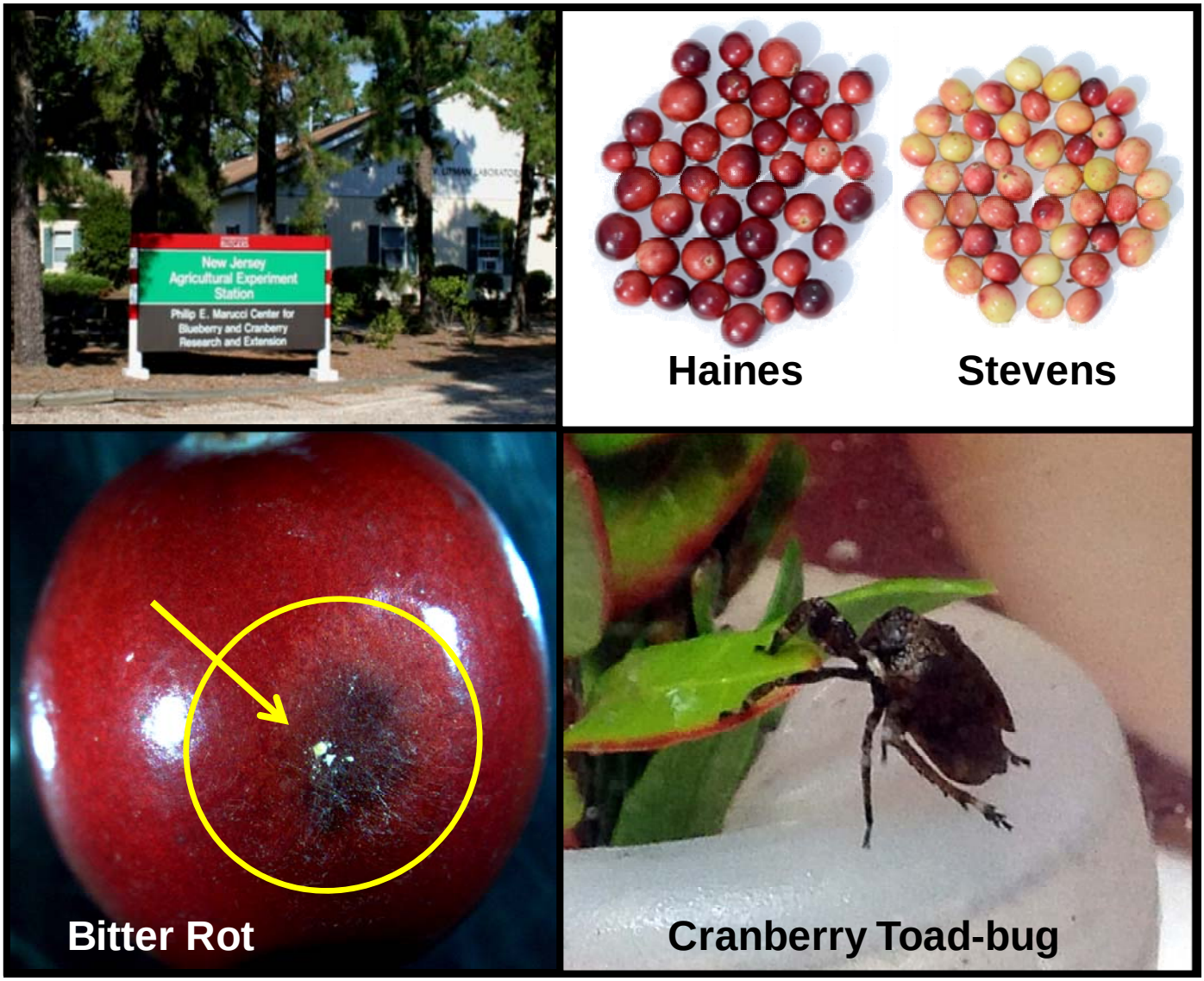
2015 Annual Winter Meeting of the American Cranberry Growers Association

Rutgers University EcoComplex

Bordentown, NJ

Thursday
January 22, 2015

RUTGERS
New Jersey Agricultural Experiment Station



Presentation Summaries

ACGA Winter Meeting Program

Thursday, January 22, 2015

Rutgers EcoComplex, Florence, NJ

8:00-8:30 Registration and Coffee

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

8:40-8:55 C**ranberry Statistics**
Bruce Eklund, National Agricultural Statistics Service, Trenton, NJ

8:55-9:10 **Bravo, the EU and other CI Horticultural Activities**
John Wilson, Cranberry Institute, East Wareham, MA

9:10-9:30 **Management of Fairy Ring and Other Diseases of Cranberry**
Peter Oudemans, Professor, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

9:30-9:50 **First Attempt at Biocontrol of Cranberry Fruit Rot**
Timothy Waller, graduate student and *Peter Oudemans*, Professor, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ

9:50-10:10 **Breeding for Fruit Rot Resistance in Cranberry: Role of Organic Acids in Resistance**
Stephanie Fong, graduate student, *J. Johnson-Cicalese*, Research Scientist, Marucci Center, *James White*, Professor, Dept. Plant Biology and Pathology, Rutgers University, New Brunswick, NJ and *Nick Vorsa*, Professor, Dept. Plant Biology and Pathology, Rutgers University; P.E. Marucci Center, Chatsworth, NJ

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

10:30-10:50 **Prevalence and Impact of Viruses in Cranberry**
James Polashock, Research Plant Pathologist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

10:50-11:10 **Developments in Cranberry Weed Control**
Brad Majek, Professor, Rutgers Agricultural Research and Extension Center, Bridgeton, NJ

11:10-11:40 **Using IPM strategies to Manage Current and Emerging Weed Pests in NJ Cranberry Production**
Hilary Sandler, Extension Assistant Professor, State IPM Coordinator, University of Massachusetts Cranberry Station, East Wareham, MA

11:40-1:00 **Lunch**

1:00-1:20 **Canopy Cooling with Mid-Day Irrigation to Alleviate Heat Stress in Cranberry Production**
Patrick Burgess, graduate student, *Peter Oudemans*, *Nick Vorsa*, and *Bingru Huang*, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ

1:20-1:40 **Results from 2014 Insecticide Trials**
Vera Kyryczenko-Roth, *Robert Holdcraft*, P.E. Marucci Center, Chatsworth, NJ and *Cesar Rodriguez-Saona*, Department of Entomology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

1:40-2:00 **Exploring Resistance against Insect Pests in Cranberries**
Elvira de Lange and *Cesar Rodriguez-Saona*, Department of Entomology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

2:00-2:15 **Release of the 'Haines' and 'Welker' Cranberry Varieties**
Nicholi Vorsa, Professor, Department of Plant Biology and Pathology, Rutgers University and *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ

2:15-2:45 **Farm Safety with Pesticides**
Ray Samulis, Burlington County Agricultural Agent, Rutgers University, Mt. Holly, NJ

2:45 **Adjournment**- *ACGA Board of Directors Meeting*

New Jersey Agricultural Statistics

Bruce Eklund, State Statistician, NJ Field Office, National Agricultural Statistics Service

USDA's National Agricultural Statistics Noncitrus Fruits and Nuts 2014 releases the Preliminary Summary noon January 23. Therefore these 2014 results cannot be discussed at the January 22 ACGA winter meeting. However, NASS did release the results of the Census of Agriculture since the last meeting. As a result, previous data, 2008-2012 are subject to five year revisions. These and 2013 data will be used to examine US and major cranberry producing state trends in bearing acres, production, and price.

Visit www.nass.usda.gov to access the 2014 report after noon, January 23, 2015. Select 'Publications' from the horizontal gray bar beneath the pictures. Find the report following the calendar. NASS also releases national and state cranberry data July 17 and August 13 2015.

Bravo, the EU and other CI Horticultural Activities

John Wilson, Cranberry Institute, East Wareham, MA

The European Union (EU) recently decided to reduce the Maximum Residue Limit (MRL) of Bravo (chlorothalonil) on cranberry from 2 ppm to 0.01 ppm, basically eliminating the use of Bravo on fruit marketed in the EU. Bravo is the primary fungicide used to control fruit rot (FR), a serious disease affecting cranberry keeping quality. The Cranberry Institute (CI) is leading an industry working group that is pursuing options that may temporarily allow Bravo's use while more permanent options become available. This effort is part of the CI's overall role in obtaining MRLs for important cranberry pesticides in priority international markets. The CI continues to pursue the registration of newer and safer chemicals that includes a new fungicide and two new insecticides. Finally, cranberry horticultural research still is a CI priority that requires communication and coordination, especially as researchers look for funding beyond their local funding organizations. An update will be provided on the 2015 round of research proposals being evaluated.

Management of Fairy Ring and Other Diseases of Cranberry

Peter Oudemans, Professor, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

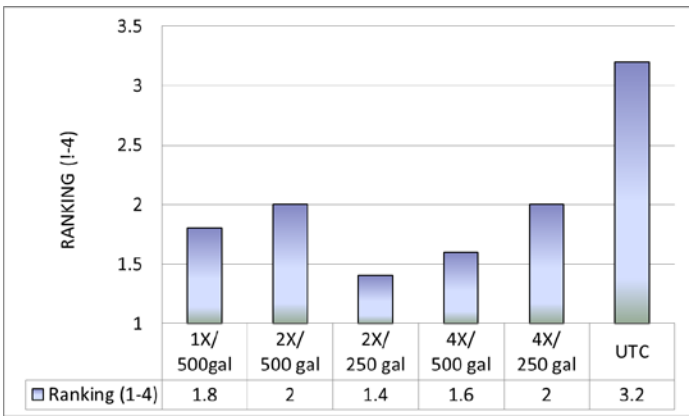
Two trials were conducted in 2014 to investigate different chemical treatments that could be used in the short-term to reduce the impact of fairy ring. Both trials were located on beds of cultivar Stevens at the Pine Island Cranberry Company. Previous research has shown that both Indar and Abound have efficacy against fairy ring, however, recent work has shown that treatments using these chemicals are not effective. Therefore, in the first trial we tested these same chemicals using a range of rates and volumes. Applications were applied using standard commercial methods (i.e. a firehose fed from a 1000 gal. reservoir). Water volume was measured using a flow meter. Plots were 2500 ft^2 (50 ft. X 50 ft.) in area and laid out as a grid with only the grids containing fairy rings being used. Each grid was treated completely and received either 500 or 250 gallons of water.

Table 1. Indar + Abound treatment rates and volumes used to test for fairy ring control

Fungicide		Rate	Volume (gallons)	Abound (fl.oz./1000gal)	Indar (fl.oz./1000gal)
I/A	BL	1X	500	8.7	6.9
I/A	GR	2X	500	17.4	13.8
I/A	YE	2X	250	17.4	13.8
I/A	RE	4X	500	34.8	27.6
I/A	PI	4X	250	34.8	27.6
UTC	WH	0X	0	0	0

Data were collected throughout the growing season through the use of an airborne drone carrying a digital camera. Missions were flown at approximately 2 week intervals and images were post processed by mosaicking and georeferencing. The location of each plot was identified by overlaying a georeferenced grid on top of the images and ranking the change in fairy ring progress.

RESULTS: Based on the aerial imagery it was determined that, in 2014, fairy ring spread occurred primarily during the interval between the second and fourth flight missions which corresponds to mid-June through mid-July. In order to rank each plot, disease spread was evaluated during that time interval for each plot. A ranking of 1-4 was used with 1 indicating no noticeable increase in ring size and 4 indicating the maximum increase. Data were analyzed to determine if treatments could be statistically distinguished. Results presented in the figure below show no significant differences among treatments; however, it is likely that over time treatment differences will increase.



Results of the 2014 fairy ring trial.

First Attempt at Biocontrol of Cranberry Fruit Rot

Timothy Waller, Graduate student *and Peter Oudemans*, Professor, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

Cranberry fruit rot is a challenging disease due to the complexity of causal pathogens. Furthermore, with recent restrictions on pesticide use and more on the horizon, alternative methods for viable control of this disease must be investigated. Effective disease control has only been achieved when applications of fungicides are made around the time of bloom. Our laboratories work has demonstrated that water-soluble cranberry floral-extracts induce and increase appressorial formation, enhance conidiation as well as increase overall hyphal growth. The purpose of this study was to evaluate a novel target that includes water-soluble floral compounds critical for pathogenesis. Selected *Bacillus*, *Paenibacillus*, registered biological controls and unknown bacterial isolates were screened for biological activity against select cranberry fruit rot pathogens *Colletotrichum acutatum / fioriniae, C. fructicola* (previously *C. gloeosporioides*) and ripe-rot pathogen *Coleophoma empetri*. Screening procedures include evaluation of selected bacteria's ability to utilize and inactivate floral extracts, in culture media inhibition of fungal growth, in water droplet suspension direct inhibition and direct contact antifungal responses as well as hyphal destruction of established pathogens on culture media. Some of the bacteria collected from cranberry tissues possessed strong antifungal attributes comparable to commercially available biological controls. In replicated field trials, bacterial suspensions were applied during and immediately following the bloom period and associated disease development phenology and rot analyses were conducted on the cranberry cultivar Stevens. This research aims at developing a foundation for future biological control screening procedures, methods of application of this knowledge, identification of hurtles to be considered and providing crucial infrastructure for much needed future research.

Relationship of Quinic and Benzoic Acid Levels with Fruit Rot Resistance in American Cranberry

Stephanie Fong, Graduate student, *J. Johnson-Cicalese*, Research Scientist, Marucci Center, *James White*, Professor and *Mariusz Tadych*, Visiting Scientist, Dept. Plant Biology and Pathology, Rutgers University, New Brunswick, NJ and *Nick Vorsa*, Professor, Dept. Plant Biology and Pathology, Rutgers University; P.E. Marucci Center, Chatsworth, NJ

Fruit rot is a major problem in the production of cranberries (*Vaccinium macrocarpon* Aiton.), particularly in New Jersey and Massachusetts. Without the use of fungicides, up to 100% of a crop can be lost. Climate warming has also exacerbated the problem in other cranberry growing regions, such as Wisconsin. To combat this growing challenge, breeding for fruit rot resistance has become a major goal of the Rutgers cranberry breeding program. Resistant germplasm has been identified and used in crosses and resistance has been found to be heritable. Cranberry fruit rot is caused by a fungal complex, with infection occurring during flowering or early in fruit development and the pathogens can remain latent until the fruit matures. *In vitro*, i.e., in petri plate culture, the naturally occurring acids found in cranberry, quinic (QA) and benzoic (BA) acids, have been shown to suppress the secretion of 'reactive-oxygen species' (ROS) produced by these fruit rot fungi. Previous research suggests that some pathogenic fungi can induce disease in mature fruit tissues by secreting ROS, resulting in cell death and subsequently fruit rot. By suppressing the production of ROS, these acids appear to reduce or prevent fungal growth in culture. The question remains whether these acids might play a role in field fruit rot resistance in cranberry.

To assess the possible role these acids play in field fruit rot resistance, we measured levels of QA and BA in cranberries through fruit development, from fruit set to mature fruit. Quinic acid levels were highest at fruit set and dropped during fruit development in all varieties. Benzoic acid began to accumulate about halfway through fruit development and levels rose as fruit matured. In our two most fruit rot resistant varieties, Budd's Blues and US89-3, the quinic acid levels were higher and declined at a slower rate than in susceptible varieties, e.g., Stevens and Mullica Queen. Benzoic acid levels in resistant varieties increased at a faster rate than in susceptible varieties, and reached higher levels in fully ripe berries.

In the upcoming season, we will evaluate QA and BA levels in cranberry breeding populations which are segregating for fruit rot resistance (e.g., a Budd's Blues x Crimson Queen cross in which resistant and susceptible progeny have been identified). If this relationship between resistance and acid levels continues to be found, this will provide strong evidence that these acids maybe one mechanism of fruit rot resistance that could be further enhanced through breeding and selection. The next step will be to identify molecular markers for organic acids and fruit rot resistance in cranberry.

Prevalence and Impact of Viruses in Cranberry

James Polashock, Research Scientist, USDA-ARS, PE Marucci Center, Rutgers University, Chatsworth, NJ

All plants are susceptible to viruses. Cranberry was unusual in that it seemed to be remarkably free from virus infection, but our knowledge regarding prevalence and virus types in cranberry is beginning to change. This is in part due to improved diagnostic techniques. Historically, only one virus was known to infect cranberry. Red ringspot was described as disease in 1966 and was determined to be caused by a virus in 1981. The virus was further characterized as a Caulimovirus distinct from Blueberry red ringspot virus. Since then, cranberry has been reported to host at least three additional viruses: Tobacco streak (2001), Blueberry scorch (2004), and Blueberry shock (2014). This presentation will focus primarily on Tobacco streak as this one is currently the most important.

Tobacco streak virus (TSV) was first detected in cranberry during a routine virus screen of vines sent to Scotland in 2001. The vines were from a germplasm plot at the Marucci Center and were originally collected in Wisconsin. No symptoms were reported and TSV in cranberry was not further studied until very recently. In 2012 in Wisconsin, some fruit of newer cranberry varieties (e.g. Crimson Queen (CQ), Mullica Queen (MQ), Demoranville (DM), and HyRed), were found to have scarring on the surface. The scarring did not appear to be associated with chemical application. Virus testing showed Tobacco streak virus (TSV) to be associated with some uprights bearing scarred fruit. TSV is an Ilarvirus with an extensive host range. Considering the potential impact on new plantings, we sought to address the following objectives.

OBJECTIVES

1. Determine if all plants with scarred fruit are TSV positive.Determine if ‘mother plants’ of CQ, MQ and DM and field plantings in NJ are TSV infected.
2. Determine if TSV positive plants bear scarred fruit when grown in a greenhouse.
3. Determine if seedlings derived from TSV positive plants are infected with the virus.
4. Determine if the virus can be transmitted to healthy plants and/or their progeny by pollination (as are other Ilarviruses).
5. Determine nucleotide and amino acid variability in TSV isolates.

METHODS

In August 2012, 65 uprights with scarred fruit were collected from the field in Wisconsin. Leaves were tested for TSV using ELISA. Both TSV+ and – uprights were rooted in Sept 2012 for further testing. Seeds (>200) from fruit on TSV+ uprights were sown Dec 2012. Follow up testing (2013) using both leaf and fruit tissue was done by ELISA kit or by RT-PCR using TSV-specific primers. All 2012 plants were re-tested in 2013 to verify earlier results. Flowers on TSV+ plants were self-pollinated and the developing fruit were monitored for scarring. Pollen was also collected and hand-applied to open flowers on healthy plants for transmission studies. Seedlings were tested in 2013 and 2014. TSV was amplified from a variety of sources (NJ and WI) and the coat protein encoding region was sequenced from each.

RESULTS

Objective 1: Not all plants with scarred fruit tested positive for TSV. Of 65 (CQ, MQ, and DM) tested in 2012, 25 were positive (38%) and 6 were 'elevated'. If 'elevated' are assumed to be positive, then about 48% of those tested were positive. The 52% testing negative were retested in April and August 2013 (new shoots) and remained negative. Some of the 'negative fruit were sent to Agdia for further virus testing. Many of these were found to be infected with Blueberry shock virus.

Objective 2: All NJ samples from the nursery tested negative for TSV. Four samples collected from the field in NJ were positive for TSV (3 Mullica Queen and 1 Crimson Queen). Seventy six plants (40 MQ and 36 CQ) were collected from a nursery in New Jersey. 200 samples (80 MQ, 60 CQ and 60 DM) were collected from commercial beds in New Jersey with plants originating the same year and nursery as those collected in WI.

Objective 3: TSV+ uprights rooted in the greenhouse in the fall 2012 bore fruit without scarring. All uprights set fruit and the plants exhibited no symptoms. Plants were retested several times using ELISA and all plants remained TSV +.

Objective 4: TSV does not appear to be seed transmitted. Seeds were collected from scarred fruit borne on TSV positive uprights. Over 234 seedlings from CQ, DM, and MQ were grown in the greenhouse for about 8 months. All were TSV negative by ELISA.

Objective 5: Pollination of flowers of healthy plants with pollen from TSV+ plants does NOT transmit TSV. Pollen from TSV positive MQ was used to pollinate healthy plants. All fruit that developed were monitored for scarring and tested for TSV. All fruit lacked scarring and all tested negative for TSV.

Objective 6: TSV isolates collected are variable in nucleotide sequence for the coat protein encoding region. This suggests that TSV has been in cranberry for some time and further that there might have been multiple introductions into cranberry. 20 isolates collected from various location and varieties in WI and NJ have 91-99% nucleotide identity. The closest sequences in NCBI to the cranberry isolates are from ornamentals grown in Ohio.

CONCLUSIONS:

1. New Jersey nursery-grown plants of Crimson Queen, Demoranville and Mullica Queen were TSV negative, as were 4-6 year old plantings of these varieties on commercial farms in New Jersey. TSV in cranberry did NOT originate from New Jersey. However, some appear to get field-infected.

2. More than half of the plants with scarred scared fruit tested negative for TSV and have remained negative after a year. However, some plants negative for TSV are infected with Blueberry Shock Virus (BlShV).

3. Plants from cuttings from TSV positive plants rooted and maintained in the greenhouse remain positive, and none have produced scarred fruit. This suggests 'recovery' or development of tolerance to the virus.

4. No seed transmission of TSV was found in cranberry.

5. Hand pollination does not transmit TSV to healthy plants or progeny from those plants.

6. The scarring may be caused by an initial ‘necrotic shock’ reaction as occurs in other plants infected with these and other Ilarviruses.

7. Flower thrips may be spreading the virus by rasping the flowers, allowing entry of infected pollen into the ‘microwounds'.

8. Early varieties may be more impacted as they tend to flower earlier; coinciding with thrips infestations.

The Bottom Line

- TSV and BlShV are emerging viruses in cranberry. Prevalence and impact in NJ is unknown.
- The link between scarring and TSV infection is substantial and appears to be the result of necrotic shock.
- Even if infected plants recover, they remain infected and can still transmit the virus.
- Long term effects of the virus (post recovery) are unknown.
- Symptoms are visible in the spring. Late in the season, affected fruit may fall off and be difficult to find.
- Plants should not be purchased from out of state unless thoroughly virus tested.
- Please let us know immediately if you see fruit with symptoms.

Scarred fruit collected from the field in Wisconsin. Symptoms range from mild (left) to severe (right). All fruit on a runner tend to be affected.
Photos courtesy of Patricia McManus, University of Wisconsin

Using IPM Strategies to Manage Current and Emerging Weed Pests in New Jersey Cranberry Production

Hilary Sandler, Extension Assistant Professor, State IPM Coordinator, University of Massachusetts Cranberry Station, East Wareham, MA.

Current weed management relies on Integrated Pest Management (IPM), the use of chemical, biological, and cultural tools in a judicious and effective manner. Just as a working knowledge of insect biology is necessary to accurately and appropriately use our current suite of insecticides within an IPM context, so too, a knowledge of weed biology is a must for effective weed IPM. Making a correct ID and knowing plant type (annual, biannual, or perennial), germination patterns, and dispersal method are all important. Dodder, an emerging weed for NJ, is an annual plant that produces many long-lived seeds; our management plan is geared towards reducing or eliminating seed production and seed germination. Most cranberry weeds are perennials with underground storage structures that make them particularly hard to manage. These structures collect the food sources (total nonstructural carbohydrates, TNC) so plants can survive from year to year. Recent research (Ghantous et al.) shows that dewberries (*Rubus* spp.) reach their lowest TNC content after the leaves have fully expanded; TNC levels continue to increase from fruit set to preparation for dormancy. Knowing when TNC are at their lowest point helps to define the best window for applying strategies such as flame cultivation, mowing, or hand weeding.

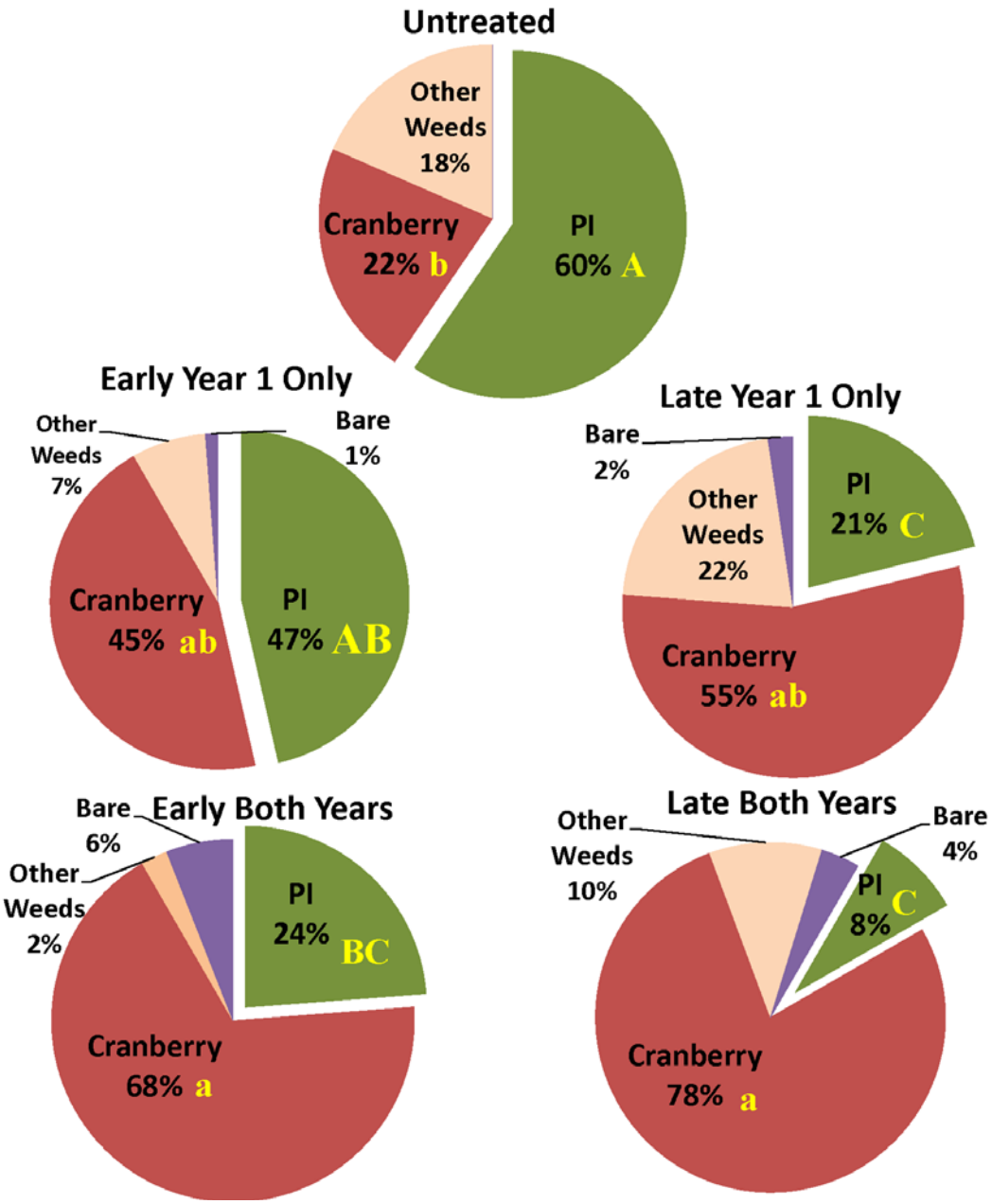
Although tank mixing herbicides is a common practice in other crops, it is rarely done in cranberry. Over the past few years, we evaluated tank mixes of Callisto (C), Poast (P), and surfactants for postemergence control of poison ivy (PI) and dodder. A mixture (1.5 oz[1] each/gal water) of C+P+ crop oil concentrate (COC) was tested at 4 MA field sites infested with PI. Treatments were: two "Early" applications (starting late May) in 2013 only, two "Early" applications in 2013 and repeated in 2014, two "Late" applications (starting mid-June) in 2013 only, two "Late" applications in 2013 and repeated in 2014, and untreated (UNT). PI cover was lower in plots treated Late 2013, Late both years and Early both years compared to UNT but treatments did not differ from one another; cranberry cover was also greater for these treatments. Effect of treatment on yield varied from site to site. This might be due to differences in cranberry variety as well as differences in vine health prior to treatment. We saw cranberry injury in one year but this was likely due to COC use in high air temperatures. In general, yields improved when PI cover was reduced, but not all sites showed the same yield effects.

What was causing the PI control? Adjuvants? Herbicides? The combo? To find out, we similarly (same rates as above) evaluated PI control in 2014 with all possible combinations using the "Early" timing. Adjuvants alone and P+COC were all ineffective. Treatments of C+ either adjuvant and C+ P+ either adjuvant were equally effective at reducing PI cover (with no treatment impact on cranberry yield). Preliminary results indicated that Callisto can be used with either COC or NIS as a spot treatment postemergence to reduce PI cover. Applications of C+P+COC and C+COC (same rates as PI study) were tried against dodder (prior to and during flowering, 1 and 2 applications). Any combination application reduced seed output compared to

[1] These rates are very concentrated and the 8 oz/A per application label limit for Callisto must be followed. We are currently working with Syngenta to get spot-treatment language on the label. To keep at 8 oz Callisto/A, you could only use 5.3 gal of the tested mixture per acre.

the UNT but applications made before dodder flowered were best. We will continue this work over the next few years to determine if lower rates of Callisto will provide adequate control of both PI and dodder and allow spot-treatment of larger areas while adhering to the legal label rate[1].

Figure 1. Average percent cover of poison ivy, cranberry, other weeds, and bare areas growing in MA cranberry farms after receiving an application of a tank mixture of Callisto, Poast, and crop oil concentrate (average of four sites). Measurements made in September of Year 2. Compare the same plant group across the different treatments; pie pieces with different letters ARE statistically different from each other. *K. Ghantous and H. Sandler, UMass Cranberry Station, unpublished data.*



Canopy Cooling with Mid-Day Irrigation to Alleviate Heat Stress in Cranberry Production

Patrick Burgess, graduate student, *Peter Oudemans*, *Nick Vorsa,* and *Bingru Huang*, Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ

High air temperature and sunlight irradiance during summer months imposes heat stress on cranberry plants and can be a contributing factor limiting optimal level of fruit production in New Jersey. Growers have been using sprinkler irrigation to promote evaporative cooling of cranberry plants during peak sun hours, a practice commonly referred to as "cooling runs". Despite wide usage of cooling runs throughout the industry, little work has been performed investigating specific plant response and whether significant increases in plant health and fruit production are being obtained. A previous study showed that midday irrigation can significantly lower canopy temperature which helps individual plants sustain higher photosynthetic rates compared to non-irrigated plants.

The current study spanning three growing seasons (2012-2014) investigated whether the sustained photosynthesis in cranberry leaves due to midday irrigation translated into positive effects on various physiological and morphological parameters. More specifically, the main objective was to determine if midday irrigation applied when canopy temperature reached 90°F or 95°F promoted whole-plant physiological status for better growth and enhanced berry production compared to non-irrigated plants. Microsensors connected to a data-logger were used to continuously monitor leaf temperature and a thermal infrared camera was used to visually evaluate canopy temperature during the hottest times of day. Length of new-growth uprights, number of leaves and fruits per new-growth upright, leaf area, leaf chlorophyll content, and total fruit weight per new-growth upright were measured. Total nonstructural carbohydrates of leaves and fruits were also measured to determine if sustained photosynthesis promoted higher carbohydrate production.

The results from three years of study demonstrate significant changes to cranberry plants in response to midday irrigation including leas chlorophyll degradation, greater leaf area and leaf count per upright, and greater upright length indicating sustained growth rates. The improved physiological status due to midday irrigation resulted in greater fruit weight and fruit count per upright and improved net harvest amounts. The results suggest that irrigating at the 90°F threshold is more effective during years with mild to moderate heat stress while the 95°F threshold can be used during years with major heat stress events. This is because the benefit of cooler canopy temperatures was outweighed by the increased level of fruit rot due to excessive water applied on 90°F treatments during very hot years (i.e. 2013). Thermal imagery revealed interesting changes to fruit temperature during mild or moderate heat stress events in 2014 and may prompt further research into threshold for fruit scald in 2015.

Results from 2014 Insecticide Trials

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

Cranberries have multiple insect pest species known to affect the marketable yield of the crop. Loss of yield can occur either through direct damage of fruit, or indirectly by damaging foliage or otherwise reducing the health of the plant. In their first generations, fruitworms and fireworms will feed on foliage, and in their second summer generations will feed directly on berries. Feeding by leafhoppers robs the plant of proteins and sugars it would otherwise put into fruit production, with the added risk of Blunt-nosed leafhopper (*Limotettix vaccinii*) transmitting False Blossom disease that can reduce the production of fruit. It is important to test new insecticides in a research setting as they become available to verify their efficacy on the pests of cranberry. Testing new insecticides will allow us to increase the number of effective compounds available to the cranberry industry, which has lost some broad-spectrum products. While newer, more selective insecticides can help conserve beneficial predatory insects and spiders, thus reducing the overall need for insecticide input, this selectivity requires multiple compounds to replace a single broad-spectrum compound. In addition to the pest species more commonly experienced by growers, minor pests that used to be controlled by broad spectrum insecticides can increase in number to become more significant pests. One recent example of this is the Cranberry Toad-bug (*Phylloscelis atra*), a sucking insect pest that has caused damage via feeding to foliage and fruit of cranberry. At high population numbers, there is potential for loss of crop in affected bogs. Current control options for Toad-bug are limited: Assail, Imidan, Actara*, and Diazinon* (* no aerial), as a post-bloom spray. Current work will expand the number of insecticides known to be effective.

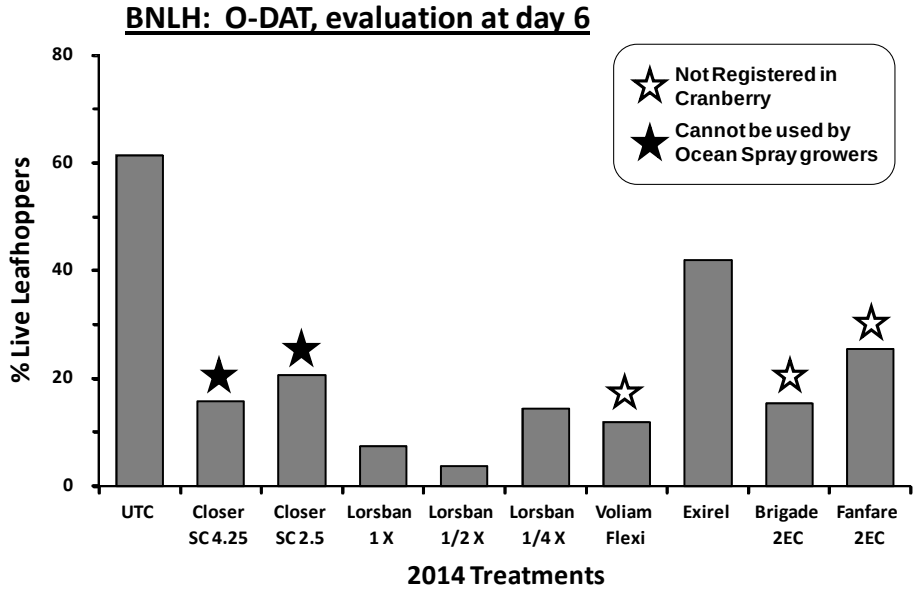
To both evaluate potential new insecticides for registration, and to test efficacy against common and emerging pests, we have continued our assessment of a range of registered and unregistered compounds. Tests were conducted in 4ft x 4ft replicated plots in an 'Early Black' research bog located at the Rutgers PE Marucci Center for Blueberry and Cranberry Research and Extension in Chatsworth, New Jersey. Application methods were the same for all evaluations: CO_2 backpack sprayer, 50 gal of volume per acre. Plants and insects were placed in ventilated water-pick vials on a light bench in the laboratory at approximately 25ºC, on a 15:9 Light:Dark cycle until evaluated for mortality.

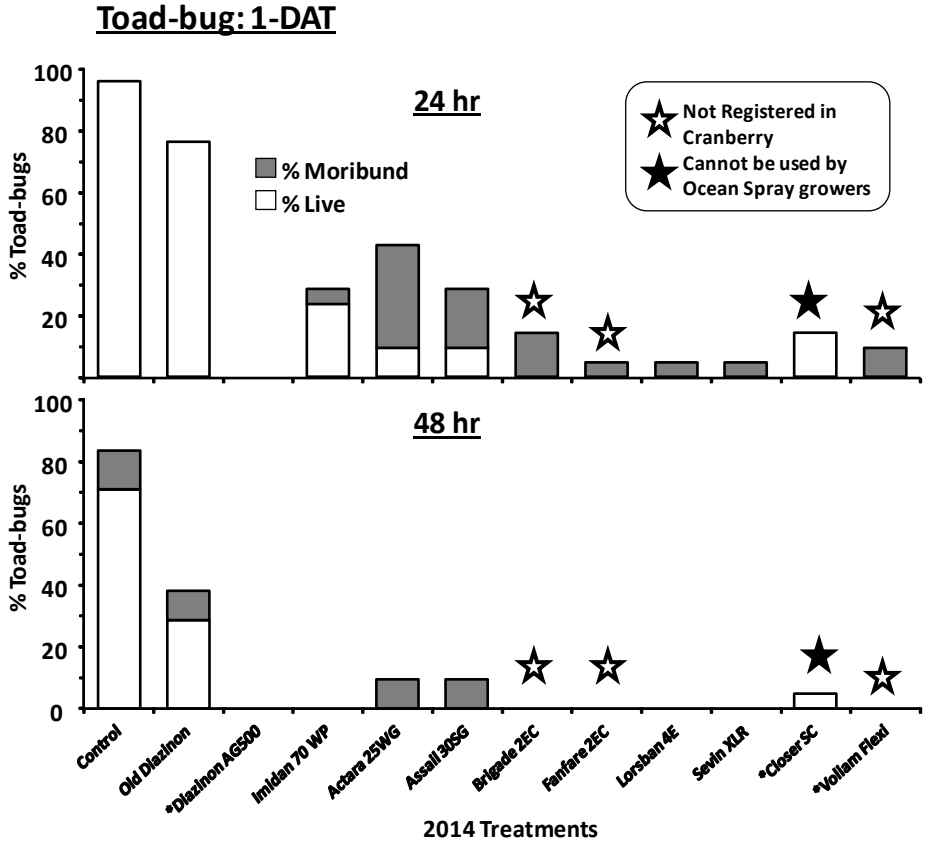
Blunt-nosed Leafhopper (BNLH): treated 6-June. Treated uprights clipped 0 and 6 days after treatment (DAT). 5-6 leafhoppers (field-collected) in each vial. Mortality assessed at 72 & 144 hrs after exposure. (3 & 6 days)

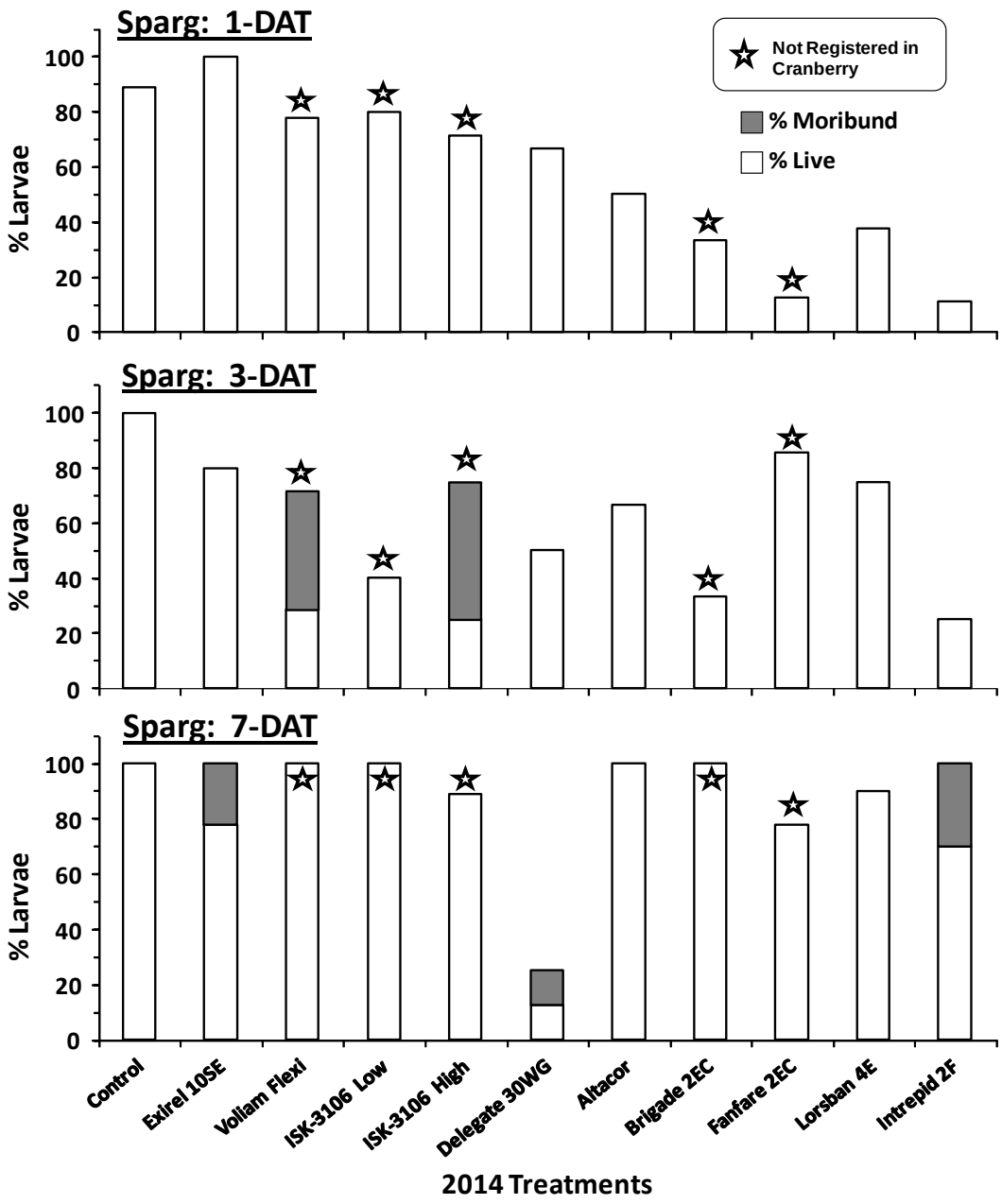
Cranberry Toad-bug: treated 29-August. Treated uprights clipped 12 hours after treatment (30-August) Three adult Toad-bugs (field-collected) in each vial. Mortality assessed at 24, 48 and 72 hrs after exposure. (1, 2, & 3 days)

Sparganothis fruitworm (Sparg) / Spotted fireworm (SFW): treated 22-July, Treated uprights clipped 1, 3 and 7 DAT. One Sparg or SFW 3rd instar larva (lab-reared) in each vial. Mortality assessed at 6 days after exposure.

Summary of 2014 efficacy trial data:



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Sparg: 3-DAT
Sparg: 7-DAT
Not Registered in Cranberry
% Moribund
% Live
% Larvae
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20
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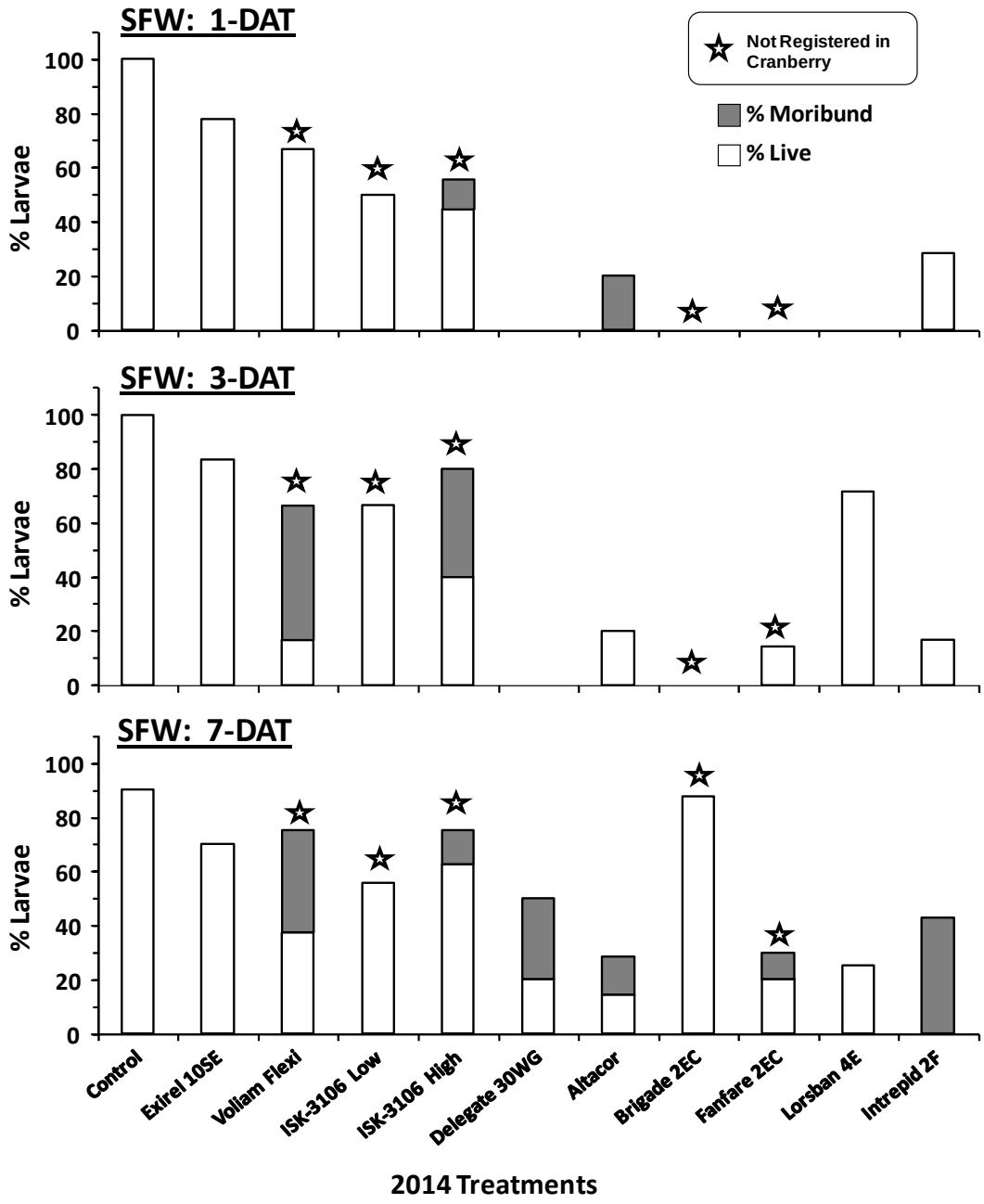
60
80
100
Control
Exirel 10SE
Voliam Flexi
ISK-3106 Low
ISK-3106 High
Delegate 30WG
Altacor
Brigade 2EC
Fanfare 2EC
Lorsban 4E
Intrepid 2F
2014 Treatments


SFW: 1-DAT
SFW: 3-DAT
SFW: 7-DAT
Not Registered in Cranberry
% Moribund
% Live
% Larvae
0
20
40
60
80
100
Control
Exirel 10SE
Voliam Flexi
ISK-3106 Low
ISK-3106 High
Delegate 30WG
Altacor
Brigade 2EC
Fanfare 2EC
Lorsban 4E
Intrepid 2F
2014 Treatments

Exploring Resistance Against Insect Pests in Cranberries

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Insects and pathogens are a major problem in cranberry production. It is common practice to use chemical insecticides to remove pathogenic microbes and herbivorous insects, but beneficial insects, such as honeybees, predators and parasitoids, could be affected as well. Therefore, we studied the defensive mechanisms that cranberry plants themselves use to combat insect pests. We focused on the most important insect pests of cranberry in New Jersey: gypsy moth, Sparganothis fruitworm, spotted fireworm and blunt-nosed leafhopper.

To assess the defensive mechanisms of cranberry, we measured direct, as well as indirect defenses – direct defenses include the production of toxic compounds that have a direct negative impact on insect herbivores, and indirect defenses include the emission of volatile organic compounds in response to herbivory that can attract the natural enemies of the herbivores, like predators and parasitoids (Figure 1).Plant volatiles may also play a role in host-plant location by herbivorous insects.

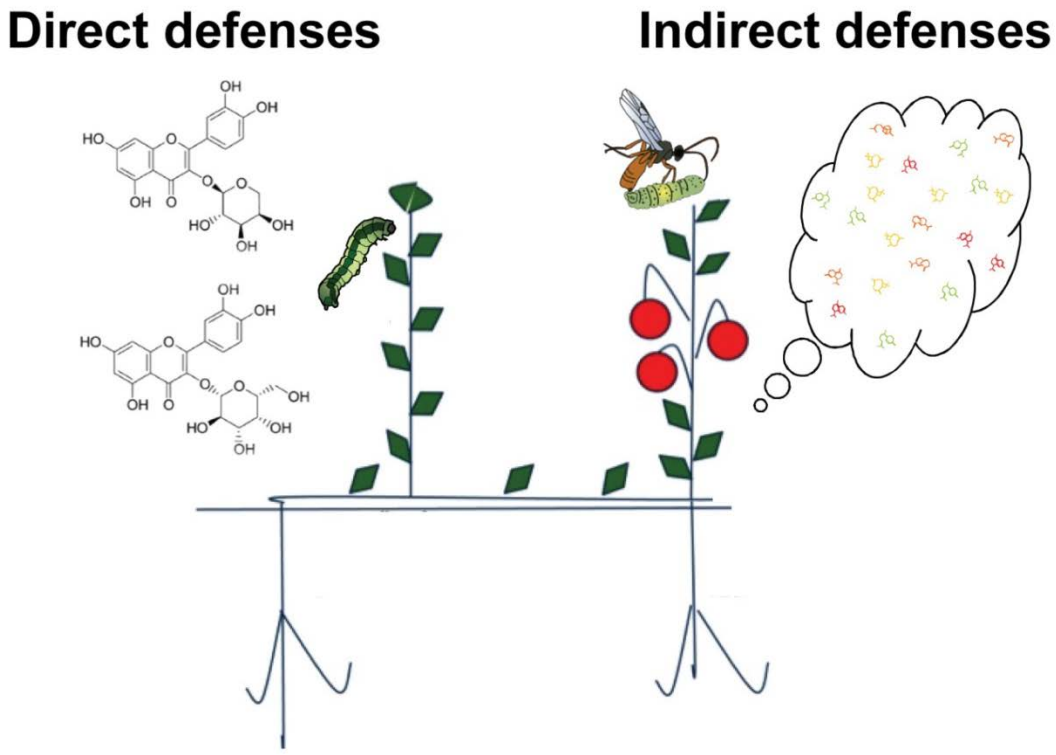

Figure 1 Direct and indirect defenses in cranberry. When attacked by an herbivorous insect, for instance a caterpillar, cranberry plants can produce toxins that have a direct negative effect on the herbivore (direct defenses). They can also emit volatile organic compounds, which is considered an indirect defense trait, as the volatiles may betray the presence of prey or hosts to predators and parasitoids, natural enemies of herbivorous insects

Gypsy moth is an invasive pest that occasionally causes extensive damage to cranberry. In a greenhouse setting, we evaluated the resistance of wild and cultivated varieties to this pest. For many crops, domestication and artificial selection for increased yield and quality have negatively affected other traits, such as resistance to herbivores. For cranberry, however, we expect recent cultivars to display higher resistance qualities, as they were bred not only for high yield, but also for high insect and pathogen resistance. Indeed, some cultivated varieties were highly resistant to gypsy moth, while a wild variety was least resistant. However, another wild variety was also highly resistant, so although there was no clear correlation between insect resistance and cultivation status, we confirmed that domestication and artificial selection of cranberry plants did not impair plant resistance against insect pests. We are still analyzing the toxins that are produced in the leaves upon insect feeding, as well as the emission of volatiles of the different cranberry varieties, to obtain multiple measures of insect resistance.

Sparganothis fruitworm and spotted fireworm are native pests of cranberry in New Jersey. In an experimental bog, we evaluated the resistance of ten cranberry varieties (again a mix of wild and cultivated plants) to these pests. Plants were sprayed with methyl jasmonate (MeJA), a plant hormone that plays an important role in the regulation of defenses. Treating plants with this compound or similar compounds leads to increased defenses in a number of crops, including tomato, grape, cotton, rice, and cranberry. However, in the complex ecological environment of the cranberry bog, MeJA treatments did not influence larval performance. The treatments did not influence plant yield at the end of the growing season, and neither did they influence plant resistance against fruit rot. However, there were large differences between varieties: overall, domestication and artificial selection has increased crop yield, but did not necessarily improve resistance against pests and pathogens. We continue to assess natural, plant-derived compounds for their effectiveness in reducing plant damage.

Blunt-nosed leafhopper vectors a phytoplasma that causes false blossom, an important cranberry disease. False blossom causes defects in the development of the flowers, thereby reducing fruit set and, as a result, yield. There was no difference in performance of the leafhoppers on healthy and false blossom-diseased plants, indicating that the disease does not influence plant defenses or nutrition for the leafhopper. Interestingly, false blossom may change the plant volatile profile compared to healthy plants. Next field season, we will study attraction of the leafhoppers to the volatiles of healthy and diseased plants, to assess whether false blossom influences the attraction of its vector. More knowledge about the interactions between the disease and the cranberry plants will help to develop practices to reduce the disease.

Overall, these results give us more information about the intricate interactions between cranberry and important pest insects, and may help to contribute to the development of novel, more sustainable methods of crop protection.

Release of the 'Haines' and 'Welker' Cranberry Varieties

Nicholi Vorsa, Professor, Department of Plant Biology and Pathology, Rutgers University and *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ

Haines™ variety

The Haines variety, tested as CNJ99-9-96 (US Patent pending; Canadian Plant Breeders' Rights pending), resulted from a 1999 cross between the Crimson Queen® variety (NJS98-23; US PP18,252 P3) as the seed parent, with '#35' as the pollen parent. The #35 variety is an unpatented variety from a 'Howes x Searles' cross from the 1940's USDA/NJAES cranberry breeding program. Haines was originally selected from 138 progeny from this cross growing in test plots at the PE Marucci Center, Chatsworth, NJ. It was selected for its very high yield potential, mid-season ripening, large round berry and uniform fruit color. In 2007, Haines was chosen for further testing in advanced replicated selection trials in Oregon, Washington and Wisconsin. Haines exhibits consistently high yields with mid-season ripening. In replicated variety trials in Wisconsin, Oregon and New Jersey, Haines exhibited less fruit rot than standard varieties, such as Stevens. Haines fruit shape is very widely ovate to round, averaging about two gram per berry. Flowering period is similar to Stevens. Although originally selected under New Jersey's climate and soils, Haines is recommended for all major cranberry growing areas. Haines variety is named in honor of William Haines Sr., an ardent supporter of the PE Marucci Blueberry & Cranberry Research & Extension Center. He provided cranberry beds for the Rutgers' cranberry breeding program in the 1990's, as well as maintained and nurtured plots of the earliest Rutgers' cranberry breeding crosses at his farm.

Welker™ variety

The Welker variety, tested as CNJ99-52-15 (US Patent pending; Canadian Plant Breeders' Rights pending), resulted from a 1999 cross between '#35'variety as the seed parent, with NJS98-34 as the pollen parent. The #35 variety is an unpatented variety from a 'Howes x Searles' cross from the 1940's USDA/NJAES cranberry breeding program. NJS98-34 is a selection from a 'Ben Lear' x 'Franklin' cross. Welker was originally selected from 112 progeny from this cross growing in test plots at the PE Marucci Center, Chatsworth, NJ. It was selected for its very high yield potential, precocious production, early to mid-season ripening, large ovate berry and uniform fruit color. In 2007, Welker was chosen for further testing in advanced replicated selection trials in Oregon, Washington and Wisconsin. Welker comes into significant production early, usually within three years, and exhibits consistently high yields with early to mid-season ripening. Flowering period is early similar to 'Crimson Queen®' and 'Ben Lear'. In replicated variety trials in Wisconsin, Oregon and New Jersey, Welker exhibited susceptibility to fruit rot in trials where fungicide treatments were omitted. Welker fruit shape is very widely ovate to ovate, averaging about two gram per berry. Although originally selected under New Jersey's climate and soils, Welker is recommended for 'oceanic climate' regions such as Oregon. The early flowering period of Welker will likely require early fungicide applications for fruit rot control. Welker variety is named in honor of William V. Welker, a former USDA weed scientist. In addition to his contributions to weed control in cranberry, he envisioned improved cranberry varieties through breeding, as well as providing guidance, vision and support to the Rutgers Blueberry & Cranberry Research & Extension Center.