2022 Annual Winter Meeting of the American Cranberry Growers Association

AMERICAN CRANBERRY GROWERS association

Virtual Meeting

Thursday
January 20, 2022

RUTGERS
New Jersey Agricultural Experiment Station

ACGA Winter Meeting Program

Thursday, January 20, 2022
Virtual

8:00-8:15 Pesticide Credits Registration

8:15-8:30 Pre-meeting Time

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

8:50-9:00 **Cranberry Statistics**
Bruce Eklund, National Agricultural Statistics Service, Trenton, NJ

9:00-9:20 **Results from Insecticide Trials for Blunt-nosed Leafhoppers in Cranberries**
Cesar Rodriguez-Saona, Extension Specialist, Department of Entomology, *Vera Kyryczenko-Roth*, and *Robert Holdcraft*, P.E. Marucci Center, Chatsworth, NJ

9:20-9:40 **Hunting for Stress Tolerance Genes in Wild Cranberry for Use in Breeding**
Jeffrey Neyhart, Research Geneticist, USDA-ARS; and *Nicholi Vorsa,* Professor, Department of Plant Biology, P.E. Marucci Center, Chatsworth, NJ

9:40-10:00 **Identifying Genetic Markers for Defense Mechanisms in Cranberry Fruit**
Joseph Kawash, Bioinformaticist, USDA-ARS, *James Polashock*, Research Plant Pathologist, USDA-ARS, *Nick Vorsa*, Professor, and *Jennifer Johnson-Cicalese*, Research Associate, P.E. Marucci Center, Chatsworth, NJ

10:00-10:20 **Results from the Fruit Quality Project, 2021**
Peter Oudemans, Professor, Department of Plant Biology, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

10:20-10:40 **Break**

10:40-11:00 **Revisiting Integrated Pest Management Strategies for NJ Cranberry Production**
Lindsay Wells-Hansen, Sr. Agricultural Scientist, Ocean Spray Cranberries, Chatsworth, NJ

11:00-11:15 **Update on Breeding for Fruit Rot Resistance in Cranberry**
Jennifer Johnson-Cicalese, Research Associate, *Nicholi Vorsa*, Professor, Department of Plant Biology, *James Polashock*, Research Plant Pathologist, USDA-ARS, *Peter Oudemans*, Professor, and *Sara Knowles*, Laboratory Technician, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

11:15-11:20 **Possible Release of a Late Variety, NJS98-11**
Nicholi Vorsa, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, Research Associate, *Thomas Spain*, Field and Greenhouse Technician, P.E. Marucci Center, Chatsworth, NJ

11:20-11:40 **Carolina Redroot: Long-term Management with Overlapping Residual Herbicides**
Thierry Besancon, Weed Science Extension Specialist, Department of Plant Biology, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

11:40-12:00 **Cranberry Institute – An Update**
Katherine Ghantous, Cranberry Institute, Carver, MA

12:00-1:00 **Break**

1:00-1:20 **Visualizing Cranberry Fruit Rot in a Different Light**
James Polashock, Research Plant Pathologist, and *Joseph Kawash*, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

1:20-1:50 **Resistance Management and the Pesticide Label, What You Need to Know**
Kate Brown, Program Associate—Commercial Agriculture, Rutgers Cooperative Extension of Burlington County, Westampton, NJ

1:50 **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 will release the 2021 Non-citrus Fruit and Nut Final Summary noon May 4, 2022 at 3 PM eastern: https://www.nass.usda.gov/Publications/Reports_By_Date/index.php We want to work with you to get the best data to accurately represent New Jersey cranberries. Thank you in advance for your help.

Until May 4, I do not have new NASS cranberry data. NASS released the production forecast for the 2021 crop August 12, 2021.

Still ongoing, 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. If asked, please help with the pesticide use survey. It ends soon.

Agricultural Resource Management Survey (ARMS III) will start soon. ARMS III alerts the public and policy makers to the financial well being and challenges of American and New Jersey Agriculture. The total New Jersey sample size is slightly over 70 so if selected, please participate. Among the many uses include alerting people not only about Ag. production and revenue but that farmers incur significant costs. These survey results also measure s your contribution to GDP.

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.

Results from Insecticide Trials for Blunt-nosed Leafhoppers In Cranberries

Cesar Rodriguez-Saona, Extension Specialist, Department of Entomology, *Vera Kyryczenko-Roth,* and *Robert Holdcraft,* P.E. Marucci Center, Chatsworth, NJ

There is continued concern among cranberry growers of a potential increase in blunt-nosed leafhopper (BNLH), *Limotettix vaccinii*, populations because of changes in pest management strategies (e.g., adoption of new reduced-risk products and decreased applications of broad-spectrum insecticides). Moreover, chlorpyrifos (Lorsban) has been banned for use in all crops. Therefore, experiments were conducted in 2021 to test the efficacy of conventional and biological pesticides insecticides for controlling BNLH nymphs in cranberries.

CONTROL OF BNLH WITH CONVENTIONAL INSECTICIDES

In 2021, we tested the efficacy of five insecticides for controlling BNLH nymphs. The insecticide treatments and rates were: Closer SC (sulfoxaflor) at 4.25 fl oz/acre, Senstar (spirotetramat + pyriproxyfen) at 16 fl oz/acre, Danitol 2.4EC (fenpropathrin) at 16 fl oz/acre, Lorsban 4E (chlorpyrifos) at 3 pt/acre, and Acephate 97UP (acephate) at 16 oz/acre. A control treatment was also included that received no insecticide. The experiment was conducted in a cranberry, var. Ben Lear bed located at the Rutgers P.E. Marucci Center. Plots were 4 ft × 4 ft each, replicated five times for each treatment. Treatments were applied using an R&D CO_2 backpack sprayer in the morning (5:00-6:00 h) of 27 May 2021.

On 28 May 2021 (i.e., a day after the treatment), treated cranberry uprights from the central portion of each plot, at least 15 cm from the plot's edges, were clipped and taken to the laboratory. In the laboratory, four uprights per treatment/replicate were placed in a florists' water pick and enclosed in a ventilated 40-dram plastic vial. The water picks were then secured on Styrofoam trays. Ten vials were setup for each treatment and five BNLH nymphs were placed inside each vial, for a total of 50 nymphs per treatment; each vial was considered a replicate. Vials were then placed on a light bench in the laboratory, and mortality was assessed on 2 June 2021. The number of leafhopper nymphs (alive, dead, or missing) per vial was recorded and the percent alive, dead, and missing was calculated. Percent control was calculated for each treatment as [1-(percent of leafhoppers alive on treated foliage/percent of leafhoppers alive on control foliage)]×100.

All insecticides tested were effective at controlling blunt-nosed leafhopper nymphs, with efficacy ranging from 70-100% (Table 1).

Table 1.

Treatment	Rate /acre	N[2]	Percent of Leafhoppers (Mean ± SE)[3]			% Control[4]
			Alive	Dead	Missing	

Control	---	10	38.0 ± 6.3	A	48.0 ± 6.8	C	14.0 ± 5.2	---
Closer SC	4.25 fl oz	10	0.0 ± 0.0	C	72.0 ± 6.1	BC	28.0 ± 6.1	100.0
Senstar[1]	16 fl oz	10	2.0 ± 2.0	C	68.0 ± 6.8	BC	30.0 ± 6.8	94.7
Danitol 2.4EC[1]	16 fl oz	10	0.0 ± 0.0	C	88.0 ± 5.3	A	12.0 ± 5.3	100.0
Lorsban 4E	3 pt	10	10.0 ± 4.5	B	54.0 ± 9.0	C	36.0 ± 8.8	73.7
Acephate 97UP	16 oz	10	0.0 ± 0.0	C	78.0 ± 7.0	AB	22.0 ± 7.0	100.0

[1] Treatments included the adjuvant Silwet-L77 at 0.25% v:v.

[2] Number of vials per treatment; each vial had 5 leafhoppers, for a total of 50 leafhoppers/treatment.

[3] Percent data were square-root-arcsine transformed prior to analysis. Means within a column followed by different letters are significantly different (Fisher's LSD test, $P \leq 0.05$).

[4] % Control = [1-(percent of leafhoppers alive in treatment/percent of leafhoppers alive in control)]×100.

CONTROL OF BNLH WITH BIOLOGICAL INSECTICIDES

We also tested the efficacy of four biological insecticides containing entomopathogenic fungi (*Isaria fumosoroseus*, *Beauveria bassiana*, or *Metarhizium anisopliae*) for controlling BNLH nymphs. Four treatments were applied on separate plots as soil drench and foliar sprays, while one treatment was applied only as a foliar spray. The soil drench treatments and rates were: NoFly™ at 2 lb/acre, Met Master at 40 oz/acre, BioCeres WP at 3 lb/acre, and BotaniGard 22WP at 10 lb/acre. The foliar spray treatments and rates were: NoFly™ at 2 lb/acre, Met Master at 16 oz/acre, BioCeres WP at 3 lb/acre, BotaniGard 22WP at 1 lb/acre, and BotaniGard ES at 1 qt/acre. All treatments with BotaniGard 22WP included the adjuvant Silwet-L77 at 0.02% v:v. In addition, an untreated (control) treatment was included that had no insecticides. The experiment was conducted in a cranberry, var. Ben Lear, bed located at the Rutgers P.E. Marucci Center. Plots were 4 ft × 4 ft each, replicated four times. All treatments were made with an R&D CO_2 backpack sprayer on 30 May 2021 for soil drench applications and on 1 June 2021 for foliar applications.

Treated cranberry uprights from the central portion of each plot, 15 cm from the plot's edges, were clipped on 2 June 2021, i.e., 1 and 3 days after treatment for the foliar spray and soil drench applications. Four uprights per treatment/replicate were inserted in a florists' water pick and enclosed in a ventilated 32 oz Deli cup container. Water picks were inserted through tightly-fitted holes cut in the bottom of each container, then secured on Styrofoam trays. Seven containers were setup for each treatment and 5 BNLH nymphs were placed inside each assay container, each container was considered a replicate. Containers with plants and insects were then placed on a light bench in the laboratory, and mortality was assessed on 14 June 2021. The number of nymphs alive, dead, or missing per container was recorded and the percent alive, dead, and missing was calculated. In addition, dead nymphs were examined under 10X magnification to check for fungal infection. Percent dead nymphs showing fungal infection was calculated. Percent control was calculated for each treatment as [1-(percent of nymphs alive on treated foliage/percent of nymphs alive on control foliage)]×100.

BioCeres and BotaniGard resulted in 100% nymphal mortality and > 77% infection compared to the control, when applied either by soil drench or foliar spray (Table 2). The NoFly™ treatment also significantly increased nymphal mortality and infection; however, mortality was 42% greater when applied as foliar spray than as soil drench (Table 2). Met Master was the weakest of all biological products tested, providing <50% control (Table 2).

Table 2.

Treatment	Rate /acre	N	Percent of Leafhoppers (Mean ± SE)[2]				% Control[3]
			Alive	Dead	Fungal Infection	Missing	
Control	-	7	74.3 ± 5.7 A	22.9 ± 5.2 D	0.0 ± 0.0 D	2.9 ± 2.9	-
Soil Drench Applications							
NoFly™	2 lb	7	34.3 ± 9.5 B	54.3 ± 10.4 C	42.9 ± 8.1 B	11.4 ± 4.0	53.8
Met Master	40 oz	7	42.9 ± 5.2 B	48.6 ± 4.0 C	40.0 ± 8.7 BC	8.6 ± 5.9	42.3
BioCeres WP	3 lb	7	0.0 ± 0.0 C	88.6 ± 5.9 AB	88.6 ± 5.9 A	11.4 ± 5.9	100.0
Botanigard 22WP[1]	10 lb	7	0.0 ± 0.0 C	80.0 ± 6.2 B	80.0 ± 6.2 A	20.0 ± 6.2	100.0
Foliar Spray Applications							
NoFly™	2 lb	7	2.9 ± 2.9 C	82.9 ± 2.9 B	77.1 ± 2.9 A	14.3 ± 3.7	96.2
Met Master	16 oz	7	65.7 ± 7.2 A	20.0 ± 6.2 D	17.1 ± 5.2 C	14.3 ± 5.7	11.5
BioCeres WP	3 lb	7	0.0 ± 0.0 C	91.4 ± 4.0 AB	82.9 ± 9.2 A	8.6 ± 4.0	100.0
Botanigard 22WP[1]	1 lb	7	0.0 ± 0.0 C	97.1 ± 2.9 A	80.0 ± 9.8 A	2.9 ± 2.9	100.0
Botanigard ES	1 qt	7	0.0 ± 0.0 C	85.7 ± 5.7 AB	77.1 ± 6.8 A	14.3 ± 5.7	100.0

[1] Treatments included the adjuvant Silwet-L77 at 0.02% v:v.

[2] Percent data were square-root-arcsine transformed prior to analysis. Means within a column followed by different letters are significantly different (Fisher's LSD test, $P \leq 0.05$).

[3] % Control = [1-(percent of nymphs alive in treatment/percent of nymphs alive in control)]×100.

Acknowledgements. This research was supported by industry gifts of pesticide and research funding and by the New Jersey Cranberry Research Council Inc., the Cape Cod Cranberry Growers Association, and Ocean Spray Cranberries, Inc.

Hunting for Stress Tolerance Genes in Wild Cranberry for Use in Breeding

Jeffrey Neyhart, Research Geneticist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ; *Nicholi Vorsa*, Professor, Department of Plant Biology, Rutgers University

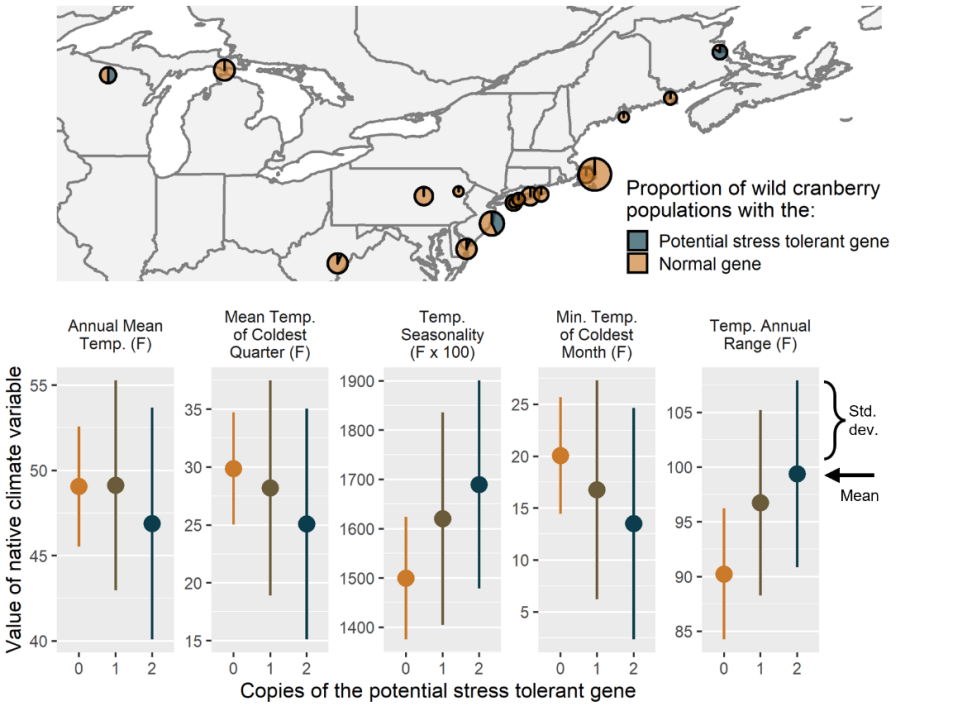
Cranberries are sensitive to stresses – such as such as heat, frost, drought, soil fertility, and diseases – caused by their growing environment, often leading to reduced fruit yield and quality. While many management practices can be effective in limited the impact of these stresses, building genetic tolerance through breeding is a more durable solution. Wild cranberry may contain useful genetic variation for stress tolerance given its adaptation to different environments. Identifying stress tolerance genes in wild cranberry can help accelerate the development of hardier varieties by incorporating wild plants in the breeding program.

Objectives:

- Identify genetic DNA markers linked with traits in the wild cranberry genome that are correlated with the climate adaptation and soil conditions related to known stresses
- Determine if there are genes in these segments that may be targets for breeding varieties with enhanced stress tolerance

For this research, we used DNA markers profiled on wild cranberry plants in the Rutgers germplasm collection, along with historical climate (temperature, precipitation) and soil (texture, pH, quality) records for each location (see map below) where wild cranberry was collected.

We identified 54 genetic markers that were highly correlated with one or more climate or soil variables. For example, one marker (see figure) was correlated with temperature extremes. This marker tags a gene that, in other plant species, is known to impart temperature stress tolerance. This evidence increases our confidence that we tagged a gene in wild cranberry that contributes to extreme temperature tolerance.



Example of a DNA marker correlated with extreme temperatures. This marker tags a temperature stress tolerance gene, and wild cranberry plants with the more stress tolerant version of the gene are found in northern locations with colder and more variable temperatures.

Other genetic markers were correlated with climate and soil data such as heat, precipitation, and soil quality. The markers may also tag stress tolerance genes and could be targets for screening wild cranberry plants to include in the breeding program.

Identifying Genetic Markers for Defense Mechanisms in Cranberry Fruit

Joseph Kawash, Bioinformaticist, USDA-ARS, *James Polashock*, Research Plant Pathologist, USDA-ARS, *Nick Vorsa*, Professor, and *Jennifer Johnson-Cicalese*, Research Associate, P.E. Marucci Center, Chatsworth, NJ

The cranberry industry is challenged by widespread and increasing losses due to fruit rot, herbivory, and environmental stressors. Mitigation of losses through the use of fungicides, pesticides, and fertilizers is becoming progressively complex due to increasing regulation and environmental stewardship. These losses can be eased through selective breeding to integrate desired defense traits into cultivars.

Marker assisted selection is an indispensable tool utilized in crop breeding for selection of desired phenotypes based on linked genomic variation. This is commonly done through the use of genetic markers that are statistically attached to a desired phenotype. Comprehensive and accurate genome sequence data, phenotypic information, and genetic references are essential for effectively facilitating this approach. Progress has been revolutionized by advancements in speed, density, and cost reduction of modern sequencing platforms for the development of genetic markers. Thus allowing for the selective breeding of traits such as yield, stress resistance, disease resistance, but also sustainability, conservation, and environmental adaptation.

Two components of cranberry defense we are currently investigating, and for which we are developing genetic markers, are broad spectrum fruit rot resistance and epicuticular wax production.

We have identified four distinct sources of broad-spectrum fruit rot resistance from our germplasm collection. Crosses integrating resistance genes in horticulturally elite genetic backgrounds have resulted in populations segregating for fruit rot resistance and high productivity. Two populations consisting of approximately 100 individuals each were assessed for field fruit rot utilizing a rating system 1-5, where 1 = 0-20% rotted fruit and 5 = 81-100% rotted fruit. We identified four potential genetic loci in 2 populations that contribute up to 27% of variance of fruit rot resistance.

For epicuticular wax production, we used a single population of approximately 90 individuals. Surface fruit wax was rated on a scale from 1-6, with 1 being the least amount of wax and 6 the highest. Using conventional quantitative trait loci mapping, we identified a single genetic locus that correlates with wax production in this population. This locus was calculated to account for 32.5% of the variability of the observed wax phenotype.

These QTL loci provide targets for candidate gene discovery, marker development, and for future breeding efforts to enhance and disease resistance and wax production into horticultural backgrounds.

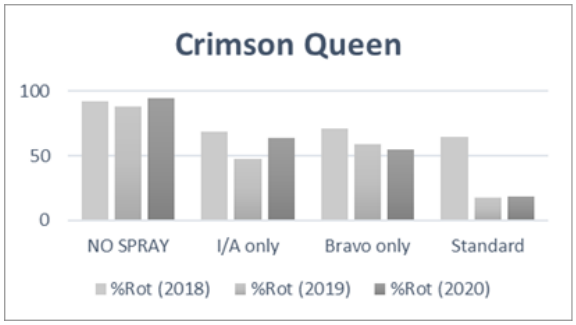
Results from the Fruit Quality Project, 2021

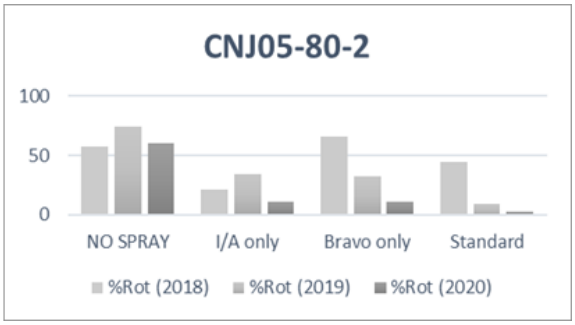
Peter V. Oudemans, Rutgers University

1. **Bravo replacement –** The search continues for effective, broad spectrum alternatives to chlorothalonil-based fungicides. Our FLEX (floral extract) lab bioassay provides rapid results using a small footprint for several important fruit rotting species. A broad spectrum of fungicides and fungicide combinations can be tested using this platform. Next, traditional field trials are used to evaluate the best treatments identified in the lab. One fungicide combination has proven especially effective and efforts for registration are moving forward. A second fungicide was found to have significant activity in the lab and in field trials a strong dosage response was seen. Use patterns indicate a mixture of modes of action should provide significant disease control

Fungicide and amount/A	HWT (g/m^2)		ROT Wt (g/m^2)		Fruit Rot (%)	
XXX 11.4fl. oz. /A	900.8	ab	91.5	bc	8.8	bc
XXX **11.4 fl.oz/A**+ **Abound + 15.5**fl. oz./A	948.6	a	27.5	c	3.8	c
YYY 11.4fl. oz./A	713.1	abc	69.8	bc	9.3	bc
YYY 10.5fl. oz./A + **Abound 15.5**fl. oz./A	708.2	abc	111.5	bc	11.1	bc
ZZZ 10.5fl. oz. /A	398.8	cd	339.9	a	49.0	a
ZZZ 10.5fl. oz./A + **Abound 15.5 fl.oz./A**	939.6	a	36.4	c	5.5	c
ZAAZ 7.3 oz/A	459.5	bcd	137.9	bc	24.5	b
Control	265.0	d	212.8	ab	54.6	a

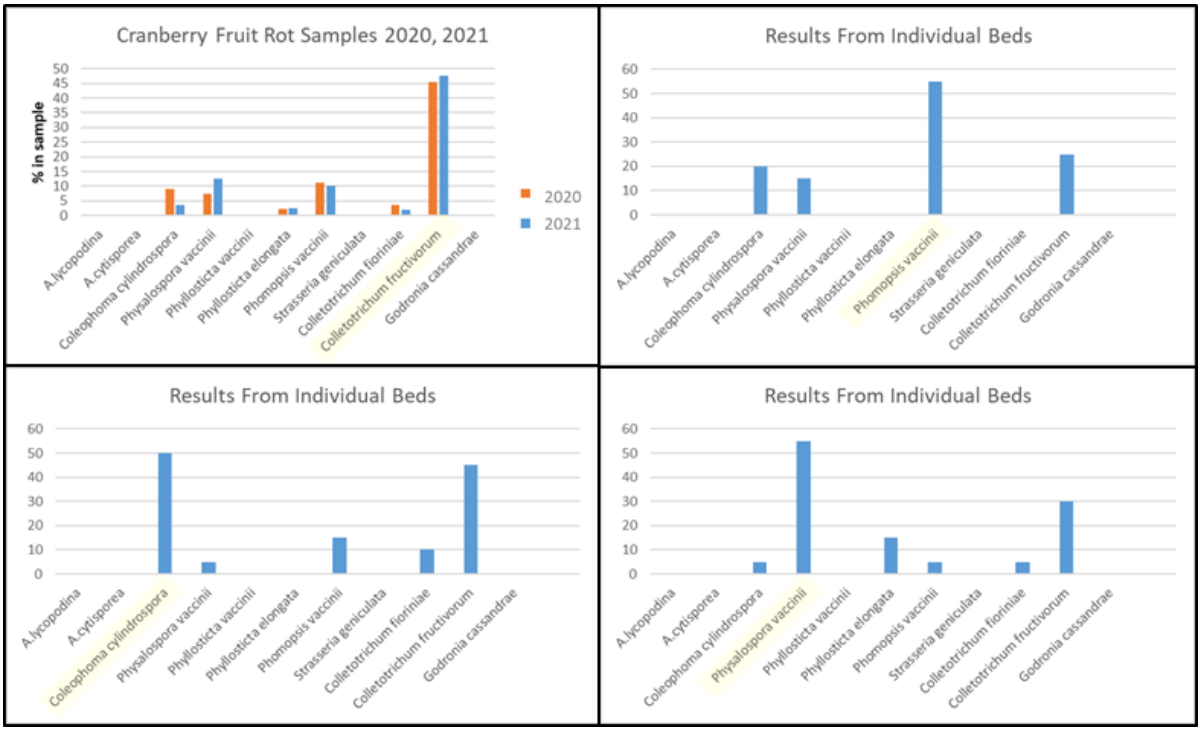
2. **Disease management in resistant cultivars -** New selections are being developed through the Rutgers Cranberry Breeding Program and fungicide use patterns are being evaluated through the Rutgers Small Fruit Pathology Program. A full report on this project is being developed collaboratively. The project demonstrates that, although fungicides are required, the more resistant genotypes require fewer fungicide sprays. In the example below the fruit rot susceptible variety Crimson Queen develops nearly 100% fruit rot without fungicide applications whereas one of the selections shown below develops approximately 50% fruit rot. With two fungicide applications made during bloom or following bloom Crimson Queen exhibits >50% fruit rot. However, the resistant genotype shows economically viable levels of fruit rot (<10%) with either treatment by year 3 after planting. On the other hand, Crimson Queen requires a minimum of 4 sprays.





3. **We continue to evaluate a** rapid method for evaluating the exposure of cranberry fruit and thereby quantifying the risk for overheating. This method will provide a rapid approach for estimating the quantity of fruit exposed at the canopy surface. This information can be translated into actionable recommendations for fruit cooling.

4. **Fungal species distribution for fruit rot.** Over the past two seasons, we have investigated the distribution of fruit rotting species from samples taken during the cranberry harvest. Samples are collected from the Ocean Spray receiving station and then plated in our Small Fruit Pathology Lab at Rutgers. The results shown below represent approximately 3000 berries/year from 160 commercial cranberry beds in NJ. Although one fungus, *Colletotrichum fructivorum*, is the most abundant overall the variation among beds is probably more important. This is especially important as we develop more specific strategies for managing fruit rot and learn more about each lifecycle. As you can see in the results for three individual beds the abundance of different is significant with *Phomopsis vaccini, Coleophoma cylindrospora* and *Physalospora vaccini* dominating in the different situations. We are beginning to use this data to make specific recommendations and also to track species shifts in response to novel fungicide programs.


Cranberry Fruit Rot Samples 2020, 2021
% in sample
2020
2021
A.lycopodina
A.cytisporea
Coleophoma cylindrospora
Physalospora vaccinii
Phyllosticta vaccinii
Phyllosticta elongata
Phomopsis vaccinii
Strasseria geniculata
Colletotrichum fioriniae
Colletotrichum fructivorum
Godronia cassandrae
Results From Individual Beds
Results From Individual Beds
Results From Individual Beds

Revisiting Integrated Pest Management Strategies for NJ Cranberry Production

Lindsay Wells-Hansen, Ph.D., Sr. Agricultural Scientist, Ocean Spray Cranberries

As one of the early adopters of Integrated Pest Management (IPM), the cranberry industry has been implementing IPM practices to improve production for nearly 30+ years. As such, the concept and principles of IPM need no introduction. However, there have been numerous changes (e.g., availability of pesticides, re-emergence of secondary pests, changes in monitoring methodologies, etc.) regarding IPM in recent years which have substantially impacted the cranberry industry. Additionally, as consumers have become more aware of the concept of 'sustainability', IPM has risen to the forefront of consumer awareness in recent years leading customers (e.g., Walmart) to set new standards for their suppliers (e.g., Ocean Spray). These changes directly affect Ocean Spray Cranberries and its grower-owners on several levels and moreover have led to a substantial push in the agricultural industry as a whole to better define and implement IPM practices.

While IPM has long been a priority for OSC, the increased interest in, and focus on, this topic from a consumer and customer standpoint has led the Co-op to once again move IPM to the forefront of priorities in the coming years. As such, it's important for grower-owners in every region to revisit and update their IPM practices so that OSC is better able to relay our story of IPM success to customers and consumers alike.

IPM definitions and standards differ across entities, but in general, IPM means responding to pest problems with the most effective, least-risk option. The basic pillars of an IPM program include (1) setting action thresholds, (2) monitoring and identifying pests, (3) prevention, and (4) control. Although IPM often focuses heavily on management of **insect** pests, it also applies to management of diseases, weeds, and the monitoring of plant phenology. Action thresholds for sweep netting have been established for most of the insect pests that are of concern for cranberry growers in all regions. In addition to these thresholds, disease and weed management guidelines have been developed for prominent pests in these categories in each growing region and are outlined in many of the university-produced cranberry production guides.

Although not yet *formally* defined universally for the industry, an effective IPM program in cranberry production should include at least weekly monitoring of a select number of representative bogs for insect pest populations, weeds, diseases, and plant phenology in an effort to obtain a representative snapshot of pest issues on the farm. This monitoring should be conducted from May to August in most regions and should combine the use of sweep netting, pheromone trapping stations, recording of plant growth stages (of both the crop and weeds), and visual observations. Accurate and thorough recordkeeping is also an invaluable component of an IPM program, allowing for more informed pest management decisions to be made within and across growing seasons and aiding the implementation of resistance management tactics.

A few of the resources available to cranberry growers that can be utilized during monitoring events are listed below:

1. Compendium of Blueberry, Cranberry, and Lingonberry Diseases and Pests, Second Edition by James Polashock, Frank Caruso, Anne Averill, and Annemiek Schilder
2. Cranberry Insects of the Northeast by Anne Averill and Martha Sylvia
3. Cranberry Pests of Quebec: An Identification Guide by Jean-Francois Landry, Michele Roy, and Caroline Turcotte
4. New Jersey Cranberry Insect Pocket Guide by Dan Schiffhauer
5. Wisconsin Cranberry Insect Pest Identification Pocket Guide by Nicole Martinson and Leroy Kummer

Revisiting IPM strategies and tailoring these approaches for different production regions where appropriate will be key as IPM programs are redefined and more guidance comes from customers. Additionally, implementing a strong IPM program on-farm is an effective approach that allows growers to make the most cost-effective, environmentally friendly pest management decisions that should allow farms to prosper for generations.

Update on Breeding for Fruit Rot Resistance in Cranberry

Jennifer Johnson-Cicalese, Research Associate, *Nicholi Vorsa,* Professor, Department of Plant Biology, *James Polashock*, Research Plant Pathologist, USDA-ARS, *Peter Oudemans*, Professor, *Sara Knowles,* Laboratory Technician, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

An important focus of Rutgers' cranberry breeding program is the development of commercially viable varieties with enhanced fruit rot resistance (FRR). Fruit rot has been exacerbated by recent increasing temperatures. The loss of fungicide labels and their loss of use in major markets, e.g. European Union, is a constant concern. Consequently, we now have FRR as a major research and breeding program objective. We have a team of people working on FRR goal. At least four sources of resistance were identified in our germplasm and found to be heritable, from which we have developed many 1st, 2nd, and now 3rd generation crosses where thousands of progeny have been screened for resistance, yield and fruit quality. Putative genetic markers for FRR have been identified to increase the efficiency of the breeding cycles. Reduced fungicide trials have been conducted with new FRR selections. Following is a brief review of our latest work.

A trial planted in 2015 of our nine advanced, i.e., best FRR selections (in Bed 11, 10' x 20' plots, 5 reps) has now been evaluated three years under reduced fungicide regimes by Dr. Oudemans' lab, with the goal of developing fungicide recommendations for a potential new FRR variety having significantly less fungicide inputs. Some selections performed significantly better than others in the trial having relatively low rot with just two Indar/Abound applications. In 2020, we planted the next generation of FRR selections in large, replicated plots for further evaluation, especially for fungicide trials (Bog 2).

Multiple years of evaluations of 1,200 progeny from 2012 crosses (CNJ12) have identified promising selections where we have combined different sources of resistance. The best of these, in both yield and resistance, were included in the Bed 2 trial and have been used in further crosses. We have now made 3rd generation crosses (CNJ18), further pyramiding sources of resistance and working to improve yield. Unfortunately, we do not have nor do we anticipate progeny with complete FRR.

We developed CNJ14-31, which is a unique population of over 200 progeny, combining three sources of FRR. Each progeny was planted in four replications (4 different beds) of field plots. It has been phenotyped (evaluated) for numerous traits, and the data is being used by Dr. Kawash to develop genetic markers. The genetic markers for FRR that have been identified and their value will be tested with future breeding populations.

In 2019, six elite FRR selections were planted at J.J. White and Pine Island Cranberry in ¼ to ½ acre plots, for evaluation under commercial production. Initial samples were collected in 2021, and although not fully established yet, some showed promising yield with low rotted fruit.

So, what's next? Dr. Polashock's lab is developing new ways to evaluate fruit rot and quality with hyperspectral imaging. Future crosses and selections should focus on increasing fruit size and higher tacy or improved hyperspectral imagery. A better understanding of the genetics and mechanisms of FRR, and the ability to screen, early in the breeding cycle with molecular FRR genetic markers could greatly improve the efficiency, i.e, expedite, our cranberry breeding program.

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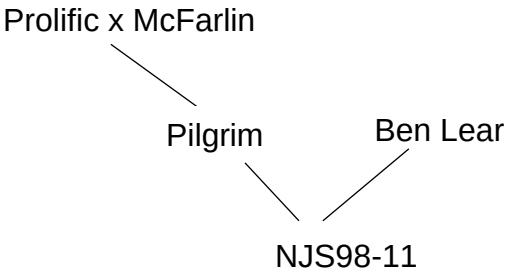
NJS98-11: Possible Release of a Late Season Cultivar

Nicholi Vorsa, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, Research Associate, *Thomas Spain*, Field and Greenhouse Technician, P.E. Marucci Center, Chatsworth, NJ

There is interest from growers in British Columbia for a late season cultivar. A late season berry would help extend the season. NJS98-11 is a selection from crosses made in 1988, the same year of crosses that gave rise to 'Crimson Queen®' and 'Demoranville®'. At the time, total anthocyanin content (Tacy) was a major selection criterion, before the rise in popularity of 'sweetened-dried' (SDCs) cranberry. NJS98-11 is from a 'Pilgrim' x 'Ben Lear' (**Fig. 1**) cross and was selected for its yield but was considered low for Tacy. NJS98-11 selection is unique in that it is a Rutgers selection with 'Pilgrim' as parent, thus offering a slightly different genetic background. 'Pilgrim' has 'Prolific' as a parent from Michigan. Since fruit with higher Tacy was paid a premium at the time for juice products, the selection was not considered for release. However, in the 1990's, this selection yielded well at both Dubay's,research plots in Wisconsin and at Chatsworth, New Jersey. Now that Tacy is less important and a large share of the industry relies on DigiEye the cultivar may have a sequencing fit.

NJS98-11 has yielded well in Wisconsin, New Jersey, and Delta, BC field variety trials. In an Elm Lake, WI trial, NJS98-11 averaged 435 g/ft^2 from 2013-2016, yielding 745g/ft2 in 2016, and fruit rot averaged 10.4%, whereas the cultivar 'Stevens' yielded 407 g/ft^2 and 12.8% fruit rot during those years, a fruit rot prone area at the time. At a Warrens, WI variety trial it averaged 516 g/ft^2, with fruit rot averaging 11.2%, whereas the cultivar 'Stevens' averaged 320 g/ft^2 and 12.6% fruit rot during years 2013-2016. Fruit weight ranged 1.9-2.2 g/berry across trials in Wisconsin, and in British Columbia slightly smaller than 2 g/berry. NJS98-11 fruit weight is typically larger in New Jersey, averaging ≈2.6 g/berry. The latest harvest we observed in New Jersey was October 7, 2015 giving a Tacy of 33, whereas Welker and Haines had Tacy of 37 and 50, respectively.

Fig 1. Pedigree of NJS98-11



Visualizing Cranberry Fruit Rot in a Different Light

James Polashock and *Joseph Kawash*, USDA-ARS

The cranberry breeding program has greatly benefited from advances in genomics (i.e. studies of the genetic material in the cranberry plant). The benefits include rapid genotyping of the plants and the linkage of genotypic differences with important traits (e.g. yield, fruit rot resistance, etc.) for marker development. One bottleneck that remains in the process is the phenotyping. Phenotyping can be thought of as the measurement of any trait of interest. The traits to be measured can be morphological (such as fruit size and color), biochemical (such as acidity or sugar content) or physiological (such as stress response). We routinely phenotype breeding plots of cranberries for fruit rot incidence. This currently involves hand harvesting of the fruit, visual sorting of the fruit (rot vs. sound), and sometimes culturing to determine the organism(s) causing the rot. This process is time consuming and labor intensive. Visual fruit rot ratings are also done in the field, but these data can be inaccurate due to subjective nature of the ratings and the fact that rotten fruit can be hidden in the plant canopy.

We are exploring ways to increase the speed, while maintaining accuracy, of phenotyping for fruit rot incidence. One method is to use imaging coupled with machine learning for classification of rotted vs. sound fruit. Imaging in the traditional sense uses visible light (i.e. the portion of the electromagnetic spectrum that the human eye can perceive, 400-750 nm wavelengths). While a lot of phenotypic data can be collected using visible light, hyperspectral sensors give us the opportunity to collect phenotypic data outside the visible light spectrum. The sensor we are testing covers the high end of the visible spectrum and a portion of the near infrared (VNIR, 600-1700 nm). Imaging in this spectral range allows us to ‘see’ the fruit differently, and more importantly, it allows us to better classify the fruit.

Our goal is to utilize this system both in the lab and in the field for rapid genotyping of fruit rot incidence and other traits such as color and surface wax.

RUTGERS New Jersey Agricultural Experiment Station
COOPERATIVE EXTENSION

Carolina Redroot (Lachnanthes caroliniana) Identification and Control

Thierry Besancon, Assistant Extension Specialist in Weed Science, Plant Biology
Baylee L. Carr, Weed Science Field Researcher

Carolina redroot (*Lachnanthes caroliniana*) is a perennial weed found in aquatic sandy acidic areas ranging throughout the eastern coast from Louisiana to Nova Scotia. Carolina redroot is classified as a high priority weed in cranberry bogs (Sandler 2018) where full sunlight exposure, sandy acidic soils, and rapid alternation of wet and dry soil periods provide optimal conditions for this species to develop. Carolina redroot can spread by seeds, but most commonly through rhizome clonal propagation. Carolina redroot often crowds out cranberry vines and other weeds in New Jersey cranberry bogs where its development is associated with open areas where vines have been killed by fairy ring disease or other "stand opening" conditions of natural and anthropomorphic origin.

Plant Identification

Carolina redroot is a monocot, easily identified by its namesake red roots and rhizomes (Figure 1A). The leaves are simple, alternate, and blade-like (Figure 1B). As the summer continues, Carolina redroot will grow above the cranberry canopy. Flower stalks are hairy and 1.5 to 4 inches tall with yellow flowers clustered in an inflorescence (corymb) (Figure 1C). Fruits produced by flowers are red with reddish-brown seeds inside (Figure 1D). When scouting cranberry bogs early in the season for Carolina redroot, it is important to look beneath the cranberry canopy for the fan-shaped seedlings (Figure 1B). Emergence occurs late April to early May when water has been removed from the bogs and the soil starts to warm up.

Figure 1. Carolina redroot rhizome (A), leaf blade (B), flower stalk (C), and seedhead (D). Photo Credit: Baylee Carr and Thierry Besançon.

Impact on Cranberry Production

In recent studies conducted by the weed science team at the Rutgers P.E. Marucci Center for Blueberry and Cranberry

Research, Carolina redroot in cranberry bogs accounts for significant yield and economic loss. Out of 120 individual plots assessed by the Rutgers University weed science program over the last 3 years, yield loss from redroot competition averaged 26%, reaching up to 80% when weed density exceeded 400 plants per square meter (Figure 2). Overall, each Carolina redroot plant reduced cranberry yield by an average of 5 grams m^{-2}. These losses result from direct competition for water, nutrients, and light. Fragments of the Carolina redroot inflorescence can also mix with cranberry fruit during harvest operations and hinder the industrial processing of cranberry fruits, further exacerbating the economic impact caused by this weed. The more weed debris in the bogs, the slower the cleaning process is and the more time and, thus, money spent to harvest.

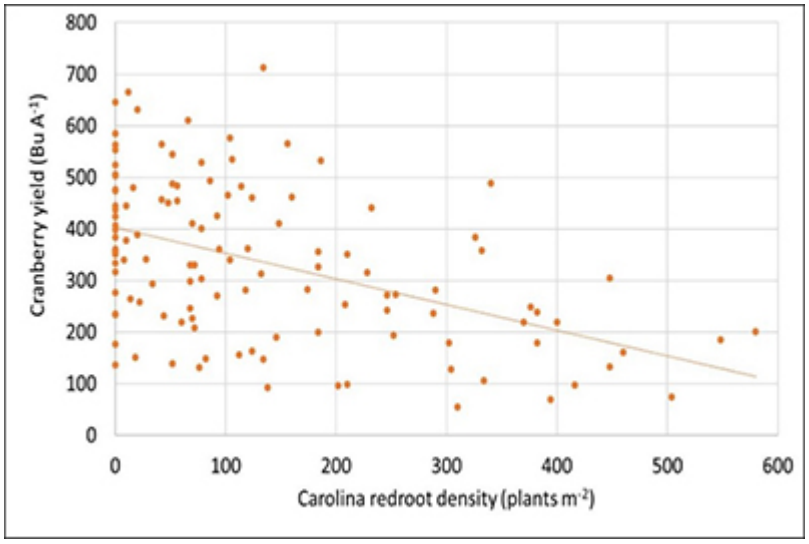


Figure 2: Impact of Carolina redroot density on cranberry fruit yield (Rutgers Weed Science).

Carolina redroot can also cause indirect negative effects on cranberry production. For example, the percent of fruitworm-damaged berries was shown to be strongly positively correlated with Carolina redroot weed biomass and density (Colquhoun et al. in prep.). Carolina redroot can also interfere with pesticide spray deposition, potentially reducing the effectiveness of fungicide and insecticide applications. Additionally, flowers of redroot are very attractive to native pollinators at a time when insecticides are applied to cranberries. The fleshy redroot rhizomes are also attractive to waterfowl (e.g., swans), which may cause tremendous damage to the bog when they feed in flooded bogs during winter months. Similar damage has been observed in Florida pastures where feral swine are feeding on Carolina redroot (Boughton et al. 2016).

Cultural Control

Strategies for controlling Carolina redroot should start with prevention. It is important to clean field equipment so that Carolina redroot seeds and rhizome fragments are not introduced into clean cranberry bogs. Unfortunately, some of the cultural practices associated with cranberry cropping encourage the development of Carolina redroot. Additionally, mechanical harvest of flooded cranberry bogs and circulation of flooding water from bog to bog create opportunities for broad dissemination of Carolina redroot seeds. Thus, plan harvest water flow from bog to bog so that, whenever possible, water is not moved from weed infested bogs into clean bogs.

Figure 3. Carolina redroot grown in full light (left) and under darkness (right). Photo Credit: Baylee Carr)

Greenhouse studies conducted in 2018 support the idea that typical agricultural practices associated with cranberry cropping such as flooding or sanding will not adversely impact the development of Carolina redroot (Besançon 2019a). Thus, holding the harvest flood for up to 4 weeks will not be effective at suppressing Carolina redroot contrary to what is observed for dewberry (Sandler and Ghantous 2021). Lack of light inhibited shoot growth and prevented the development of new rhizomes (Figure 3). Use of black tarp in small areas colonized by Carolina

redroot, such as patches of dead vines caused by fairy ring disease, could help prevent further expansion of this weed.

Management Calendar

The management calendar for Carolina redroot emphasizes early season split applications of pre emergence herbicide followed by mid-season application of post-emergence herbicide before emergence of the floral stalk.

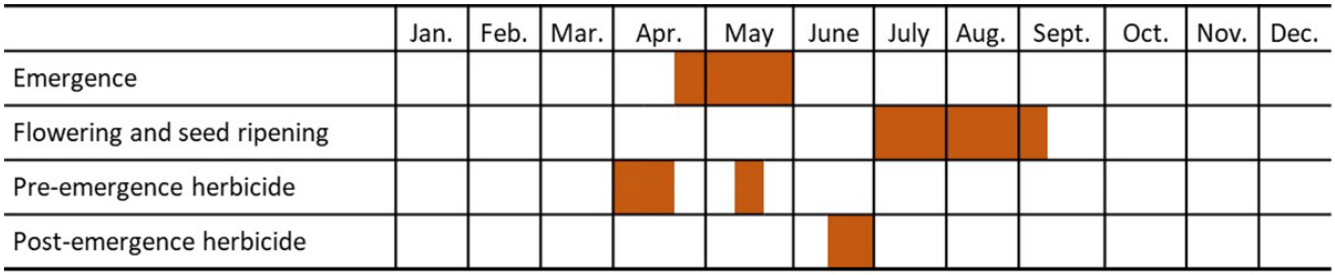


Figure 4. Carolina redroot biological cycle and timing of herbicide applications.

Chemical Control

Recommendations for controlling Carolina redroot stress proper timing of herbicide application to reduce the number of emerging shoots and prevent the formation of the floral stalk. Ill-timed herbicide treatments will result in ineffective pre emergence control as Carolina redroot may have already emerged or ineffective postemergence control that will not prevent the formation of a seedhead. Ongoing research evaluating strategies combining applications of napropamide and mesotrione for control of Carolina redroot have shown promising results with over 80% control by the end of the season after 3 years of repeated applications (Figure 4) (Carr et al. 2017, Besançon 2019b).

Table 1. Comments on pre- and post-emergence herbicides for control of Carolina redroot.

Treatment	Timing	Herbicide	Product Rate	Comments
Pre-emergence application	Mid–April following removal of winter flood	Devrinol 2-XT (napropamide 2 lb a.i./gal) Devrinol DF-XT (napropamide 50%) Casoron 4G (dichlobenil 4%)	6 to 9 qt/A 9 to 18 lb/A 100 lb/A	These herbicides should be applied before Carolina redroot starts emerging to provide effective suppression of its growth. Effective control will only be obtained if these applications are followed by postemergence mesotrione applications in mid-June. **Only the Devrinol 2-XT formulation has a 24c (Special Local Needs; SLN) label in NJ allowing split applications before cranberry bloom.** **The application of Devrinol DF-XT (no SLN for this formulation) and Casoron 4G is limited to early spring prior to cranberry budbreak.**
Overlapped pre-emergence application	30 days after initial pre-emergence application but before cranberry bloom	Devrinol 2-XT (napropamide 2 lb a.i. /gal)	6 to 9 qt/A	This application will help suppress further Carolina redroot emergence. If rainfall does not occur, the treatment must be shallowly incorporated or followed by sufficient water to wet the soil to a depth of 2 to 4 inches. **The cumulated amount of napropamide applied each year cannot exceed 9 lb a.i./A.**
Broadcast foliar application	Mid–June to early July	Callisto or Motif (mesotrione 4 lb a.i./gal)	8 fl oz/A	This treatment should be coupled with pre-emergence applications (see below) for optimal Carolina redroot suppression. Apply mesotrione when Carolina redroot leaves have emerged above cranberry canopy but before the emergence of a floral stalk. The use of a nonionic surfactant (NIS) at 0.25% v/v is recommended.
Spot foliar application for small areas infested by Carolina redroot	Mid–June to early July	Callisto (mesotrione 4 lb a.i./gal)	1.1 fl oz/gal	**Callisto received a 24(c) (Special Local Needs) label in NJ for spot-application of a concentrated mesotrione solution**. At 1.1 fl oz/gal and 30 GPA, you can only spray out 7.3 gal/A per application to stay within the maximum labeled rate of 8 fl oz/A per application. Apply Callisto when Carolina redroot leaves have emerged above cranberry canopy but before the emergence of a floral stalk. Include a nonionic surfactant (NIS) at 0.25% v/v.

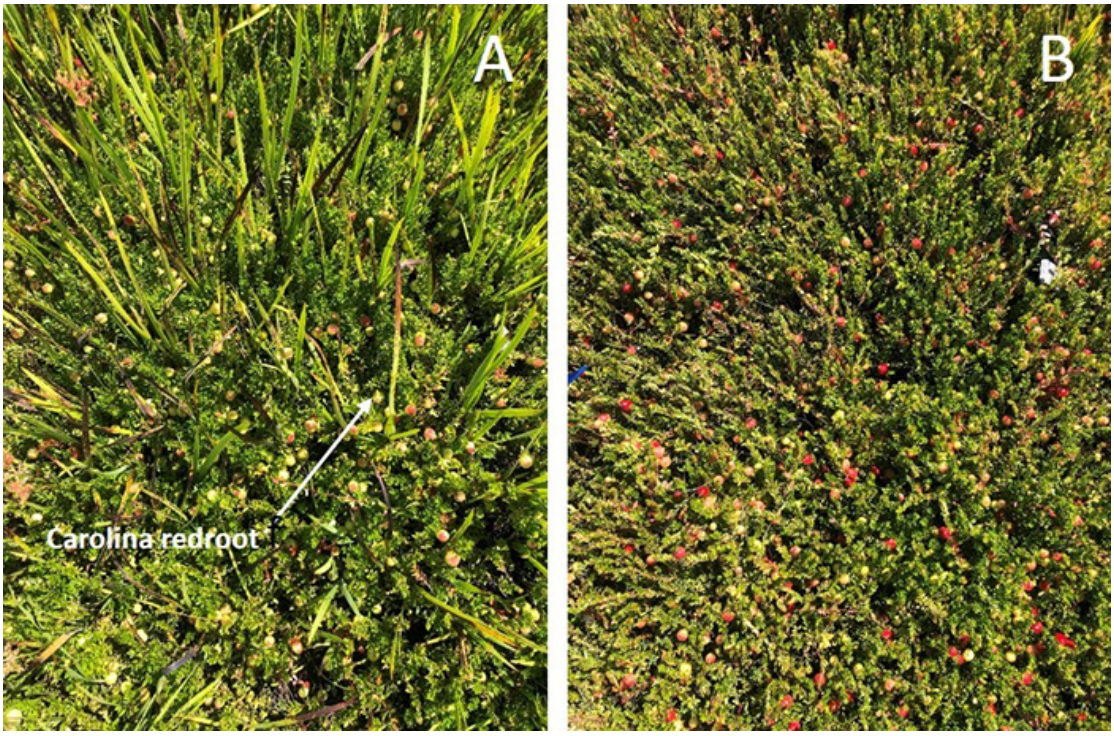


Figure 5. Carolina redroot in untreated plot (A) and in plot treated with split application of Devrinol 2-XT at 9 qt/A in mid-April and mid-May followed by Callisto at 8 fl oz/A applied in mid-June (B).

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For more information: njaes.rutgers.edu.

Cooperating Agencies: Rutgers, The State University of New Jersey, U.S. Department of Agriculture, and Boards of County Commissioners. Rutgers