2021 Annual Winter Meeting of the American Cranberry Growers Association

AMERICAN CRANBERRY GROWERS association

Virtual Meeting

Thursday
January 21, 2021

RUTGERS
New Jersey Agricultural Experiment Station

Presentation Summaries

ACGA Winter Meeting Program

Thursday, January 21, 2021
Virtual (Zoom) Meeting

8:30-8:45 Join the Zoom Call

8:45-9:00 Welcoming remarks– ***Shawn Cutts*, President, ACGA**
Treasurer's report **– *Shawn Cutts***

9:00-9:15 **An Update from the Cranberry Marketing Committee**
Michelle Hogan, Executive Director, Cranberry Marketing Committee

9:15-9:35 **An Update from the Cranberry Institute**
Bill Frantz, Executive Director, Cranberry Institute

9:35-9:55 **Rutgers Hybrids: Nutrition and Canopy Management for Maximum Productivity**
Nicholi Vorsa, Professor, Department of Plant Biology, Rutgers University; *Jennifer Johnson-Cicalese*, P.E. Marucci Center, Chatsworth, NJ

9:55-10:15 **Advances in Berry Quality Research: Overheating, Fruit Rot and More**
Peter Oudemans, Professor, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ

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

10:30-10:50 **The Next 'Omics'**
James Polashock, Research Plant Pathologist, USDA-ARS, P.E. Marucci Center, Chatsworth, NJ

10:50-11:10 **Impact of Environment and Herbicide Applications on Seed Germination of Off-type Cranberry**
Thierry Besancon, Weed Science Extension Specialist, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

11:10-11:30 **Novel Bio-insecticide Manufacturing, Application, and Efficacy in Cranberries**
Shawn Steffan, Associate Professor, Dept. of Entomology, University of Wisconsin-Madison/ Research Entomologist, US Department of Agriculture, Agricultural Research Service

11:30-11:50 **Update on Herbicide Strategies for Suppressing Carolina Redroot**
Baylee Carr, Weed Science Technician, Rutgers University, P.E. Marucci Center, Chatsworth, NJ

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

1:00-1:20 **Update on 2020 Cranberry False Blossom & Fruit Rot Trials**
Lindsay Wells-Hansen, Senior Agricultural Scientist, Ocean Spray, Chatsworth, NJ

1:20-1:40 **Cranberry Insect IPM: Best Management Practices**
Cesar Rodriguez-Saona, Professor, Department of Entomology, Rutgers University, New Brunswick, NJ; *Robert Holdcraft* and *Vera Kyryczenko-Roth*, P.E. Marucci Center, Chatsworth, NJ

1:40-2:00 **Prescribed Fire for Crop Safety and Forest Management May also Reduce the Risks of Ticks to Cranberry Farm Workers**
Michael Gallagher, Research Ecologist, USDA Forest Service, Northern Research Station, New Lisbon, NJ

2:00 **Adjournment**- *ACGA Board of Directors Meeting*

Rutgers Hybrids: Nutrition and Canopy Management for Maximum Productivity

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

Over the past decade and a half, the Rutgers cranberry breeding program has released six cranberry varieties and is in the process of releasing a seventh, Vasanna™. Crimson Queen® was introduced in 2006, Demoranville® and Mullica Queen® in 2007 and Scarlet Knight® in 2010. Welker® and Haines® were introduced in the past five years. Crimson Queen, Demoranville, Mullica Queen, Welker and Haines were selected for various fruit quality attributes, such as yield, season, berry size, Tacy, adaptation, etc. Vasanna, a full-sibling of Haines, was selected with Haines originally at Marucci Center in 2007. Vasanna has done well in variety trials in Wisconsin, Oregon and especially well in British Columbia. Vasanna's superior performance in peat soils and adaptation to British Columbia's climate is particularly noteworthy. However, they were all selected for increased crop potential, i.e., high and sustainable yield using the cultivar Stevens as a standard. The development of these varieties, i.e., increased yield potential, was premised on a strategy similar to corn productivity. Increases in corn yield over the past eight decades serves as an example (**Fig 1**).

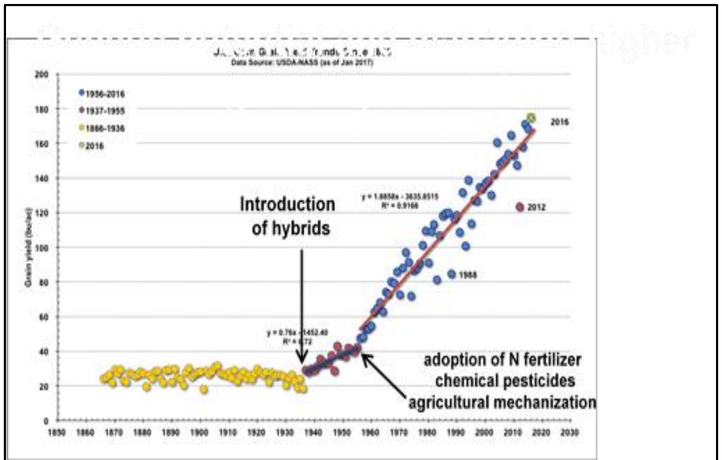


Fig. 1 US corn yields from 1850 to 2020.

The increases in corn yields were initiated in the mid 1930's with improved genetics, e.g., hybrids, but was further accelerated with higher nitrogen inputs occurring in about the 1960's. Taking advantage of the improved genetics requires adapting higher nutrition inputs to maximize genetic potential.

Canopy Management and Plant Nutrition for Rutgers Cranberry Varieties

The strategy for increasing yield in the Rutgers breeding program was to select varieties that will utilize higher nitrogen inputs for fruit production. Rutgers breeding populations were fertilized with higher nitrogen inputs during the selection phase. However, one concern is that much of the fertilizer recommendations that have been developed for cranberry have been based on response to 'older' genetics, e.g., Stevens, Pilgrim, Ben Lear, Early Black, Howes. There is little research concerning fertilization specific to recent cranberry releases. Thus, much of the fertilizer management for the recent hybrids is being developed from grower observations and trials. A Wisconsin cranberry grower has beds with sustained high yields, e.g., seven year average 575 bbl/ac with the cultivar Mullica Queen (**Fig 2**). Five-year average yields for the early maturing

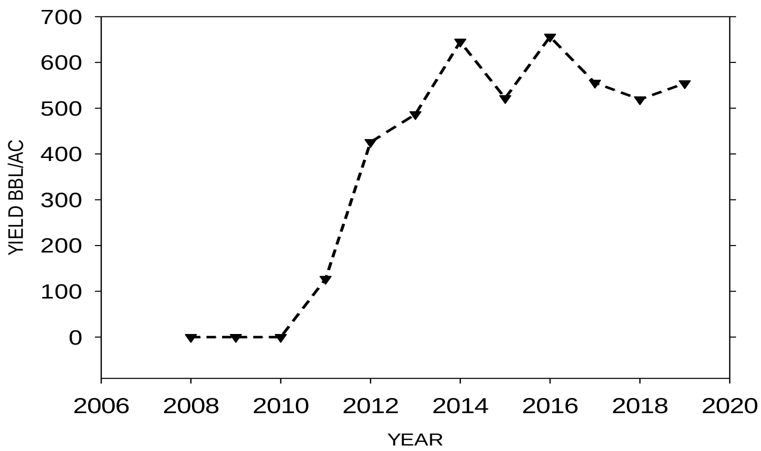


Fig 2. Mullica Queen yields over 11 years in a Wisconsin Rapids commercial bed planted in

cultivars Crimson Queen was 498 bbl/ac and for Demoranville 456 bbl/ac, while the 5-year average yields for Ben Lear and Stevens were 328 bbl/ac and 285 bbl/ac, respectively (**Table 1**). To maximize yield, management issues include bed construction, drainage, bed establishment, fertilization for establishment, fertilization of mature beds, irrigation/water management, winter flood, weed control, etc. Yields can suffer if one condition is not optimal.

Canopy structure appears to be critical. One characteristic of high production beds is to have roots close to each fruiting upright, as in the left runner in **Fig 3.** Light sanding even after the first growing season appears to be advisable to have prostrate runners rooted along the length of the runner. **Plant nutrition is critical** for sustained productivity. Nutrition status not only affects current year's productivity but likely affects floral primordia bud set in late summer-early fall for the subsequent year's crop potential. One needs to keep in mind that approximately 10 lbs of nitrogen are removed for every 100 bbls of fruit produced. Thus, if production is 500 bbls/ac, that requires 50 units of N just for the crop. The most critical time for fertilizer application is during fruit set, thus one needs to determine an estimate of what the crop will be, taking into account bloom (flower density) and pollination. If pollination is poor, there is the potential for excessive runner growth. There appears to be some difference of opinion regarding when to start applying fertilizer: one grower delays fertilization a bit, i.e., let the vines start to show slight deficiency while another grower does not let vines show any deficiency; both growers have excellent yields. Fertilizer is dosed up to five or six applications. Pea-sized fruit at bed's edge seems to be a good guide as to when to start the applications.

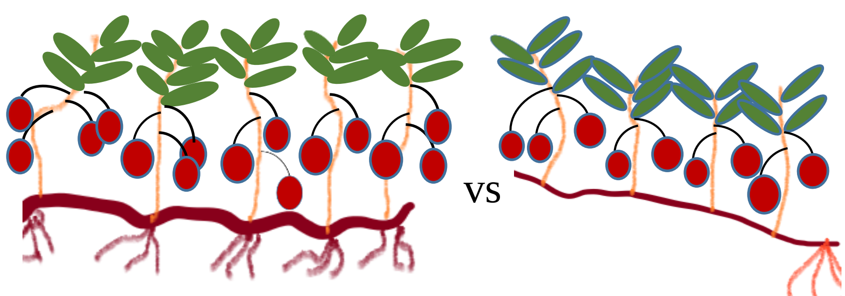


Fig 3. Canopy structure – runner on the left is well rooted at each fruiting upright, compared to the runner on the right rooted only at one point.

Table 1. Units of N applied to commercial beds and average production for various varieties at a Wisconsin Rapids grower.

	N UNITS	BBL/AC
CRIMSON QUEEN	50	498
DEMORANVILLE	50	456
MULLICA QUEEN	55	561
HAINES	55	-----
BEN LEAR	30	328
LEMUNYON	25	---
STEVENS	30	285

Advances in Berry Quality Research: Overheating, Fruit Rot and More

Peter V. Oudemans, Matt Hamilton, Ethan Aizikovitz, Katie Vorsa and Christine Constantelos

Introduction. Cranberry management prioritizes the delivery of firm, well colored fruit, suitable for inclusion in various post-harvest products. The primary factors influencing fruit quality are provided in the Table below. All of these factors can become complex problems

Table 1. Factors affecting fruit quality

Factor	Impact on Quality	Cause
Fruit rot	Unusable fruit	Fungal infection
Over heating	Unusable fruit	Late season overheating
Phytotoxicity	Small or poorly colored fruit	Fungicide choice and timing

Fruit Rot: In 2020 the fruit rot management program changed significantly due to new incentives for export quality that controlled fungicide use patterns. This will not be the last time significant changes like this are made. We are facing increasing pressure to remove the older fungicides classified in the multisite mode of action group from our toolbox. This will have serious consequences because these are not just effective fungicides that provide a broad spectrum of activity, but also help suppress fungicide resistance. Of the modern fungicides that remain, we are left with two modes of action (SI and QoI fungicides). Research on fruit rot in 2020 has focused on the evaluation of fungicides to identify new modes of action and development of effective use patterns. Our lab group has developed an improved bioassay that is used to evaluate fungicides in the lab prior to these fungicides being tested in the field. The advantage of this approach is that many more fungicides and fungicide combinations can be screened under laboratory conditions than can be reasonably tested in the field. Using this approach we identified some candidate fungicide treatments and then tested them in field trials. The field trial confirmed the results of the bioassay and a new fungicide for cranberry fruit rot was identified. This fungicide has now been elevated to high priority with IR4 for registration.

Fruit rot is a disease complex that includes over 15 possible fungal species, however, in New Jersey there are five common species that cause field rot. Differential sensitivity to fungicides can lead to a selective force that will alter the population structure or species composition. This is something we must monitor for fungicide control. In 2020, the NJ populations continue to exhibit high levels of the pathogen *Colletotrichum fructivorum*. New, effective fungicide programs will obviously affect this species, however, lab screening will also continue studying other species to ensure broad spectrum disease control programs are developed.

Over-heating: Crop loss due to over-heating is an issue we are actively investigating from several points of view. First of all, over-heating events are episodic and much like frost events, if they can be predicted, protective action can be taken. Modeling the conditions for over-heating are continuing and must include solar radiation, wind speed, shaded temperature and berry development. There are only a few days each year when conditions are met for an over heating event. We have developed a simple weather station for monitoring berry temperature that can be easily deployed in the field. Mock cranberries can be purchased (https://www.shapeways.com/product/9B492WR85/cranberry-33-22-t09-stack-stag?optionId=86115877&li=marketplace) and used with specific temperature probes. Protection from overheating using different sprayable materials could be an effective approach. We have investigated a variety of materials such as Surround, Parka, Raynox and Vapor Gard. Vapor Gard is one material that has provided mixed, but promising results. An important component for over-heating is berry exposure or conversely berry shading. This has a lot to do with the canopy density and where the fruit are positioned within that canopy. For example, in 2020 results from a Mullica Queen bed showed no treatment effect mainly because of a deep canopy that provided significant shading. On the other hand, positive treatment effects were seen with a younger Haines bed with a less protective canopy. Thus, it is essential to fully characterize the canopy and level of exposure before investing in costly protective treatments. Irrigation for evaporative cooling is the most effective approach for berry cooling. However, sprinkler systems should be optimized for effective cooling.

The Next 'Omics

James Polashock, USDA-ARS

Advances in technology are driving the 'omics revolution. The suffix omics simply means 'the rigorous study of'. For example, all of the DNA in an organism is referred to as the genome. The rigorous study of the genome is referred to as genomics. All genes in any genome are not expressed or 'turned on' at any given time. For example, the DNA (i.e. the genome) of cranberry has all of the genes needed to flower, but the genes associated with flowering are generally 'turned off' when the plant is not flowering. The genes that are expressed at any given time and in any given tissue form the transcriptome, the study of which is transcriptomics. Expressed genes can be translated into proteins, the study of which is proteomics. Proteins in plants perform a myriad of functions. Among those functions is to catalyze chemical reactions. The products of those chemical reactions form molecules called metabolites, collectively, the metabolites form the metabolome, the study of which is metabolomics.

Cranberry breeding goals can be enhanced by utilizing all aspects of the 'omics revolution. You have heard me discuss our progress in cranberry genomics and transcriptomics. This presentation will introduce our recent work in metabolomics. Specifically, I will discuss the metabolites associated with fruit rot resistance. It is expected that the knowledge gained through this and related studies will facilitate a 'reverse genetics' approach to breeding and cranberry crop improvement.

Impact of Environment and Herbicide Applications on Seed Germination of Off-type Cranberry

Thierry E. Besançon, *Baylee L. Carr, and Maggie H. Wasacz*
P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth
thierry.besancon@rutgers.edu

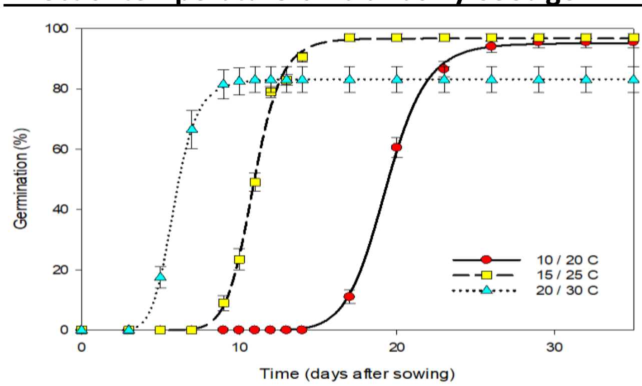
Cranberry (*Vaccinium macrocarpon* Aiton) is a native species of the New Jersey Pine barrens, where cross-pollination occurs frequently between wild plants and selected cultivars planted for commercial production. Seeds from cross-pollination are viable and produce off-type varieties with lower fruit production and stronger vegetative vigor. Off-type varieties can easily out-compete planted cultivars, lowering the yield potential of cranberry bogs over time.
Because of limited existing literature data, laboratory and greenhouse studies were conducted to determine the effect of various environmental factors:

- **Temperature regime** (8/16 h night/day): 10/20 C, 15/25 C, 20/30 C
- **Solution pH**: 3, 4, 5, 6, 7, and 8 at 25 C
- **Lighting conditions**: 15 min of red (R) light; 15 min far red (FR) light; 15 min FR followed by 15 min R; 15 min R followed by 15 min FR; complete darkness; natural light. Following exposure to R or FR light, seeds were germinated under complete darkness conditions.
- **Water potential**: -0.1, -0.2, -0.4, -0.6, -0.8, and -1.0 mPa potential + deionized water (0 mPa)
- **Seeding depth**: 0, 0.5, 1, 2, 3, and 4 cm depth

Statistical analysis: Four parameter Hill function to determine the time to reach 50% seed germination (D_{50}), the time of germination onset (LAG), and the final germination percentage (G_{max})

Cranberry seed germination in response to various pre-emergence herbicides was also evaluated under growth chamber conditions (8/16 h night/day photoperiod at 25C). Herbicides tested were **Callisto** at 4, 6, and 8 fl oz /A; **Casoron 4G** at 25, 50, and 100 lb/A; **Devrinol DF-XT** at 6, 12, and 18 lb/A; **Evital 5G** at 80, 120, and 160 lb/A.

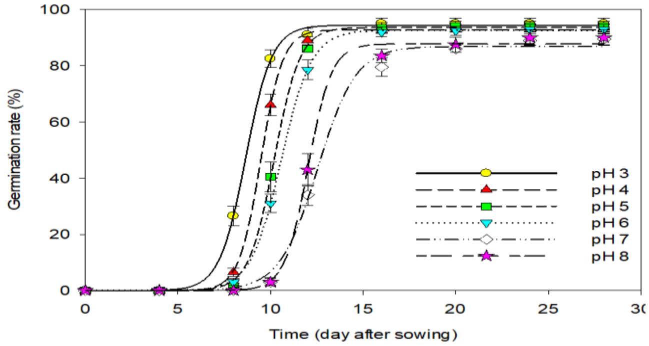
Effect of temperature on cranberry seed germination



Temperature regime (°C)	LAG		D_{50}		G_{max}
	--- Days ---				--- % ---
10/20	12.4	A	19.3	A	96
15/25	6.8	B	10.9	B	98
20/30	3.3	C	5.9	B	81

Cranberry seed germination onset was faster in an alternating 20 / 30 C temperature regime, whereas total germination (98%) tended to be greater at 10/20 C and 15 / 25 C.

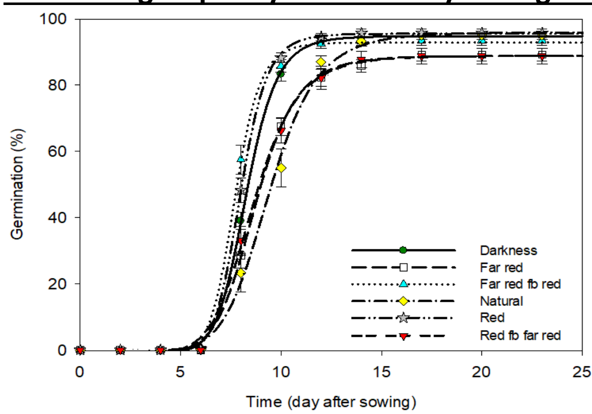
Effect of solution pH on cranberry seed germination



pH	Length Root	Length Total	Leaf	Secondary roots	Color index
	---- mm ----		----- % -----		--- 0 to 4 ---
3	439 A	1478 A	62 A	96 A	0.1 D
4	305 B	927 B	8 B	78 B	0.5 CD
5	184 C	474 C	0 C	0 C	1.3 C
6	128 D	319 D	0 C	0 C	2.2 B
7	118 D	300 D	0 C	0 C	2.7 AB
8	100 E	249 E	0 C	0 C	3.2 A

As expected for an acidophilic species, germination onset was faster at pH 3-5 than higher pH; however total germination did not decrease as pH increased. Emerged seedlings showed reduced root and shoot development as pH increased, while production of leaves and secondary roots 30 d after seeding was stopped for pH greater than 4.

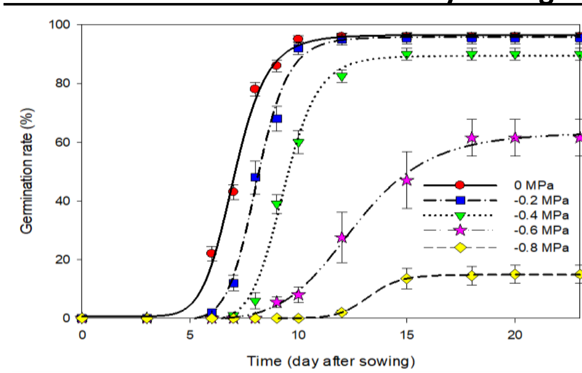
Effect of light quality on cranberry seed germination



Lighting conditions	LAG	D_{50}	G_{max}
	--- Days ---		--- % ---
Darkness	5.2 B	8.3 BC	94 A
Red	5.1 B	7.9 CD	95 A
Far-red fb Red	5.4 B	7.7 D	94 A
Far-red	5.3 B	8.7 AB	89 B
Red fb Far red	5.1 B	8.6 B	90 B
Natural	6.3 A	9.4 A	95 A

Cranberry germination was not affected by the absence of light nor by red light compared to natural light condition but decreased by 5% on average when exposed to far-red light.

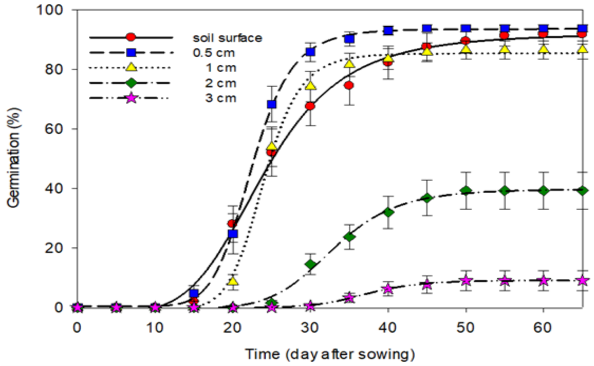
Effect of water stress on cranberry seed germination



Water potential (mPa)	LAG	D_{50}	G_{max}
	----Days ----		--- % ---
0.0	4 C	7 C	96 A
-0.2	5.2 BC	8.1 BC	93 A
-0.4	6.2 BC	9.4 B	90 A
-0.6	6.7 B	11.9 A	62 B
-0.8	9.4 A	12.6 A	18 C

No germination occurred below -0.8 mPa while rate and total germination significantly decreased at solution osmotic pressure lower than 0.4 mPa.

Effect of seeding depth on cranberry seed germination

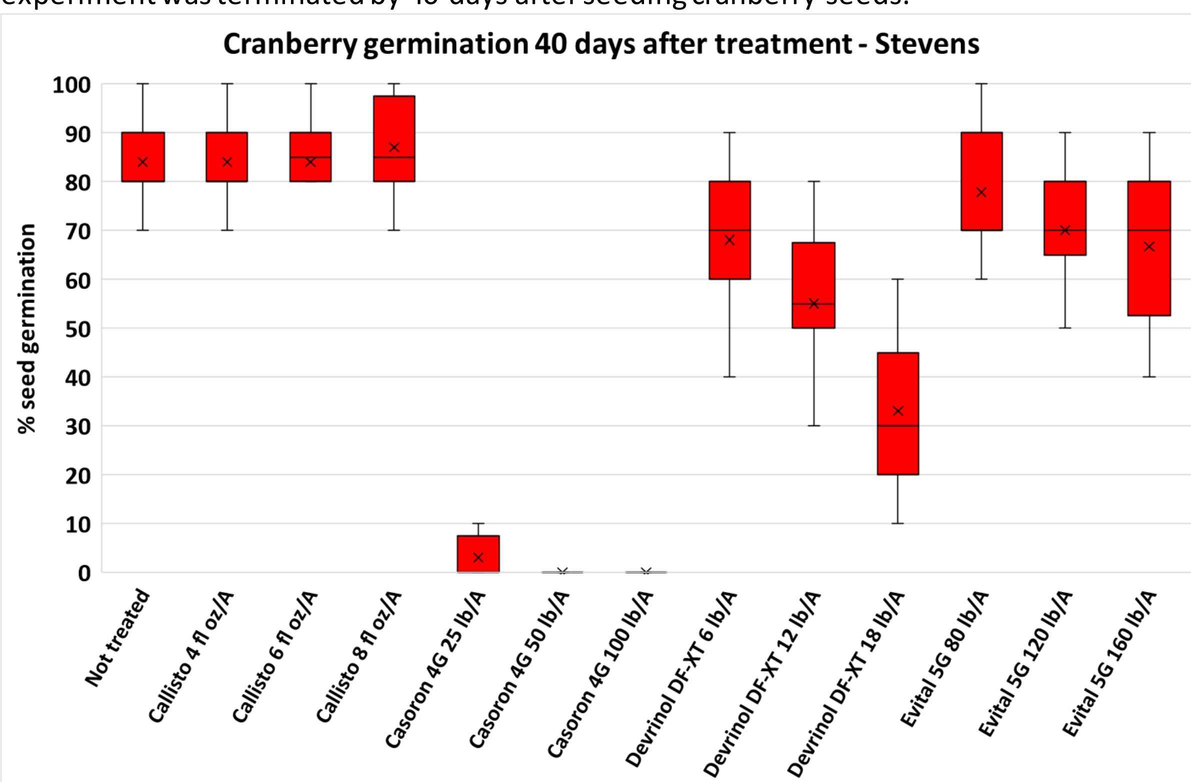


Seeding depth (cm)	LAG		D$_{50}$		G$_{max}$	
	---- Days ----				--- % ---	
0	12.4	D	5.1	B	92	A
0.5	14	CD	4.7	B	94	A
1	14.8	C	4.9	B	86	A
2	19.8	B	5.8	A	38	B
3	22.8	A	6.1	A	12	C

Germination onset decreased with increasing burial depth, while total germination decreased by 48% when depth increased from 1 to 2 cm and no germination occurred at 4 cm. These data suggest that emergence of off-type cranberry seedlings may occur over a long period ranging from mid-spring to late summer in New Jersey. Seed sensitivity to burying could be exploited by growers through the deposition of sand over the top of crop canopy which is an operation frequently conducted for stimulating the rooting of new cranberry stolons.

Effect of pre-emergence herbicides on cranberry seed germination

Seeds were collected from three different varieties (Haines, Mullica Queen, and Stevens), stratified at 3°C for 2 months, and seeded on Petri dishes containing preemergence herbicide mixed in agar. The trial was replicated 5 times and two different runs were conducted during the winter 2018-2019. Cranberry seed germination was quantified several times a week and the experiment was terminated by 40 days after seeding cranberry seeds.



Callisto, regardless of rate applied, did not provide any control of cranberry seed germination compared to the untreated check. Similarly, Evital 5G did not reduce seedling emergence more than 17% when used at the highest labeled rate (160 lb/A). Devrinol DF-XT had higher activity, reducing seed germination by 30% at 12 lb/A and by 50% at 18 lb/A. However, only the 12 lb/A rate is labeled for sandy beds. Casoron 4G was the most effective treatment with complete inhibition of cranberry seed germination at 50 or 100 lb/A. Similar results were noted by Dr. Jed Colqhoun in Wisconsin on cranberry grown on peat plugs for Casoron and Callisto. However, Devrinol was noted having no activity on cranberry seed germination in the WI study. This might be caused by organic matter binding of the herbicide in peat plug, which is less of a problem in agar. The study will be continued this summer by looking at germination of seed grown in a mix of sand and peat moss and treated with some of the preemergence herbicides mentioned here.

These results highlight the need for rotating preemergence herbicide with different modes of action, not only for preventing the onset of herbicide resistant weed species, but also for expanding the spectrum of weeds controlled by these herbicides, including off-type cranberry seedlings.

Novel Bio-insecticide Manufacturing, Application, and Efficacy in Cranberries

Shawn Steffan, Associate Professor, Dept. of Entomology, University of Wisconsin-Madison/
Research Entomologist, US Department of Agriculture, Agricultural Research Service

Two nematode species that are native to the wild peatlands of central Wisconsin, *Oscheius onirici* and *Heterorhabditis georgiana*, have been cultured and shown to be highly virulent bio-control agents for insect pests of US cranberries. Efficacy in the field when targeting cranberry flea beetle larvae (*Systena frontalis*) has ranged from 60-95%. Mass propagation efforts of the nematodes have been refined to minimize inputs and maximize nematode virulence and concentrations. Preliminary studies have also revealed that the nematodes kill various dipteran pests, such as mosquito larvae and spotted-wing drosophila. Optimal application modes, timings, and rates continue to be investigated.

Manufacture

Nematode propagation relies primarily on the use of mealworms hosts (=food) for the developing nematodes. The insects are killed by the nematodes and their bacterial symbionts. The hosts are incubated within vessels and ferment for 2-4 weeks. It is relatively easy to grow millions of nematodes on the countertop, but it is a very different proposition to grow hundreds of millions or billions of them. It is also difficult to store and transport the nematodes without seeing significant mortality. The nematodes like to be in soil substates, and they are killed easily in the sunlight or when they dry up. Thus, we need to get them from the fermentation tank to the soil without causing much trauma. In essence, mass propagation of the nematodes has four stages: infection, gestation, harvest, and concentration. We use materials that readily maintain hydration of the host substrate, while at the same time promoting oxygen-exchange between the insect hosts and the ambient air. A sloped tray with a water bath at the lower end allows water to be wicked up the slope. The slope is lined with burlap, which wicks up the water while providing significant surface area for oxygenation. The insect hosts are infected and gestated here. Gestation is then completed within shallow trays. Harvest of emerging nematodes is accomplished by irrigating the trays and allowing the rinsate to pour through stacked sieves. Nematodes are concentrated and cleaned by flushing water through the sieves.

Application

In 2018, a series of experiments were conducted in the field to determine the impact of nozzles on the survival and efficacy of both nematodes. Nematodes were most effective when all nozzles and filters were removed from the boom sprayer. In 2020, applications of the nematodes were conducted using a low-pressure, gravity-fed spraying system.

Figure 1. Gravity-fed nematode application system, designed by WI cranberry grower, Steven Bartling. In the photo, the nematode 'slurry' can be seen dripping from the boom-arm onto the cranberry canoopy. Nematodes should be applied at dusk and watered in immediately to protect them from UV light and desiccation (photo courtesy Steven Bartling).

Efficacy

The nematodes readily kill cranberry flea beetles, sparg larvae, and girdler larvae. It also kills white grubs, various caterpillars, fruit flies, and mosquitoes. The way the nematodes kill is by entering the host insect through the various openings in the insect larva's body. Then the nematode deploys its payload, which is a mass of bacteria. The bacteria then start a massive infection, killing the insect. The bacteria continue to propagate and effectively liquify the insides of the insect cadaver. This liquified, bacteria-rich substance is the nematode's favorite food. Literally, the nematode "farms" the bacteria within the body of the insect, and when the insect is dead and the bacteria have eaten the insides of the cadaver, the nematodes forage throughout the cadaver and eat the bacteria. The nematodes turn a few generations within the cadaver and then emerge to hunt new insect hosts. In the past, we've seen 60+% mortality of flea beetles in August, following a nematode soil-soak in late June. At an organic marsh in Wisconsin, 90+% mortality was observed for flea beetles.

Overlapping Napropamide and Mesotrione Applications in Cranberry for Suppressing Carolina Redroot

Baylee L. Carr, Maggie H. Wasacz, and Thierry E. Besançon
P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University
thierry.besancon@rutgers.edu

The perennial nature of cranberry (*Vaccinium macrocarpon* Aiton) production predisposes the crop to a diversity of weeds ranging from herbaceous to woody perennial species. Carolina redroot [*Lachnanthes caroliniana* (Lam.) Dandy] is a troublesome perennial weed of New Jersey cranberry bogs that severely impacts fruit yield and harvest efficiency.

Fig. 1 Carolina redroot shoot and rhizome

Field studies were conducted in 2020 in Chatsworth, NJ, to evaluate Carolina redroot control and cranberry tolerance response to herbicide programs based on overlapping of PRE followed by POST applications. Treatments included napropamide at 6 or 9 lbs a.i./A single- or split-applied PRE alone, or followed by single or double POST mesotrione at 0.25 lb a.i./A. Dichlobenil PRE at 4 lb a.i./A equally split was also included. PRE applications were made immediately after draining of winter flooding water (mid-April), and eventually renewed 30 days later. POST treatments were first applied when Carolina redroot reached cranberry canopy height, and eventually renewed 30 days later.

Treatment	PREEMERGENCE Devrinol 2-XT		POSTEMERGENCE Callisto	
	PRE-A	PRE-B	POST-C	POST-D
1	Untreated Weedy Check			
2	6 lbs a.i./A	---	---	---
3	6 lbs a.i./A	---	0.25 lbs a.i./A	---
4	6 lbs a.i./A	---	0.25 lbs a.i./A	0.25 lbs a.i./A
5	3 lbs a.i./A	3 lbs a.i./A	0.25 lbs a.i./A	---
6	3 lbs a.i./A	3 lbs a.i./A	0.25 lbs a.i./A	0.25 lbs a.i./A
7	9 lbs a.i./A	---	---	---
8	9 lbs a.i./A	---	0.25 lbs a.i./A	---
9	9 lbs a.i./A	---	0.25 lbs a.i./A	0.25 lbs a.i./A
10	4.5 lbs a.i./A	4.5 lbs a.i./A	0.25 lbs a.i./A	---
11	4.5 lbs a.i./A	4.5 lbs a.i./A	0.25 lbs a.i./A	0.25 lbs a.i./A
12	4 lbs a.i./A	2 lbs a.i./A	0.25 lbs a.i./A	---
13	6 lbs a.i./A	3 lbs a.i./A	0.25 lbs a.i./A	---
14	Casoron 2 lbs a.i./A	Casoron 2 lbs a.i./A	---	---
15	Untreated Weed-Free Check			

Carolina Redroot Density

Napropamide applied at 6 lb a.i./A with POST applications of mesotrione provided 44% Carolina redroot control 120 DA-A. Splitting this rate into two unequal applications (4 fb 2 lb a.i. /A) decreased Carolina redroot density nearly 63% compared to the weedy check.

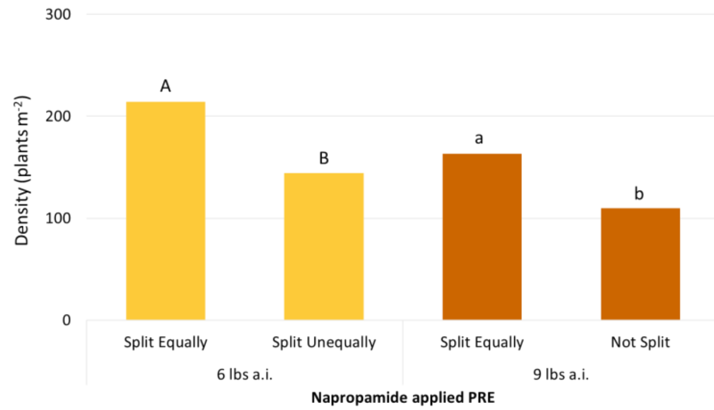


Fig. 2 Carolina redroot density 120 days after PRE-A

Napropamide applied at 9 lb a.i./A and followed with mesotrione POST averaged 47% Carolina redroot control 120 DA-A, and specifically reduced 76% the number of plants 76% when two mesotrione applications were included.

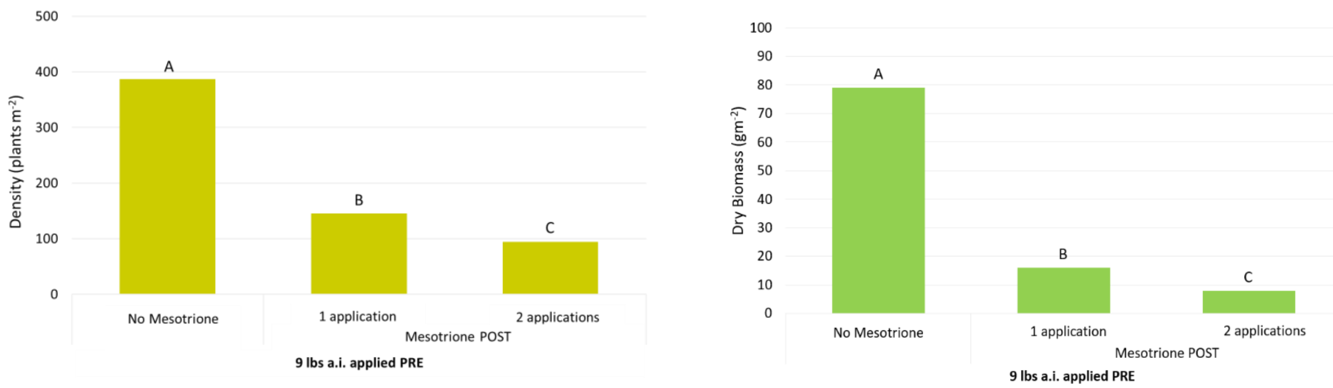


Fig. 3 Carolina redroot density (a) and biomass (b) 120 days after PRE-A

Flower Stalk Production

Number of flower stalks produced was 93% reduced when herbicides were applied, regardless of treatment. No flower stalks emerged when napropamide applications where followed by one or two mesotrione applications.

Crop Yield

As a result of crop injury (chlorosis), plots in which dichlobenil was applied yielded 47% less than those treated with napropamide. An average 30% yield decreases was noted with split-applied napropamide at 9 lb a.i./A compared to a single application in early spring, regardless of POST mesotrione applications. No yield decrease occurred with split application of napropamide at 6 lb a.i./A.

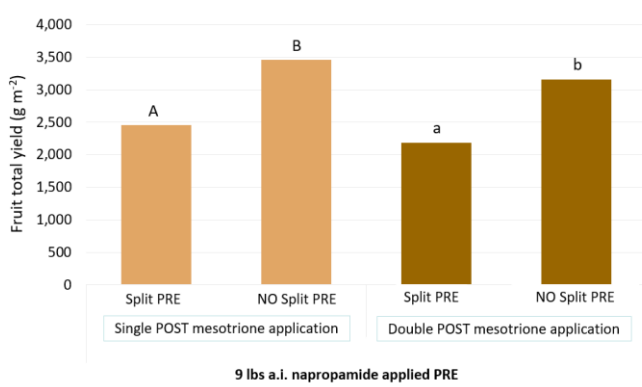


Fig. 4 Cranberry yield effects from split and no-split applications of napropamide in combination with mesotrione POST

Update on Cranberry False Blossom & Fruit Rot Trials-2020

Lindsay Wells Hansen, Sr. Agricultural Scientist, Ocean Spray Cranberries, Chatsworth, NJ

Cranberry fruit rot (CFR) and Cranberry False Blossom Disease (CFBD) are among the most important disease issues facing cranberry production in New Jersey. The need to identify effective and durable management methods (conventional and biological) for both is critical.

Cranberry Fruit Rot Trial 2020 Update

Registered fungicide options are limited, and the industry relies heavily on single-site mode of action (non-broad spectrum) fungicides for fruit rot management. Overreliance on these chemicals may result in fungicide resistance and the loss of the only few available management options. Treatment with a biological fungicide, Vectorite with CR-7 (*Clonostachys rosea* CR-7), has been shown to be efficacious in reducing fruit rot in other fruit crops when delivered by bees. *C. rosea* works by competing with pathogenic fungi for infection areas within the flowers, fruit and other plant parts. This developing technology is being developed and marketed by Bee Vectoring Technologies™ (BVT).

In collaboration with BVT, the OSC Ag Science team launched a multi-state (New Jersey, Massachusetts, and Washington) collaborative field trial in 2020, evaluating the effect of 'Technical CR-7' (*C. rosea* applied as a spray formulation) in combination with standard grower-applied fungicides on cranberry fruit rot incidence and yield. This work allowed us to compare the efficacy of the Technical CR-7 spray application across regions to assess the potential fit of this product in a CFR management program. Overall, treatment with Technical CR-7 in addition to grower-applied fungicides did not result in a significant advantage for cranberry fruit rot incidence, yield, or berry size compared to treatment with fungicides alone. Percent poor values at three and six-week Keeping Quality assessments were numerically, but not significantly, lower for plots treated with CR-7 in addition to fungicides compared to plots treated with fungicides alone in New Jersey and Washington (not evaluated in MA). Trials conducted by P. Oudemans and D. Schiffhauer investigating bee-delivery of Vectorite CR-7 to cranberry flowers demonstrated difficulties in confirming delivery of the product to cranberry flowers in the field. Further investigation with refined methods is planned for this year to determine the practicality and potential usefulness of *Clonostachys rosea* in managing fruit rot pathogens in NJ cranberries.

False Blossom Trial 2020 Update

Once cranberry false blossom disease becomes established in a bed, the only currently available management tactics are to control the insect vector (Blunt-nosed leafhoppers) or to remove infected vines. Due to the systemic nature of this disease, complete eradication is nearly impossible using these tactics. Observations and previous work by Dan Schiffhauer suggest that CFBD-infected cranberry plants are 'weaker' than healthy plants, and as such, may be more susceptible to dieback from stress events such as sanding and/or applications of high rates of Casoron® (dichlobenil). OSC and Rutgers weed science teamed up to conduct a field trial to evaluate the impact of sanding and dichlobenil applications (alone and in combination) on the survival of CFBD-infected cranberry vines. CFBD-infected and non-infected (healthy) uprights were tagged in three experimental beds having substantial CFBD incidence. Within each bed, plots were treated with: (1) a single application of Casoron® at 100 lb./A, (2) a split application of Casoron® at 50 lb./A, or (3) no Casoron®. Two of the experimental beds were sanded in the 2019/2020 winter, and one bed was left un-sanded. The survival status of the tagged uprights was evaluated after fruit set in the 2020 season. Unfortunately, this trial was laden with unanticipated challenges, and the data are inconclusive. Perhaps not surprisingly, the number of CFBD-infected uprights that died back throughout the season was higher compared to the number of healthy uprights that died back, regardless of the sanding or Casoron® treatment. In general, CFBD-infected uprights that were treated with Casoron® at 100 lb./A in combination with sanding had the lowest survival rate, followed by CFBD-infected uprights that were treated with Casoron® at 50 lb./A in combination with sanding compared to all other treatments. More work is needed to determine the potential impact and usefulness of sanding and herbicide application combinations in managing cranberry false blossom disease in established plantings. Greenhouse trials further investigating the effect(s) of these treatment combinations on CFBD-infected plants will be conducted by the Rutgers Weed Science and Entomology teams in 2021.

Cranberry Insect IPM: Best Management Practices

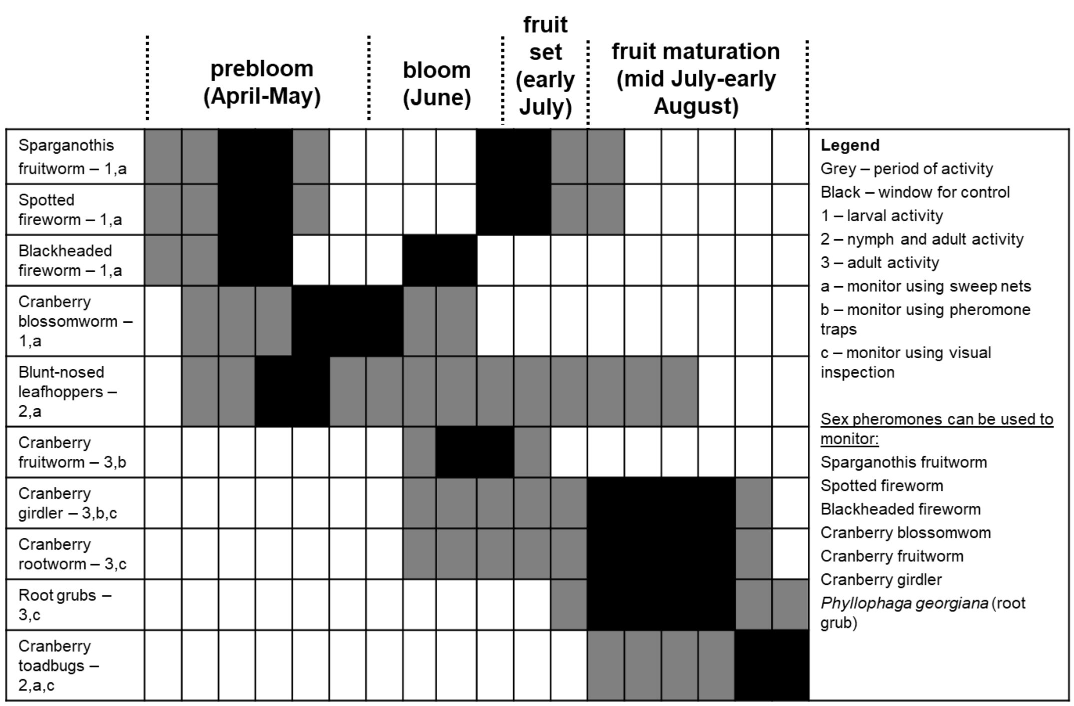
Cesar Rodriguez-Saona, Professor, Department of Entomology, Rutgers University, New Brunswick, NJ; *Robert Holdcraft and Vera Kyryczenko-Roth*, P.E. Marucci Center, Chatsworth, NJ

Insect Pest Monitoring

Once the water is removed until bloom, growers should scout their beds using sweep net sampling for lepidopteran pests (blackheaded fireworm, spotted fireworm, Sparganothis fruitworm, and cranberry blossomworm) (Figure 1), and blunt-nosed leafhoppers. We use the combined threshold for gypsy moth, blossom worm, and armyworm of 4.5 larvae per 25 sweeps, and a threshold for blackheaded fireworm and Sparganothis fruitworm of 1.5 larvae per 25 sweeps. If lepidopteran pest numbers exceed the threshold, we recommend growers to use a selective insecticide (Intrepid, Altacor, Exirel, or Delegate) for the control of these pests. Intrepid is an Insect Growth Regulator (IGR), which are very effective against lepidopteran pests. Avaunt can be used to control most lepidopteran pests except for Sparganothis fruitworm.

From the beginning of bloom until the end of August, we recommend monitoring insect populations using pheromone traps (Figure 1). Pheromone lures are commercially available for monitoring adult male Sparganothis fruitworm, cranberry fruitworm, and blackheaded fireworm. Placing pheromone traps for a particular pest is most important if your farm has a previous history of infestation. Pheromone traps are useful for knowing whether an insect is present, when it is present, and its peak flight activity. There is, however, no information available on whether trap captures correlate with amount of damage and the need for treatment. Thus, visual observations of leaf and fruit injury are also required.

Figure 1. Activity Periods of Cranberry Insect Pests in New Jersey



Traps should be checked weekly and number of moths counted (it is critical to know how to identify the different moth species before monitoring). One trap should be placed every 10 acres (whenever possible). Below is a list of where to get supplies for IPM programming. This is not an endorsement of any particular company. Some vendors are manufacturers, and sell direct, while others are only retailers.

Phero Tech, Inc., 7272 Progress Way, Delta, B.C. Canada V4G 1E9
800-665-0076, www.pherotech.com
Scentry Biologicals, Inc., 610 Central Ave., Billings, MT 59102
800-735-5323, www.scentry.com
Suterra, LLC., 213 Southwest Columbia St., Bend, OR 97702
866-326-6737, www.suterra.com
Trece, Inc., 7569 Highway 28 West, P.O. Box 129, Adair, OK 74330
866-785-1313, www.trece.com
Great Lakes IPM, 10220 Church Rd. NE, Vestaburg, MI 48891
800-235-0285, www.greatlakesipm.com
IPM Tech. Inc., 4134 N. Vancouver Ave., #105, Portland, OR 97217
888-476-8727, www.ipmtech.com
Gempler's, P.O. Box 270, Mt. Horeb, WI 53572
800-382-8473, www.gemplers.com
AgBio, Inc., 9915 Raleigh St., Westminster, CO 80031
877-268-2020, www.agbio-inc.com
ISCA Technologies, P.O. Box 5266, Riverside, CA 92517
951-686-5008, www.iscatech.com "

Insect Pest Management
Six insecticides have recently been registered in cranberries. There are:
Cormoran. This insecticide from ADAMA is a mix of Rimon (novaluron) and Assail (acetamiprid). The cranberry use rate is 9-12 fl oz/acre and the label lists several insect pests including leafhoppers, blackheaded fireworm, cranberry blossomworm, Sparganothis fruitworm, and spotted fireworm. This insecticide has provided good control on leafhopper nymphs in our research trials (Table 1). This toxicity against leafhoppers is most likely due to Assail since Rimon has no toxic effects on leafhoppers. Rimon is an insect growth regulator (chitin inhibitor) that has potential toxicity on honeybee brood when foraging bees pick up residues from the field and take them back to the hive. Thus, care needs to be taken when using this product pre-bloom.

Exirel (cyantraniliprole). This insecticide from FMC has a use rate of 10-20.5 fl oz/acre and the label lists Sparganothis fruitworm, blackheaded fireworm, and cranberry fruitworm as target pests. In our insecticide trials, this product has provided excellent control of caterpillars ("worms") (Table 1). Exirel belongs to the same class of insecticide as Altacor (diamides). I recommend using these insecticides in rotation with Intrepid and Delegate for the control of lepidopteran pests.

Verdepryn (cyclaniliprole). This insecticide is distributed by Summit Agro USA and has a use rate of 8.2-11 fl oz/acre. The label lists spotted fireworm and cranberry fruitworm as target pests. In our insecticide trials, this product has provided excellent control of caterpillars ("worms") (Table 1). Verdepryn belongs to the same class of insecticide as Altacor and Exirel (diamides). I recommend using these insecticides in rotation with Intrepid and Delegate for the control of lepidopteran pests.

Movento (spirotetramat). This insecticide from Bayer Crop Sciences has a use rate of 8-10 fl oz/acre in cranberries. The label lists cranberry tipworm and leafhoppers as targets. In our insecticide trials, this product has provided excellent control against cranberry tipworm. However, cranberry tipworm has not been a pest problem of cranberries in New Jersey. It provides some control against leafhopper nymphs (Movento inhibits lipid metabolism so it works best against immature insects); however, the label says to not apply until after petal fall. Because Movento has limited use in New Jersey cranberries, I did not include it in Table 1.

Closer (sulfoxaflor). This insecticide from Corteva (former DowAgrosciences) has a use rate of 2.75-5.75 fl oz/acre in cranberries. The label lists leafhoppers as target pests. In our insecticide trials, Closer has shown good-to-excellent leafhopper control (Table 1). This product cannot be used when bees are active (between 3 days prior to bloom and until after petal fall).

Danitol (fenpropathrin). This insecticide from Valent has a use rate of 16-21.33 fl oz/acre in cranberries. The label lists armyworms and leafhoppers as target pests. Danitol is a pyrethroid with broad-spectrum activity. Pyrethroids are known for causing secondary pest outbreaks due to non-target toxic effects on natural enemies. We do not have efficacy data for this insecticide yet, so we do not recommend its use at this time. This product is highly toxic to honey bees and other pollinators.

Table 1. Efficacy of Registered Cranberry Insecticides (New Insecticides in Bold)

Insecticide	Sparganothis Fruitworm	Spotted Fireworm	Blackheaded Fireworm	Leafhoppers	Toadbugs	Bee Toxicity
Altacor	+++	+++	+++	--	--	--
Assail	+	++	++	+++	+++	xx
Exirel	**+++**	**+++**	**+++**	**--**	**--**	**x**
Verdepryn	**+++**	**+++**	**+++**	**--**	**--**	**x**
Closer	**--**	**--**	**--**	**+++**	**++**	**xx**
Cormoran	**+**	**++**	**++**	**+++**	**+++**	**xx**
Confirm	+++	+++	+++	--	--	--
Delegate	+++	+++	+++	--	--	xxx
Diazinon	+++	+++	+++	+++	+++	xxx
Imidan	++	++	++	++	++	xxx
Intrepid	+++	+++	+++	--	--	--
Lorsban	+++	+++	+++	+++	+++	xxx
Rimon	+	++	++	--	--	xx
Sevin	+++	+++	+++	+++	+++	xxx

+++ Excellent control, ++ Moderate-to-Good control, + Poor control, – No control; x = bee toxicity

Prescribed fire around cranberry bogs may also reduce the risks of tick-borne disease to farm workers and families

Dr. Michael R. Gallagher, USDA Forest Service Northern Research Station, New Lisbon, NJ**;** *Dr. Jesse Kreye*, Penn State University, State College, PA; *Alexis Everland*, Tall Timbers Research Station, New Lisbon, NJ; *Dr. Andrea Egizi*, Rutgers Center for Vector Biology, New Brunswick, NJ; *Julia Defeo*, Rutgers University, Camden, NJ

Introduction

Ticks are an increasingly abundant cause of debilitating and potentially deadly diseases and that are present throughout New Jersey and the Pine Barrens. Reducing tick-borne disease cases remains a complicated challenge that is expected to continue gaining importance as ticks and their diseases expand to new regions. Farm and forest workers, who spend significant time outdoors in vegetation may have elevated risk of exposure to ticks and the diseases they carry. In New Jersey, black-legged ticks (*Ixodes scapularis*), lone star ticks (*Amblyomma americanum*), and dog ticks (*Dermacentor variabilis*) are the most medically important ticks because they vector a range of diseases that can range from debilitating to deadly.

Managing ticks is an onerous challenge, complicated by the complex lifecycles of ticks and the transient nature of their wildlife hosts. However, prescribed burning is a useful forest management tool and is commonly used on cranberry farms to protect crops and maintain surrounding forest health and may be additionally helpful in controlling the threat of ticks. Historic documents from New Jersey, the southeast, and the Appalachians suggest that the burning of forests may once have played an important role in controlling ticks. Yet there is limited observational research to support this in most environments including New Jersey Pine Barrens. From 2019-2020 a study was conducted to compare tick populations and their disease burdens in burned and unburned forests, as a first step in exploring whether prescribed fire may have the added benefit of reducing ticks in eastern pine forests like those of the Pine Barrens. We used burned and unburned areas under numerous jurisdictions to account for other factors that might influence tick populations and diseases. These included multiple cranberry farms, conservation areas, and public forests. Half of the areas had been burned in 2019 and half had not been burned in many years. We also hypothesized that the effects of fire on tick and wildlife habitat in the years following a treatment may be additionally important in explaining long-term trends post fire. For instance, ticks are very sensitive to extreme heat and dryness, which may be factors when understory shrubs have been burned off. Therefore, we took additional forest structure and microclimate measurements in our plots.

Methods

To accomplish this work, we used a variety of methods to collect each type of data. Ticks were caught during 3 days in early June, early August, and early October each year using standard drag and sweep methods, or essentially walking paths through the wood while wiping a sheet of white fabric over or through the shrubs that ticks could latch on to. All ticks captured were collected in vials or ethyl alcohol for storage until genetic analysis for diseases could be performed. Forest understory vegetation, which ticks crawl up while looking for a host and use for hiding and moisture, was measured using rulers and a laser-based approach called light detection and ranging (LiDAR), with a terrestrial laser scanner (Leica Geosystems BLK360). Temperature and humidity conditions were also measured at approximately 6 inches above the ground with autonomous weather sensors at a 5-minute interval throughout the study period. Finally, genetic tests for standard tick-borne diseases were conducted by the Rutgers Center for Vector Biology.

Results and Discussion

In 2019 and 2020, we captured a total of 4440 and 3605 ticks, respectively, including tick adults, nymphs, and larva. Compositionally, our samples were quite interesting. Over 95% all of the ticks caught in both years were lone star ticks, and not the expected black-legged ticks. This result compares similarly however to ongoing work of a concurrent study using pit-fall traps as a sampling method. Of all of the ticks caught, black-legged ticks accounted for only 85 in 2019 and 6 in 2020, nearly all of which were found in unburned forest. We also found very few dog ticks in 2019, but not in 2020 and some winter ticks (not a threat to humans), almost completely in unburned forest in 2019, but none in 2020. Thus, we focus our analysis primarily on the lone star tick samples.

During the June and July/August sampling periods in both 2019 and 2020, roughly 50% fewer lone star ticks were observer in burned areas than in unburned areas (Figure 1), suggesting a sustained effect of prescribed burning for at least 2 growing seasons after burning. Although tick counts increase steeply in October samples in both years, this is not necessarily indicative of an important rebound for multiple reasons. First, ticks caught in October were all larva, which cannot yet carry disease because they have not yet fed (if they had they would not be exposed searching for a host). Larva hatch when an adult female drops from a host in an area and lays eggs. The female's life is then complete and will not lay more eggs, and most larva do not survive. The data from 2020 suggests that despite the increased larva in October 2019, fewer still survived in burned areas to become nymphs the following spring than in unburned forests. Similarly, adults and nymphs, which can carry disease, remained at similarly low numbers in 2020 where burns had occurred in 2019. Lone star ticks captured in 2019 were tested for *Rickettsia amblyommatis, Ehrlichia chaffiensis,* and *Ehrlichia ewingii* and found rates of infection that are common elsewhere in NJ, and that these rates were not significantly different between burned and unburned areas.

Microclimate and forest structures are likely important factors in the survival of ticks, either facilitating cool, damp, shady conditions or more exposed and dry conditions. Similarly, ticks climb vegetation to reach the body height of their hosts, but if there are fewer stems to climb or shorter statured stems, the likelihood of successfully encountering a host is diminished. As expected, prescribed fire reduced shrub layer vegetation in the forest understory and a substantially warmer and drier microclimate followed, along with colder winter conditions. Changes in forest structure and microclimate may also impact the behavior of wildlife hosts, such as white-tailed deer in terms of the amount of time they spend in certain areas. We suspect these environmental changes help sustain low tick populations following prescribed burning and limit the potential for reestablishment from reinvasion. Tick-borne diseases may be decreased

This study remains active and will involve analyses of the 2020 tick samples for infectious diseases and a closer examination of how fire frequency and quality may further explain changes in tick populations in burned areas. In addition, the continuation of sampling through 2021 will provide data to better understand how tick populations recover following burning.

Conclusions

Our results suggest that prescribed burning can reduce ticks and thus the exposure of tickborne diseases in forests around cranberry farms. Likewise, while we found few black-legged ticks overall, those that we found were only in unburned areas. These effects appear to be durable for at least 2 growing seasons following burning, and potentially longer as forests recover. This durability is likely due to the extended effects of fire on tick habitat. Additional research will help clarify how fire frequency and quality may better explain reductions in ticks and the durability of those reductions.

Figure 1. Difference in lone star tick populations in burned areas