2020 Annual Winter Meeting of the American Cranberry Growers Association

Rutgers University EcoComplex

Bordentown, NJ

Thursday
January 23, 2020

RUTGERS
New Jersey Agricultural Experiment Station

ACGA Winter Meeting Program

Thursday, January 23, 2020
Rutgers EcoComplex, Bordentown, NJ

8:00-8:30 Registration and Coffee

8:30-8:50 Welcoming remarks– ***Shawn Cutts*, President, ACGA**
Treasurer's report **–** ***Shawn Cutts***

8:50-9:10 **Cranberry statistics**
Bruce Eklund, National Agricultural Statistics Service, Trenton, NJ

9:10-9:35 **Traits we have found in cranberry**
Nicholi Vorsa, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ; and *James Polashock*, Research Plant Pathologist, USDA-ARS

9:35-10:00 **Progress towards managing fruit quality in 2020**
Peter Oudemans, Professor, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

10:00-10:25 **How weeds impact cranberry yield and fruit quality**
Thierry Besancon, Weed Science Extension Specialist, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

10:25-10:40 **Break**

10:40-10:50 **Fumigation trial on new plantings**
Chad Hutchinson, Director of Research, and *Aaron Perreault*, Northeast Sales Account Manager, Tri-Est Ag Group, Greenville, NC

10:50-11:00 **VacciniumCAP: Leveraging genetic and genomic resources to enable development of blueberry and cranberry cultivars with improved fruit quality attributes**
James Polashock, Research Plant Pathologist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ; *Nicholi Vorsa*, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ

11:00-11:25 **Machine learning assists cranberry fruit rot resistance breeding**
Joe Kawash, P.E. Marucci Center, Chatsworth, NJ; *James Polashock*, Research Plant Pathologist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ; *Nicholi Vorsa*, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ

11:25-11:55 **Managing moss in cranberries**
Katherine Ghantous, Research Associate, Cranberry IPM, Cranberry Station, East Wareham, MA

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

1:00-1:20 **Cranberry institute – An update**
John Wilson, Cranberry Institute, Carver, MA

1:20-1:45 **Can we exploit cranberry's own defenses to fight against phytoplasma infection?**
Cesar Rodriguez-Saona, Professor, Department of Entomology, Rutgers University, New Brunswick, NJ; *James Polashock*, Research Plant Pathologist, USDA-ARS; and *Vera Kyryczenko-Roth*, P.E. Marucci Center, Chatsworth, NJ

1:45-2:10 **Important farm health and safety concerns related to machinery operation and pesticides application**
Bill Bamka, Agriculture & Natural Resources County Agent II, County Extension Dept. Head, RCE of Burlington County, Rutgers New Jersey Agricultural Experiment Station

2:10 **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 2018 Non-citrus Fruit and Nut Final Summary noon June 18, 2019. The next release, for the 2019 crop, is May 5, 2020 in the Non Citrus Fruit and Nuts report:
https://www.nass.usda.gov/Publications/Reports_By_Date/index.php

NASS released the production forecast for the 2019 crop August 12, 2019. This cranberry forecast is included in the Crop Production report. This includes the National and State level forecasts. NASS released these results shortly before the August 2019 ACGA meeting so NASS does not yet have new estimates to present at the 2020 ACGA winter meeting.

Currently NASS is collecting pesticide use data for important crops in important states. This includes New Jersey cranberries. Data collection ends soon. Without good data, policy makers tend to make assumptions about pesticide use that can lead to counterproductive policy.

You can get e-mail alerts for New Jersey and Regional customized reports:

https://www.nass.usda.gov/Statistics_by_State/New_Jersey/index.php

Look under 'I want to' on the left.

Traits we have found in cranberry

Nicholi Vorsa, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ; and *James Polashock*, Research Plant Pathologist, USDA-ARS

Over the past decades the Rutgers cranberry breeding program's main objectives have focused largely on increasing productivity, anthocyanin content, fruit quality and more recently particular focus has been on increasing fruit rot resistance. Other traits of horticultural interest are season of harvest, fruit size, Brix, epicuticular wax, fruit shape, etc. Low anthocyanin content at one time for the 'white juice' product was of interest. For sweetened-dried cranberries a TAcy 'window'of 35-50 mg/ 100g FW appears optimal. Other objectives, such as reducing 'added-sugar' in cranberry products, could possibly be achieved by reducing the high level of acidity of cranberry fruit, which is typically four to five times what is found in apples, grapes, peach, etc., thus less sugar would be needed to balance the acids for palatability. Two recessive low acid traits, one low citric and one low malic, were found in our germplasm collection and were determined to be controlled by major genes. In developing breeding populations derived from these germplasm accessions to recover homozygous low acid genotypes/phenotypes, we have also identified other recessive traits including male-sterility and 'pumpkin' fruit. In our fruit rot resistance breeding program, we have identified an 'albino' trait derived from the cultivar 'Cumberland'. Another trait that we are studying is the genetic basis of epicuticular wax formation, as a possible trait to reduce heat scald. Other traits, based on major genes, that have been identified are 'Yellow Bell' and 'Murphy's Green'. We have also identified quantitative genetic variation for anti-oxidants including proanthocyanidins (PACs), anthocyanins, and flavonols.

Progress towards managing fruit quality in 2020

Peter Oudemans, Chris Constantelos, Tim Waller, Dave Jones, Julian Allen

Introduction

Cranberry fruit quality is measured with the goal of selecting fruit well suited for SDC production. In the current protocol the incidence of fruit rot, fruit size, firmness and color are the most important factors. These components of fruit quality are affected by both cultural practices which we can control and environmental conditions which can be managed, up to a point.

Fruit rot	Timing of fungicide application Type of fungicide used Environmental conditions Variety of cranberry
Fruit size	Fertilizer use patterns Fungicide types Irrigation management Variety of cranberry
Firmness	Environmental conditions Over heating Variety of cranberry
Color	Use of mancozeb fungicides Use of other products Quality of light and other environmental factors Variety of cranberry

In today's talk I will discuss the impact of many of the practices used to improve cranberry fruit quality.

Heat management and overheating.

The growing season of 2019 was an exceptional season for fruit quality. Overheating events were minimal and during the critical later part of the season especially during color development nonexistent. Not surprisingly overheating trials yielded very little data on efficacy since fruit were all of exceptional quality.

Fungicide Trials

Fungicide trials were focused on identifying replacements for chlorothalonil. Three approaches were taken for this. One was to search for new modes of action in field trials and candidate fungicides have been identified. The next step is to process these materials through the IR4 registration process. A second approach was to identify use patterns for mancozeb products that would minimize detrimental effects. In general, these trials have shown that in-bloom applications have lower negative effects. A third approach that offers some significant promise is a new lab based bioassay developed through the work of Tim Waller. This approach will allow a higher throughput of candidate fungicides and has the advantage of examining each pathogens species individually

How do weeds impact cranberry yield and fruit quality?

Thierry Besançon,
Weed Science Extension Specialist
P.E. Marucci Center for Blueberry and Cranberry Research and Extension
Rutgers University, Chatsworth, NJ

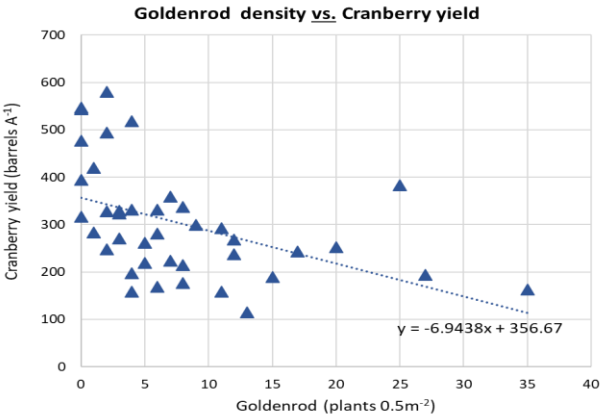
EFFECT OF WEED COMPETITION ON CRANBERRY YIELD AND QUALITY

An exhaustive understanding of the impact of various weed species and weed density on cranberry yield and quality would allow for management prioritization. Surprisingly, minimal documentation of these relationships is available. This information would be particularly useful as growers consider reducing inputs to address economic challenges. They would be able to focus on those weeds that have the greatest crop impact as opposed to those that may be abundant but primarily affect aesthetics.

With this in mind, our objectives were to:

- ⇨ Establish a methodology to document weed impacts on cranberry yield and quality.
- ⇨ Test the methodology across a spectrum of weed species and regions.

The long-term goal is to establish a "library" of weed species thresholds that could serve as a resource for growers, crop scouts and other pest management decision makers. Quantified weed parameters included density, biomass and ground cover. Cranberry parameters included berry yield, number, color, rot, insect damage, total anthocyanin content (TAcy) and Brix. Weed species included dewberry (*Rubus* spp.) and flat-top goldenrod (*Euthamia graminifolia*) in Wisconsin, Carolina redroot (*Lachnanthes caroliniana*), yellow loosestrife (*Lysimachia terrestris*) and red maple (*Acer rubrum*) in New Jersey, and haircap moss (*Polytrichum commune*) in Massachusetts.

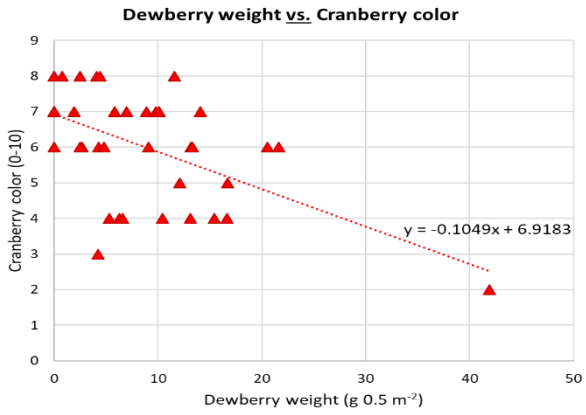


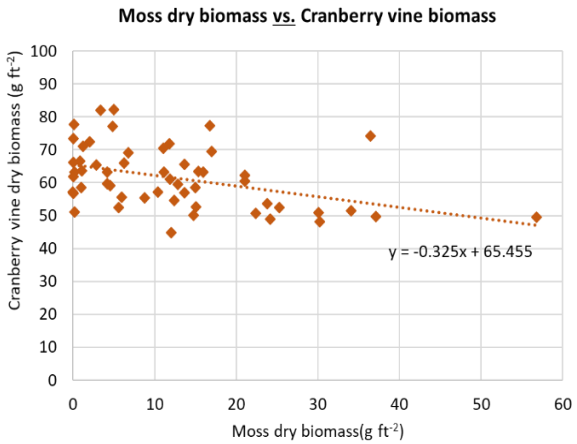
Flat-top goldenrod

Goldenrod density and biomass were negatively correlated ($p < 0.005$) with total berry yield and average berry weight. However, goldenrod biomass was positively correlated ($p < 0.01$) with the number of commercially acceptable ("good berries") fruits. This indicates that goldenrod significantly decreases cranberry productivity with increasing weed density, but that remaining berries may be larger and have more uniform size because of a reduced number of fruits per vine.

Dewberry

Dewberry negatively affected not only cranberry yield but also color. Each percent of dewberry ground cover reduced cranberry yield by two barrels (100-lb weight) per acre. Shading of cranberry vines by prostrate-growing and large-leaved dewberry may explain the negative impact on fruit coloration.



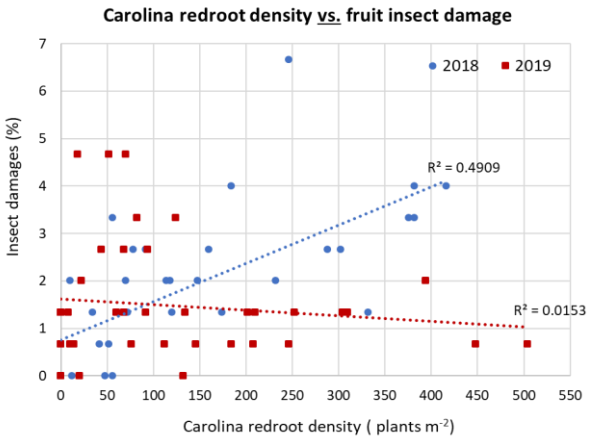


Haircap moss

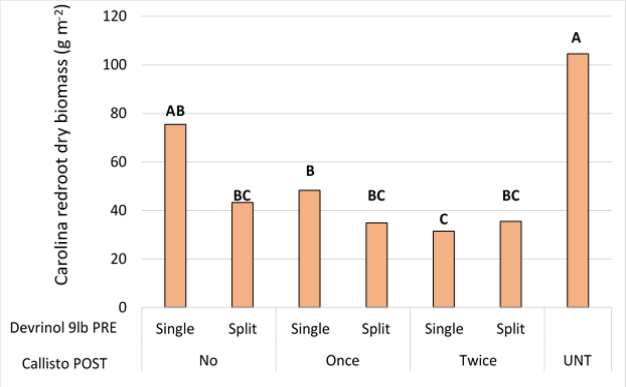
The impact of moss on cranberry yield and quality was more challenging to quantify as moss biomass harvest was difficult and other factors likely affect cranberry production in areas where moss was prevalent, such as moisture management. With that said, cranberry yield was still inversely related to moss biomass. Cranberry vine biomass decreased with increasing moss biomass, which can also signals that edaphic conditions that stimulate moss development may be detrimental to cranberry development.

Carolina redroot

Both in 2018 and 2019, the relationship between Carolina redroot biomass and density were also negatively related to cranberry yield. ($p < 0.0001$). Interestingly, a strong positive relationship was documented between Carolina redroot density and fruit insect damage in 2018 ($p < 0.01$) but not in 2019, maybe because of the cyclicality of insect species that could be associated with Carolina redroot. No significant effect of Carolina redroot was noted on the percentage of rotten fruits at harvest.



CAROLINA REDROOT CONTROL WITH SPLIT-APPLICATIONS OF DEVRINOL 2-XT



Studies were conducted in 2019 to evaluate Carolina redroot control with split applications of Devrinol 2-XT preemergence, followed or not by Callisto postemergence. Devrinol 2-XT was applied as a single shot (9 lb a.i/A) on April 30, or split between a first shot on April 30 (4.5 lb a.i/A) followed by a second shot 4 weeks later on May 29 (4.5 lb a.i./A). Devrinol treatments were followed by Callisto applied postemergence at 4 oz a.i/A either once (June 17) or twice (June 17 and July 17).

In the absence of postemergence application, Carolina redroot biomass decreased by 42% in plots that received split applications of Devrinol 2-XT compared to a single application. The benefit of two versus a single application of Callisto was evident only in plots that received a single preemergence Devrinol 2-XT application. Overall, plots with split application of Devrinol at 9 lb a.i./A had significantly lower Carolina redroot dry biomass than plots with a single preemergence application (orthogonal contrast $p = 0.0175$).

Based on these results, EPA granted New Jersey on January 1st, 2020, a 24C Special Local Need label for use of Devrinol 2-XT in cranberry allowing split applications before the start of bloom within the limit of 18 qt (9 lb active ingredient) per acre and per year.

VacCAP
IMPROVING FRUIT QUALITY

Presented by
James Polashock, USDA-ARS

VacciniumCAP: Leveraging genetic and genomic resources to enable development of blueberry and cranberry cultivars with improved fruit quality attributes

Vaccinium crops (primarily blueberry and cranberry) provide a vital contribution to the U.S. economy and numerous health and social benefits. The production and consumption of these crops continue to expand worldwide. However, U.S. *Vaccinium* industries face numerous challenges to maintain profitability. First, the challenges, as perceived by growers, handlers and nurseries were assessed and ranked through a nationwide survey. Based on those results, a comprehensive project was created to address the needs identified. Improvement of fruit quality traits emerged as the primary target. These traits include fruit firmness, flavor, shelf life, and appearance. *Vaccinium* breeders already select for some of these traits but lack the capacity for unified and comprehensive testing across a range of environments. Additionally, breeders have limited molecular tools to facilitate selections for higher quality fruit.

To address these issues, the VacciniumCAP project goals are to: 1) Expand DNA-based assay capacity and implement marker-assisted selection for fruit quality and other traits; 2) Expand fundamental knowledge and tools to inform breeders and industry about the added value of fruit quality traits; 3) Identify and use existing cultivars with superior genes as parents in new crosses; 4) Recruit and train students and postdoctoral scholars, and inform and engage the public.

These results will enable long-term impact by establishing new skills and tools to facilitate successful *Vaccinium* breeding programs. This will ultimately lead to improved fruit quality production and delivery to markets, while improving the profitability, consumption and sustainability of *Vaccinium* crops.

The VacciniumCAP project was funded by USDA-NIFA-SCRI (Award #2016-51181-25400, 2019-2023) to create a nationwide transdisciplinary research approach to address the proposed objective.

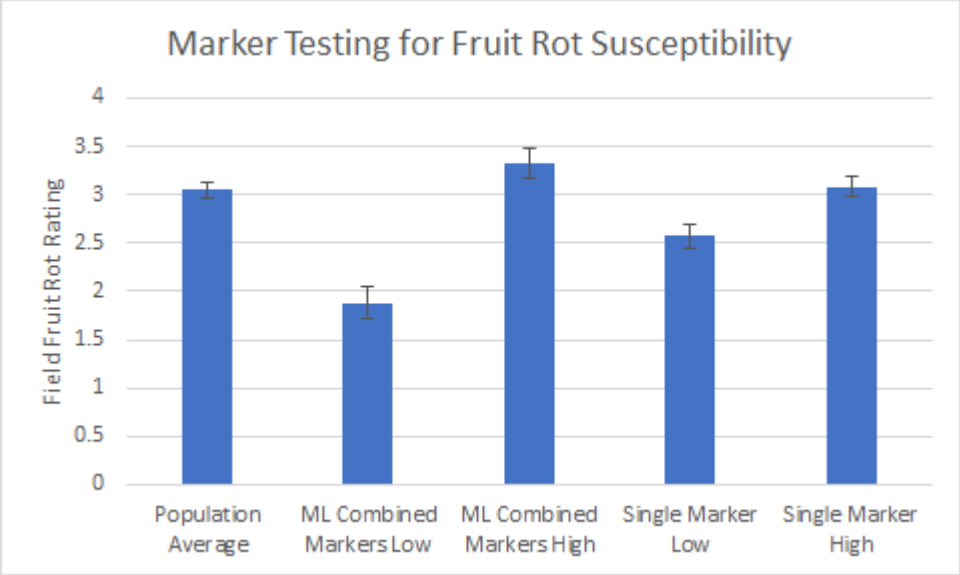
NC STATE UNIVERSITY · Washington State University · Michigan State University · USDA · Rutgers · Wisconsin University of Wisconsin–Madison · UF University of Florida · University of Georgia · Plant & Food Research · Fondazione Edmund Mach

Machine learning assists cranberry fruit rot resistance breeding

Joseph Kawash, ORISE Scholar; James Polashock, USDA-ARS; Jennifer Johnson-Cicalese, Rutgers P.E. Marucci Center; Nicholi Vorsa, Rutgers P.E. Marucci Center

Marker assisted selection is an invaluable tool utilized in crop breeding through selection of specific genotypes to propagate desired phenotypic traits. Currently, most marker assisted selection methodologies rely on genetic markers developed from either quantitative trait loci (QTL) studies or genome wide association (GWAS) studies. In these studies, there is usually a small number of highly contributing genetic sources. However, there is ongoing research demonstrating that many phenotypes, such as fruit rot resistance (FRR), are not limited to single or few genetic components that are easily identified in QTL and GWAS methods, but often are the result of several small and complex-interacting, e.g. epistatic, variants of multiple genetic components. Enhancing FRR through breeding is challenging due to fruit rot being incited by a complex of pathogenic fungi varying in location and year, and the complexity of identifying and following genetic FRR contributors. As next generation sequencing, especially methods such as genotyping by sequencing, becomes more cost effective for the discovery of increasingly larger proportions of genetic variation within a population, it becomes more feasible to identify these co-contributing variations of multiple genetic components and assess their interactions.

Machine learning (ML) methods offer an alternative way of providing information for marker assisted selection with an increased ability to identify complex interacting and epistatic genetic markers. The use of ML for marker assisted selection has already been utilized in several agriculturally relevant species including wheat, cattle, and maize, to help decipher complex genetic interactions and yield desired traits at the population level. We have developed methodology for cranberry that expands on these studies and combines ML and genotyping by sequencing to efficiently provide informative genetic markers for selection. Results were validated in several populations of cranberry previously studied for low acid traits. When we utilized ML methods to study the polygenic trait of FRR in two populations of cranberry that was not well characterized using conventional QTL analysis software, we were better able to clarify causative genetic interactions for FRR. Four major genetic contributors on four different chromosomes were identified in these populations with three markers contributing to an estimated 23% of phenotypic variance in one population and two markers contributing to an estimated 27% of the variance in the remaining population.



Managing Moss in Cranberry Beds, AGCA Winter Meeting 2020

Katherine Ghantous, Research Associate, UMass Cranberry Station, East Wareham

Moss is an emerging weed issue for cranberry growers in Massachusetts and other cranberry growing regions. Although present in cranberry for decades as a minor weed, growers have recently begun to perceive it as becoming more widespread and difficult to control despite practices, such as improved drainage and water management, which should discourage moss growth. It is unclear why moss has emerged as a major weed in the last decade. Possible contributing factors are changes in farm practices over time (e.g., fertility management, drainage and irrigation practices, other cultural practices), effective control of other weeds with herbicides that create opportunities for moss to thrive (since mosses do not respond to herbicides currently registered for use in cranberry), or climate change. Moss has also been documented as an increasing problem in lowbush blueberry, a closely related crop.

The most commonly encountered and prevalent mosses found as weeds in MA cranberry beds are haircap (*Polytrichum commune*) and sphagnum (*Sphagnum* spp.). Recent surveys of two beds at State Bog (UMass Cranberry Station) revealed an unexpected diversity of mosses and have identified at least seven additional species. These additional species were found only sporadically (low abundance).

Traditional control measures, such as spot treatment of moss patches with high rates of iron sulfate, are not adequate for managing widespread infestations. Currently registered herbicides, such as Casoron, Evital, Devrinol 2-XT, QuinStar, or Callisto, provide little to no control of moss.

Over the past several years, we screened several “non-traditional herbicide” products including acetic acid (20% horticultural strength), ammoniated soap of fatty acids, potassium salts of fatty acids, and various iron sulfate products. Most were injurious to cranberry, and those that were effective and not injurious are either impractical due to high cost/amount of material needs per acre or unfeasible to apply on a largescale. None are currently registered for use on cranberry. Recent herbicide screening trials of dozens of herbicides not currently registered in cranberry have identified two promising preemergence herbicides that demonstrated control of moss and crop safety on dormant vines. These herbicides were tested specifically on haircap moss, but may also control other species. The industry is currently working with the respective chemical companies to pursue registration, and hope to have new tools in the hands of growers as soon as possible.

2020 Update from the Cranberry Institute – John Wilson

There have been changes at the Cranberry Institute (CI). Terry Humfeld retired at the end of December 2019 and Bill Frantz is the new Executive Director. Under Terry's management, the CI made important strides in the areas of funding horticultural and health research as well as pursuing health communications. Many know Bill from his years at Ocean Spray Cranberries, Inc. His role at the CI will be similar to Terry's. Unfortunately, he was not able to attend this year's ACGA Meeting but is anxious to visit NJ.

The 2020 CI Update will cover areas of horticultural research, international MRLs and look at how we are doing in the search for new chemicals.

Horticultural Research is the industry's commitment to its future and the CI's role is to prioritize projects and organize regional stakeholder funds. The 2019 cranberry crop was significantly smaller than expected which will reduce funding available for research projects in 2020. The importance of research coordination and funding across growing areas will be emphasized at the meeting. There have been several retirements among cranberry researchers across the US and Canada and retaining these positions is getting harder. The CI works to maintain coordination and communications with researchers. Some researchers meet at their annual scientific meetings like the entomology or pathology conferences. But not all cranberry researchers go to these meetings. A long time ago, cranberry researchers organized a NACREW (North American Cranberry and Extension Workers) conference that takes place every other year. Last August, approximately 50 cranberry researchers met in British Columbia. They spent 3 days discussing research results and visiting local grower farms that have pest issues. The next NACREW meeting will be in 2021 in NJ.

MRLs. Approximately 30% of the crop is exported – mostly to Australia, Canada, China, EU, Japan and Korea. Australia and Canada have been the most accommodating and accepting of new MRLs but the EU continues to be more restrictive and conservative in using risk-based toxicity assessment. For example, trying to get a quinclorac (Quinstar) MRL has been taking an unusually long time to get approved – we don't expect to receive a cranberry MRL until sometime in 2022. In addition to delays in new MRL approvals, the EU is in the process of removing cranberry MRLs from some older chemicals like chlorothalonil (Bravo) and chlorpyrifos (Lorsban). The current status of the MRLs in the various export markets will be presented at the meeting.

The search for new chemicals continues. Last year, we had a few new chemicals approved for use in cranberry and we expect a couple new ones this year. Last year we had spirotetramat (Movento) and cyantraniliprole (Exirel) approved for use in the US and Quadris Top (a combination products of azoxystrobin and difenoconazole) approved in both the US and Canada. We started work on Movento in 2009 and was approved in Canada in 2014 and in the US in late 2018; Exirel work began in 2009 and was approved in Canada in 2016 and in the US in 2018; Quadris Top work began in 2012 and approved in 2018 in both the US and Canada.

Can we exploit cranberry's own defenses to fight against phytoplasma infection?

Cesar Rodriguez-Saona, Department of Entomology, Rutgers University, New Brunswick, NJ
James Polashock, Research Plant Pathologist, USDA-ARS
Vera Kyryczenko-Roth, P.E. Marucci Center, Chatsworth, NJ

The foraging and feeding behaviors of insect vectors are known to affect the transmission of insect-borne diseases. Disease infection causes changes in phytochemicals, especially volatiles, nutrients and chemical defenses, of host plants that can facilitate the performance and preference of insect vectors. In an agro-ecosystem, these changes in infected host plants can also affect non-vector herbivorous insects. A better understanding of the mechanisms underlying tri-partitate interactions among plants, pathogens, and herbivores could help in the development of ways to reduce disease transmission by improving host-plant resistance against diseases and pests of crops.

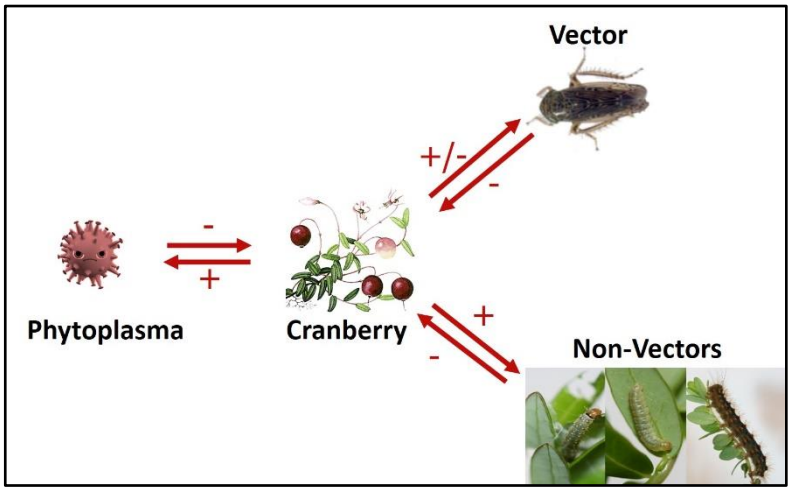


Fig. 1. Interactions among insect herbivores, cranberries, and the phytoplasma that causes false blossom disease.

In cranberries, false blossom disease is caused by a phytoplasma that needs the blunt-nosed leafhopper (BNLH), *Limotettix vaccinii* Van Duzee, for its transmission (Fig. 1). We have conducted studies to determine if (1) phytoplasma infection enhances BNLH performance and preference on infected plants, (2) phytoplasma infection enhances the performance of three non-vector leaf feeders, and (3) phytoplasma infection alters levels of phytochemicals and expression of gene related to primary (i.e., nutrients) and secondary (i.e., plant defenses) metabolism in cranberries.

We found that phytoplasma infection has conflicting effects on its vector. BNLH nymphal and adult survival was similar on infected and uninfected cranberries. However, nymphs developed more slowly and adults had higher mass on infected plants than on uninfected plants, indicative of a short-term positive effect. In contrast, BNLH females laid more eggs on healthy, uninfected plants than on infected plants. When given a choice between uninfected plants and an air control, BNLH preferred volatiles from uninfected plants. We found that uninfected plants emit higher volatile emissions than infected plants.

The larvae of three common non-vector herbivores: spotted fireworm (*Choristoneura parallela* Robinson), Sparganothis fruitworm (*Sparganothis sulfureana* Clemens), and gypsy moth (*Lymantria dispar* L.) had 2–3 times higher mass, and damaged 1.5–3.5 times more leaves, when feeding on infected compared with uninfected plants (Fig. 2). Sparganothis fruitworm and gypsy moth larval survival was also improved on infected plants.

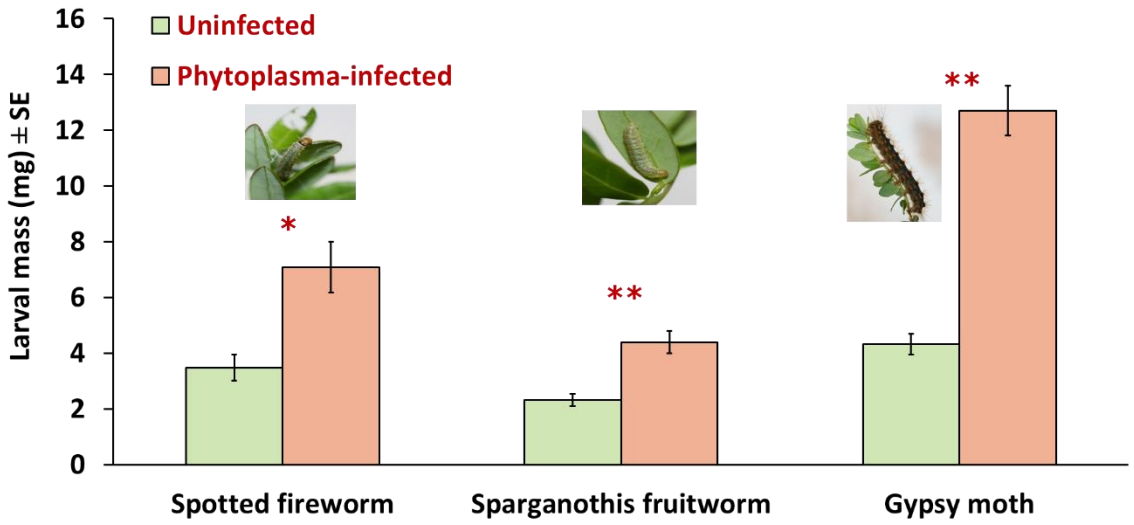


Fig. 2. Larval mass of spotted fireworm (*Choristoneura parallela* Robinson), Sparganothis fruitworm (*Sparganothis sulfureana* Clemens), and gypsy moth (*Lymantria dispar* L.) feeding on uninfected and phytoplasma-infected cranberry plants.

We found that nutrient levels were higher, while defensive proanthocyanidins were lower, in infected plants compared with uninfected plants. Phytoplasma infection also increased expression of 132 genes and suppressed expression of 225 genes in cranberries. Expression of genes associated with nutrient metabolism (i.e., carbohydrate) were up-regulated, while those associated with defensive pathways were down-regulated, in the phytoplasma-infected plants. In summary, our results indicate that phytoplasma-infected plants may rely on visual and chemical cues to attract its vector. After attraction, feeding by BNLH might be facilitated through elevated nutrient and reduced defensive metabolite levels in infected plants. This vector facilitation also benefits other, non-vector, herbivores in the cranberry community.

Acknowledgements. This research was supported by the New Jersey Cranberry Research Council Inc., the Cape Cod Cranberry Growers Association, the Cranberry Institute, and Ocean Spray Cranberries, Inc.