environmental factors responsible for overheating and then to develop methods for identifying scald prone conditions.

1. Albedo is the fraction of solar energy (shortwave radiation) reflected from the fruit surface. It is a measure of the reflectivity. As fruit ripens, going from white → yellow → red the albedo declines and more solar radiation is absorbed. Thus, as fruit matures it becomes more vulnerable to overheating.
2. Solar radiation absorbed by the fruit causes overheating. Internal temperatures over 108F can result in permanent damage to the fruit. However, these temperatures must be sustained and short intervals of heating do not result in permanent damage.
3. Cloud cover can greatly reduce the chances of overheating
4. Position in the canopy can also affect the degree of shading and therefore overheating.
5. Canopy depth and direction of training may impact the degree of shading.
6. Irrigation can provide temporary reduction of temperature through evaporative cooling however, the challenge is to irrigate the proper timing, amount and to deliver efficiently.
7. A second challenge is to identify of the conditions leading to scald so that preventative measures can be implemented.

Fruit Rot has been an issue since the beginning of cranberry cultivation. Chlorothalonil (Bravo, Echo, etc.) has become the backbone for disease management programs. Although this fungicide has some phytotoxicity during bloom it is an excellent post-bloom fungicide providing sufficiently long-lasting control and provides excellent resistance management. On the downside, it is a suspected toxin to pollinators, has toxicity to aquatic organisms, is a suspected human carcinogen and has suffered increasing regulations. An alternative to chlorothalonil is mancozeb. This fungicide provides excellent fruit rot control and resistance management. However, reduced TACY and fruit size (leading to reduced yields) have caused this fungicide to fall into disfavor with growers. Although, environmental and pollinator impacts are fewer than chlorothalonil this fungicide has impact on predatory mites. Both of these fungicides were developed several decades ago and are being targeted for elimination by national and international regulatory agencies. Newer fungicides such as azoxystrobin (Abound...etc.) and DMI fungicides (Indar and Proline) are effective against fruit rot however, are at risk for resistance. The most accepted strategies for fungicide resistance include use of the low risk materials chlorothalonil or mancozeb.

At this time there is no evidence that resistance is developing in cranberry to our most “at risk” fungicide Abound. However, several of the fungal species causing fruit rot are naturally insensitive to either Indar or Abound. By mixing these materials we are able to increase the spectrum of action. The goal today is to discover new fungicides with activity against the fruit rotting fungi (of which there are several) that can be used alone or in combination to achieve acceptable levels of disease control.

To this end we have conducted disease management trials to evaluate new fungicides, new use patterns and a novel cuticle treatment to identify future fruit rot management programs. The following five fruit rot management trials were conducted in 2017.

1. SDHI trial. One of the newest and most exciting groups of fungicides being developed are the SDHI group. We tested five SDHI fungicides (including Kenja) and found activity in only two. Registration is progressing with one of the materials which was tested as a solo material as well as in combination with a new, highly effective DMI material.
2. Frontend trials are aimed at finding replacements for the Indar/Abound treatments currently used.
3. Backend trials are aimed at finding replacements for chlorothalonil or mancozeb applications.
4. A mancozeb trial was conducted to determine if use patterns could be modified to reduce the phytotoxic impact of this material on yield.
5. Parka, a new cuticle enhancer, was tested to evaluate impact on fungicide efficacy and fruit splitting.

Understanding the Role of Flowers in Fungal Infections Leading to Cranberry Fruit Rot

Timothy James Waller, recipient of the William S. Haines Senior Research Endowment
Advisor: Dr. Peter V. Oudemans

Cranberry fruit rot is caused by 15+ species of plant pathogenic fungi that can severely reduce cranberry production if not properly controlled. It is well known that bloom time applications are critical for effective disease control and in the absence of fungicides the pathogens infect newly set fruit and lie dormant throughout much of the growing season. In my research I have examined the connection between chemicals present in flowers and infection by fungi in relation to the bloom period. In this presentation, I will provide results from the fruit rotting fungus *Colletotrichum fioriniae* which causes fruit rot on both cranberry and highbush blueberry. This fungus is relatively easy to work with in the lab and behaves similarly to other fruit rotting species making it useful as a test organism.

Cranberry floral extracts (FEs) dissolved in water on the plant surface increase the number of spores in an infection droplet (droplet of water) and stimulate the spores to germinate and infect faster with specialized structures called appressoria. These two characteristics explain the importance of flowers in the spread of disease and the fruit rotting process. Most importantly, FEs decrease the time needed for infection to occur by half (12 h in water to 6 h in FEs). This means there will be a greater number of infections in the presence of flowers (during bloom), likely indicating *why* the critical disease control window is during the bloom period.

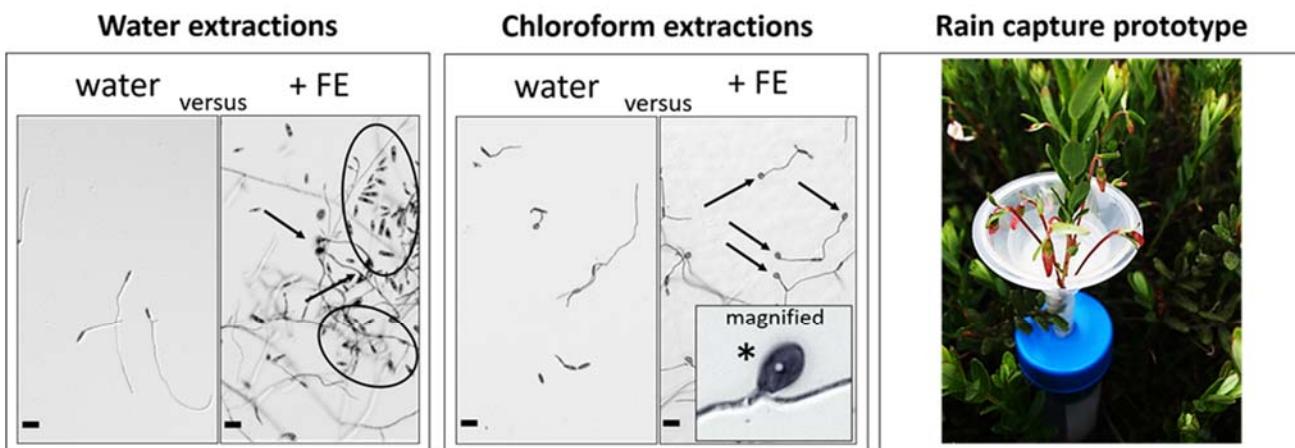
Other types of flowers also stimulate this pathogen. Related species such as lingonberry and laurel produce FEs that stimulate spore production and this is likely tied to sugars present in the flowers. However, flowers from these plants do not stimulate appressoria, indicating that at least two types of compounds are active in flowers. When chloroform was utilized, instead of water, to extract cranberry flowers the extracts stimulated spores to germinate and form appressoria, but not increase spore numbers. This again suggests that flowers produce more than one type of compound with activity for fungal growth.

Analysis of the chloroform extracts revealed hexadecanoic acid (HEX) as the most potent stimulatory compound characterized. HEX is common component of the plant's waxy surface, especially in flowers, and is considered to be water insoluble. Thus, it is difficult to conceive how this compound can be active in water extracts. It is possible that small fragments or plates of HEX can be suspended in water moving across the flower's surface.

Rain water collection devices were utilized to determine if HEX or other similar compounds could become mobilized in natural field-settings. The water samples clearly show that stimulatory compounds could in-fact be carried by water that had run off of flowers and, not surprisingly, stimulation was greatest closest to the flowers. This result presents a novel opportunity to develop a monitoring tool to better time fungicides and possibly modify recommendations to improve fruit rot control. I will conduct field trials this summer to compare HEX-based versus calendar-based fungicide regimes to evaluate the potential of this concept.

I have tested HEX as a treatment to exploit pathogen stimulation in conjunction with fungicides as a 'trap' spray aimed at synchronizing fungal germination in the presence of fungicides. The purpose is to increase the efficacy of fungicides especially during early season sprays. In two separate field trials, one focusing on the front-end Indar/Abound applications (2) and another on the back-end Bravo applications (3) were investigated using this 'trap' approach. The front-end trial had two applications of HEX suspended in crop oil as a carrier, combined with Indar/Abound followed by three applications of Bravo (with no HEX added). This trial had an increased number of sound fruit, indicating that this approach should be more intensely studied. In the back-end trial the combination of crop oil and Bravo damaged fruit. In the upcoming season different carriers/adjuvants will be evaluated for both carrier properties and phytotoxic effects with the aim to increase the number of tools available for disease management.

In summary, cranberry flowers affect *at least* two important disease factors; stimulation of spore production (disease spread) and appressorium formation (fruit infection). By understanding the biology of this fruit-fungus interaction we have the potential to direct future recommendations, implement site-specific monitoring tools, create or lengthen the lifespan of our limited fungicide tool box and provide markers for developing fruit rot resistant varieties.



The three types of floral extracts (FEs) used in this research: water-based, chloroform-based, and collected rainwater run off of flowers.

Water extracted FEs: stimulate high levels of spore production (*circled areas*) due to floral sugars dissolved into the water, and infection structures, aka appressoria, (*arrows*) due to floral waxes suspended in the water.

Chloroform extracted FEs: are mainly waxes and almost always stimulate the spores to germinate and form appressoria (*arrows*) without additional spore production. Magnified image shows an appressorium with an internal light spot (white spot in the middle) indicating a penetration peg, meaning these structures can penetrate plant surfaces and cause infections.

Rain capture devices: were utilized to determine if HEX or other similar compounds could become mobilized in natural field-settings. The water samples clearly show that stimulatory compounds could in-fact be carried by water, presenting a novel opportunity to develop a monitoring tool.

BOGS – a Tool for Record Keeping

Brian Wick, Executive Director
Cape Cod Cranberry Growers' Association

The BOGS Online Grower System is a web-based pesticide and nutrient record keeping tool that has been developed by the Cape Cod Cranberry Growers' Association and utilized by Massachusetts growers for the past several years. The idea for the tool is to have one place where all of these records can be stored but also a simple to use tool that has alerts built into it regarding pesticide use that are based on label and/or handler requirements. All New Jersey state pesticide reports are integrated in the system. BOGS integrates pesticide use data electronically with the Ocean Spray Cranberries ePURS system and with Pappas/Lassonde. Other handler reports can be emailed or printed as necessary. It was designed by cranberry growers, for cranberry growers. It has been beta tested by a New Jersey grower and we are now extending the opportunity to use the system to more growers. The presentation will include a demonstration on how the system works.

Assessing Soil Health using Next-generation Sequencing Technology

James Polashock, Research Plant Pathologist, USDA-ARS, *J. Kawash*, ORISE Postdoc,
and *P. Oudemans*, P.E. Marucci Center, Chatsworth, NJ

BACKGROUND

Soil health is an important component of crop production, but it is largely ignored in many crop systems, including cranberry. Soil health is defined by an amalgam of many different components including physical, chemical and biological properties. Assessment of soil health is typically limited to evaluating only the physical and chemical properties of the soil. Yet, the soil is a living ecosystem and the organisms living in the soil can directly affect plant health positively (such as mycorrhizae-which are beneficial symbionts) or negatively (such as plant pathogens), while others are neutral or contribute indirectly.

Although cranberry fields can be productive for decades, yields sometimes decline over time and this can be partly due to diminishing soil health. The microbial communities that inhabit the root zone of plants are very complex and consist of billions of organisms from different taxonomic groups (e.g. bacteria, fungi, arthropods, nematodes). The makes characterizing the soil microbial community challenging. An emerging method utilizes next-generation sequencing technology coupled with bioinformatic analyses.

METHODS

To identify the inhabitants of the soils in the root zone of cranberry plants, we collected soil samples from two commercial farms in Burlington county. DNA was isolated from the soil with the expectation that DNA of all of the organisms in a given sample are represented in the extract. Barcode regions of the DNA were then selectively amplified. The barcode is a small fragment of DNA that can be used to identify the organism from which it was extracted. Specifically, we amplified a portion of the 16S ribosomal DNA to identify bacteria and the ribosomal intergenic spacer (ITS) region to identify fungi. The amplified regions were sequenced on the next-generation Illumina platform. This platform allows the generation of sequence data from millions of fragments. The sequence data were then compared to extensive databases where similarity was used to classify the organisms from which the DNA were derived. Results from all samples were used to identify the 'core' microbial community associated with commercial cranberry culture and represents the first time such analyses were conducted.

RESULTS and CONCLUSIONS

The bacterial communities were similar across all soils samples, sharing 14 (25%) of the identified phyla. While the fungal communities were more diverse; only 5 (17%) phyla were present in all samples. A defined 'core' community will make it easier to determine how deviations from the core assemblage of organisms affect plant health. Assays to rapidly detect those organisms found to impact plant health will be developed.

ACKNOWLEDGMENTS

Support: Kristy Adams, Kate Brown, Oudemans Lab personnel

Funding: USDA-NRCS-CIG grant 69-2B29-15-246 to P. Oudemans, NJ Cranberry & Blueberry Research Council

Carolina Redroot Control with Preemergence Herbicides and Effects on Fruit Yield and Quality

Thierry Besançon, Extension Weed Science Specialist, and Baylee Carr,
P.E. Marucci Center, Chatsworth, NJ

New Jersey produced 29.6 million kg of cranberries in 2016 at a farm value of \$28 million (USDA 2017). New Jersey production is concentrated in the Pine Barrens coastal plain where sandy acidic soils are optimal for cranberry. The perennial nature of cranberry predisposes the crop to a diversity of weed species ranging from herbaceous weeds to woody perennial species. Carolina redroot [*Lachnanthes caroliniana* (Lam.) Dandy] is a perennial herbaceous weed species member of the *Haemodoraceae* family. Its proliferation and the lack of efficient control strategies has been an increasing source of concern for New Jersey cranberry growers. Information regarding herbicidal control of Carolina redroot is extremely limited and restricted to blueberry production (Myers et al. 2013).

A study was initiated in 2017 in order to evaluate Carolina redroot control and crop response following a spring application of preemergence herbicide at various labelled rates with X equal to the maximum labeled rate. **Evital 5G** (norflurazon) was applied at 10 (1/16X), 20 (1/8X), 40 (1/4X), and 80 (1/2X) lb a⁻¹, **Devrinol DF-XT** (napropamide) at 12 (1X) lb a⁻¹, and **Casoron 4G** at 50 (1/2X) and 100 (1X) lb a⁻¹.

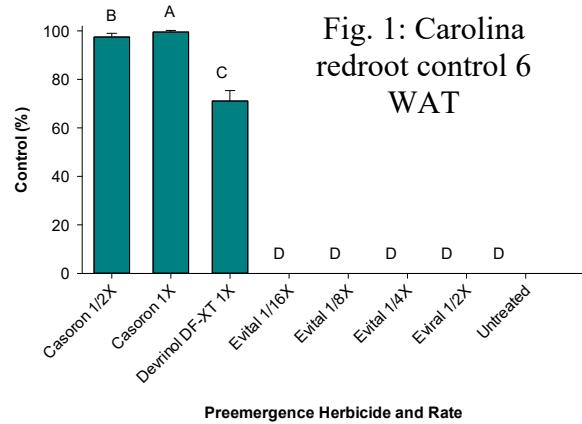


Fig. 1: Carolina redroot control 6 WAT

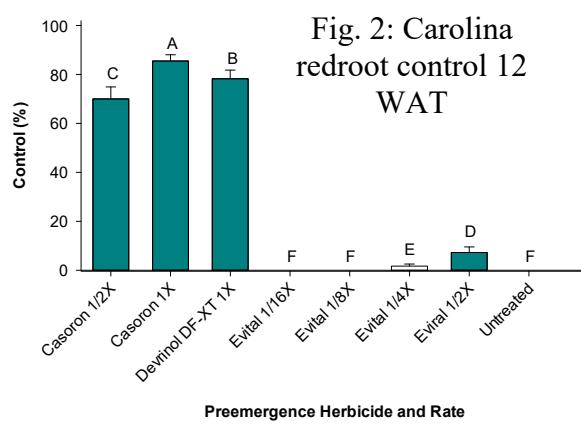
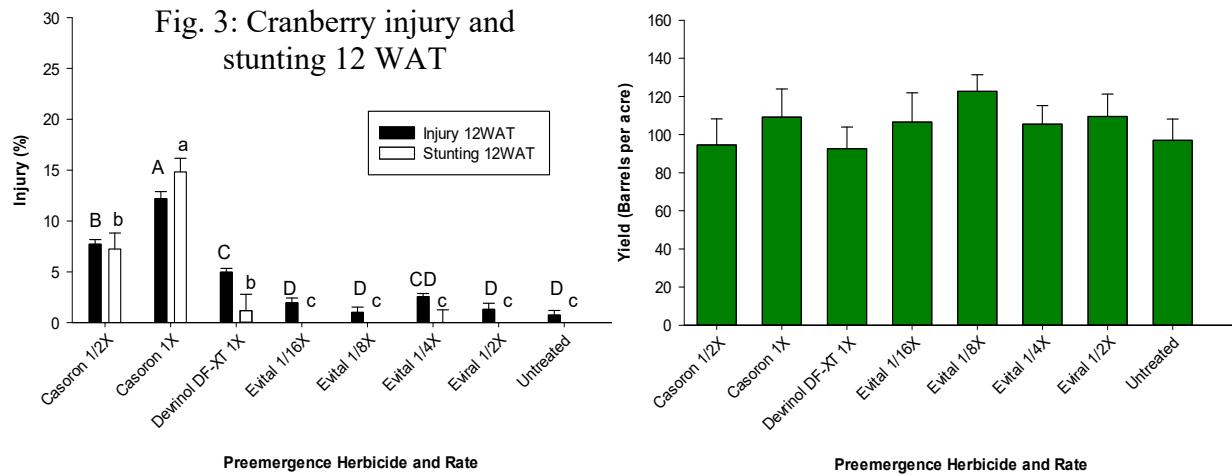


Fig. 2: Carolina redroot control 12 WAT

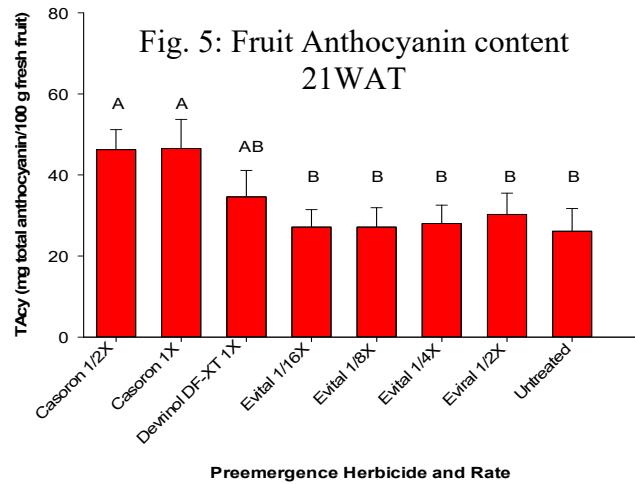
Carolina redroot control 6 weeks after treatment (WAT) was 71% with Devrinol DF-XT, 97% and 99% with Casoron at 1/2X and 1X, respectively (Fig 1). Control 12 WAT remained above 70% with Devrinol, but decreased by 27% and 14% with Casoron at the 1/2X and 1X rate, respectively (Fig 2). Evital never provided more than 7% Carolina redroot control, regardless of rate applied. Carolina redroot density 15 WAT was 480 plants m⁻² in the untreated check but declined by 73% with Casoron at the 1X rate (130 plants m⁻²). The lack of sufficient full season control with Casoron at the 1/2X rate and Devrinol was illustrated with Carolina redroot density at 15WAT declining by 29% and 25%, respectively (data not shown). All of the plants counted 15 WAT were recently emerged seedlings that grew back from rhizome unaffected by the preemergence herbicide application. Carolina redroot dry biomass significantly decreased 15 WAT with applications of Devrinol (-62%) and Casoron at the 1/2X (-68%) and 1X (-90%) rates. No significant reduction was noted with Evital, regardless of applied rate. Even if some late season Carolina regrowth was

noted, the significant decrease in weed biomass may interfere with the ability of the plant to build



up nutritional reserves and restrict weed development the next season.

Cranberry injury, mostly in the form of leaf chlorosis, was noted for all herbicide treatments, peaking 12 WAT with 12% for Casoron at the 1X, 8% for Casoron at the 1/2X rate, and less than 5% for Devrinol and Evital (Fig 3). Casoron, regardless of rate, caused significantly more vine stunting than Evital and Devrinol. However, higher crop damages with Casoron did not translate into significant yield reduction compared to the untreated check, Devrinol, or Evital (Fig 4).



to UV, and consequently increase the production of anthocyanins. In the absence of Carolina redroot control, the fruit TACy value tends to increase with higher Carolina redroot density. This may be due to a modification of the spectral reflectance properties of the crop canopy or increased water stress when Carolina redroot density increases.

Studies will again be conducted in 2018 to further evaluate the effects of fall or/and spring herbicide preemergence applications to control Carolina redroot as well as impact of herbicide on cranberry productivity and fruit quality. This should allow us to provide efficient Carolina redroot control recommendations.

Fruit firmness, sugar content, titratable acidity, and rate of rotten fruits were not significantly different depending on the preemergence herbicide applied in spring. However, the total anthocyanin of the fruits increased significantly with Casoron at the 1/2X and 1X rates compared to Evital or the untreated check (Fig 5). The production of anthocyanin is generally considered to be a plant response to environmental stress. Casoron primarily inhibits cell division on the roots and shoots. This may contribute to water stress or higher exposure of the plants

Management of Cranberry Insect Pests: Leafhoppers and Toadbugs

Cesar Rodriguez-Saona, Professor, Department of Entomology, Rutgers University
Vera Kyryczenko-Roth, and Robert Holdcraft, P.E. Marucci Center

Efficacy of various insecticides against toad bugs

Field experiments were conducted in 2017 to test the toxicity of registered and non-registered insecticides on toad bugs. The following insecticides were evaluated: Diazinon, Sevin, Assail, Agri-Mek, Closer, Lorsban, Cormoran, Beleaf, and compound X. The experiment was conducted in an 'Early Black' cranberry bog located at the Rutgers PE Marucci Center for Blueberry and Cranberry Research and Extension in Chatsworth, New Jersey (see Figure). Plots were separated by a 1 m tall silt fence to prevent movement of insects between plots.



Treatment plots were arranged in a complete randomized block design with 4 replicates. Applications were made with a custom boom sprayer on a New Holland 1920 tractor. The sprayer was calibrated to deliver 50 gal of volume per acre at 35 psi. Vacuum sampling was used to monitor nymph and adult toad bugs. Plots were sprayed on 4 August. Pre-spray samples were taken on 2 August, and post-spray samples were taken on 10 August. Numbers of toad bugs were counted (nymphs and adults were combined), with the aid of a magnifying lens.

Effect of damage by toad bugs on cranberry

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. This experiment started in July and ended on 10 August. Cages were placed over cranberry uprights in the field (see picture). Treatments consisted of 0, 5, 10 or 20 toad bugs per cage ($n = 5$ cages per treatment). At the end of the experiment, berries and foliage were harvested by clipping uprights. To characterize damage, the number of damaged/undamaged uprights and dwarfed/healthy berries will be counted. All berries were weighed.



Effects of false blossom on cranberry resistance to herbivores

Nakorn Pradit, PhD student, Department of Entomology, Rutgers University

Blunt-nosed leafhoppers are vectors of a phytoplasma that causes false blossom disease in cranberries. This disease causes abnormalities in flowers including shortened, discolored and streaked petals, enlarged calyx, straighten inflorescence, and abnormal development of floral parts into leaves (phyllody). False blossom imposed a severe threat to the cranberry industry in the US in the 1st half of the last century. However, in the 2nd half of the last century, management of leafhoppers through the development of resistant varieties and effective chemical controls reduced its incidence. Recently, the disease has re-appeared in many NJ cranberry farms due to changes in management practices and the use of new (possibly more susceptible) varieties. To address this issue, we are conducting studies to understand the effects of phytoplasma-infected cranberry plants on resistance to leafhoppers and other insect herbivores. We are asking two main research questions: 1. Are phytoplasma-infected cranberry plants more resistant or susceptible to leafhoppers and other non-vector insect pests? and 2) what are the mechanisms of this resistance/susceptibility? So far, results show that phytoplasma infection makes cranberries more susceptible to its vector and also non-vector insect herbivores (see below). Infected plants have higher nitrogen content and lower amounts of proanthocyanidins. These studies will help identify possible mechanisms of insect pest resistance in cranberries and develop tools for improving control methods against insect vectors and other pests of cranberries.



Phytoplasma-infected cranberry plant (left) and healthy plant (right)

Acknowledgements

Support: Kris Dahl, Jennifer Frake, and Ben Keating

Funding: New Jersey Cranberry Research Council Inc., Cape Cod Cranberry Growers Association, and Ocean Spray Cranberries, Inc.

