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WISCONSIN STATE CRANBERRY GROWERS Association

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"Cran-blue" project: update on Vaccinium hybrid plants and fruit characteristics

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An update was provided on the progress of new *Vaccinium* hybrid plants in development by USDA-ARS in Wisconsin and New Jersey. A practical introduction and explanation were given on how interspecific crosses work to generate new hybrid plants, and a brief history of blueberry and cranberry plant improvement in the United States was covered. The variation for fruit flavor, size, and growing regions found in the genus *Vaccinium* was presented as a valuable source of genetics that could improve cranberry culture and its downstream products.

We demonstrated that first-generation hybrids of Andean blueberry (*Vaccinium meridionale*) and American cranberry (*V. macrocarpon*) display useful variation for flowering, fruit texture, and shelf-stability [Figure 1]. The Andean blueberry can also be widely crossed with Highbush blueberry (*V. corymbosum*) and lingonberry (*V. vitis-idaea*), making genetic transfer of unique traits possible by using hybrid plants as genetic bridges. To maintain cranberry cultural practices, optimization of soluble solids with flotation is necessary and achievable. A dehydration assay showed that "cranberry-blueberry hybrid" fruit have slower rates of dehydration relative to blueberry, signifying an improvement in shelf-stability. Additional studies in fruit chemistry are needed to understand the contributions and both blueberry and cranberry genetics in the "cran-blue" hybrid fruit.

As a new venture in cultivation, growers can expect to reach breakeven in 4 to 5 years, using a comparable market analysis in Aronia berry. The "cran-blue" hybrid plants also produce viable seed, which promises continued improvement of "cran-blue" fruit.

Figure 1: The fruit characteristics of 'Andean blueberry by American cranberry' first-generation hybrids. An initial cross of the two parent plants produced nearly 500 first-generation hybrid plants. The hybrid plants are capable of producing fruit which varies from more "cranberry-like" to more "blueberry-like". The outer skin of the hybrid fruit (known as cuticle) is also impacted by the hybrid nature of the plants. Nearly all the hybrids which produce fruit also produce viable seed, which ensures that the hybrid plants can improve in a second generation.

Acknowledgements. This project was supported by USDA-ARS (project no. 5090-21220-007-00-D provided by Juan E. Zalapa); Ocean Spray Cranberries, Inc.; and Wisconsin Cranberry Growers Association.

WSCG State Advocacy Overview

Jordan Lamb
The Welch Group

Attorney Jordan Lamb, a Principal with The Welch Group in Madison, serves as the WSCGA's state legislative counsel. Successful management of state government relations for the WSCGA depends on our comprehensive approach to the unique challenges ranging from environmental to business issues that are faced by Wisconsin cranberry growers. Our approach to each issue depends on a combination of legal analysis, statute and rule design, constituency involvement, political action, and media management.

The Wisconsin State legislature is currently "in session" until mid-March 2024. This session began in January of 2023. The first six months of this legislative session was dominated by the preparation of the 2023-2025 biennial budget bill. The remaining months were focused on stand-alone bills. Following are issues that our state advocacy team worked on as a part of the this session.

CRANBERRY RESEARCH STATION PROPERTY TAX EXEMPTION
As a part of the 2023-25 biennial budget bill, the Wisconsin State Legislature and Governor Evers enacted a statutory property tax exemption for the Wisconsin cranberry research station. All other agricultural research stations are property tax exempt, and this statutory change gives equal treatment to the cranberry research station. The exemption went into effect as of January 1, 2023.

AGRICULTURAL ROAD IMPROVEMENT PROGRAM
As a part of the 2023-25 biennial budget bill, the Legislature and the Governor provided $150 million in one-time funding for a newly created Agricultural Road Improvement Program. The program will provide grants to municipalities to improve posted roads so that they can move to non-posted status. Priority will be given to those roads with the highest agricultural economic impact. Improving rural agricultural roads will support Wisconsin agriculture and agribusiness.

FARMER-LED CONSERVATION PROGRAMS
The 2023-25 biennial budget bill also included additional and continued funding for three farmer-led conservation programs at DATCP – the Producer-led Watershed Grant Program, the Nitrogen Optimization Pilot Program and the Cover Crop Insurance Premium Rebate Program. WSCGA supports these conservation initiatives that are led by farmers.

WISCONSIN FARM BUREAU HEALTH PLAN
Farmers need more options for affordable health insurance for themselves, their families and their employees. Legislation has been introduced which would permit the Wisconsin Farm Bureau Federation to offer a health benefit plan to Farm Bureau members that is *exempt* from state insurance laws. As a result, the plan could rate individuals and offer options that are not required to comply with all state insurance mandates. This type of plan is currently authorized to be offered by Farm Bureaus in several other states including TN, KS, IN, IA, and TX. WSCGA supports this legislation as a way to offer additional options for affordable health benefits.

ONLINE CARBON CALCULATOR

This legislation would direct the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) to create a free, web-based carbon calculator for farmers to use to estimate carbon emissions produced directly or indirectly from their agricultural activities. Establishing this uniform credit calculation method makes it easier for farmers and increases reliability and value of these credits in the free market. WSCGA supports this as an additional tool to help farmers get credit for conservation practices.

CDL TRAINING GRANTS

One of the biggest challenges for Wisconsin agriculture is our persistent workforce shortage. This legislation requires the Department of Workforce Development to create a commercial driving training grant program. This program will provide grants to employers to train drivers. Grants up to $3,000 will be provided for each individual trained, or 50% of the cost of training, whichever is less. This bill responds to changes to federal training requirements, which has impacted the availability of driver training.

ABOVEGROUND PETROLEUM STORAGE TANKS

This legislation would restore the regulation of aboveground petroleum storage tanks to the Department of Agriculture, Trade and Consumer Protection (DATCP). Currently, aboveground farm fuel storage tanks and all other aboveground tanks under 5,000 gallons are exempt from regulation by DATCP. This is, in part, due to an administrative ruling issued in July 2019. This legislation corrects the July 2019 administrative ruling by restoring DATCP's authority to regulate these tanks but also importantly preserves the exemption from regulation for farm tanks that existed prior to 2019. The only new requirement would be that farm tanks would have to register with DATCP to provide information about the location of their tank to fire departments and other emergency responders if this legislation is enacted.

Enforcing the Endangered Species Act may soon limit pesticide use: making sense of a complex situation

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For many years, the US Environmental Protection Agency (EPA) has struggled formidably to consider requirements of the Endangered Species Act when registering or re-registering pesticides. However, recent court orders have stimulated EPA to develop proposals to streamline the process and the result is likely to change pesticide registrations in the very near future. With these broad implications in mind, the intent of this article is to make an extremely complex situation somewhat understandable, such that with awareness those interested can participate and be represented in the process.

First, some background. When the EPA registers a new pesticide or re-registers an existing use, the agency is required to determine if the use would have adverse effects on plants and wildlife, including threatened and endangered species and their habitat. This process is called an “effects determination” or “biological evaluation”. There can be three outcomes to this evaluation: 1) no effect; 2) may affect, but not likely to adversely affect; or 3) may affect, likely to adversely affect species or their critical habitat.

Determinations that fall within either of the “may affect” categories (#2 or #3) trigger a consultation between EPA and “the Services” – the US Fish and Wildlife Service and the National Marine Fisheries Service. After consultation, the EPA may then require pesticide changes on the full label if all geographies need to be included or on special bulletins that affect only specific geographies where the species or habitat occur.

Now, here’s the rub. These biological evaluations are very detailed and typically take 4 to 12 years to complete for each pesticide. There are thousands of pesticides registered in the US. And there are over 1,700 threatened or endangered species, and each combination of pesticide and species needs to be considered individually. The resulting “glacial pace” of progress has resulted in the EPA being sued several times for not complying with the Endangered Species Act. As the agency notes in the introduction to the Draft Herbicide Strategy discussed below: “Even if EPA completed this work for all of the pesticides that are currently subject to court decisions and/or ongoing litigation, that work would take until the 2040s, and even then, would represent only 5% of EPA’s ESA obligations”.

In December 2022, the 9th Circuit Court of Appeals effectively said “enough”, noting that the EPA was “engaging in a whack-a-mole strategy to comply with the Endangered Species Act”. In short, the agency was told to spend less time defending lawsuits and more time developing a streamlined solution. And the court gave the EPA a short time to do so. The herbicide strategy, for example, is required to be finalized and implemented by the end of March 2024.

The proposed solutions. Generally, the proposed solutions combine population level strategies with a menu of mitigation measures that could be adopted to protect the species and habitat. More specifically, there are three efforts recently underway at EPA to accomplish this goal: the Federal Mitigation Pilot Project, the Vulnerable Species Pilot Project, and the Herbicide Strategy.

In the ***Federal Mitigation Pilot Project***, the EPA is working with "the Services" and other groups such as USDA to come up with a list of mitigation measures that could reduce adverse effects on listed species and their habitat. This pilot includes 3 pesticides (glyphosate, imidacloprid, and pyraclostrobin) and 12 listed species and their critical habitats. These discussions among agencies and partner groups appear to be continuing.

In the ***Vulnerable Species Pilot Project***, 27 particularly vulnerable species were selected for protection from adverse pesticide-related effects. These species also have distinct and limited geographical spread in localized areas across the country. In this case, EPA intends to communicate required protections for these species and their habitat using the online "Bulletins Live! Two" system. These bulletins list the Pesticide Use Limitation Areas or the specific geographical areas affected and the mitigation strategies that are required within these locations. The mitigation strategies could include spray drift and/or runoff reduction strategies, or in some cases, complete avoidance where no pesticides can be used within specific geographical areas. The agency's goal was to finalize these mitigations by the end of 2023, but as that deadline approached the EPA was sent back to the drawing board with a new goal of considering a revised plan by Fall 2024.

The ***Draft Herbicide Strategy*** likely represents the broadest potential impact of the current three efforts and therefore deserves a bit more description. This strategy would address agricultural herbicide use in the lower 48 states. Uses outside agriculture, such as residential and aquatic, are not included. The initial focus is on herbicides because they account for the greatest amount of annual pesticide use by far, and the vast majority of that is in agriculture, but it's anticipated that agricultural insecticide and fungicide use will be addressed soon after this effort using the herbicide strategy as the template.

The herbicide project specifically addresses the major routes of herbicide off-target movement: spray drift and runoff/erosion. The current effort considers 900 listed threatened or endangered species as well as their critical habitat (i.e., plants that support listed species). The strategy describes three steps: 1) identify whether listed plants or plants that listed animals need for food or habitat would be impacted; 2) identify mitigation measures to reduce those impacts; and 3) identify the geographic locations where the mitigation measures would be required.

The amount of mitigation required would be specific to the herbicide, use site, and use pattern. For spray drift, first a maximum buffer distance is established based on application characteristics such as droplet size and aerial vs ground boom delivery. That buffer distance can then be reduced by adopting mitigation measures from a list or getting credit for those already implemented (like wind breaks). The list of drift mitigation strategies listed in the strategy is quite specific, including aspects such as droplet size, wind speed, hooded sprayers and relative humidity.

For runoff and erosion, first a point level for the amount of needed mitigation is established based on the risk for each herbicide. The risk level for each herbicide ranges from 0 (low risk) to 9 (high risk). Applicators and farmers can then select from a menu of mitigation strategies to meet that necessary point level. Some strategies are worth 1 point (lower likelihood of success) up to 3 points (high likelihood for success). Examples of mitigation strategies include cover crops (1 point), terrace farming (2 points), vegetated ditches (1 point), and grass waterways (1 point). There are a few exceptions to the runoff/erosion mitigation requirement, such as for tile drained fields, those under a verified conservation plan, and when the field is more than 1,000 feet from affected species.

The third step is to identify the geographic extent where spray drift and runoff/erosion mitigation is required. In some cases, such as where a listed animal generally relies on plants for food or habitat, the mitigation requirements would apply across agriculture in the lower 48 states and would be listed on the full pesticide label. In other cases where the affected species are geographically limited, the mitigation requirements would only apply to those areas and would be listed online in “Bulletins Live! Two”. In some situations, both scenarios could exist where general requirements applicable to all agriculture in the lower 48 states are included on the main pesticide label and more specific geographic requirements are listed in the online bulletins.

So where does this all go from here? Given the complexity of the situation and large volumes of public input in the process, it’s a bit hard to get detailed right now on specific pesticide use limitations. However, pesticide label changes to address Endangered Species Act compliance are expected when new pesticides are registered and existing uses reregistered. In some cases, existing mitigation strategies (such as vegetated ditches and flat fields) will likely be enough to be able to still use most if not all pesticides with minimal impact. In other cases, growers and applicators will likely need to adopt and account for additional buffers and mitigation strategies. There will also likely be situations where specific pesticides can’t be used, or mitigation strategies are too costly or impractical to adopt. In all these scenarios, pesticide use certainly will be made more complicated by the burden of checking general labels and possibly the online geography-specific bulletins for requirements, and documenting that they’ve been met.

There’s still much to be learned about these projects and the details will be important as they become clearer. There are also likely to be some changes in the proposals based on public comment. At this time, it’s important that the agricultural community stays updated on the process and is involved as much as is possible.

Distribution and diversity of the cranberry false blossom phytoplasma and leafhopper populations.

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The cranberry false blossom disease (CFBD) causing phytoplasma is an obligatory, parasitic pathogen that cannot survive outside of a plant or insect host. Phytoplasmas have been shown to be capable of replication within both their plant and insect hosts, but it is unknown if CFBD is capable of the latter. In the field, CFBD manifests as floral abnormalities (bright pink flowers, erect pedicels, unopened flowers), reddened foliar growth, and distinct witches' brooming above the canopy of the bed. Symptom latency for CFBD is unknown, due to the rate of colonization being difficult to determine but could be 1-month to many years. During this time, plants may already be viable reservoirs for vectoring of the disease. The blunt-nosed leafhopper (BNLH), *Limotettix vaccinii* (Hemiptera: Cicadellidae), is an insect native to North America, ranging from Nova Scotia and Quebec in Canada, south into New Jersey and Maryland and west into Minnesota and Iowa in the U.S. BNLH has only one generation per year and overwinters as eggs laid in the plant stem tissue of cranberry vines. Nymphal life stages are restricted to crawling and jumping forms of motion, while adults have been traced over thousands of kilometers of movement, increasing the range of transmission during the adult life stage. There is no known economic threshold for BNLH, but a treatment of broad-spectrum insecticides before bloom during the nymphal life-stage has been found most effective at reducing populations. Through broad-spectrum insecticide applications and a shift to more resistant varieties, CFBD was successfully managed. In the years since CFBD mitigation, several broad-spectrum insecticides have been banned, increasing reliance on more selective, lower impact chemistries. Further, new hybrid varieties with unknown disease or insect resistance have started to replace the once popular Stevens and McFarlin varieties, offering earlier harvest, larger fruit, and deeper color. In the late 1990's CFBD re-appeared and has since spread significantly. Coincidentally, in 2019, Wisconsin reported the presence of CFBD at several commercial marshes, as well as recent outbreak populations of the blunt-nosed leafhopper vector.

The primary goal of this research was to offer growers insight into the seasonal phenology of both the CFBD phytoplasma and the BNLH vector. The project was conducted over three growing seasons, 2021, 2022, and 2023, building upon methods and findings from each year to the next. Our research goals were to:

1) Evaluate the spatiotemporal dynamics of cranberry false blossom disease (CFBD)
2) Assess the seasonal phenology of blunt-nosed leafhopper (BNLH) in Wisconsin cranberry
3) Determine the species composition of leafhoppers in Wisconsin cranberry
4) Evaluate feeding injury by BNLH at different densities and different life stages.

Molecular Testing to Determine Degree of Pathogen Infection

Upright sampling was performed on a monthly basis from May to August 2021-2023, except during bloom when frequency was increased to weekly. Additionally, post-harvest collections were done in the months of September, October, and November in 2022 and 2023. All collections were from the same bed in central Wisconsin. Each visitation saw the collection of five symptomatic uprights and five nearby, asymptomatic uprights from throughout the entire bed. Additionally, during the 2023 field season five uprights were taken from a particularly dense cluster of symptomatic uprights. Uprights were annotated for symptoms and imaged prior to dissection by organ type (root, stem, old leaf, new growth leaf, pedicel, flower/fruit) and each sample underwent DNA extraction via a modified CTAB protocol. All DNA extractions from 2022 and 2023 underwent qPCR testing due to the increased sensitivity, the decreased number of steps for error potential, and the quantification potential of the technology. A subsample of samples that returned positive results in qPCR underwent PCR and were sent out for Sanger sequencing for confirmation of CFBD phytoplasma DNA amplification. Our results suggest that the CFBD phytoplasma infects the plant in its entirety, colonizing tissues from root to apical bud. Additionally, preliminary results suggest that there may be a seasonality to bacterial load within certain plant tissues as the season progresses, offering the potential for tracking windows of increased acquisition by the insect vector.

	2022		2023		
	Symptomatic Uprights	Asymptomatic Uprights	Symptomatic Uprights	Asymptomatic Uprights	Symptomatic Block Uprights
Total Number Uprights Sampled	167	160	147	153	146
Total Number of Positive Returns	163	24	113	37	118
Percent Positive Returns	97.60%	15.00%	76.87%	24.18%	80.82%

Table 1: Calling efficiency of symptomatic uprights in the field.

Insect Seasonal Phenology

Field sites were identified and determined based on previous season reports of *L. vaccinii* from grower operators, industry integrated pest management scouts, and our own observations at the start of each growing season. We sampled 4-6 sites depending on the year due to chemical applications in the previous or the current year and lack of insect presence. All sites were in central Wisconsin, between the regions of Nekoosa and Black River Falls. Sampling was done weekly, beginning in early May. Collections continued through the month of August to coincide with the transition to harvest season and natural die-off of the species. If a site elected to apply a chemical insecticide listed for control of leafhoppers, collections continued for two weeks to confirm the applications efficacy and then ceased when numbers plummeted. Population count data of *L. vaccinii* was obtained via sweep net, utilizing a 20-sweep transect line covering approximately 20m. Each field site had five beds sampled from, and each bed had transects performed in two locations to assess potential edge effect; 1m from the edge and 1m from the central irrigation/division line; for a total of ten weekly samples per farm per week. Fixed sprinkler heads were used as benchmark locations so that transects were uniform between weeks. The earliest incidence of BNLH in sweeps occurred in the third week of May and saw a sharp increase in populations for two to three weeks following egg hatch (Figure 1). Juvenile nymph populations persisted through the second week of July in both 2021 and 2023, and through the third week of July in 2022. The first occurrence of adult BNLH was in the third week of June in 2021, and the fourth week of June in 2022 and 2023. Adult populations steadily grew for a number of weeks (two weeks in 2021, four weeks in 2022, and three weeks in 2023) before declining. The last occurrence of BNLH in sweep sets happened in the second, fourth and first week of August in 2021, 2022, and 2023 respectively. When comparing the average number of leafhoppers swept along the edge of a bed to the number swept in the interior of the bed, we see no evidence to suggest a preference for one location over another at either the nymphal or adult life stages.

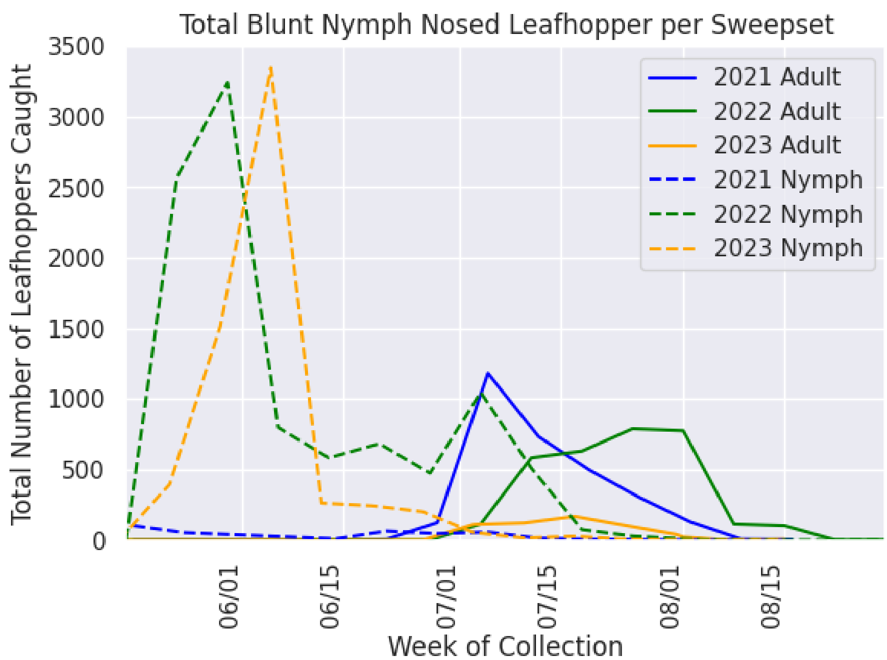

Figure 1: Total number of BNLH swept in each week of the 2021, 2022, and 2023 growing seasons. Dotted lines represent the nymphs, while solid lines represent adults.

Leafhopper Species Composition/Characterization

Specimens were observed in the laboratory under a dissecting microscope for identification, sorted per leafhopper morphotype and life stage, counted, and stored in glass vials of 70% ethanol. Inferential population statistics and error calculation was completed and the data displayed graphically to visualize the abundance of *L. vaccinii* through the growing season. By-catch, consisting of all floral and faunal material that was not *L. vaccinii*, was observed under a dissecting microscope for other leafhopper species. Non-BNLH leafhopper species were brought to the University of Wisconsin Madison Insect Diagnostics Lab for identification to the furthest taxonomic level possible. The abundance and morphotype percentages were calculated to determine species composition. Total number of leafhoppers swept was averaged across all beds on all farms for the given week. Leafhopper species identification for the nymphal lifestage was not possible due to the necessity of adult form sexual organs for positive identification. BNLH was the most prevalent leafhopper species throughout the 2021, 2022, and 2023 growing seasons, representing 80.87%, 93.53% and 63.4% of all leafhopper populations, respectively (Figure 2). Identification of the five next most prevalent genera throughout the same three years were *Macrosteles quandrilineatus* (Aster leafhopper), *Empoasca* sp. (most likely Potato leafhopper), *Athysanus argentarius* (Silver leafhopper), *Scaphytopius* sp. (most likely Sharp-nosed leafhopper), and *Gyponana* sp. (most likely Red-eyed leafhopper).

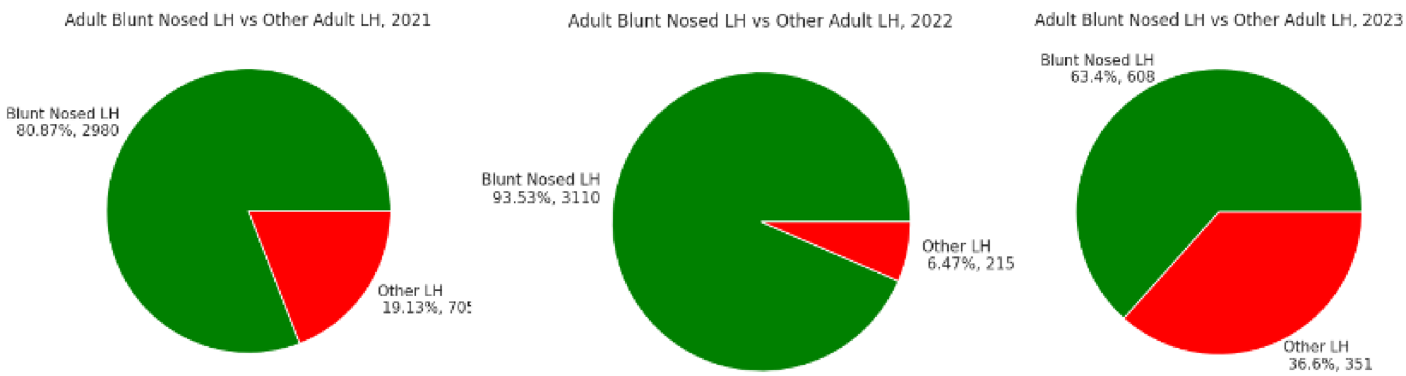

Figure 2: Comparison of number of BNLH captured per growing season versus all "Other Leafhopper (LH)" species found in Wisconsin cranberry.

Feeding Assay

The injury to cranberry foliage was compared between uprights contained in enclosures harboring different densities of *L. vaccinii* at two life stages: nymph and adult. Cranberry uprights for the nymphal experiment were obtained from a Nekoosa, WI farms that received no chemical applications in the previous 14 days, no previous insecticide treatments targeting BNLH, and no confirmed reports of BNLH in the previous growing season. Healthy cranberry uprights collected from the field were stored at 4°C overnight, washed, and immersed in water for 24-hours, to mimic a common submergence practice in the cranberry industry for insect control to ensure insect-free clean uprights. Uprights were visually screened for injury and only asymptomatic uprights were selected and grouped based on similar levels of foliage density across all treatments. The insect enclosure consisted of individual plastic, semi-translucent cylinders capped with a mesh screen, wedged into cutout recesses in a sheet of polystyrene foam[12]. The roots of the uprights were passed through a hole cut into a layer of polystyrene into a tray housing water which was aerated. All BNLH adults and nymphs were collected from the field and transported in paper bags stored in a chilled cooler. Individuals were then briefly anesthetized via CO2 gas and individually transferred into enclosures on the day of collection. Plants were monitored every other week for a total of ten weeks, with *L. vaccinii* individuals anesthetized and removed from enclosures after two weeks of feeding opportunity. During the two weeks of insect exposure, observations were performed every 2-3 days to record mortality during the feeding period. An individual was considered dead if it was found at the bottom of the enclosure and non-responsive for more than 20 seconds. Visible injury manifested in the form of leaf curl and/or localized leaf necrosis. Results of the feeding assay show that the injuries that were categorized as leafhopper feeding injury occurred in the control as well as all three treatments in both the nymphal and adult studies. The injury observed on the control uprights could indicate that the uprights obtained from the field may have been fed upon by leafhoppers prior to the assay. However, the data suggests that the density of insects plays a role in feeding injury manifestation during the initial observation performed during removal of the nymphal and adult BNLH. Looking at subsequent weeks, the trend subsides, suggesting that injury manifestation is not delayed over time and can be seen within a week of feeding. The presence of injury on leaves throughout all treatments and the control may suggest that BNLH feeding might not be directly responsible for the injuries, but rather exacerbate an existing injury. It is also true that other stressors, both biotic and abiotic, can cause similar types of injury in cranberries.

Potential Next Steps

- Differential quantification of bacterial vs plant titer in different plant organs throughout season, allowing phenological characterization of infection throughout a growing season
- Perform molecular qPCR techniques on the blunt-nosed leafhopper vector to confirm acquisition, opening up research questions such as transmission potential and insect colonization by the pathogen
- Establish CFBD infected plant cuttings in a greenhouse setting
- Explore potential for alternative plant reservoirs of CFBD in weed species commonly found in Wisconsin cranberry marshes
- Fluorescent marking of CFBD phytoplasma to allow imaging of the pathogen within the plant and/or insect host

Recommendations

- Active early season scouting efforts, especially into early June, can maximize control
- Consider density of BNLH present in sweeps, even if chemical controls were used in the year prior
- Reach out with reports of leafhopper activity and/or cranberry false blossom presence at your marsh

Management of cranberry flea beetle using *Steinernema carpocapsae* in Wisconsin

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Cranberry flea beetle (*Systena frontalis*) is a challenging late season pest in Wisconsin. Growers have few insecticide management options in late July and August due to pre-harvest interval (PHI) restrictions and few available effective materials, leading to an increased interest in control of this pest using entomopathogenic nematodes which do not carry pre-harvest intervals or concerns with maximum residue limits (MRL's) with major handlers. *Steinernema carpocapsae* (Capsanem, manufactured by Koppert Biological Systems, Inc.) is a generalist predatory species that will infest and kill soil-dwelling larvae of insects in several families, including flea beetles. A 2021 plot trial demonstrated strong flea beetle management using two separate 750 million nematode/acre applications of *Steinernema carpocapsae* spaced two weeks apart in mid and late June (1.5 billion nematode/acre season total). A subsequent trial in 2022 demonstrated rate-dependent control using season total rates of 500 million/acre, 1 billion/acre, and 1.5 billion/acre split in the same fashion into two separate applications applied in mid and late June (Figure 1). All three season total rates were significantly better than untreated control, but control significantly improved as the season total rate increased (Figure 1). Two separate 2023 trials were initiated to expand on the results seen in 2021 and 2022. Plotwork examined the difference between taking 500 million/acre, 1 billion/acre, and 1.5 billion/acre and splitting this season total into four separate applications in each of the four weeks of June vs. taking these same rates and splitting the allocation in half and applying the season total rate in two separate applications in mid and late June. A field scale trial conducted at three separate commercial operations in central Wisconsin with severe flea beetle pressure examined the 1.5 billion/acre season total rate applied to full beds in four 375 million/acre applications in each of the four weeks of June with conventional boom equipment compared to adjacent beds left as untreated controls. Control of cranberry flea beetle improved in the plotwork trial as the number of applications was increased for each rate (Figure 2). That is, applying 1.5 billion in four separate applications of 375 million/acre each was better than applying 1.5 billion in two separate applications at 750 million/acre, though some differences were numerical rather than significant (Figure 2). The field scale trial showed significant, season-long control of cranberry flea beetle at all three commercial sites without usage of commercial insecticides compared to the untreated control beds that experienced moderate to severe damage that required insecticide application at all three trial locations (Figure 3).

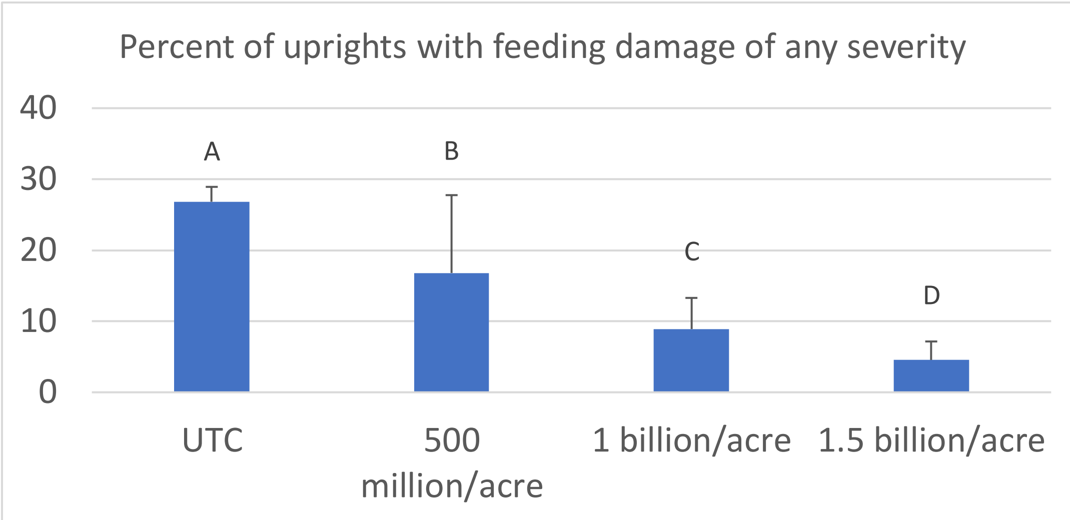

Figure 1: results of the 2022 plotwork trial demonstrating a rate-dependent relationship between season total of *S. carpocapsae* (Capsanem) applied per acre and quality of control achieved.

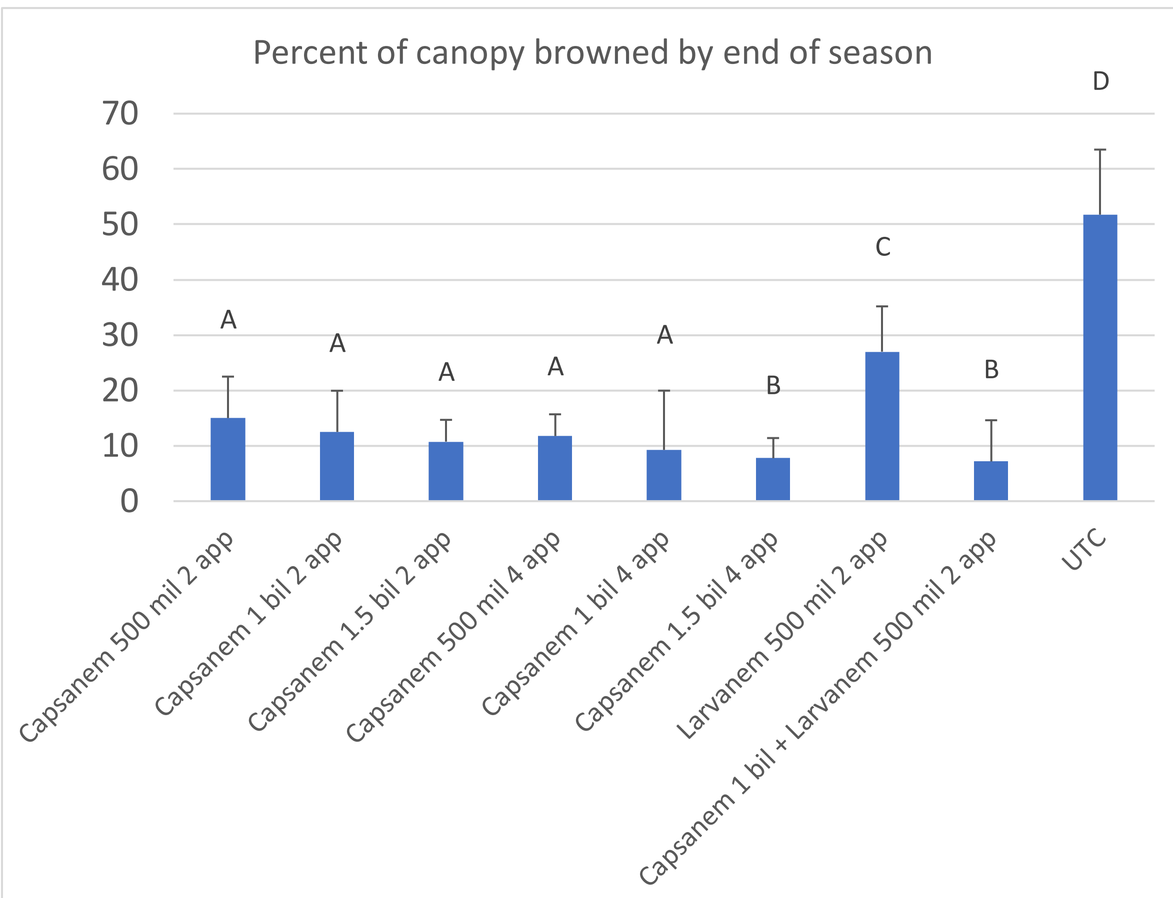

Figure 2: results from the 2023 plotwork trial evaluating splitting the season total *S. carpocapsae* (Capsanem) rates tested in 2022 into two vs. four separate applications. The trial also included

applications of a different entomopathogenic product (Larvanem) that is in testing and not discussed in this summary.

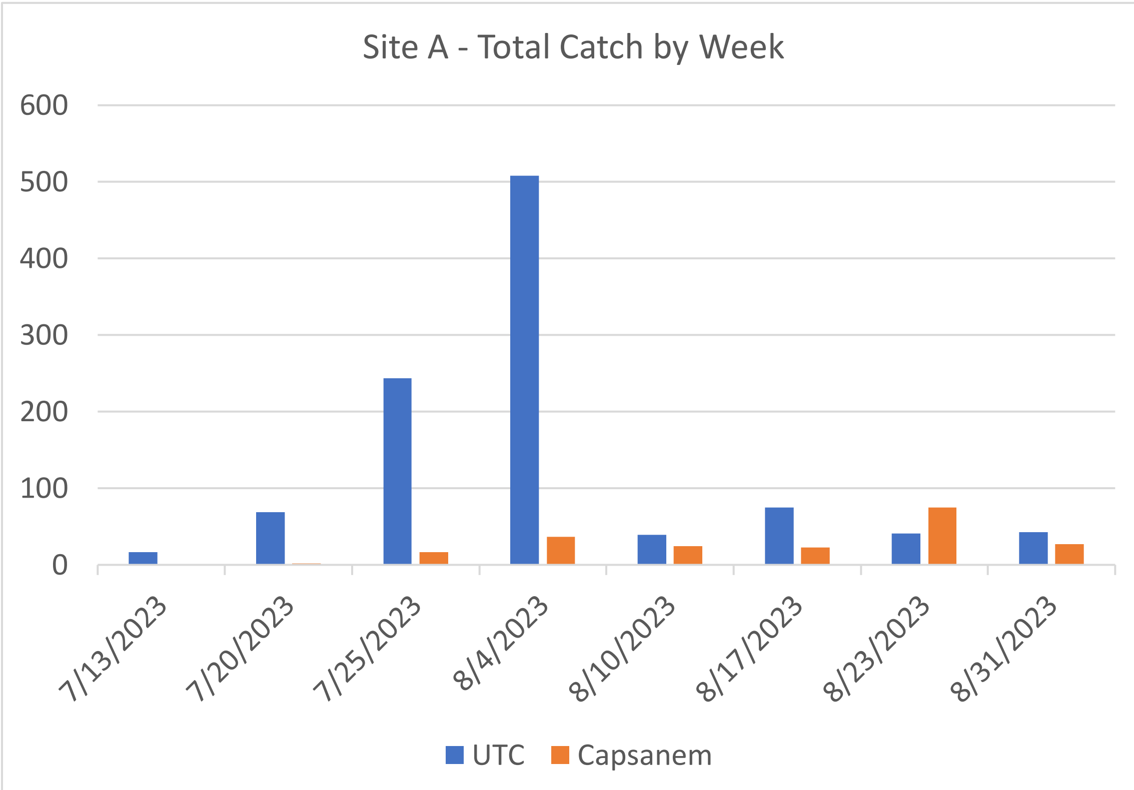

Figure 3: season-long weekly flea beetle catch totals (each bar is a sum for the associated treatment bed that week) for one of three field sites tested in 2023. The UTC treatment was sprayed with insecticide on 7/25/2024 and 8/4/2024 after the population in the treatment crossed the economic threshold on both dates. The Capsanem treatment bed was not sprayed with insecticide in 2023 due to populations never crossing economic threshold. This result was consistent across all three locations in 2023.

Effect of Calcium Fertilization on Fruit Quality

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Calcium (Ca) is an essential macronutrient and its uptake by plants occurs mostly through new root tips. Once in the plant, Ca moves through the xylem towards actively transpiring organs (i.e., leaves and fruit). Thus, Ca will accumulate preferentially in these organs, with more Ca^{+2} going to leaves rather than fruits. Once Ca accumulates in an organ, it is completely immobile (i.e., Ca^{+2} will not translocate from leaves to fruit). Fruit Ca accumulation occurs only at the beginning of fruit development because fruit transpiration decreases as the fruit develops, due to loss of xylem functionality and an increase in fruit cuticle thickness (Figure 1). Therefore, Foliar calcium applications increase fruit calcium content and thus fruit quality. The objective of this study was to evaluate the effect of foliar calcium applications during early stages of fruit development on fruit calcium concentration and fruit quality.

In 2022 and 2023, we initiated a study evaluating different application time and rates of Ca^{+2} fertilizers in cranberry fruit during early stages of fruit development (Table 1). The study was established at the Wisconsin Cranberry Research Station near Tomah, using the cultivar 'Stevens' in Year 1, and with the addition of the cultivar 'BG' and two other locations in Year 2. Samples were collected for fruit Ca^{+2} and firmness analysis at the end of the season in both Year 1 and Year 2.

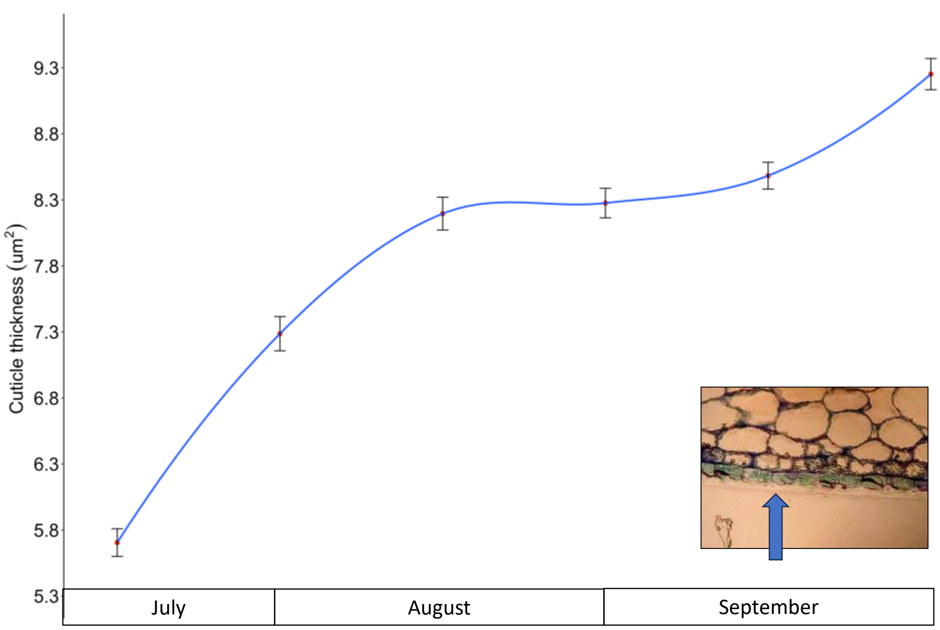

Figure 1. Changes in cranberry fruit cuticle thickness through fruit development until harvest.

Table 1. Summary of foliar calcium application treatments in Year 1 and 2 of the study.

Year	Location	Application number	Calcium Product	Treatment	Phenological Stage: Pre-bloom	Phenological Stage: 10% Bloom	Phenological Stage: 50% Bloom	Phenological Stage: 100% Bloom
1	1	Single	Ca Chloride ($CaCl_2$)	Control 750 ppm 1500 ppm 3000 ppm	✓	-	-	-
				Control 750 ppm 1500 ppm 3000 ppm	-	✓	-	-
				Control 750 ppm 1500 ppm 3000 ppm	-	✓	-	-
				Control 750 ppm 1500 ppm 3000 ppm	-	-	-	✓
		Multiple	Ca Chloride ($CaCl_2$)	1500 ppm	✓	✓	✓	✓
				1500 ppm	-	✓	✓	✓
				1500 ppm	-	-	✓	✓
2	1 2 3	Multiple	Ca Chloride ($CaCl_2$)	Control 750 ppm 1500 ppm	-	✓	✓	✓
			Ca Carbonate ($CaCO_3$)	Control 750 ppm 1500 ppm	-	✓	✓	✓

In Year 1, single applications of $CaCl_2$ were not effective in increasing fruit Ca content or fruit firmness (Figure 2). However, multiple foliar applications of $CaCl_2$ at 10%, 50% and 100% bloom as well as at 50% and 100% bloom were effective in increasing fruit Ca content in cranberry 'Stevens', but fruit firmness (Figure 3). In Year 2, in addition to the two locations and cultivar 'BG', calcium carbonate ($CaCO_3$) was used as foliar fertilizer.

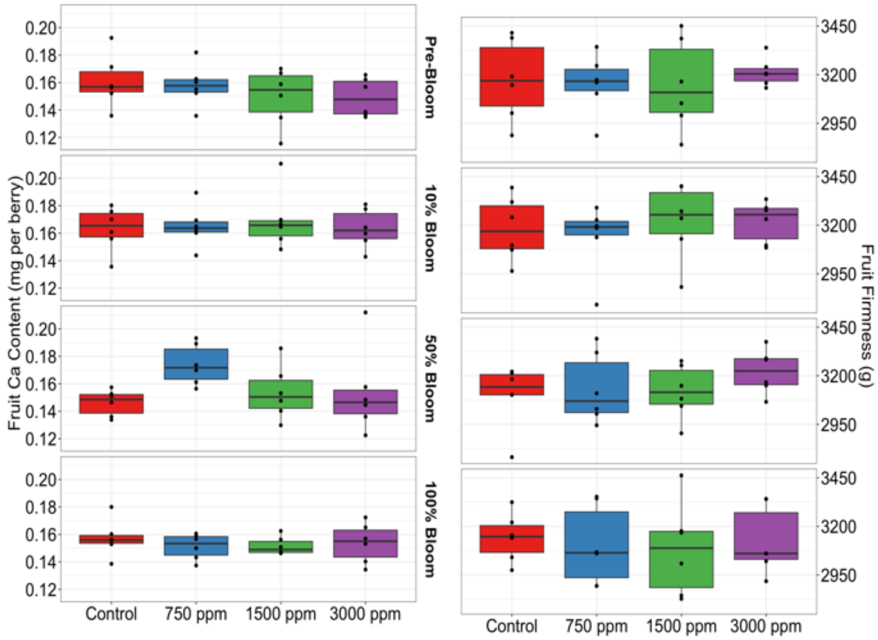

Figure 2. Effect of single foliar calcium (Ca) on fruit Ca content and fruit firmness at pre-bloom, 10%, 50%, and 100% bloom in cranberry 'Stevens'.

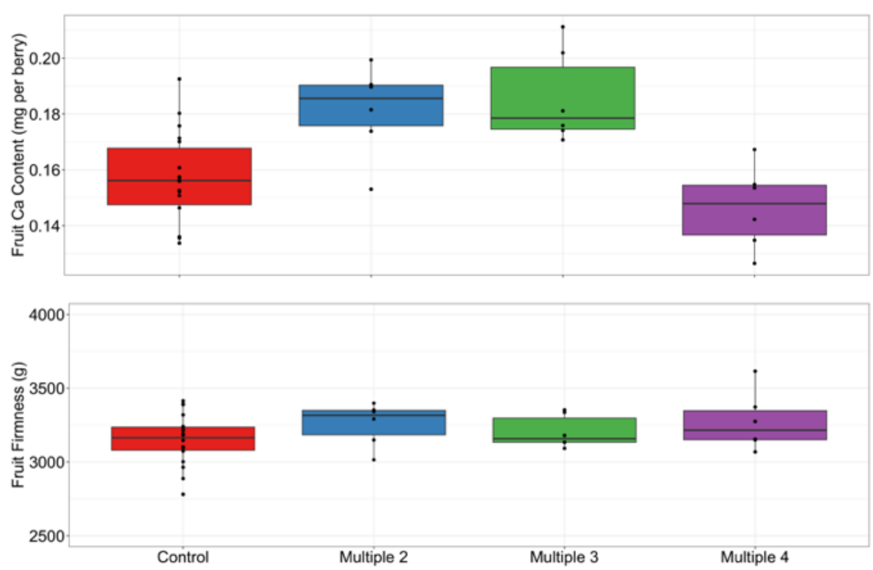

Figure 3. Effect of multiple foliar calcium (Ca^{+2}) on fruit Ca^{+2} content at pre-bloom, 10%, 50%, and 100% bloom (Multiple 4), at 10%, 50%, 100% (Multiple 3), at 50% and 100% (Multiple 2) in cranberry 'Stevens'.

Overall, there was no effect of multiple foliar applications of $CaCl_2$ or $CaCO_3$ on fruit Ca content or fruit firmness (Figure 4). However, differences in fruit calcium content between locations suggests that other ways of increasing calcium in the fruit might be explored. Acknowledgment to funding provided by USDA NIFA HATCH Grant (Accession Number: 025852).

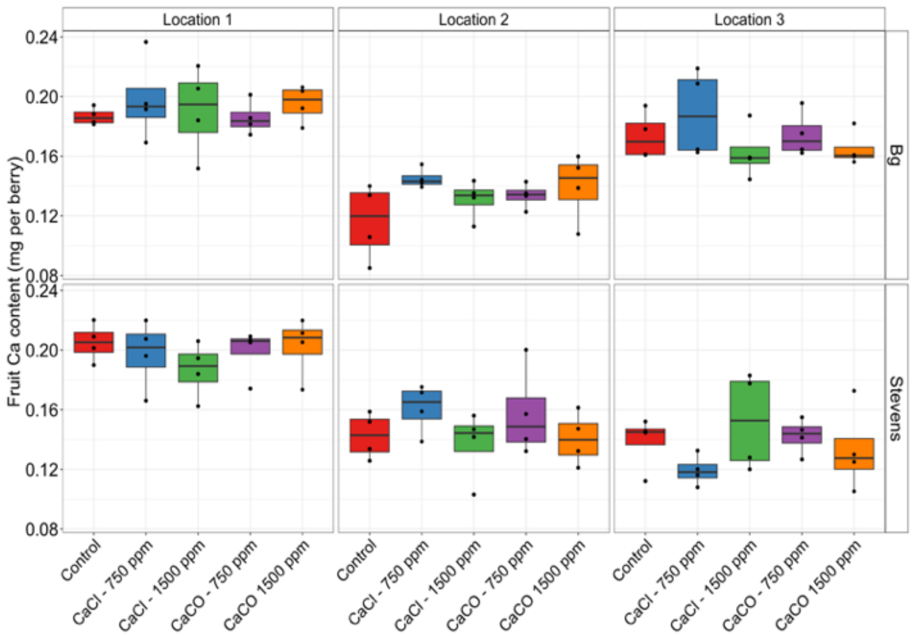

Figure 4. Effect of multiple foliar calcium (Ca^{+2}) on fruit Ca^{+2} content 10%, 50%, and 100% bloom at three different locations in cranberry 'Stevens' and 'BG'

Of Buds and Bits: A QTL Inference Study on Conventional Upright Traits and Their Relevance to Digital Phenotyping in *Vaccinium macrocarpon Ait*

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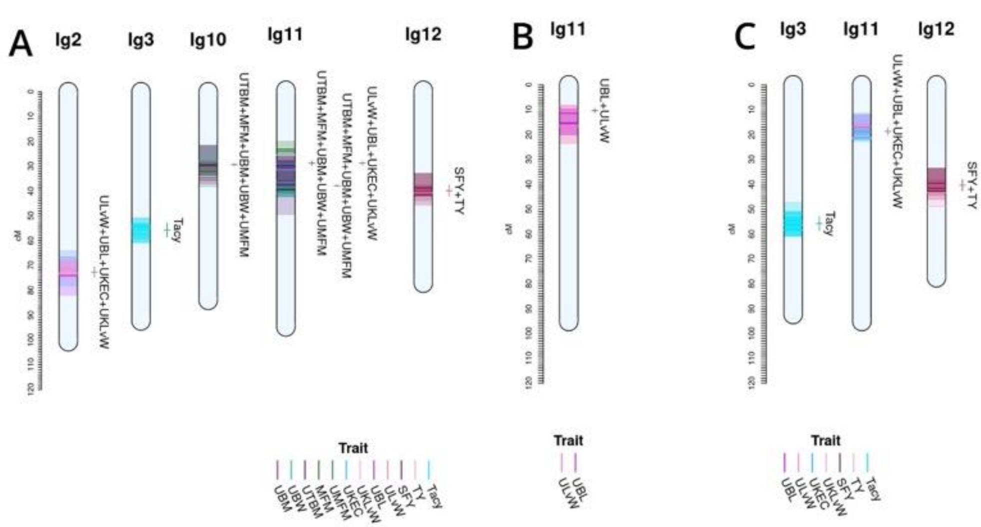
Cranberry (Vaccinium macrocarpon Ait.) breeders have been working for nearly 200 years to improve the quality and yield of cranberries by focusing on specific traits that affect fruit growth. Recently, advancements in genetic technology have allowed for faster and more accurate selection of these traits, helping breeders achieve better results. In this study, we looked at 29 traits related to cranberry fruit quality, yield, and chemical composition in two cranberry populations (called CNJ02 and CNJ04) over three years. We identified key areas in the cranberry genome, known as "quantitative trait loci" (QTL), which are linked to important traits. In the CNJ02 plants, we found 170 major QTL, while CNJ04 had 69 major QTL. Some of these QTLs were consistent across multiple years, indicating they are reliable targets for breeding. The research also identified "meta-QTL," which are stable genomic regions relevant across different studies, years, and plant populations. We found 22 of these meta-QTL, which are useful for breeding cranberry plants with consistent improvements in berry color, shape, and size. In summary, by using these advanced genetic tools, the study supports improved breeding techniques that could lead to better cranberry quality, yield, and genetic traits, making cranberries a more productive and profitable crop.

Figure 1. Noteworthy multi-trait, co-located QTL for cranberry populations CNJ02 (A), CNJ04 (B), and both CNJ02 and CNJ04 (C), based on results from this study.



Acknowledgements. This project was supported by USDA-ARS (project no. 5090-21220-007-00-D provided to JZ); USDA AFRI NIFA (grant no. 2022-67012-37202 provided to JL); NIH (grant no. 5 T32 GM135066AM; UW-Madison Biotechnology Training Program; provided to AM); USDA NIFA (project no. 2019-51181-30015; VacciniumCAP); Ocean Spray Cranberries, Inc.; Wisconsin Cranberry Growers Association; and Cranberry Institute.

Identification of cranberry fruit rot fungi associated with vegetatively propagated cuttings and young beds

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Cranberry fruit rot (CFR) is a disease complex consisting of more than 12 phytopathogenic fungal species. This disease complex is one of the most serious problems for cranberry growers, causing >33% loss of total production. Efforts to control CFR, primarily focus on the use of fungicide applications early in the season. However, there is limited research focused on tackling disease management from other perspectives. Aside from preventative fungicide programs for CFR, cranberry has no known pre-establishment practices to mitigate fruit rot. *Phyllosticta vaccinii*, the causal agent of Early Rot of cranberry, is a concern in the first three years following planting and most common in warmer cranberry producing regions. With increasingly warm growing seasons in Wisconsin, management of this pathogen becomes more important. A 2023 survey of Wisconsin cranberry growers at Cranberry School revealed that nearly 95% (n=55) do not assess potential diseases in propagative cuttings prior to planting. Approximately 71% (n=41) of growers deal with Early Rot in the first few years of plant establishment.

The main objective of this project is to determine the total number of the fungal pathogens associated to CFR in propagation material and young beds (1-3 years old) at different sampling moments. We hypothesized that due to the development of Early Rot in the first 3 years in many Wisconsin marshes, it is suspected that *P. vaccinii* would be dominant in cranberry vine cuttings.

In 2023, plant material was collected in two occasions: early summer and a late summer. During early summer, vegetative cuttings that were recently mowed and would be planted were collected. During late summer, vine cuttings and berries from young beds (1-3 years old) were collected. Plant material originated from seven commercial marshes in central and northern Wisconsin from several cultivars.

Depending on the feasibility of the early summer collection, cuttings were sampled at three sampling points: 24 hours after mowing, mid-point between mowing and planting and 24 hours prior planting. Fungal pathogens associated with propagative cutting materials were identified by plating leaves, runners, and upright tissues on nutrient media to isolate fungi and PCR detection. As for the late summer collection, processing was the same for leaf, woody tissue and berries sampled from beds 1-3 years old at harvest. Fungi were identified through morphology and DNA sequence to determine how similar these were to pathogenic fungi belonging to the CFR disease complex.

No cuttings collected exhibited obvious symptoms of fungal or other pathogen infection. Regardless of the sampling point, farm, cultivar and plant tissue type, cranberry fruit rot pathogens including *Colletotrichum* spp., *Phomopsis* spp., *Coleophoma* spp., *Godronia* spp., *Allantophomopsis* spp. and *Phyllosticta* spp. were identified on all plant tissues (Figure 1). Of these fungi, *Colletotrichum* spp. is one of the main pathogens we isolate from rotten fruits at harvest. A significant presence of *Alternaria* spp., a type of fungi, was observed; however, it is not considered part of the CFR disease complex due to its uncertain pathogenicity toward cranberries. In the CFR, there are two species of *Phyllosticta* spp. When trying to determine which of *Phyllosticta* spp. we were able to find, it was genetically closer to *Phyllosticta elongata* as opposed to *P. vaccinii.*

41% of CFR pathogens, including *Coleophoma* spp. (Ripe rot), *Diaporthe (Phomopsis) vaccinii* (Viscid rot), *Godronia cassandrae* (End rot), *Allantophomopsis* spp. (Black rot), *Phyllosticta elongata* (Berry speckle), were both isolated from the plant tissue and identified using the PCR approach. *Colletotrichum gloeosporioides, which causes bitter rot*, was not isolated or detected.

Only 16% of fungi associated to CFR and *Alternaria* spp. were isolated. Data is still being finalized and analysis will include differences across cultivars, bed age and farms.

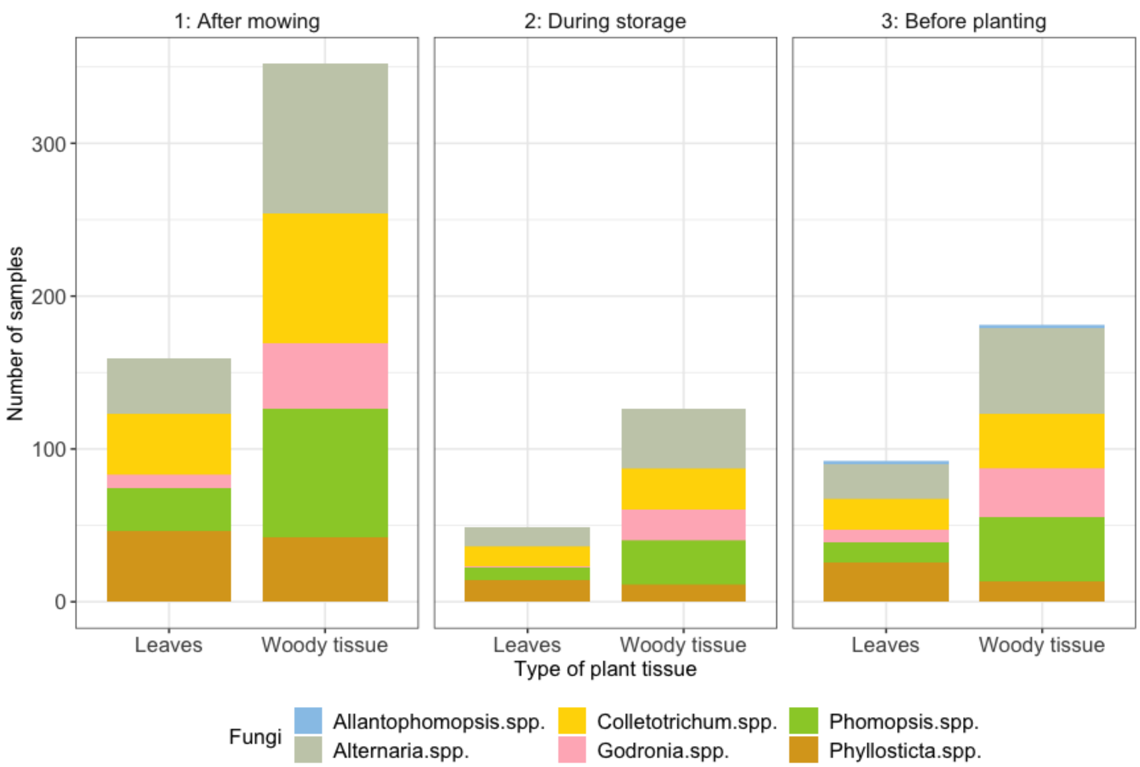

Figure 1. Bar plot with the names of fungi isolated that are the same as those in CFR complex across all collected samples from seven farms.

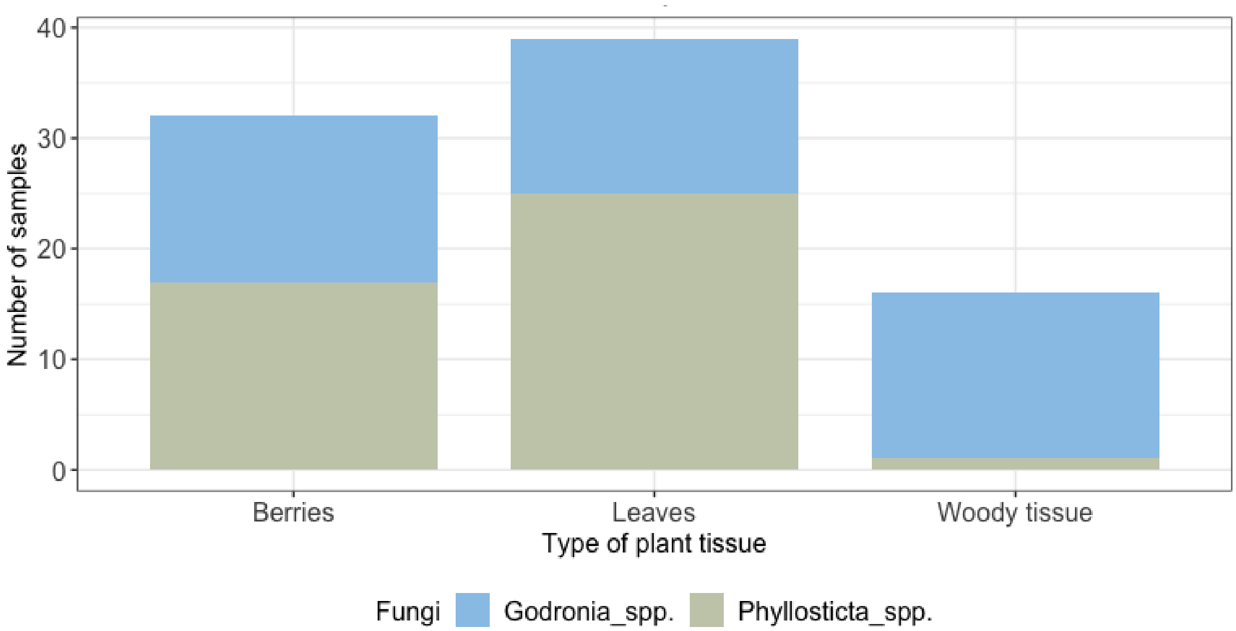

Figure 2. Bar plot with the names of fungi isolated that are the same as those in CFR complex across all collected samples from seven farms.

Propagative material may harbor latent (inactive) infections of some CFR pathogens. Therefore, cuttings could potentially serve as a source of introduction of CFR disease-causing pathogens to new beds. Currently, we lack information on how the presence of fungi in cutting material correlates with the incidence of fruit rot. While it might not be possible to completely eradicate these pathogens, it is important to utilize cultural practices to reduce inoculum, such as removal of plant debris and timely fungicide applications during bloom.

Acknowledgements

Thank you to the Wisconsin Cranberry Board for funding this project. Grower cooperation is critical to determine incidence of CFR associated fungi in cranberry vine cuttings across Wisconsin and their support this past summer will contribute to advancing our understanding of CFR biology and aid in formulating future recommendations for pathogen management.

Evaluation of heat treatments for control of fruit rot pathogens in cuttings

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Cranberries are established via vegetative propagation. Vines are mowed from healthy 5–10-year-old beds, stored in bales, and watered continuously for up to 6 weeks before being transported and replanted. Replanted vines are disced into freshly sanded beds where they will root and establish within 3 years. Due to the endophytic nature (ability to live in plants without causing apparent disease) of the fruit rot fungi, many remain in cranberry beds on plant tissues season after season (McManus 2001; Oudemans et al. 1998). Possibly exacerbating this situation is the use of cranberry cuttings from established beds to propagate new cranberry beds. If endophytic fungi associated with cranberry fruit rot (CFR) are present in these symptomless cuttings, this propagation method could introduce CFR pathogens into new plantings. Previous studies (Caruso, McManus and Oudemans, *unpublished*) demonstrated through fungal isolation from cranberry plants that many CFR pathogens overwinter and survive in the woody tissues and second-year leaves on cranberry uprights. Further, CFR fungi have also been isolated from healthy (symptomless) cranberry flowers and fruits (Tadych et al., 2012). Currently, these cuttings used for propagation material are not tested or treated for pathogens prior to establishment in new beds. Heat treatments have been proven successful in treating plant cuttings from citrus (Thapa et al, 2020) and strawberry (Turecheck et al., 2021). Introducing these heat treatment methods into cranberry propagation could reduce losses in newly planted cranberry beds by reducing initial inoculum when planting.

To test survival of fungal spores against heat treatment, *in vitro* studies were completed with isolates of *Colletotrichum acutatum*; *C. acutatum* was chosen as a study organism due to its prevalence in rotted fruits in Wisconsin marshes, as well as its ability to sporulate in culture. Fungal spores were tested against 37, 42, 44, 47, and 49°C. Results from *in vitro* studies showed that survival of fungal spores was inhibited beyond 47°C (Figure 1).

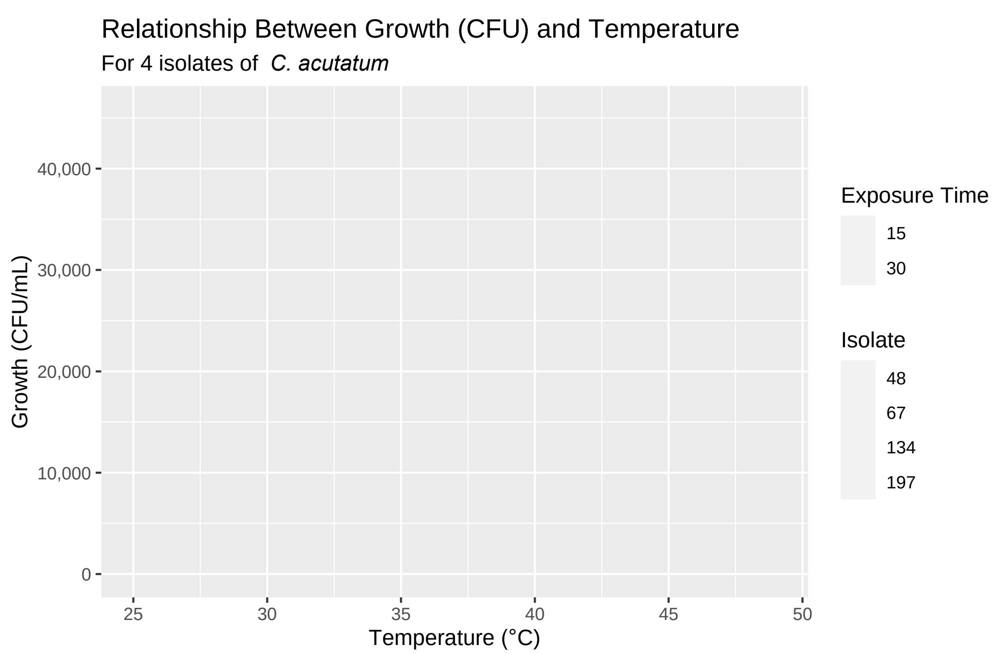

Figure 1. There is a clear relationship between increasing temperature and reduced spore survival, with no spores surviving beyond 47°C for all isolates tested.

Additionally, preliminary experiments were done in the greenhouse to test plant survival against heat treatments. Varieties 'Stevens' and 'Mullica Queen' were used, and cuttings were exposed to 37, 42, 44, 47, and 49°C for 15- or 30-minutes. Results from this experiment showed that there was no statistical difference, at a confidence level of $\alpha = 0.05$, between plant survival when comparing any temperature treatment to the control (25°C) (Figure 2).

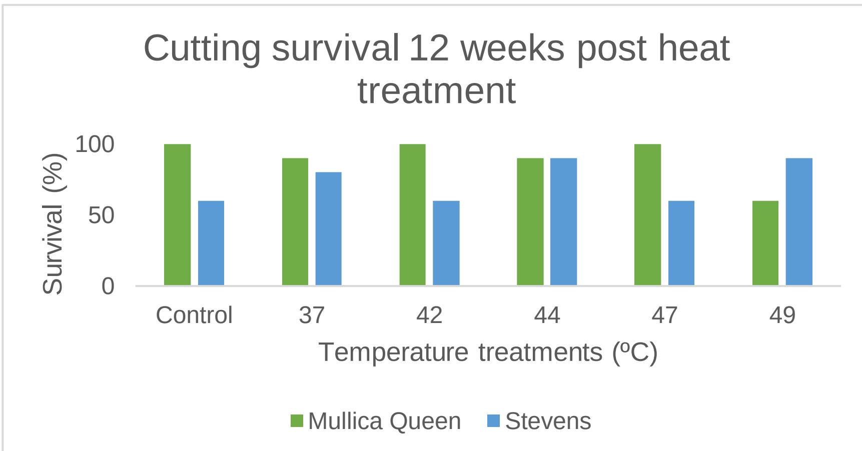

Figure 2. Mullica Queen and Stevens cuttings survival rates 12 weeks post heat treatment. At an α level of 0.05, there was no significant difference in survival of cuttings exposed to heat compared to the control for both varieties.

Based on these results, temperature ranges were reduced (25, 44, 47, and 49°C) for dip inoculation trials, wherein cuttings from Stevens were inoculated with spores from *C. acutatum* prior to being heat treated. Cuttings were submerged in spore suspensions for 24 hours prior to heat treatments. Results from this experiment showed that heat treatments had a significant impact on survival of inoculated cuttings compared to the controls (Figure 3).

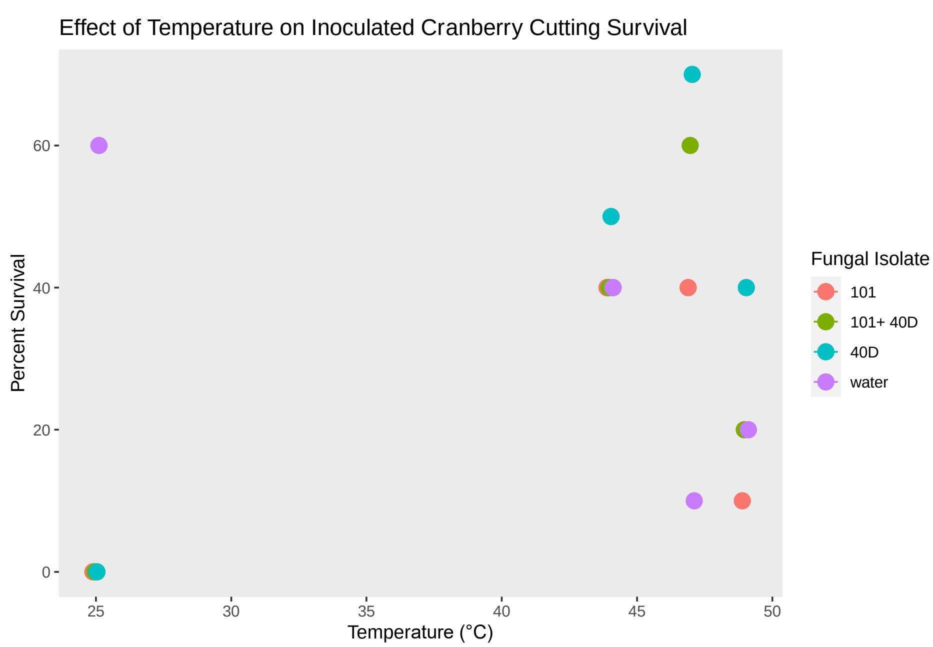

Figure 3. At 12 weeks after inoculation and heat treatment, Stevens cuttings inoculated with fungal isolates survived at significantly higher rates (α=0.05) when treated with heat when compared to the controls. "Water" is a non-inoculated control and 25°C is a non-heat-treated control. No inoculated and non-heat-treated cuttings survived.

Wisconsin Cranberry Fruit Rot Fungicide Efficacy Trials

Allison Jonjak[1] and Leslie Holland[2]

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Environmental Conditions

The 2023 growing season was characterized by a quick transition into spring followed by a hot and dry summer. Little to no rain throughout the season resulted in a significant drought experienced across much of the state. The bloom period was average with conditions remaining dry through fruit set and maturity. Due to these conditions, Wisconsin growers were not challenged by high disease pressure. Overall, fruit quality was very high in 2023 in our field trials, and this was consistent with fruit quality across the state.

Fungicides

The two main classes of fungicides used on cranberries for fruit rot control in Wisconsin include the demethylation inhibitors (DMI; e.g., Indar, Proline) and the quinone outside inhibitor (QoI; e.g., Abound, Satori, Aframe). Premixtures of DMI and QoI fungicides include products such as Quadris Top. The Fungicide Resistance Action Committee (FRAC) codes for DMI and QoI fungicides are 3 and 11, respectively. To prevent selecting for strains of pathogens resistant to fungicides, growers should not apply more than two sprays of fungicides with the same FRAC code per growing season. The DMI (FRAC 3) fungicides are considered *Medium* risk for fungicide resistance development, while the QoI (FRAC 11) fungicides are considered *High* risk for fungicide resistance development. In Wisconsin, these two classes of fungicides represent our primary chemicals for fruit rot prevention.

Trial Logistics

Field trials for fungicide screening were conducted at the Wisconsin Cranberry Research Station in Black River Falls, WI. All trials took place on a 4-year-old 'Mullica Queen' bed. To increase rot conducive conditions, this bed received additional irrigation in the evening during bloom and fruit blush, and an additional application of nitrogen fertilizer in the summer. Fungicides for all treatments were applied at approximately 20% and 80% in-bloom, which corresponded to June 15 and June 22, respectively. Fruit was harvested on September 29, and immediately evaluated for rot and phytotoxicity in the laboratory. Three trials were conducted:

- Trial 1 – implementation of experimental fungicide chemistry "Exp. 29" with current grower standards (FRAC 3 and 11)
- Trial 2 - implementation of experimental fungicides in FRAC 7, that may be registered soon for cranberry, with current grower standards (FRAC 3 and 11)
- Trial 3 – biological control agent screening; two biologicals were tested.

Results

Due to the lack of conducive conditions for fruit rot development, disease pressure was extremely low in 2023. Average fruit rot in untreated controls was ≤ 3%. Due to these low rates of fruit rot across all trials and treatments, we were unable to make meaningful conclusions about product effectiveness. Yield was average to high for all trials and no significant differences across treatments were observed. No phytotoxicity was observed.

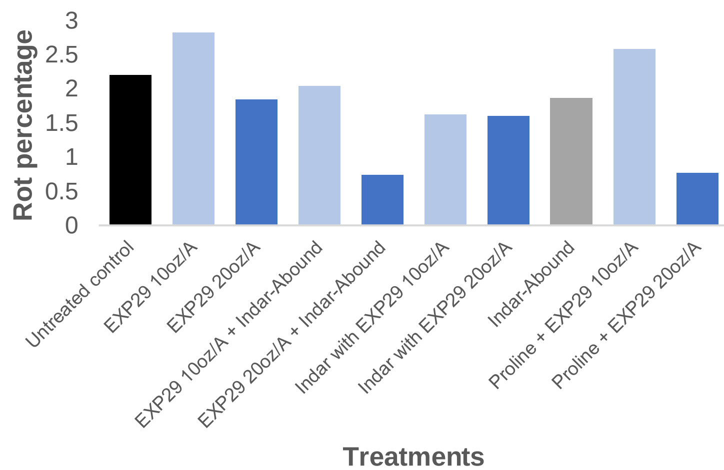

Figure 1 – Trial 1 findings. Percent (%) fruit rot for implementation of experimental fungicide chemistry "Exp. 29" with current grower standards (FRAC 3 and 11). There was no significant statistical difference observed between treatments. Products listed before the "+" were applied at 20% bloom and products after the "+" were applied at 80% bloom; all other products were applied at 20% and 80% (i.e., no rotation).

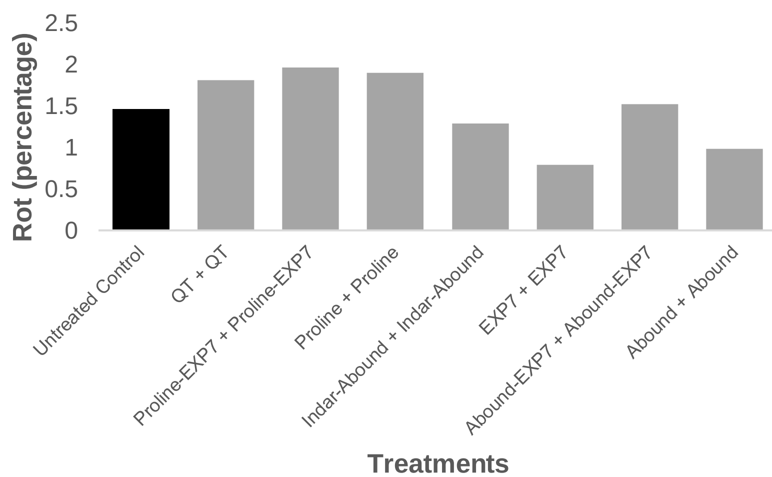

Figure 2 – Trial 2 findings. Percent (%) fruit rot for implementation of FRAC 7 with current grower standards (FRAC 3 and 11). There was no significant statistical difference observed between treatments. Products listed before the "+" were applied at 20% bloom and products after the "+" were applied at 80% bloom; all other products were applied at 20% and 80% (i.e., no rotation).

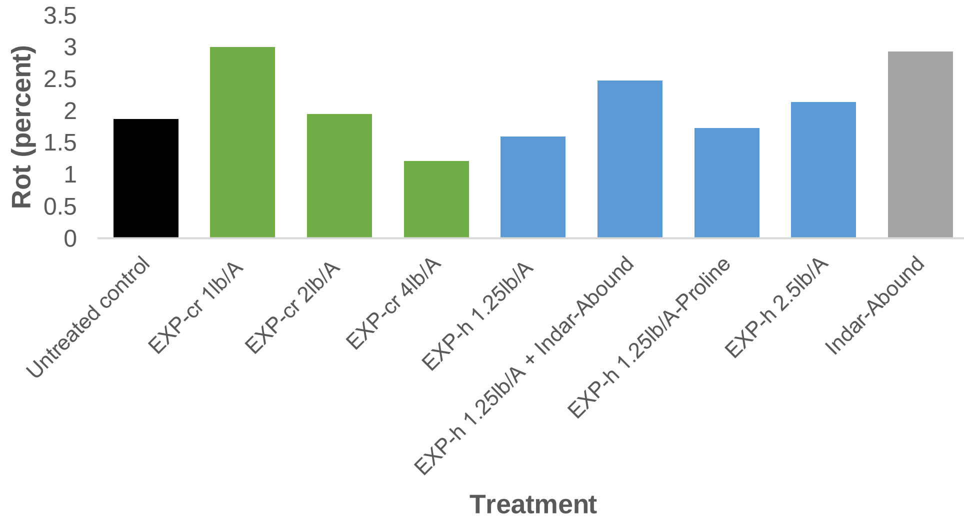

Figure 3 – Trial 3 findings. Percent (%) fruit rot for the biological control implementation with current grower standards (FRAC 3 and 11). There was no significant statistical difference observed between treatments. Products listed before the "+" were applied at 20% bloom and products after the "+" were applied at 80% bloom; all other products were applied at 20% and 80% (i.e., no rotation).

Despite the low rates of fruit rot, we did observe differences in fruit rot fungal diversity across the different treatments. Specifically, we observed a reduction in several key fruit rot pathogens when plants were treated with experimental fungicides (results based on fungal isolation from treated fruits). We will continue to explore these trends in future years.

Next Steps
Fungicide products and use patterns evaluated in 2023 will be tested again in 2024. Efforts will be made to increase the fruit rot conducive conditions in the experimental bed where the fungicide trials are carried out.

Acknowledgements - We would like to acknowledge Holland lab students and staff, Eithan Pozas, Fabian Rodriguez Bonilla, and Celeste Huff, as well as Wade and Max at the Wisconsin Cranberry Research Station for their support during trial deployment and data collection.

Exploring ericoid mycorrhizal fungi: fungal biodiversity in wild and cultivated cranberry

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Associations with fungal symbionts are near-universal for vascular plants, and while cranberries (Vaccinium macrocarpon) are no exception, details of their relationship with beneficial root endophytes remains a significant knowledge gap for cranberry production. Ericaceous plants, including cranberry, blueberry, rhododendron and more, form mutualisms with Ericoid mycorrhizal fungi (ErMF), the endophytic root fungi that co-evolved with them in acidic peat bogs. ErMF are the only mycorrhizal fungi known to form associations with cranberry. Across other vaccinium crops, studies show that these fungi conferred increases in photosynthesis, chlorophyll content, biomass, metal tolerances (Fe, Al, Zn), and salt tolerance. ErMF may be able to expand these in cranberry as well. From the few studies that have been done in cranberry, we know that inoculation has resulted in enhanced production of uprights, provided plants with organic and inorganic P, increased plant's capacity to utilize nitrates as N source, increased water potential in the shoots, and resulted in higher rates of gas exchange. But even with these promising results, we need to expand our knowledge base before we can make any recommendations to growers. The first step in establishing potential field applications is to gain a better understanding of the ErMF populations that Wisconsin growers might access.

Our research investigates the genetic diversity of ErMF across wild and cultivated cranberry roots for comparison of cultivated versus wild systems. Here we report the sequencing and metabarcoding analysis of all fungal root endophytes from cranberry root samples across wild and cultivated growth sites in Wisconsin, USA. Roots of V. macrocarpon were sampled from seven different locations of wild cranberry growth and from the farms of five cooperating growers. Roots were cleaned, surface-sterilized, and freeze-dried, then sent for Illumina sequencing focusing on the ITS2 region. Preliminary results indicate substantial variation in the cranberry root microbiome between wild and cultivated sites, as well as across farms based on the growing region.

We looked first at the whole fungal community in the roots. Figure 1 is a Venn diagram presenting the number of genetically distinct fungi present across location types. These results were surprising to us, as triple the number of fungi were present in cultivated sites compared to wild sites. We did not expect such a wide gap, and this could be a result of any number of factors, from management practices, the growing media, or influences of other ecological factors. The overlap of 69 fungal entities between cultivated and wild locations is also reflected in Figure 2, where samples from wild site samples in orange and those from cultivated site in blue cluster together on opposite sides of the figure, however there is some overlap as shown by the orange dots that sit with the blue cluster. This tells us that the cultivated communities (blue) are overall more similar to each other than they are to the wild communities (orange), with some overlap.

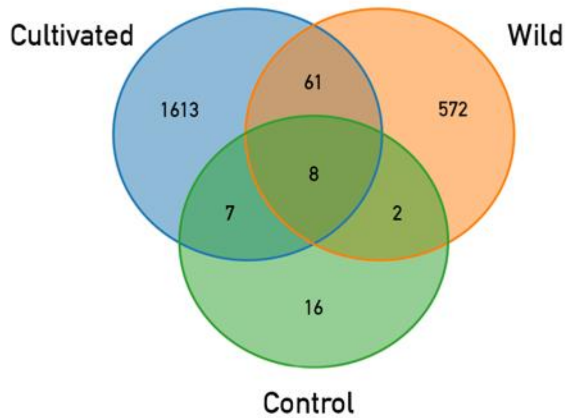

Figure 1. Venn diagram comparing the number of distinct fungal entities found across all cranberry sites by location, with cultivated sites in blue, wild sites in orange, and the hydroponic control in green.

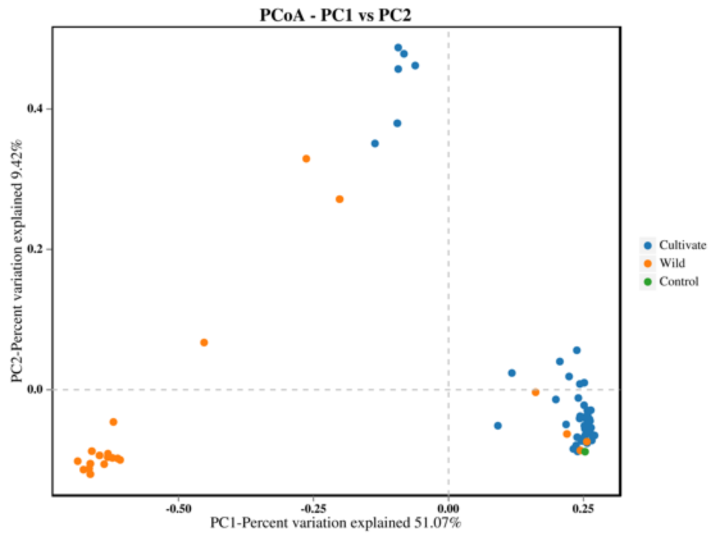

Figure 2. Principal coordinates analysis (PCoA) demonstrates fungal community similarity across cranberry site type, with cultivated sites in blue, wild sites in orange, and the hydroponic control in green.

Looking at the ErMF communities specifically, this analysis is still in progress and has changed since we presented data at Cranberry School 2024. However, we can affirm that while the quantities of these confirmed beneficial fungi vary from location to location (likely a results of different management practices), most sites do have these fungi present already. We look forward to sharing our findings.

Acknowledgements

Thank you to the growers who wrote letters of support for this research and allowed me to come sample from your marshes, and to all the Cranberry School attendees who completed our feedback survey expressing interest in further work. Funding for this project was provided through USDA NCSR #**GNC20-302** and USDA-ARS project no. 5090-21220-007-00-D provided to JZ.

Cranberry Phenotypic Diversity and Genetics of Fruit Quality Traits

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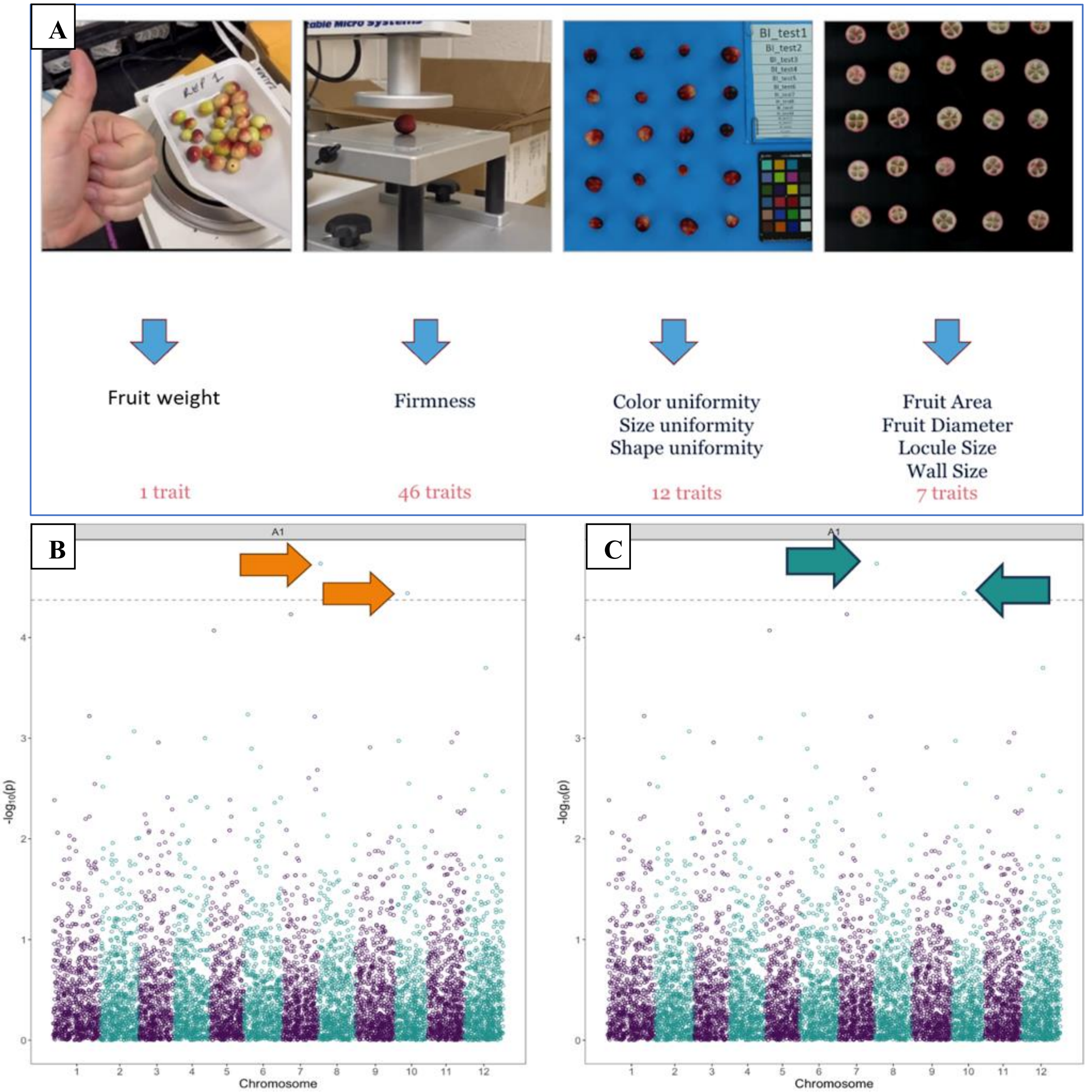
Cranberries are a popular fruit known for their health benefits, and sweetened dried cranberries (SDCs) are one of the most valuable cranberry products. However, many cranberries soften too much and break down during the production process, especially in the phase where they are infused with sweetness, leading to significant losses. Research has shown that cranberry firmness, which affects how well they hold up during processing, is partly determined by genetics. In our study, we looked at a large collection of 312 unique cranberry plants to see how traits or factors like firmness, color, size, shape, and internal structure vary across different types. We conducted the study for two years and collected fruit in two harvests per year (mid-September and mid-October), thus 1248 cranberry fruit samples with 25 fruit each were collected. Ultimately, the fruit was utilized to study 56 traits, including fruit weight, firmness (46), external appearance (12), and internal structure (7). In a preliminary analysis for fruit weight and one firmness trait (maximum compression force or H1), the cultivar effect was highly important, the year effect was not important, and the harvest effect was only important for firmness and not for fruit weight. We also ran a preliminary genetic test to identify the genes associated with fruit weight and H1 and found two chromosomal regions associated with fruit weight and two for firmness. By identifying favorable genetic traits, our findings could help breeders develop cranberry varieties that are better suited for processing, making them more attractive for growers, producers, and consumers alike. This could lead to higher quality and less waste in cranberry products for years to come.

Figure 1. Phenotypic workflow for fruit quality analysis in a large and diverse cranberry collection (n=312) (A). Genetic analysis preliminary result for cranberry fruit weight (B) and maximum compression force (H1) (C).



Acknowledgements. This project was supported by USDA-ARS (project no. 5090-21220-007-00-D provided to JZ); USDA AFRI NIFA (grant no. 2022-67012-37202 provided to JL); USDA NIFA (project no. 2019-51181-30015; VacciniumCAP); Ocean Spray Cranberries, Inc.; Wisconsin Cranberry Growers Association; and Cranberry Institute.

WISCONSIN CRANBERRIES

2024 Grower Polls

Jan 25, 2024

Wisconsin Dells

Allison Jonjak
Cranberry Outreach Specialist
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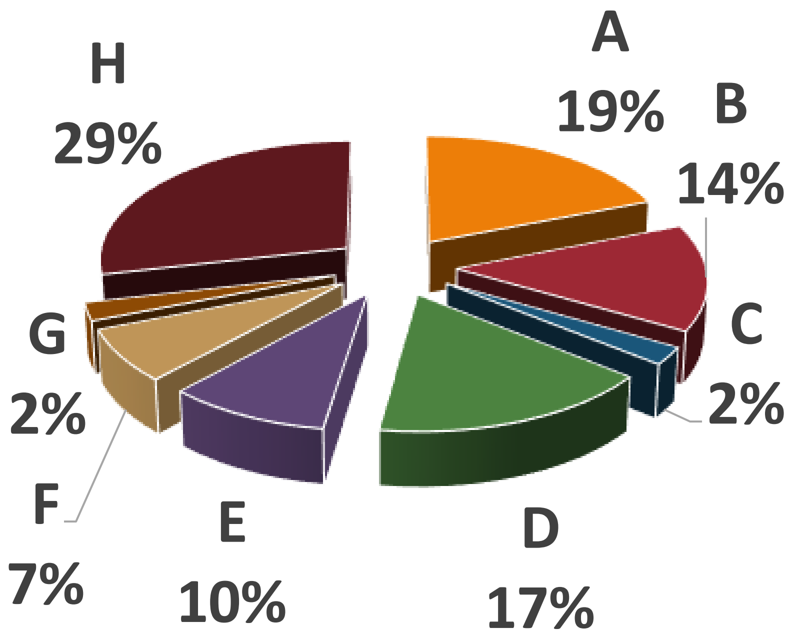
Extension
UNIVERSITY OF WISCONSIN-MADISON

Grower Priorities

What Region Are You From

a. Cranmoor
b. Tomah
c. Pittsville
d. Warrens
e. Black River
f. Manitowish Waters
g. Northwest Region (Spooner Stone Lake Gordon)
h. other

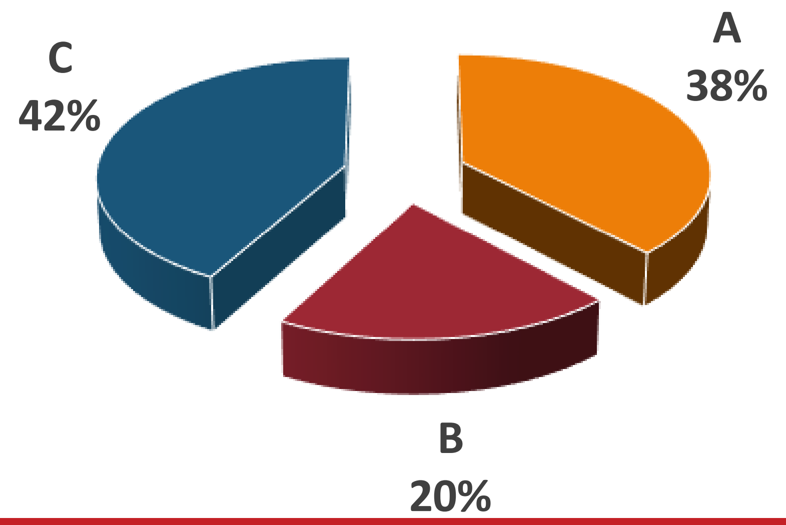


Insects

Insects

What was the main yield-reducing pest of the 2023 crop?

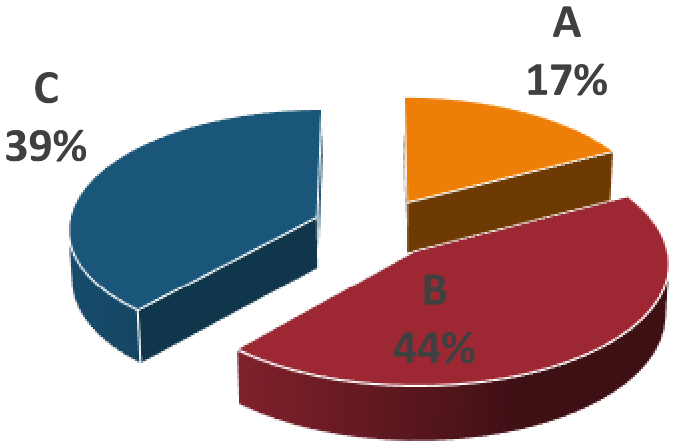
a. Insects
b. Disease/rot
c. Weeds



Insects

Was your insect pressure in 2023:

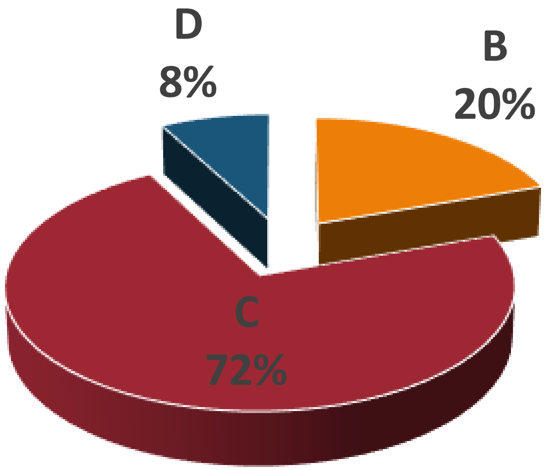
a. Up from 2022
b. Down from 2022
c. Similar to 2022



Insects

How many insecticide sprays did you apply in the 2023 growing season?

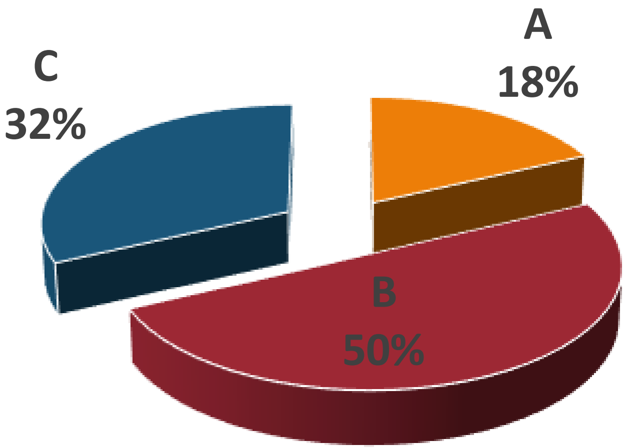
a. 0
b. 1 to 2
c. 3 to 4
d. 5 to 6
e. more than 6



Insects

Was the flea beetle population on your marsh in 2023:

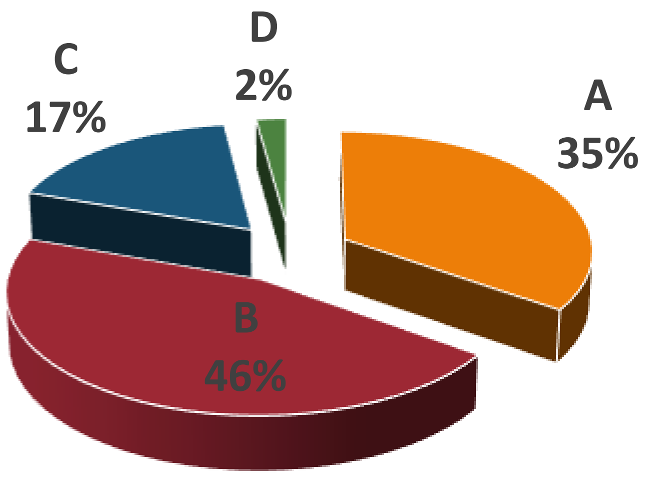
a. up from 2022
b. down from 2022
c. same as 2022



Insects

How many sprays did you apply specifically for flea beetle in 2023?

a. 0
b. 1
c. 2
d. 3
e. 4 or more



Insects

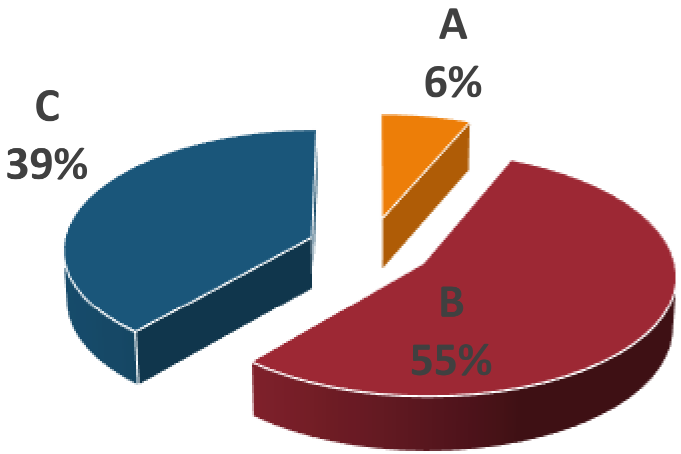
What insecticide(s) did you use for flea beetle control in 2023?

a. Assail
b. Diazinon
c. Rimon
d. Altacor
e. Actara
f. Imidan
g. other

Insects

Have you noticed a reduction in yield in areas where you had flea beetle pressure the previous year?

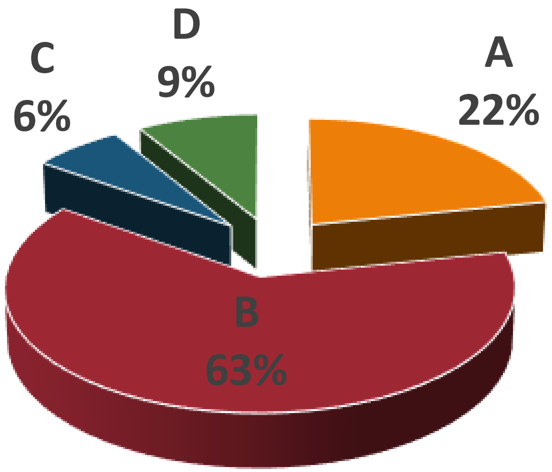
a. Yes
b. No
c. Maybe



Insects

How concerned are you about leafhoppers on your marsh?

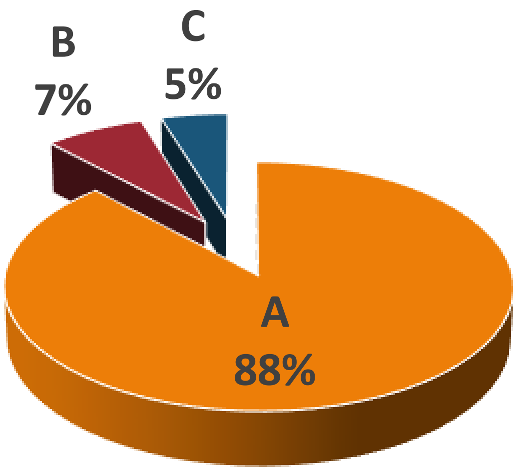
a. Not concerned at all
b. Slightly concerned
c. Moderately concerned
d. Very concerned



Insects

How many times did you spray for leafhoppers in 2022?

a. 0
b. 1
c. 2
d. 3 or more



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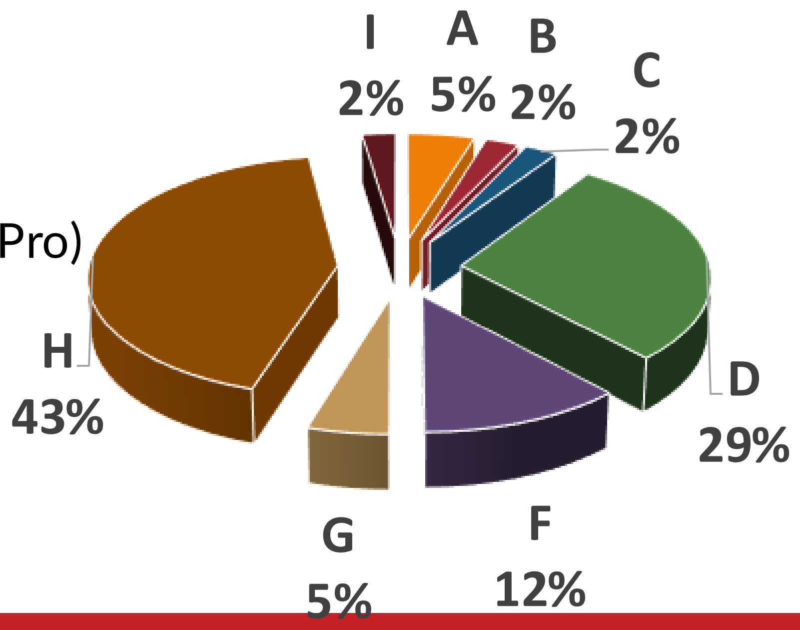
Insects

What do you plan to use in the early season instead of Lorsban to control insect pests?

a. Acephate (Orthene)
b. Sevin (Carbaryl)
c. diamide (Altacor, Exirel, Verdepryn)
d. A spinosyn (Delegate, Entrust)
e. Phosmet (Imidan)
f. A neonicotinoid (e.g., Actara, Venom, Assail, Admire Pro)
g. Diazinon
h. Fanfare
i. Other

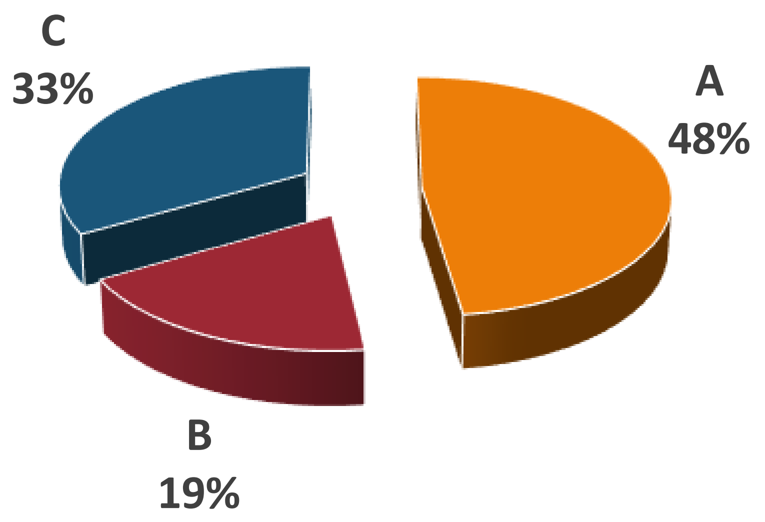


Physiology

Physiology

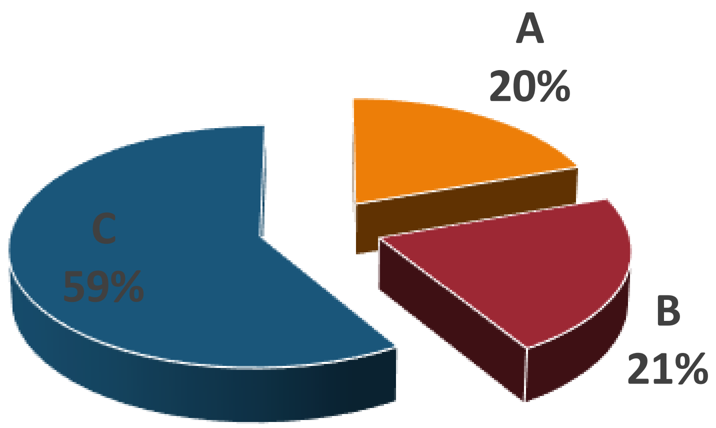
In 2023 your yields were:

a. Higher than average
b. Lower than average
c. Similar to previous years



Physiology

In 2023 your fruit size was:
a. Bigger than average
b. Smaller than average
c. Similar to previous



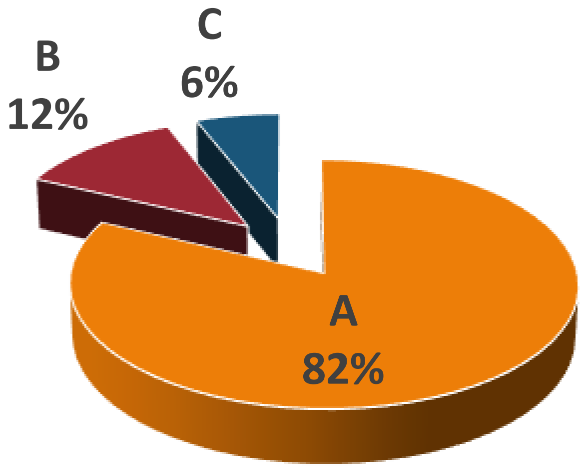
Physiology

In 2023, your fruit firmness was:

a. Similar to previous years

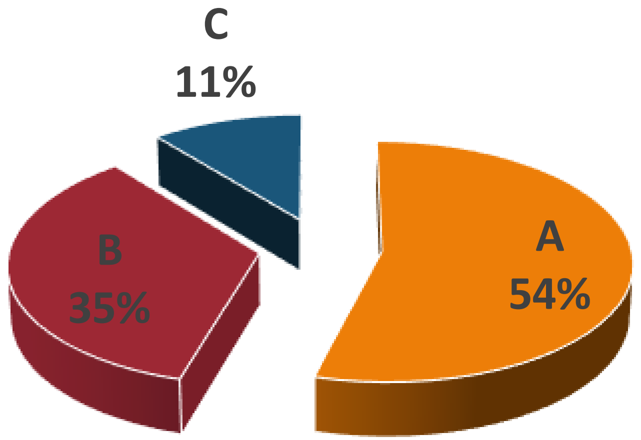
b. Better than in previous years

c. Worse than in previous years



Physiology

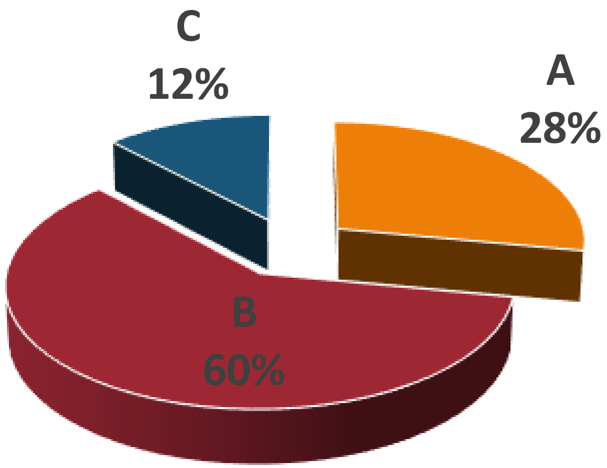
In 2023, your fruit rot incidence was:
a. Similar to previous years
b. Lower than in previous years
c. Higher than in previous years



Physiology

Did you have yield losses due to cold damage during 2023:

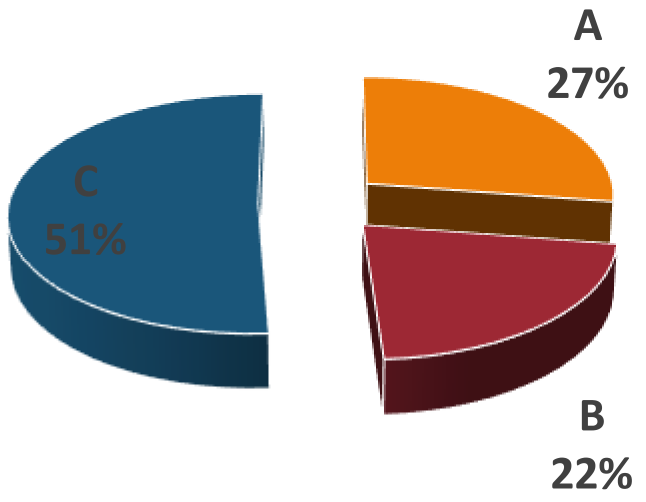
a. yes
b. no
c. I'm not sure



Physiology

What kind of winter damage did you notice on your marsh?

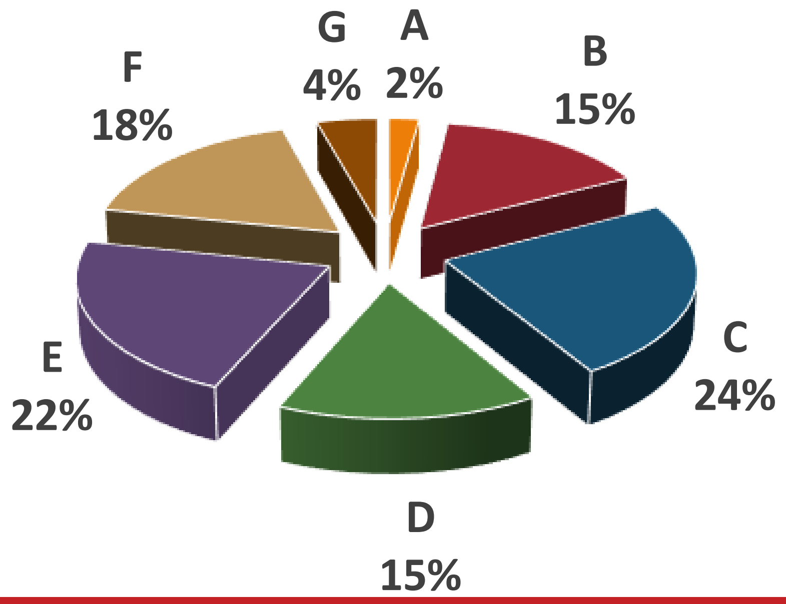
a. Leaf drop on edges of bed
b. Leaf drop on entire bed
c. None



Physiology

When do you put your first doses of N P K

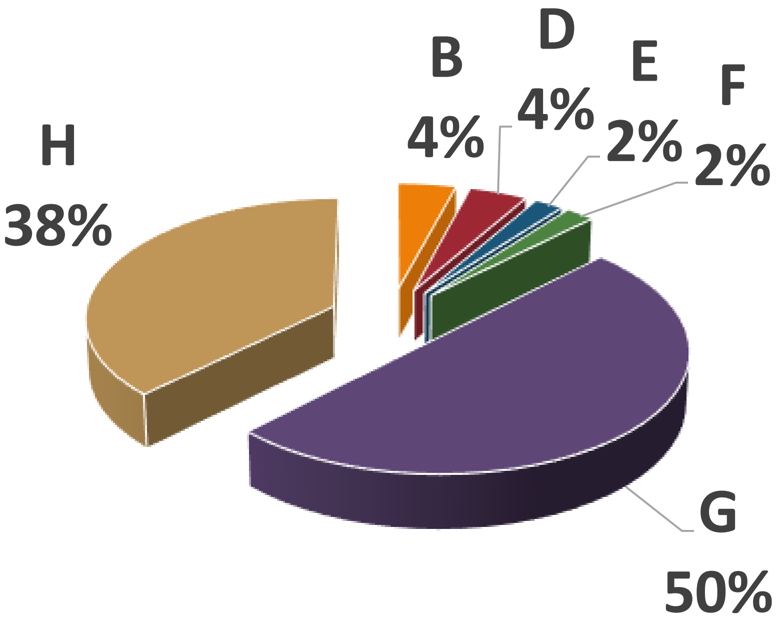
a. bud break
b. before bloom
c. at bloom
d. 50% bloom
e. fruit set
f. pinhead
g. pea size



Physiology

When do you apply your last doses of N P K

a. bud break
b. before bloom
c. at bloom
d. 50% bloom
e. fruit set
f. pinhead
g. pea size
h. full size
i. red berry



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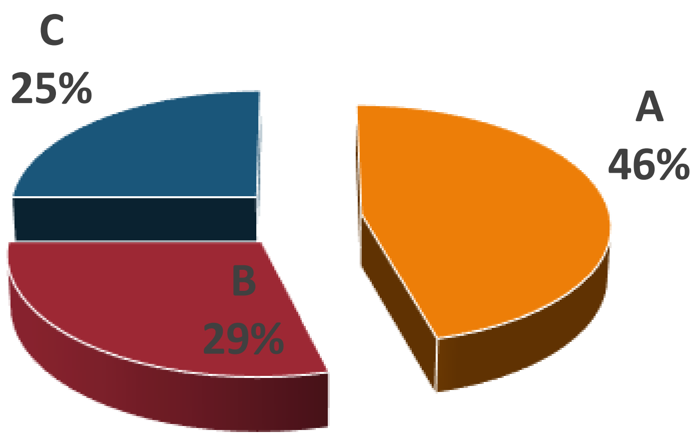
Physiology

Do you monitor water quality at your marsh?
a. Yes
b. No, but I'm interested in implementing a monitoring system.
c. No, and I'm not interested in implementing a monitoring system.



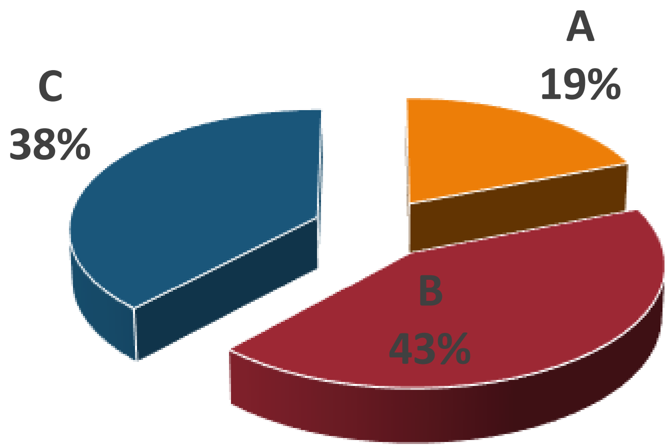
Physiology

If you monitor water quality, do you know how to interpret the results from the lab and what they mean in terms of management?

a. No

b. No, but I keep them as a marsh record.

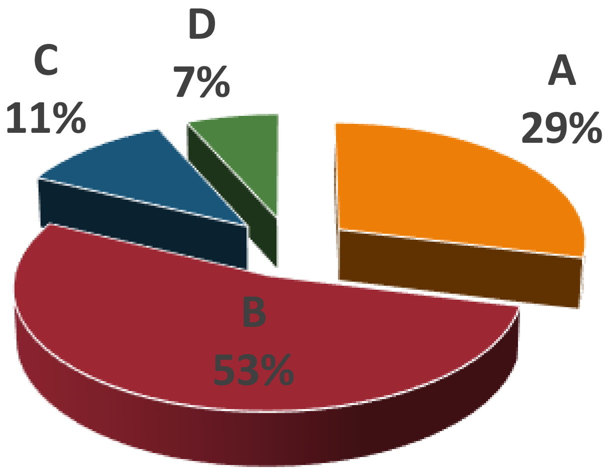
c. Yes, and I have changed practices based on these results.



Physiology

How interested are you in learning how to monitor water quality (i.e., what to measure and when) and interpret lab results?

a. Very interested
b. Somewhat interested.
c. Not interested
d. I'm already doing this, and I don't need more information.



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Diseases

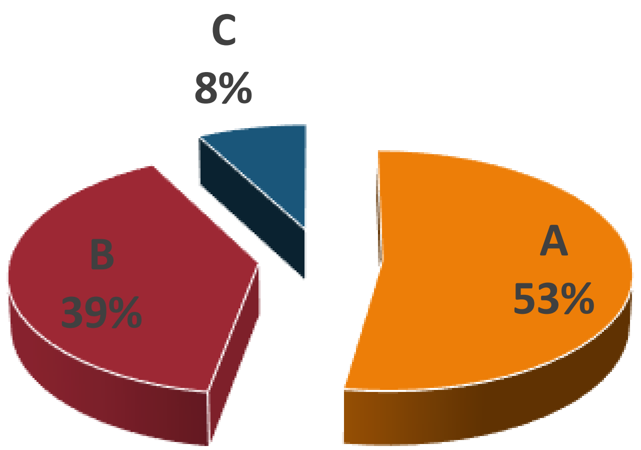
Diseases

For fruit rot control, do you make fungicide applications based on in-bloom percentages (ex. 20% and 80%) or based on the calendar (ex. first fungicide application in early bloom, then a second application 10-14 days later?)

a. Apply fungicides at approximately 20% and 80% bloom based on estimated percentages

b. Make a fungicide application in early bloom, then follow up with a second application about 10 days later

c. Make a fungicide application in early bloom, then follow up with a second application about 14 days (2 weeks) later



Diseases

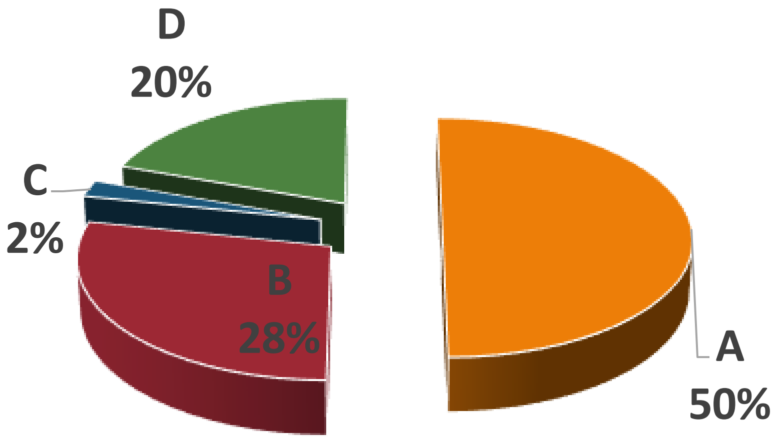
Do you spray fungicides on your entire marsh for fruit rot control?

a. Yes, on all varieties

b. No, only on modern hybrids (ex. Mullica Queen, Crimson Queen, etc.)

c. No, only on older varieties (ex. Stevens, Ben Lear, etc.)

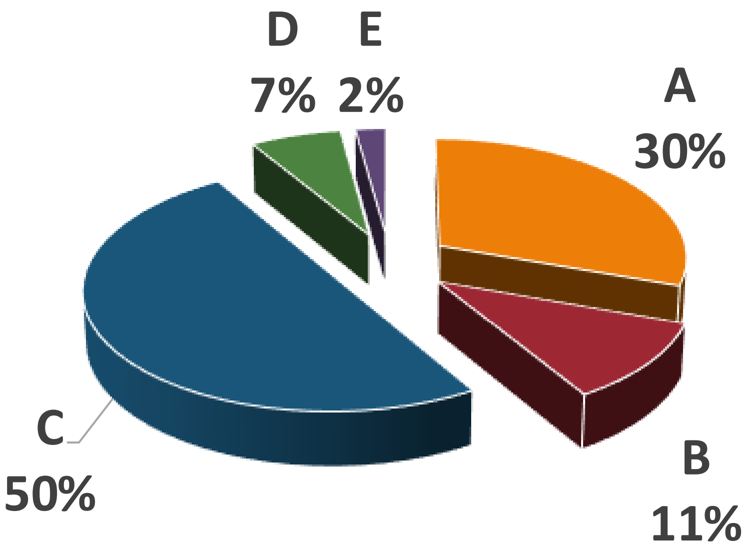
d. No, we do not use any fungicides on our marsh



Diseases

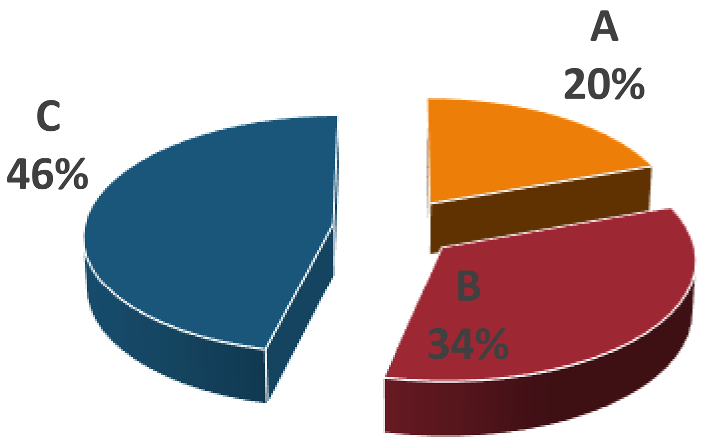
How many fungicide applications did you make in the 2023 growing season to control fruit rot?

a. 0
b. 1
c. 2
d. 3
e. more than 3



Diseases

Over the last 5 years, have your fungicide practices changed for managing fruit rot?
a. Yes, I use more fungicide applications
b. Yes, I use fewer fungicide applications
c. No, I use the same number of fungicide applications



Diseases

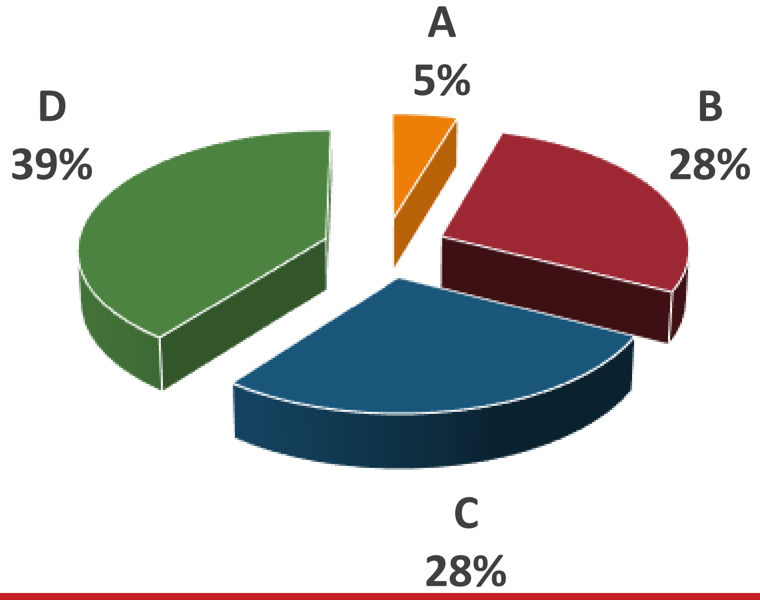
Do you use fungicides on newly renovated beds in the first 1-2 years to prevent early rot?

a. Yes, in year 1

b. Yes, in year 2

c. Yes, in BOTH years

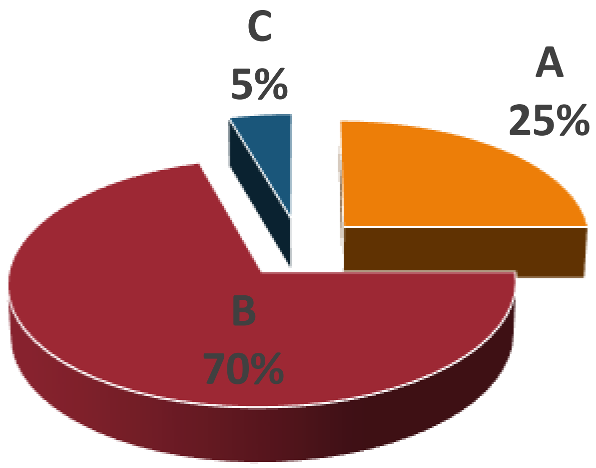
d. No, we do not use fungicides to prevent early rot in the first couple of years



Diseases

Did you see symptoms of the cranberry viruses (Tobacco Streak Virus and/or Blueberry Shock Virus) in 2023?

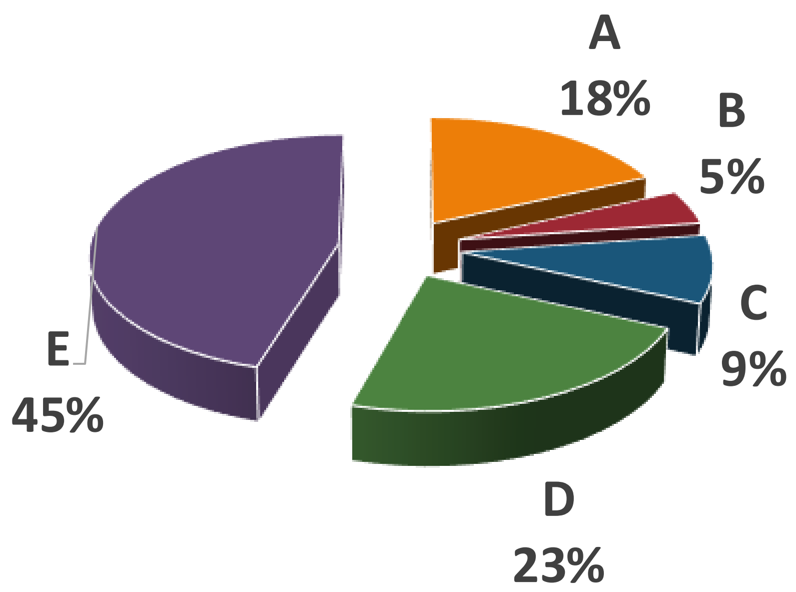
a. Yes
b. No
c. Not sure, I did not look



Diseases

In the next 5 years, what is your biggest disease-related concern for cranberry?

a. False blossom
b. Viruses
c. Fungicide resistance development in fruit rot pathogens
d. Impact of climate changes on fruit rot development
e. Lack of effective chemicals (ex. fungicides) to control diseases



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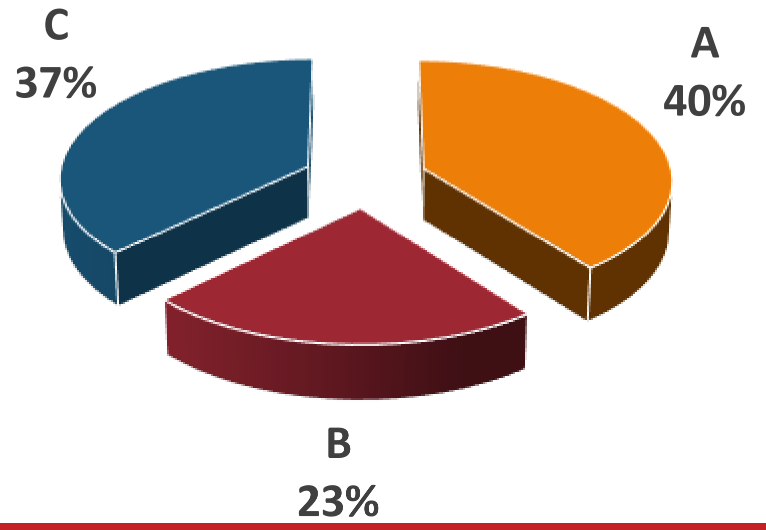
Diseases

As a result of recent research on false blossom disease in Wisconsin, have you gained new knowledge on the disease?

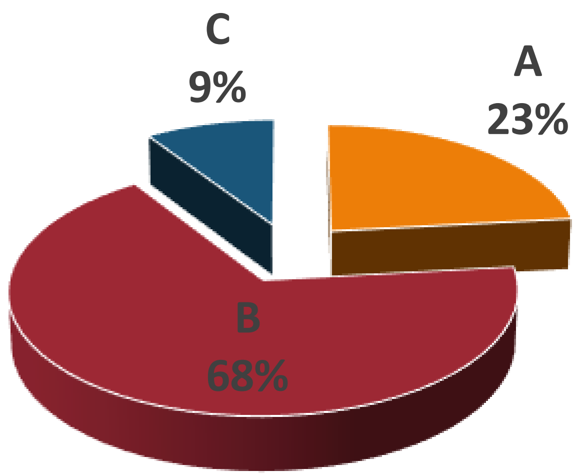
a. Yes, my knowledge and understanding of false blossom disease has increased
b. No, my knowledge and understanding of false blossom disease has not increased
c. Somewhat, my understanding of false blossom has increased a little, but I already knew most of what was shared



Diseases

Have you observed false blossom disease at your marsh in the last 5 years?

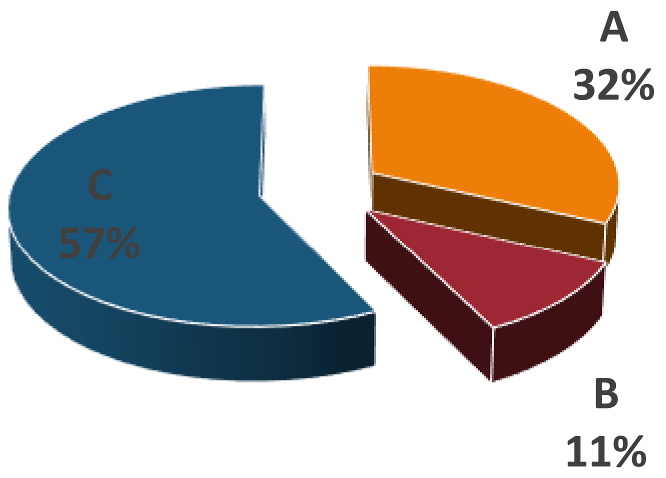
a. Yes
b. No
c. Note sure, I have not looked



Diseases

If effective biocontrol options were available to control fruit rot, would you consider using them?

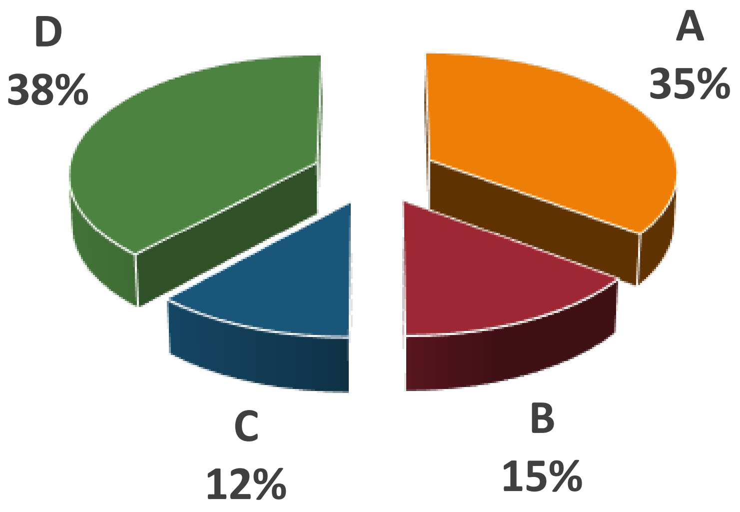
a. Yes
b. No, I'm not interested in biocontrols
c. Maybe, depends on the costs



Diseases

When was the last time you dealt with Early rot?

a. 1-3 years ago
b. 4-6 years ago
c. 7-9 years ago
d. more than 10 years ago



Weeds

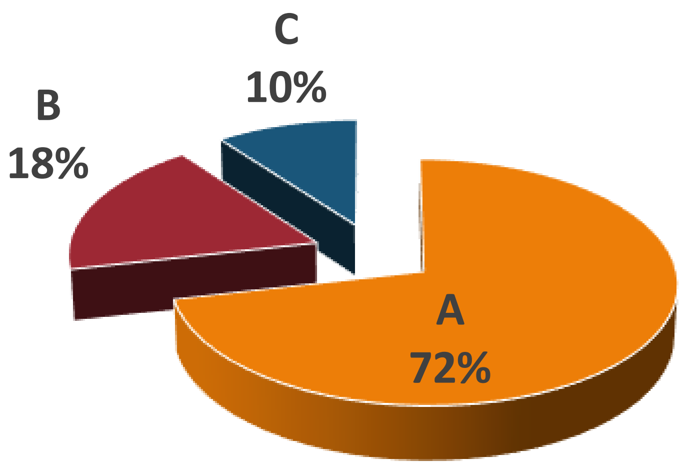
Weeds

Do you have moss on your marsh?

a. Yes, but only in a few beds;

b. Yes, extensively across the marsh;

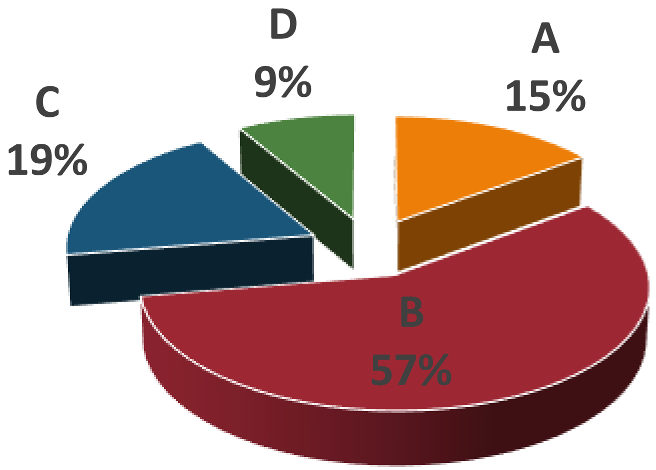
c. No moss on my marsh!



Weeds

Do you feel that your weed pressure impacts cranberry yield?

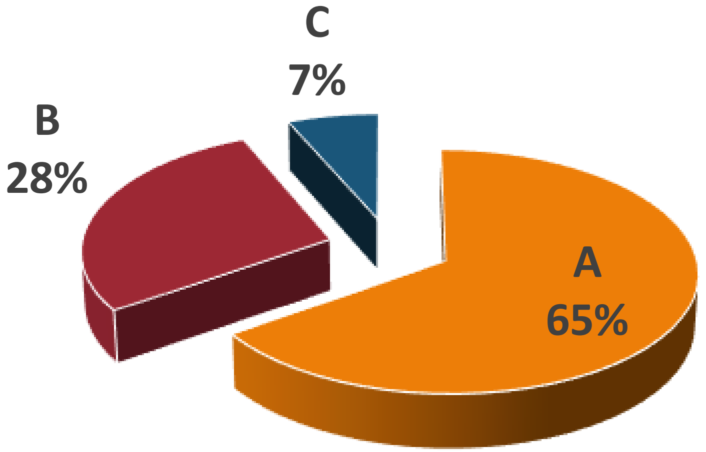
a. No impact
b. Yes, by 10% or less
c. Yes, by 11 to 25%
d. Yes, by greater than 25%



Weeds

Do you use Casoron in your established beds:

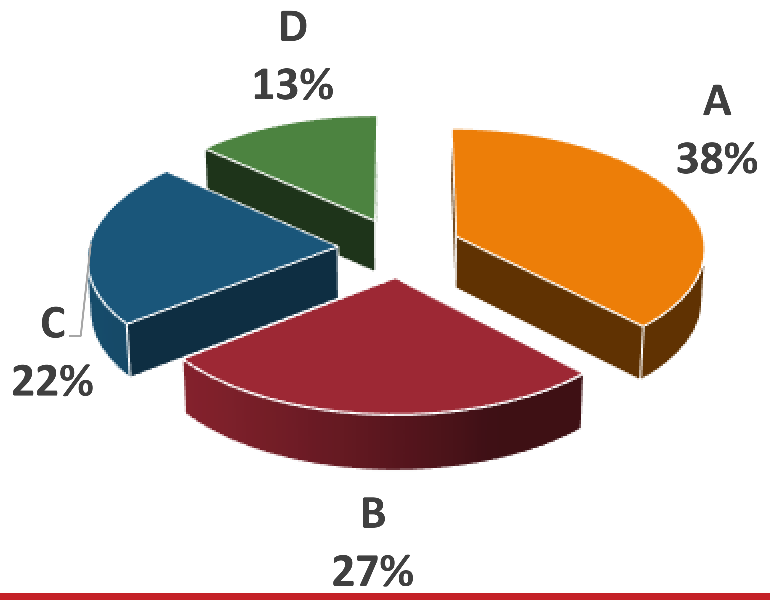
a. Yes, I use it every year
b. Yes, but not every year
c. No, I don't use Casoron



Weeds

How important is it to you that your herbicides control cranberry seedlings?

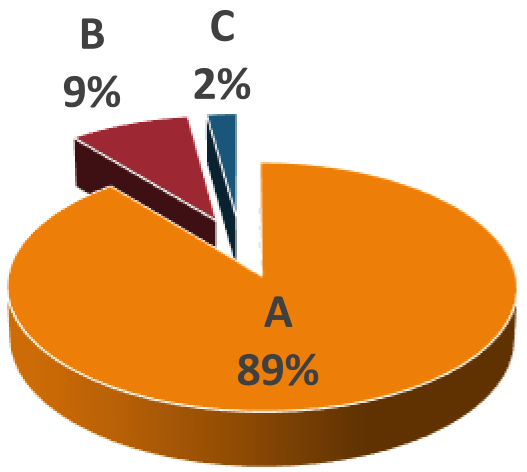
a. Not concerned at all
b. Mildly concerned
c. Moderately concerned
d. Very concerned



Weeds

Have you used QuinStar herbicide in the past two growing seasons?

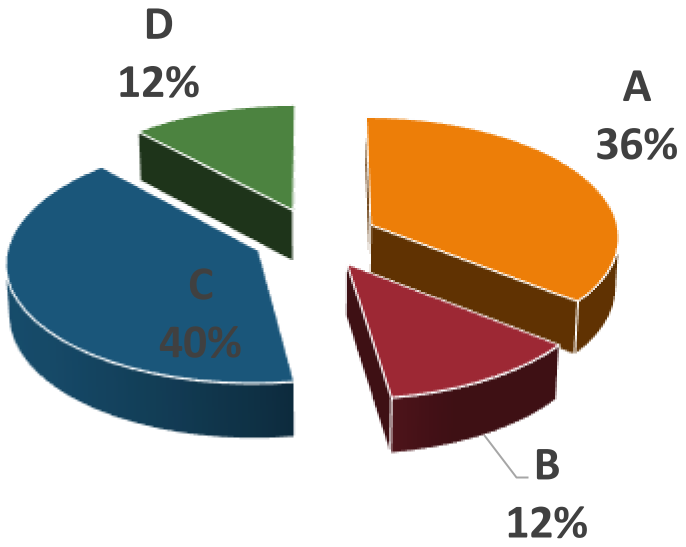
a. No
b. On some but not all of my varieties
c. On all my varieties



Weeds

If there weren't handler MRL concerns about QuinStar herbicide, would you use it?

a. Yes
b. Very likely
c. Maybe
d. No



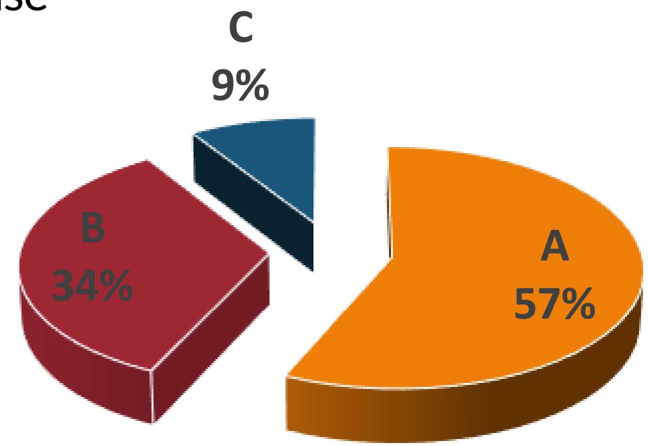
Weeds

When considering surfactants with your pesticides:

a. I use the same surfactant product every year, if possible

b. I use whatever the dealer delivers with the pesticide

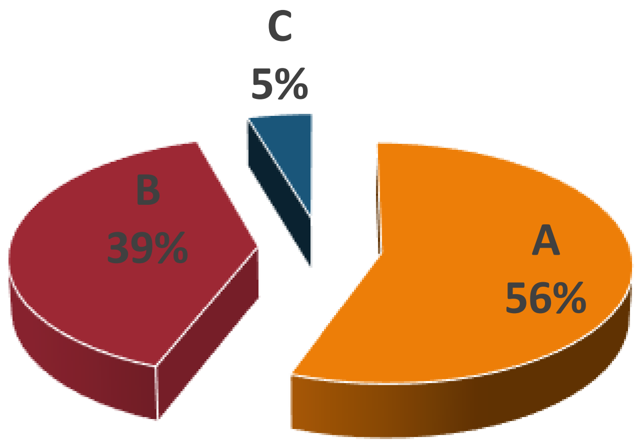
c. I'm not that concerned about which surfactant brand I use



Weeds

Are you concerned about the development of herbicide-resistant weeds on your marsh?

a. Very concerned;
b. Somewhat concerned;
c. Not at all concerned.



Questions?
What else would you like to know?

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Extension
UNIVERSITY OF WISCONSIN-MADISON

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