2016 Annual Winter Meeting of the American Cranberry Growers Association

Rutgers University EcoComplex

Bordentown, NJ

Thursday January 21, 2016

RUTGERS
New Jersey Agricultural Experiment Station

Presentation Summaries

ACGA Winter Meeting Program

Thursday, January 21, 2016

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

9:00-9:20 **An Update on Status of Pesticides and CI Activities**
John Wilson, Cranberry Institute, East Wareham, MA

9:20-9:45 **Utilizing infrared Thermal Imaging in Cranberries to Study Heat Stress, Optimize Irrigation and Monitor Plant Health**
Peter Oudemans, Professor, Department of Plant Biology & Pathology, Rutgers University, New Brunswick, NJ*; Lisa LaManna, Chris Constantelos, Dave Jones, Tim Waller, Jessica Torres & Josh Gager*, P.E. Marucci Center, Chatsworth, NJ

9:40-10:00 **A Metagenomics Approach to Understanding Footprint Disease of Cranberry**
James Polashock, Research Plant Pathologist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

10:00-10:25 **Cranberry Breeding Update: Fruit Rot Resistance and Variety Trials**
Nicholi Vorsa, Professor, Department of Plant Biology & Pathology, Rutgers University & *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ

10:25-10:45 **Break**

10:45-11:05 **Identifying Genes of Interest for Cranberry Breeding**
Guillaume Daverdin, Post-doctoral Researcher, *Stephanie Fong, Yifei Wang, Jennifer Johnson-Cicalese, James Polashock & Nick Vorsa,* Department of Plant Biology & Pathology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

11:05-11:30 **Management of Cranberry Insect Pests: Leps and Toadbugs**
Cesar Rodriguez-Saona, Associate Extension Specialist, Department of Entomology, Rutgers University; New Brunswick, NJ; *Vera Kyryczenko-Roth*, *Robert Holdcraft*, P.E. Marucci Center, Chatsworth, NJ, and *Dan Schiffhauer*, Ocean Spray, Chatsworth, NJ

11:30-12:00 **Alternative Methods for Aerial Applications of Pesticides**
Bud Cary, Dragonfly Pictures Inc., Philadelphia, PA

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

1:00-1:30   **Using the New Weed Guide, Setting Management Priorities, and Research Update on Weed Control**
             Hilary Sandler, Extension Assistant Professor, State IPM Coordinator, University of Massachusetts Cranberry Station, East Wareham, MA

1:30-2:00   **Farm Safety with Pesticides**
             Ray Samulis, Burlington County Agricultural Agent, Rutgers University, Mt. Holly, NJ

2:00   **Adjournment**- _ACGA Board of Directors Meeting_

Cranberry Statistics

Bruce Eklund, National Agricultural Statistics Service, Trenton, NJ

The U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) will not publish the Noncitrus Fruits and Nuts Preliminary 2015 Summary scheduled for January 21. We will publish the Noncitrus Fruits and Nuts 2015 Annual Summary on July 6, 2016. This report contains the final estimates of acreage, yield, production, use, price and value of the 2015 noncitrus fruit and nut crops by state. Cranberries data by state are part of both of these national reports. There is also a cranberry only 2016 production forecast for August 12. For more information, contact Sue King at sue.king@nass.usda.gov or 202-690-8122.

An Update on Status of Pesticides and CI Activities

John S. Wilson, Cranberry Institute, East Wareham, MA

The Cranberry Institute will present a review of activities from 2015. This includes a status update on several cranberry pesticides, an MRL update and the latest on horticultural research activities.

With respect to pesticides, there are updates on chlorothalonil (Bravo), chlorpyrifos (Lorsban) and several other materials. A year ago, the European Union reduced the Bravo MRL from 2 ppm to 0.01 ppm. This caused a significant problem for NJ growers trying to control fruit rot while they had to meet export qualifications. With the support of a number of international groups over the past year, the CI pursued every option to offset or delay this action. In the end, we were unsuccessful in getting a reprieve in 2015 but we were able to successfully get an EU import tolerance of 5 ppm approved in a relatively short amount of time. So even though chlorothalonil was unable to be used in 2015, it should be approved for use in 2016.

There were several instances in 2015 where EPA's pesticide regulatory authority was challenged in court by environmental groups. A few of these court rulings affected some of the chemicals used by cranberry growers. Towards the end of 2015, EPA published its intention remove all food tolerances for Lorsban. Here EPA is responding to a court ruling that forced them into this action and told agriculture that if they want to continue using this insecticide, a good argument is needed. CI organized industry members to put together a response that included specific data on how Lorsban is used and how it still could be used in manner that did not pose any environmental risk. These comments were submitted earlier this month and we won't know how this will be resolved until later this year.

In response to a number of environmental groups, EPA is taking an aggressive stance on protecting pollinators. Over the past year, they proposed new labeling that highlights pollinator and bee safety. In addition, they are beginning to look at a class of insecticides called neonicotinoids. In cranberry, this includes imidacloprid (Admire), acetamiprid (Assail) and thiamethoxam (Actara). EPA has determined these to be potentially harmful to bees/pollinators and is asking the scientific community to submit data that EPA can use to further refine their evaluation. They intend to publish their final recommendations by the end of the year.

Sulfoxaflor (Closer) is another insecticide that EPA is pulling from the market over pollinator concerns. Though this isn't used much in cranberry, it is registered for use in cranberry and was on the 2015 Pesticide Chart. But because it lacks key international MRLs, it is restricted for export use by a number of handlers. So existing stock being held by end users can be used but no more is being sold until EPA reevaluates the impact of this insecticide to pollinators. There will be additional changes to the 2016 Pesticide Charts that will be discussed at the meeting.

The CI continues to track MRL changes in international markets. The High Priority chemicals important in NJ are quinclorac (Quinstar) and prothioconazole (Proline). For Quinstar, the CI expects a Codex MRL in 2016 and an EU MRL in 2017. Codex approved an MRL for Proline in 2015, and an EU MRL is expected in 2016. The CI formed a Technical Committee to better track

the many MRL changes and to evaluate when the industry should comment on international market proposals.

Funding for Horticultural Research continued in 2015. On a side note about research … last year cranberry researchers met in Bandon OR. This group gets together every other year to discuss the latest research and look for opportunities to collaborate.
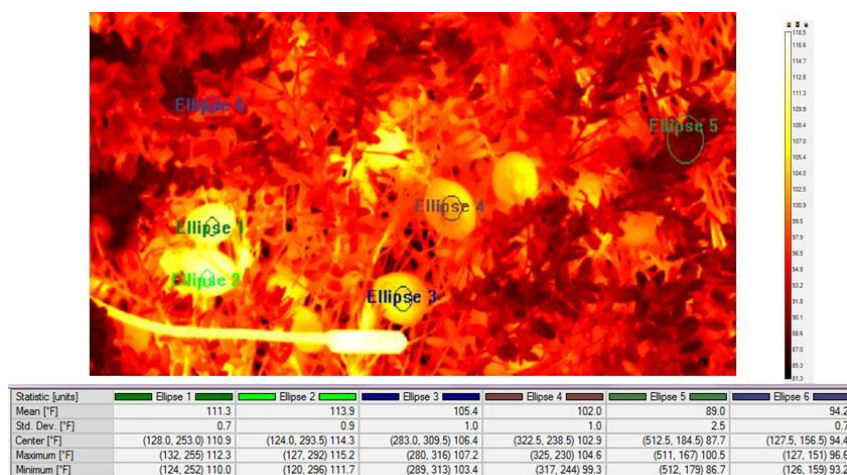
Grant funding for horticultural research continues to be competitive and the CI works to supplement researcher funding that comes from outside sources (such as university, state or federal grants). The CI organizes and tracks this supplemental funding that comes from grower groups and handlers. Grower/handler funding is important because it shows the commitment that exists in all growing areas to ensure future production. Last year, funding for horticultural research was the highest since 2012; growers/handlers contributed on average about $0.10 per barrel.

Utilizing infrared Thermal Imaging in Cranberries to Study Heat Stress, Optimize Irrigation and Monitor Plant Health

Peter Oudemans, Professor, *Lisa LaManna, Chris Constantelos, Dave Jones, Tim Waller, Jessica Torres & Josh Gager* Department of Plant Biology & Pathology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

In 2015 several activities were performed to better under how fruit heating occurs. The relationship between canopy temperature measurements and fruit temperatures was measured. The objective was to better understand the accuracy of canopy temperature measurements for detecting periods of stress where damage to the fruit would be incurred. In Fig 1 it can be seen that fruit surface temperatures between 102 – 113.9F were recorded while canopy temperatures ranged from 89 – 94.2F. This was considered a significant disparity and we believe that damage could be inflicted on fruit while canopy temperatures remain below the 95F threshold for cooling irrigation runs.

Fig. 1. A thermal image taken of the cranberry canopy during between 2-3pm on Aug. 12, 2015. Canopy and fruit temperatures are measured inside six ellipses illustrated below. The average temperatures inside of each ellipse are provided in the table below. A temperature probe can be seen running along the bottom of the image.

Statistic [units]	Ellipse 1	Ellipse 2	Ellipse 3	Ellipse 4	Ellipse 5	Ellipse 6
Mean [°F]	111.3	113.9	105.4	102.0	89.0	94.2
Std. Dev. [°F]	0.7	0.9	1.0	1.0	2.5	0.7
Center [°F]	(128.0, 253.0) 110.9	(124.0, 293.5) 114.3	(283.0, 309.5) 106.4	(322.5, 238.5) 102.9	(512.5, 184.5) 87.7	(127.5, 156.5) 94.4
Maximum [°F]	(132, 255) 112.3	(127, 292) 115.2	(280, 316) 107.2	(325, 230) 104.6	(511, 167) 100.5	(127, 151) 96.6
Minimum [°F]	(124, 252) 110.0	(120, 296) 111.7	(289, 313) 103.4	(317, 244) 99.3	(512, 179) 86.7	(126, 159) 93.2

Since there was no data available on the relationship of fruit surface temperature and internal temperatures we conducted a series of experiments to measure internal temperatures. In Fig. 2 it can be seen that the fruit internal temperature increased to as much as 110F while shielded temperatures (typical of normal temperature measurements) did not exceed the 95F threshold for cooling. Also, fruit color and fruit position in the canopy greatly influenced the internal temperature of the fruit. We found red fruit temperatures were significantly higher than green fruit and shaded fruit was cooler than exposed fruit. These general findings correlate well with the thermal camera observations of fruit surface temperatures and identify a source of significant crop loss that is caused by overheating due to solar radiation.

Fig. 2. Graph showing shielded air temperature and internal berry temperature during the summer of 2015. Comparisons fruit of different colors (green-red) and position in the canopy (degree of shading) show the impact of color and position on the internal berry temperatures.
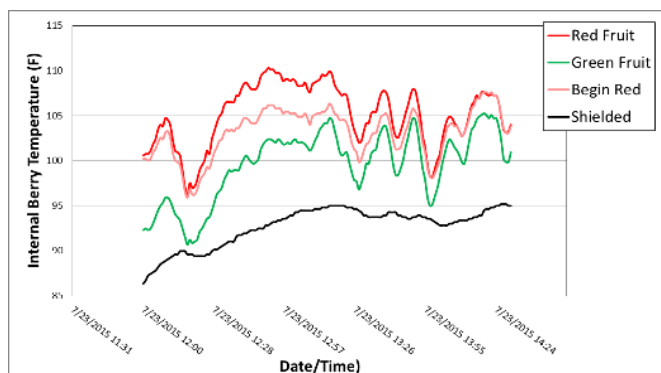
To provide a means of measuring fruit temperature without purchasing expensive thermal cameras we introduced the use of small meat thermometers to measure internal fruit temperatures. In Fig. 3 we present an example of meat thermometer being used to test internal berry temperature.

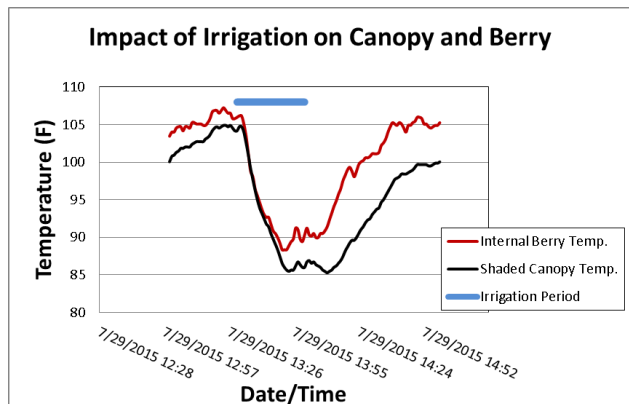Fig. 3. An inexpensive meat thermometer being used to probe the internal berry temperature of a cranberry.

This information on internal berry temperature was not useful with developing thresholds. Since no thresholds were available these were developed for 10 different cranberry varieties. In general it was found that after incubating fruit in a hot water bath that similar symptoms could be induced as were seen in the field. Thus experiments were conducted by holding fruit under water at set temperatures for 2hrs. The results were then measured by testing the firmness of the fruit immediately following the treatment and 48hrs later. Based on these results we established that 110F was the maximum internal temperature that cranberries could withstand before becoming soft and beginning to decay.

Fig. 4. Image showing the appearance of cranberry fruit following 2hr of incubation in a hot water bath at the temperatures described.

Based on the research conducted thus far we began to investigate two methods for managing over heating of cranberry fruit. The first was irrigation to provide evaporative cooling and the second was to evaluate the use of a kaolinite clay product (Surround) which is advertised to prevent sunburn or over heating of fruit. To assess the value of irrigation for cooling fruit several questions were raised. For example, how much cooling can irrigation offer, how much irrigation (duration) is required and finally do the negative effects of irrigation (increased fungal disease) negate the benefits? To approach these questions and to examine the feasibility of irrigation we conducted several cooling experiments to measure the impact of internal berry temperature. In Fig. 5 we measured internal berry temperature before, during and following a 30 min. irrigation during early afternoon on July 29, 2015. These data demonstrate that both internal berry temperature and shaded canopy temperature dropped almost immediately following the initiation of irrigation. While berry temperatures rose back to pre-irrigation levels after approximately 2hrs canopy temperatures remained lower.

Fig. 5 Internal berry temperatures measured before, during and following an irrigation event.

In the second temperature control experiment the kaolinite clay product, Surround, was used at two levels (25 and 50 lb/acre) to coat fruit and protect from over-heating (Fig. 6).

Fig. 6. Field trial using Surround to coat canopy and fruit to test for protection from over-heating. In the upper panel the coating of clay on the canopy can be clearly seen. On the lower panel the coverage on fruit is obvious.
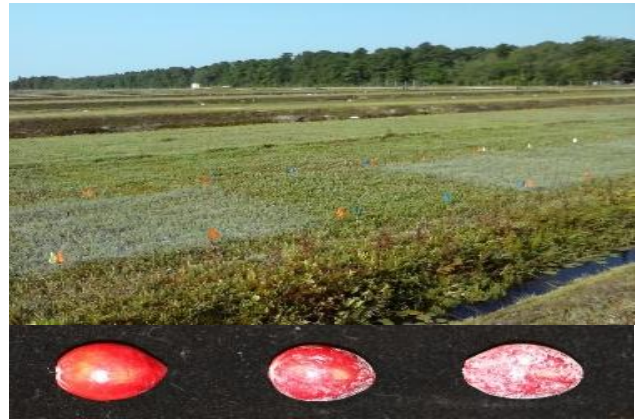
These treatments were evaluated by collecting thermal camera imagery over each plot and measuring fruit temperature in each image. The experiment consisted of three treatments and 3 replications and was conducted twice. The results (Fig.7) demonstrate that average temperature during periods of stress was depressed by the treatments and fruit surface temperatures were held below threshold of 110F at both levels of clay application.

Fig. 7. Fruit surface temperature of fruit treated with kaolinite clay at 0lb/acre (blue) 25lb/acre (lime) and 50lb/acre (orange).

The results of this study show that small temperature reductions (just a few degrees below the 110F threshold) can have dramatic effects on fruit quality and yield.
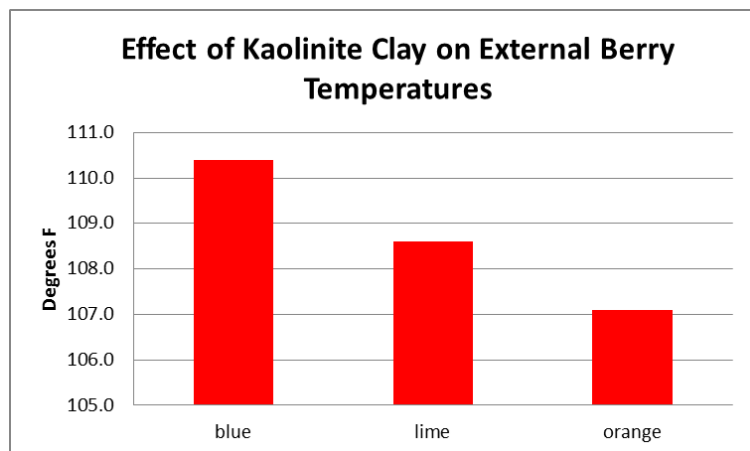
The research conducted this summer has opened several new areas of investigation. In 2015 we assembled a team of researchers to investigate several questions related to canopy heating and cooling and will emphasize development of a model to predict heat scald of cranberry fruit. Specifically we plan to develop predictions of wet and dry bulb temperature readings so that growers can determine when irrigation will provide sufficient cooling without damaging the crop.

A Metagenomics Approach to Understanding Footprint Disease of Cranberry

James Polashock, Plant Pathologist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

BACKGROUND
The identification of the causal agent of a disease can be difficult. This is especially true when the pathogen is in the soil. For example, fairy ring disease of cranberry was first reported over 100 years ago. Although many attempts were made to identify the causal agent, the pathogen was not properly identified and characterized until a few years ago. Footprint disease is another for which the casual organism has remained elusive. Footprint disease of cranberry causes patches of dead vines or bare spots in established fields. It is most often seen in beds of 'Stevens'. Above ground parts of the plant have been extensively examined and cultured, but the casual agent has not been identified. Cultures from soil samples have also been attempted. Many soil organisms were isolated, but none were verified to be the casual agent. One problem with samples from the root zone is that the soil contains thousands of different organisms. These organisms can grow at different rates and faster growing organisms can mask slower growing organisms. In addition, many cannot be cultured using current technology. These issues make analysis of soil microorganisms by culturing tedious and with a high probability of failure. Here we applied a new technique for detection and identification of soil microorganisms potentially associated with footprint disease. The proposed method combines the high-throughput power of next-generation sequencing with advanced bioinformatics to identify all of the microorganisms in a given sample (i.e. the whole microbiome). This technique is referred to as metagenomics. Metagenomics is defined as the study of genetic material recovered directly from environmental samples. Thus, culturing of the organisms is not required.

OBJECTIVES
1. Assay the soil microbiome in footprint- affected and healthy areas in 'Stevens' cranberry beds.
2. Compare the organisms identified in all samples using bioinformatics to search for microbial associations with the disease.

METHODS
Paired soil samples (healthy and footprint- affected) were collected from two different farms in New Jersey. DNA was extracted from all of the samples. The DNA was sampled for bacteria and fungi using kingdom-specific primers. The resulting fragments were sequenced on the Illumina HiSeq 2500 (a high-throughput next-generation sequencing platform). The organisms in the samples were identified using bioinformatics and placed into OTUs (operational taxonomic units). The OTUs were compared in an effort to find specific organisms or patterns associated with footprint disease.

RESULTS
A total of 12 soil samples were collected (6 healthy and 6 footprint-affected). Reads for both bacteria and fungi totaled in the millions. These reads were assembled into thousands of OTUs. Many of the OTUs could not be determined to the species level or even the genus level. However, we were able to analyze the data at several taxonomic levels across all of the samples. Although many samples were found to contain pathogenic organisms, these organisms were not consistently found in all footprint-affected samples. In fact the only organisms that were

consistently found in all samples were two mycorrhizae species, *Oidiodendron maius* and *Rhizoscyphus ericae*. You may recall that mycorrhizae are beneficial fungi that colonize the roots of many plants to form a symbiotic relationship. Among the potential benefits of colonization are: enhanced water and nutrient uptake, increased drought resistance, increased pathogen resistance, reduced herbivory, and increased stress tolerance.

Remarkably, we found *O. maius* was generally found in much higher levels in the healthy plants, while *R. ericae* was found in much higher levels in the footprint-affected plants. This relationship requires more detailed study.

CONCLUSIONS
Although thousands of organisms were detected in the cranberry soils tested, the only ones that stood out as being associated with healthy vs. footprint-affected were species of mycorrhizae. Based on these data, we propose that some isolates of *R. ericae* may actually be harmful to the plants. Isolates of both species are being cultured for further testing.

Cranberry Breeding Update: Fruit Rot Resistance and Variety Trials

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

 Fruit Rot Resistance: Fruit rot is a major problem in the production of cranberries, particularly in New Jersey and Massachusetts. Breeding for fruit rot resistance is the principal goal of the Rutgers cranberry breeding program. In our cranberry germplasm collection of over 300 accessions, four varieties were identified to have some level of fruit rot resistance. DNA fingerprinting of these four fruit rot resistant (FRR) varieties indicated they were genetically distinct, i.e. unrelated, sources of resistance. Two varieties, 'Budd's Blues' and accession US89-3, appear to have a relatively high level of resistance, and two varieties, 'Holliston' and 'Cumberland' have moderate resistance. Both Budd's Blues and US89-3, however, unfortunately are very poor yielding, and are not commercially viable. On the other hand, although having moderate resistance, Cumberland, typically has respectable yields. Variety US89-3 is also of interest to us because of its high total polyphenolic, anti-oxidant, content in mature fruit.

 These four FRR varieties were used in 55 crosses in 2005 and 2006 and 1,642 progeny plots were established in 2009 and evaluated for fruit rot resistance and yield during 2011-2014. An additional 32 and 37 first cycle crosses were made in 2009 and 2010, respectively. The results from the first breeding and selection cycle suggest that fruit rot resistance is highly heritable and that higher fruit rot resistance can be achieved, along with economically viable fruit productivity. By complementary hybridization, productive FRR selections from 2005 and 2006 crosses were identified: Budd's Blues x (Stevens x US89-3) and US89-3 x (Early Black x Holliston) (see **Fig. 1**). As mentioned, these four FRR varieties appear to be unrelated which may indicate that more than one mechanism of fruit rot resistance exists in cranberry. If this is the case, it affords the opportunity to 'pyramid genes' to further increase resistance with additional breeding and selection cycles.
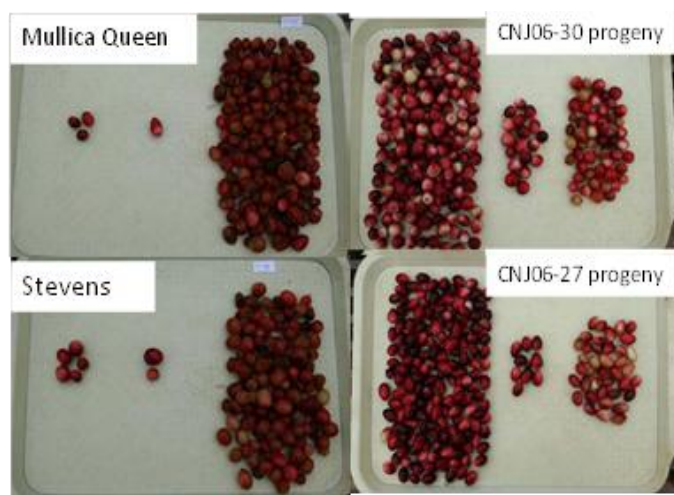

Figure 1. Fruit samples (1 sq. ft.) divided into 3 groups, sound, partially rotted, and entirely rotted fruit; from 2 resistant selections, CNJ06-30 progeny [Budd's Blues x CNJ97-86-4 **(**Stevens **x** US89-3)] and CNJ06-27 [US89-3 x CNJ98-164-37 **(**US88-81 x Holliston], and 2 susceptible controls, Mullica Queen and Stevens. The majority of fruit from the resistant selections are sound; in addition, their yields and TAcy are comparable to Stevens, the industry standard for productivity.

 Thus, the second breeding cycle was initiated with 46 crosses in 2012, 20 crosses in 2013, 11 crosses in 2014, and 29 crosses in 2015. In the 5 acre beds at PE Marucci Center, a FRR progeny evaluation trial was planted in May 2014 of over 1,700 progeny in 5' x 5' plots from 27 2012 crosses. Evaluation of this trial will be initiated in 2016 under reduced fungicide program. In spring 2015, an additional 980 progeny from 14 2013 crosses were planted. Also in

2015, a replicated trial (5 reps of 10' x 20' plots of each variety, Bog 10) of the top 11 FRR selections from 2005 and 2006 FRR crosses, along with Crimson Queen as the susceptible control, was planted to evaluate fruit rot under various reduced fungicide regimes, and to evaluate these selections for possible cultivar release. Evaluations of the 2015 trials are anticipated to begin 2017.

Variety Trials: Trials of our advanced selections planted at cranberry growers in Washington, Oregon, Wisconsin, British Columbia, and Quebec were evaluated and samples harvested for yield and fruit quality traits. 2015 field trial data for the new releases 'Welker' and 'Haines' will be presented.

Identifying Genes of Interest for Cranberry Breeding

Guillaume Daverdin, Post-doctoral Researcher, _Stephanie Fong, Yifei Wang, Jennifer Johnson-Cicalese, James Polashock_ & _Nick Vorsa,_ Department of Plant Biology & Pathology, Rutgers University, New Brunswick, NJ; P.E. Marucci Center, Chatsworth, NJ

Breeding populations from various crosses that are being grown at the Rutgers PE Marucci Center and evaluated for horticultural traits (e.g. yield, fruit rot resistance (FRR), berry size, bloom date, etc.) and fruit chemistry (e.g. TAcy, titratable acidity, organic acids, phytochemicals, etc.), present the opportunity to identify the genes controlling these traits in cranberry. We are implementing new DNA analytical technologies on those breeding populations where we have gathered field and chemistry data on each progeny of a given cross. One new DNA technology is referred to as 'genotyping-by-sequencing' (GBS) which identifies specific genetic differences between two class types, e.g. fruit rot resistant vs. susceptible, that occur in a segregating population or family. For example, we have a population of over 90 individuals derived from a Budd's Blues x Crimson Queen cross, where there are progeny that are fruit rot resistant and progeny that are fruit rot susceptible. With GBS, we have identified regions on the Budd's Blues genome (chromosomes) that appear to be associated with higher fruit rot resistance. We hope to find different FRR genes from other varieties. For example, we are currently analyzing other progenies from different crosses, e.g., Cumberland x Budd's Blues, with GBS to identify other FRR genes. With this information we can be more precise in selecting parents that will combine different FRR genes, with the hope of 'pyramiding' these genes to enhance fruit rot resistance in future cranberry cultivars. In addition to FRR, we will be analyzing these populations for other horticultural and fruit chemistry traits, and applying this GBS technology to identify genes controlling these traits as well. To date we have developed a high density genetic map and identified putative FRR regions on the cranberry genome which provides for candidate gene discovery and pyramiding of FRR quantitative-trait-loci (QTL) into elite horticultural backgrounds.

Management of Cranberry Insect Pests: I) Leps

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

The continued availability of broad-spectrum insecticides, such as organophosphates and carbamates, for use in cranberries is under threat from the FQPA of 1996. In the last decade, the pesticide industry has experienced a mini-revolution in terms of discovery of novel insecticides that are not only very selective and effective at very low rates but also safe to the environment and human health. Most notable of these recent discoveries include methoxyfenozide (Intrepid), spinoteram (Delegate), acetamiprid (Assail), rynaxypyr (Altacor), novaluron (Rimon), thiamethoxam (Actara), and indoxacarb (Avaunt). Here we tested some of these new insecticides against two major insect pests of cranberries in New Jersey: Sparganothis fruitworm and spotted fireworm.

Methods

In 2015, an experiment was conducted to test the efficacy of two rates of a new insecticide - compound X (anthranilic diamide), Actara (neonicotinoid), Avaunt (oxadiazine), and Lorsban 4E (organophosphate) in controlling 1st and 3rd instar larvae of Sparganothis fruitworm and spotted fireworm on cranberries.

The treatments and rates were: Actara at 4 oz/ac, Avaunt at 6 oz/ac, compound X at 16.4 floz & 22 floz/ac, and Lorsban 4E at 3 pt/ac. The experiment was conducted in an 'Early Black' cranberry field located at the Rutgers PE Marucci Center for Blueberry and Cranberry Research and Extension in Chatsworth, New Jersey. Plots were 1.22×1.22 m each (1.49 sq meters), replicated 10 times. Control plots received no insecticide. Applications were made with R&D CO_2 backpack sprayer, using a 1-liter plastic bottle. The sprayer was calibrated to deliver 50 gal of vol per acre at 30 psi, using a single T-jet VS 110015 nozzle, yielding 69.5 ml per plot. Half of the plots were treated on 28 July, while the other half was treated on 3 August.

Treated uprights were randomly selected from the central portion of each plot and clipped for use in the lab assay, with a 30 cm buffer around plot edges left un-sampled. Those plots treated on 28 July were sampled one day after treatment (1 DAT) on 29 July, while plots treated on 3 August were sampled three days after treatment (3 DAT) on 6 August. For each assay container, three insecticide-treated uprights were inserted in florists' water picks and enclosed in a ventilated 40-dram plastic vial, then secured on Styrofoam trays. Eight vials were setup for the 1st instar of each species and 10 vials were setup for the 3rd instar of each species on each of the two sample dates, 1 DAT and 3 DAT. Three 1st instar larvae or one 3rd instar larva were placed in each vial, with each vial considered a replicate. All larvae used in the assay were obtained from lab colonies kept at the Rutgers PE Marucci Center for Blueberry and Cranberry Research and Extension in Chatsworth, New Jersey. First instar larvae were freshly hatched neonates, while young 3rd instar larvae had been reared to the appropriate stage on artificial wheat-germ diet. Vials with plants and insects were placed on a light bench in the laboratory at approx. 25°C, on a 15:9 L:D cycle.

Mortality was assessed for both instars 7 days after setup; 1 DAT was assessed on 5 August, while 3 DAT was assessed on 13 August. All live 3rd instar larvae were weighed during

evaluation, and larval mass was recorded. Numbers of larvae (alive, moribund, dead, or missing) were recorded. Percent surviving (live) larvae was calculated per vial (%Live = No. live/No. recovered×100). Data were analyzed using ANOVA and means separation by Fisher's LSD test at $P = 0.05$. Percent data were arcsine square-root transformed prior to analysis.

Results

Compound X was very effective at controlling both 1st and 3rd instars Sparganothis fruitworm and spotted fireworm (Tables 1 and 2). Overall compound X was as effective as the organophosphate Lorsban (grower standard) in reducing larval survival, but more effective than the neonicotinoid Actara and the oxadiazine Avaunt. Although not significant in most cases, numerically, larval mass was the lowest in the compound X treatment as compared with the other treatments (Table 3).

Table 1. 2015 Sparganothis Fruitworm Assay

Treatment	Rate /ac	% Surviving Larvae (mean ± SE)							
		1st Instar Larvae				3rd Instar Larvae			
		n 1 DAT		n 3 DAT		n 1 DAT		n 3 DAT	
Actara	4 oz	24	62.5 ± 11.7 A 0.0	24	29.2 ± 9.8 B (58.8)	10	100.0 ± 0.0 A 0.0	10	70.0 ± 15.3 A (22.2)
Avaunt	6 oz	24	0.0 ± 0.0 B (100.0)	24	29.2 ± 9.8 B (58.8)	9	0.0 ± 0.0 B (100.0)	6	16.7 ± 16.7 B (81.5)
Compound X	16.4 floz	24	0.0 ± 0.0 B (100.0)	24	4.2 ± 4.2 C (94.1)	9	0.0 ± 0.0 B (100.0)	8	25.0 ± 16.4 B (72.2)
Compound X	22 floz	24	0.0 ± 0.0 B (100.0)	24	4.2 ± 4.2 C (94.1)	7	0.0 ± 0.0 B (100.0)	6	50.0 ± 22.4 A B (44.4)
Lorsban 4E	3 pt	24	0.0 ± 0.0 B (100.0)	24	0.0 ± 0.0 C (100.0)	8	12.5 ± 12.5 B (86.1)	9	77.8 ± 14.7 A (13.6)
Control	-	24	50.0 ± 14.1 A -	24	70.8 ± 9.8 A -	10	90.0 ± 10.0 A -	10	90.0 ± 10.0 A -

Means within a column followed by different letters are significantly different (Fisher's test, P=0.05)

Percent data were arcsine square-root transformed prior to analysis.

Numbers in parenthesis are % control = [1-(%live larvae in treated / %live larvae in control)]*100, Minimum % Control = 0

Table 2. 2015 Spotted Fireworm Assay

Treatment	Rate /ac	% Surviving Larvae (mean ± SE)							
		1st Instar Larvae				3rd Instar Larvae			
		n	1 DAT	n	3 DAT	n	1 DAT	n	3 DAT
Actara	4 oz	24	50.0 ± 10.9 A (14.3)	24	45.8 ± 8.8 A B (8.3)	10	80.0 ± 13.3 B (20.0)	9	100.0 ± 0.0 A 0.0
Avaunt	6 oz	24	50.0 ± 10.9 A (14.3)	24	66.7 ± 12.6 A 0.0	9	100.0 ± 0.0 A 0.0	10	100.0 ± 0.0 A 0.0
Compound X	16.4 floz	24	0.0 ± 0.0 B (100.0)	24	0.0 ± 0.0 C (100.0)	9	0.0 ± 0.0 C (100.0)	8	0.0 ± 0.0 B (100.0)
Compound X	22 floz	24	0.0 ± 0.0 B (100.0)	24	0.0 ± 0.0 C (100.0)	9	0.0 ± 0.0 C (100.0)	7	0.0 ± 0.0 B (100.0)
Lorsban 4E	3 pt	24	0.0 ± 0.0 B (100.0)	24	29.2 ± 11.7 B (41.7)	9	0.0 ± 0.0 C (100.0)	8	0.0 ± 0.0 B (100.0)
Control	-	24	58.3 ± 12.2 A -	24	50.0 ± 10.9 A B -	9	100.0 ± 0.0 A -	10	100.0 ± 0.0 A -

Means within a column followed by different letters are significantly different (Fisher's test, P=0.05)

Percent data were arcsine square-root transformed prior to analysis.

Numbers in parenthesis are % control = [1-(%live larvae in treated / %live larvae in control)]*100,   Minimum % Control = 0

Table 3. 2015 Semi-Field Assay: Larval Mass

| Treatment | Rate /ac | Final larval mass (mg) (mean ± SE) | | | | | | | |
| | | Sparganothis fruitworm | | | | Spotted fireworm | | | |
		n	1 DAT		n	3 DAT		n	1 DAT

Treatment	Rate /ac	n	1 DAT		n	3 DAT		n	1 DAT		n	3 DAT	
Actara	4 oz	10	0.0112 ± 0.0018	A	8	0.0084 ± 0.0021	A B	8	0.1202 ± 0.0950 A	9	0.0122 ± 0.0024	A
Avaunt	6 oz	1	0.0018	A	1	0.0014	A B	9	0.1473 ± 0.0918 A	10	0.0542 ± 0.0345	A
Compound X	16.4 floz	1	0.0016	A	2	0.0027 ± 0.0002	A B	1	0.0009 A	3	0.0008 ± 0.0001	A
Compound X	22 floz	0	n/a	-	5	0.0017 ± 0.0005	B	1	0.0008 A	3	0.0012 ± 0.0007	A
Lorsban 4E	3 pt	1	0.0119	A	7	0.0128 ± 0.0020	A	0	n/a -	1	0.0007	A
Control	-	9	0.0125 ± 0.0029	A	5	0.0083 ± 0.0058	A B	9	0.0185 ± 0.0066 A	10	0.0146 ± 0.0022	A

Means within a column followed by different letters are significantly different (Fisher's test, P=0.05)

Management of Cranberry Insect Pests: II) Toadbugs

Cesar Rodriguez-Saona, Department of Entomology, Rutgers University; *Vera Kyryczenko-Roth*, P.E. Marucci Center; & *Dan Schiffhauer*, Ocean Spray

In the last decade, the pesticide industry has experienced a mini-revolution in terms of discovery of novel insecticides that are not only very selective and effective at very low rates but also safe to the environment and human health. However, except for neonicotinoid insecticides, many of the newer insecticides have no or little control over piercing-sucking insects (order Hemiptera) such as leafhoppers, toad bugs, mirids, etc. There is concern among cranberry growers of a potential increase in secondary pests, such as the cranberry toad bug, because of recent changes in pest management strategies (e.g., adoption of new reduced-risk products and decreased applications of broad-spectrum insecticides).

The Cranberry Toad Bug

In 2013 we observed damage in cranberry bogs by the cranberry toad bug, *Phylloscelis atra*, in New Jersey. Although we had seen toad bugs in cranberry bogs in the past we had never seen them causing damage to the vines and fruit. Toad bugs are hemipteran insects (similar to blunt-nosed leafhoppers) but belong to the Family Dictyopharidae (planthoppers) (as opposed to leafhoppers, which belong to the family Cicadellidae). Toad bugs feed only on cranberries. This insect has a single generation per year. It overwinters as eggs. The nymphs appear by the end of June through August, and the adults from August through October. Eggs are laid from September through October. Feeding damage can be noticed in two stages. First stage feeding damage on vines causes closing in (towards the branch) of the leaves on the new growth. Second stage feeding causes changed in color (reddish to brown) of new growth. The damage can be seen from July until harvest. This damage will cause dying of the branch and the berries to shrivel up. Heavy infestation will result in dwarfed berries. Little information is currently available on the ecology, impact, monitoring, and management of cranberry toad bugs.
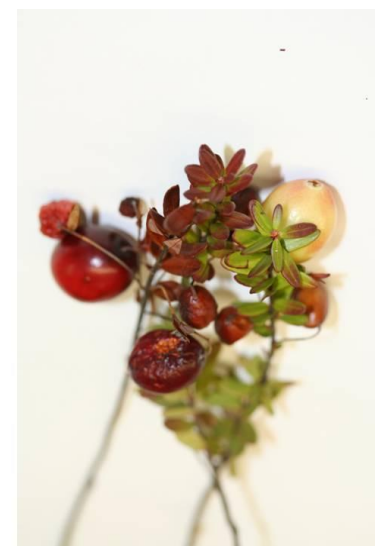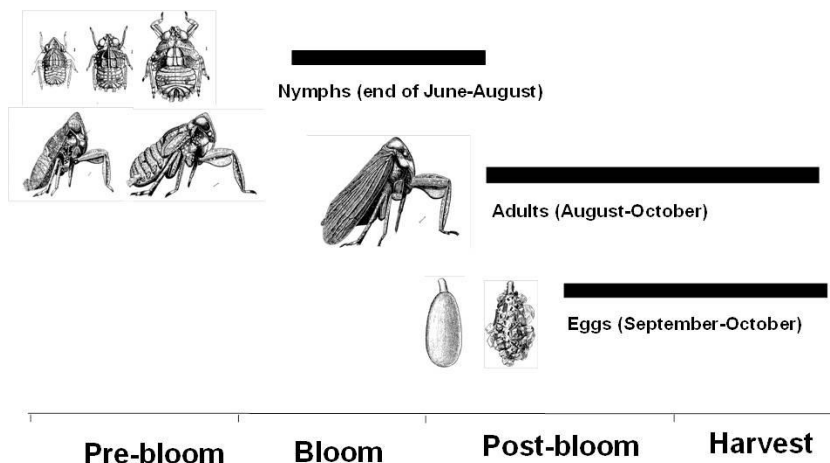

The cranberry toad bug life cycle (left) and damage showing shriveled and dwarfed berries (right)

Methods and Results

Little is known on the impact of damage by toad bugs on cranberry yield. This information is important for the development of treatment thresholds. We conducted a study to determine whether toad bug feeding impacts cranberry fruit quality and health by characterizing feeding damage. Treatments consisted of 0 (control), 10, 25 or 50 nymphs and were replicated 5 times. Nymphs are the main target of insecticide applications and the cause of most of the early damage to the vines. At the end of the experiment, berries will be harvested by clipping uprights. To characterize damage, the number of dwarfed and healthy berries will be counted. All berries will be weighed.

Toad bug damage to uprights differed among treatment (see Figure). There were no differences in number of damaged uprights between the control and 10 toadbugs; however, there were 3 times more damaged uprights at densities equal or greater than 25 toadbugs. No differences were found on number of damaged fruit or fruit weight.
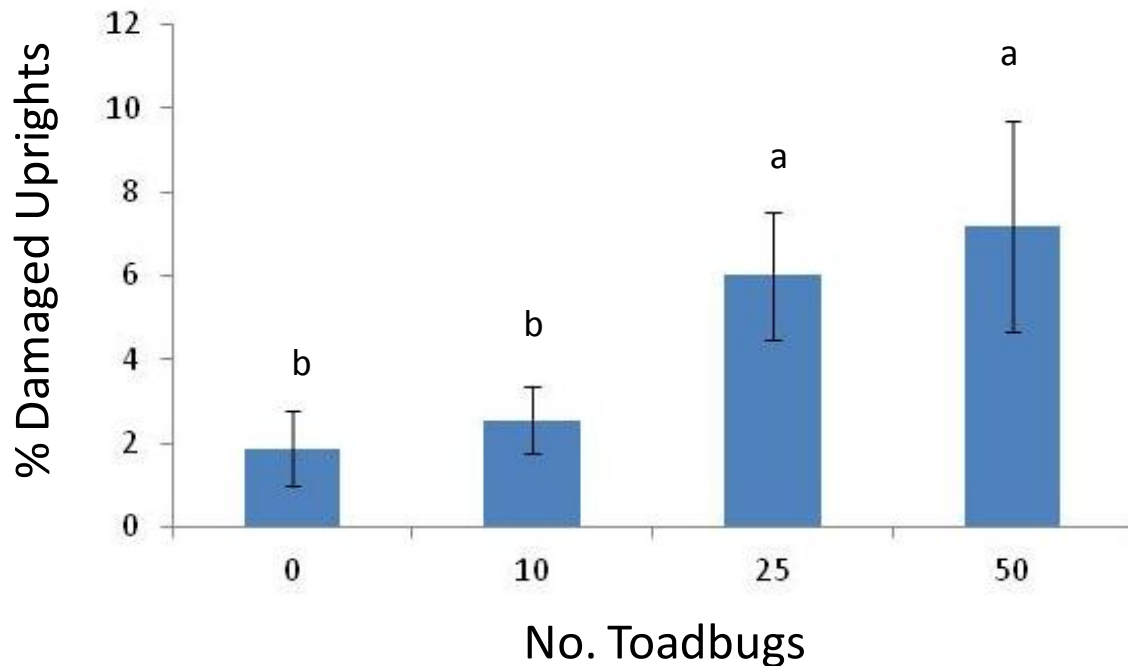
Using the New Weed Guide, Setting Management Priorities, and Research Update on Weed Control

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

Managing weeds in perennial crops systems present challenges not encountered in annual cropping systems. Perennial weeds are usually well-adapted (e.g., having rhizomes, stolons, tubers), making control very difficult. Managing weeds in cranberries has another level of difficulty since the cranberry vines grow to form a continuous mat across the ground. Weeds are often intermingled with the vines making postemergence herbicide applications problematic due to either crop safety concerns and/or getting enough herbicide to the target plant. We need a way to help prioritize weeds so growers can better decide how they should expend their limited time and financial resources.

We initially developed a priority grouping system (1995) to help growers prioritize their weeds. This system categorized weeds into 4 groups based on subjective evaluation of three criteria: ease of control, ability to spread, and impact on yield. During the creation a new weed guide, we revised and expanded the prioritization. The Priority Rating of each weed was determined by considering four criteria: impact, biological form or type, invasive or reproductive capacity, and adaptation to the cranberry habitat. For each weed, a score of 8, 4, 2, or 1 was assigned to each criterion. The impact of the weed on the cranberry plants themselves, 8 = killing or significantly crowding out vines; 4 = reducing vine vigor; 2 = reducing yield; and 1 = little effect. For biological form, 8 = perennial similar to cranberry; 4 = perennial different than cranberry; 2 = perennial or biennial plant; and 1 = annual plant. For reproductive or invasive capacity, 8 = vigorous stolons and rhizomes; 4 = low to moderate production of stolons and rhizomes; 2 = propagation by seed only with many seed; and 1 = propagation by seed only with few seed. Well-adapted plants that are hard to pull received a score of 8; well-adapted plants that are easy to pull scored a 4; 2 = marginally adapted, hard to pull; and 1 = marginally adapted, easy to pull. The total number of points determined the final Priority Rating: 4 to 7 points (Low), 8 to 15 points (Medium), 16 to 23 points (High), and 24 to 32 points (Very High). By using a 4-tiered ranking system within each of the selected criteria, the revised Priority Ratings distributed the weeds along a wider continuum. The new system created 32 possible scores compared to the previous system of 4 scores. The broader distribution gives growers greater precision for prioritization.

We have ranked 144 weeds in the recently published English-version of the *Identification Guide for Weed in Cranberries* (2015). The priority rankings are denoted for each weed with a corresponding number of squares in the upper right-hand corner of the page; readers can quickly see the Priority Rating when viewing the photographs. Readers can then understand how each weed attained its Priority Rating by viewing the ranking tables located towards the end of the publication. Since soil and environmental conditions can vary among cranberry production areas (includes BC, MA, NJ, OR, QC, WA, WI, and the Atlantic provinces), the rankings can be used as a baseline and adjusted to re-define the Priority Rating of a particular weed for any particular area.

Dewberry (Rubus spp., brambles) Management. Current management options outlined in the UMass Cranberry Chart Book will be discussed. *Using Flame Cultivation*. Flame cultivation (FC) uses brief exposures of high temperature to control weeds. In this study, three sites in

southeastern Massachusetts with dewberry present were studied over a 2-yr period to determine if seasonal timing and frequency of exposure to FC would impact dewberry stem length and biomass, both in the year of and the year following treatment. Dewberry plants were treated (9 s exposure with an open flame hand-held torch) to seven timing regimes (one application in June, July, or August or two applications in June/July, June/August, and July/August, or untreated). All treatments reduced aboveground dewberry biomass compared to untreated plots 1 yr after treatment. The timing and frequency of FC treatments were not significant when the weed was growing amongst cranberry vines. Timing and frequency of exposure had more impact on dewberry stem length and biomass when weeds were treated in the absence of cranberry (Ghantous and Sandler, submitted for review to Weed Technology).
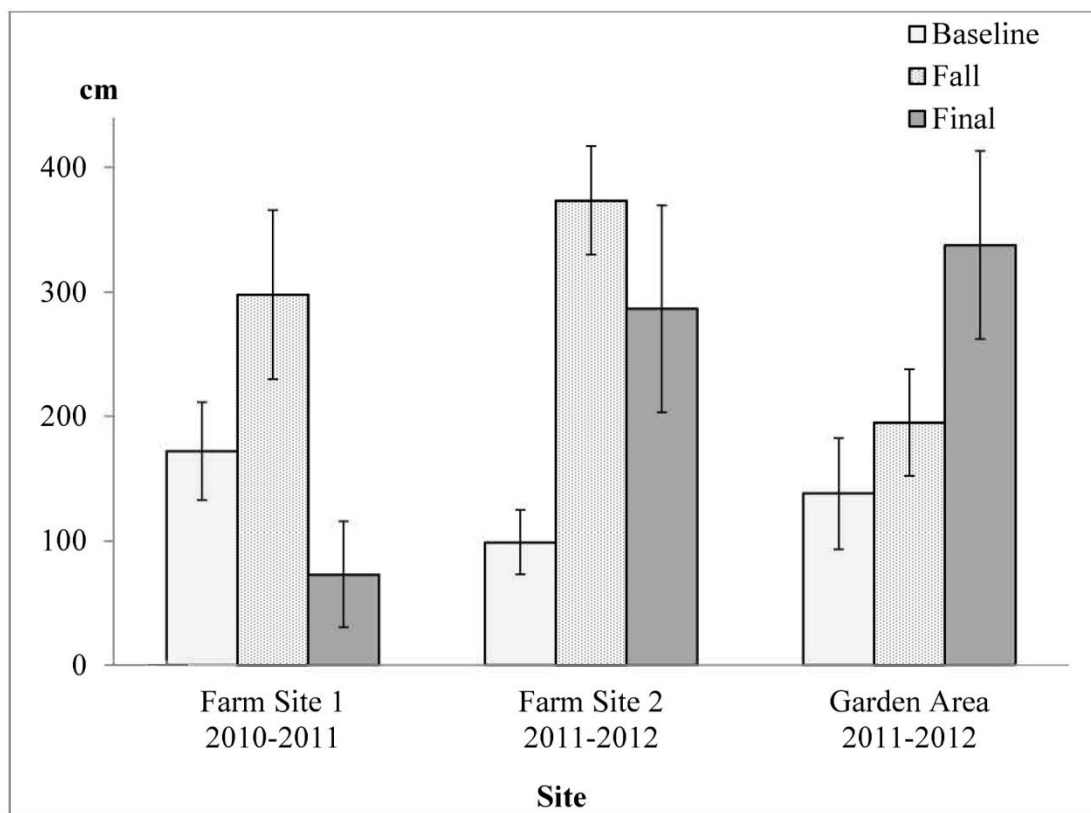

Figure 1. Average cumulative dewberry stem length per plot (mean ± SE, n=5 at Farm Site and n=4 at Garden Area) from untreated plots measured at the initiation of the study (baseline), fall in the year of treatment (3 mo after baseline), and the final measurement (1 yr after baseline).
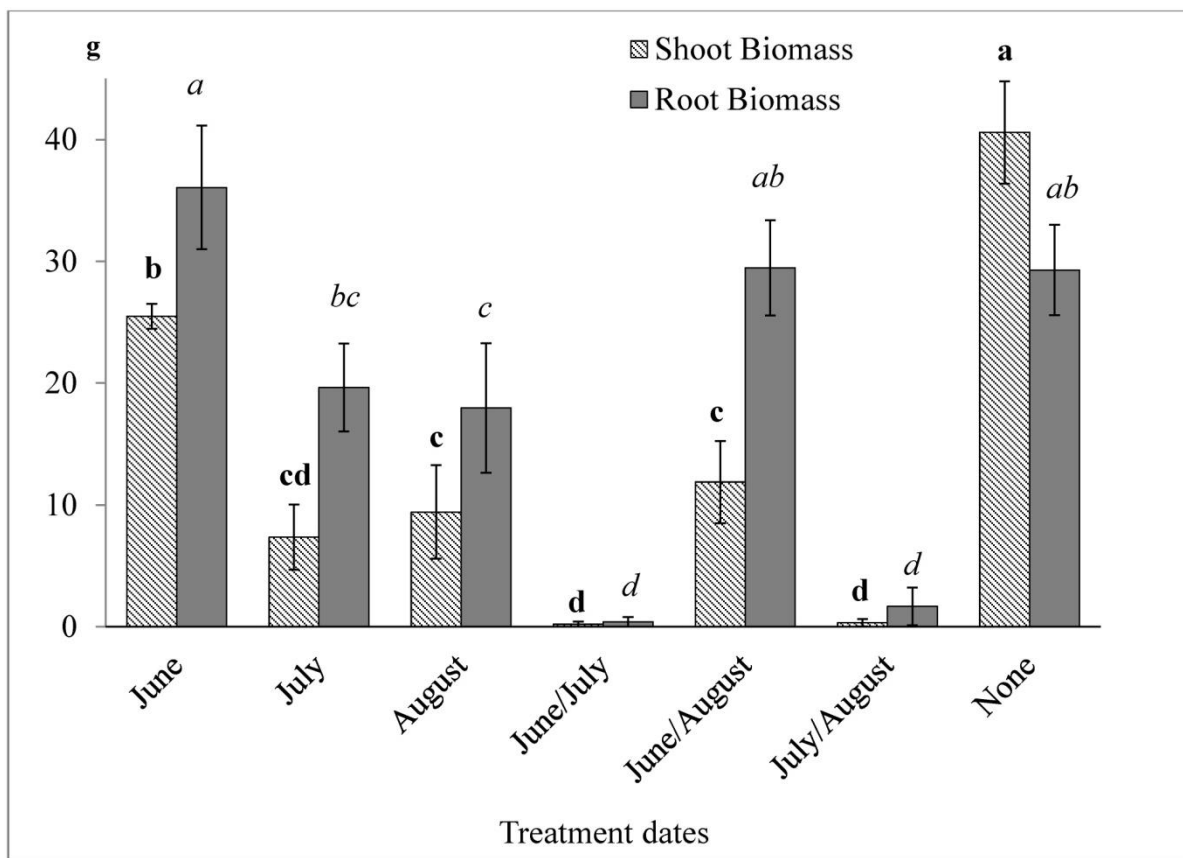
Figure 2. Average dewberry shoot and root biomass per plot (mean ± SE, n=4) 1 yr after the study initiation at the Garden Area. Treatments were a 9-s $0.25m^{-2}$ exposure with a hand-held open flame torch. Means with similar letters within a biomass category are not significantly different according to *Duncan's New Multiple Range Test* ($P \leq 0.05$). Bolded lowercase letters indicate comparisons among shoot biomasses and italic letters indicate comparisons among root biomass.