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Biological Control in the Cranberry Agroecosystem

By Christelle Guédot and Didier Labarre

Cranberry growers are always interested in diversifying their pest management strategies to reduce inputs, increase sustainability, and improve environmental stewardship of the land. One Integrated Pest Management (IPM) strategy we do not talk about enough is biological control. Biological control is a pest management strategy that can be integrated within an IPM program with care for, and understanding of, all the natural enemies that are present in agroecosystems. Natural enemies are represented by very diverse groups of insects and other arthropods that feed on pest insects and thereby provide pest management in a natural and environmentally-sound approach. Natural enemies include predators (e.g. spiders, ladybugs, praying mantis), parasites who do not kill the host (e.g., flies, mites, and lice), parasitoids (e.g., wasps, flies), and pathogens (fungi, bacteria, viruses, and nematodes). Biological control can be implemented according to three strategies: Importation, Augmentation, and Conservation biological control.

The first strategy, i**mportation biocontrol** (aka classical biocontrol), is of importance in the case of new invasive pest species. In this strategy, researchers return to the native range of the invasive pest to identify and collect the natural enemies of the pest species in its original location. This is a very lengthy process of about 10 years that requires quarantine, mass rearing, evaluations of non-target species in the invaded range, and regulatory permits. For the most part in cranberry, we deal with native insect pests and therefore there has not been a historical need for importation biocontrol in cranberry. This strategy is currently being implemented for other fruit insects, such as spotted-wing drosophila and brown marmorated stink bug, with increasing success in reducing these pest populations.

The second strategy is called **augmentation biocontrol**. Here, naturally-occurring natural enemies that have been determined to be effective biocontrol agents and can be reared in mass in insect-rearing facilities are released in the area that needs to be controlled. One example would be the entomopathogenic nematodes that are mass reared and released into cranberry beds to kill several pests, including flea beetle, cranberry fruitworm, and sparganothis fruitworm (Steffan 2022). Another example would be the minute parasitic wasps of the genus Trichogramma that lay eggs inside butterflies and moths' eggs, thereby preventing them from hatching.

Finally, the third strategy is **conservation biocontrol** in which the goal is to capitalize on the naturally occurring natural enemies by providing habitat and resources for them to thrive in our agroecosystems and by reducing pesticide applications that would negatively impact them.

The case of cranberry

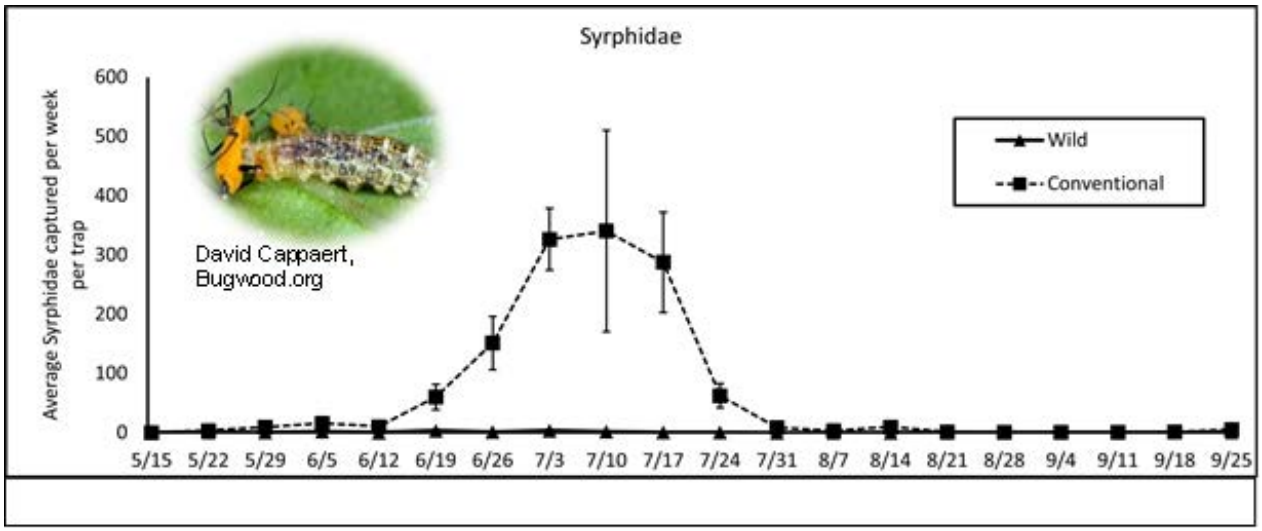

Fig 1. Seasonal occurrence of syrphid flies in wild vs. conventional cranberry.

Natural enemies

Cranberry is a great example of a native crop embedded into a natural ecosystem that harbors natural enemy populations which can be fostered to help reduce pest populations. A diversity of natural enemies has been documented to attack our pest complexes, including syrphid flies (Fig. 1), parasitoid wasps (Fig. 2), predators, nematodes, and others. Natural parasitism rate varies widely among pest species, with larval parasitism rates of ~60% for the false armyworm and sparganothis fruitworm, ~20% for the green spanworm, ~10% for the blackheaded fireworm, and almost no parasitism for the brown spanworm (Drolet et al., 2019).

Augmentation

Figure 2. Trichogramma pretiosum wasp on moth egg. Photo by Max Badgley.

Some nematode species and strains can be purchased from different companies in the US or are reared by the Steffan's Lab at USDA-ARS. They are either mass reared in bioreactors or using an alternative host (also called factice host), which are usually mealworm larvae. They can then be applied at rates around a billion per acre. Nematodes are microscopic and relatively resistant, so they can be easily mixed with clear water and sprayed into beds. The key to their efficacy is to get them washed down into the ground with water, where they can survive for multiple days and move around up to 1 m, looking for a host. Nematodes parasitize pests when they are at their larval stage, so their application should be synchronized when the targeted pest is at this stage. They have proven to be effective biocontrol agent against the cranberry fruitworm, sparganothis fruitworm, red-headed flea beetle and the cranberry girdler. Similarly, multiple species of parasitic wasps in the genus Trichogramma are available commercially and can be easily bought by the billions. Different indigenous species, such as T. pretiosum (Fig. 2) in Wisconsin, have been found naturally parasitizing different cranberry pests. They are also typically reared on a factice host (usually sterilized eggs of the Mediterranean flour moth) in insect rearing facilities. They are applied as pupae parasitizing their factice host egg, and they emerge as adults in the days following their application. Freshly emerged adults then mate and go on looking for moth eggs. Therefore, their application should be synchronized with the targeted pest's flight, which is also approximately their egg-laying period. They can either be applied manually (stuck on cardboard pieces spread across the fields), or mechanically. Direct injection spraying devices are currently being developed in Quebec, CA to allow Trichogramma pupae application in water (just like any other pesticide), which make it possible to apply them at a large scale quickly and with limited human resources. Their application rate is around 1 million per acre, but their adult lifespan is around 2 or 3 days, so they must be applied two to three times during

the pest's flight to maximize results. Neither of these two augmentative biocontrol agents have a detrimental effect on the crop, but their establishment on the marsh is expected to be limited. Thus, they must be reapplied year after year, similar to insecticides, minus the risks to human health and the environment.

Conservation

Implementing conservation biocontrol can be accomplished via the establishment of flower patches (such as pollinator gardens) or allowing weeds on marsh edges to flower, as these would provide nutritional resources, in the form of nectar and pollen, and habitat that would provide nesting areas, refugia from pesticide sprays, and hibernation sites. Reducing the number of insecticide applications and using reduced risk pesticides would also greatly benefit natural enemies and should be considered throughout the season. For example, implementing a spring flood helps reduce the use of insecticides. A 30hrs spring flood in late May was shown to be as effective as a broad-spectrum insecticide application of Chlorpyrifos in reducing the numbers of black headed fireworm, cranberry fruitworm, and sparganothis fruitworm, while supporting more biocontrol agents in the form of spiders and parasitoids in flooded beds compared to sprayed beds (van Zoeren et al., 2018). Parasitism rates were also shown to be higher on neglected marshes where they reached close to 50% of cranberry fruitworm egg parasitism by the parasitic wasp T. pretiosum (Fig. 2; Simser, 1995), with similar observations in British Columbia with blackheaded fireworm eggs (Li et al., 1993). These high parasitism rates can be linked to the fact that very little to no insecticides were used on those marshes since most broad-spectrum insecticides not only kill pest species, but also natural enemies. Marshes implementing IPM strategies were observed to foster natural enemy communities thereby benefiting from natural biocontrol and minimizing crop losses. For more information on how to select pesticides, please see this Oregon State publication or download the app "Reduce bee poisoning from pesticides".

In summary, the two biological control strategies that are the most relevant to cranberry at this time are augmentation and conservation. Augmentation biocontrol would require purchasing commercially-available natural enemies such as parasitoid wasps or nematodes and releasing them at the appropriate times and in the right amounts to best target the pest species. Conservation biocontrol could be implemented with minimal input by providing floral resources and habitat, reducing pesticide usage, and using reduced-risk pesticides to foster naturally-occurring populations of natural enemies.

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Calculating Percent in Bloom

By Allison Jonjak

There's no new information in this article. Cranberry growers today calculate % in bloom following the same time-tested calculation we've been using for generations. Because % In Bloom is the best way to time disease protection, we're providing a refresher article for easy access and to share with workers new to the beds.

1. Choose a bed of the variety you are curious about, and step carefully in, at least 5 paces from the ditch edge. Choose a "regular" place—not obscured by weeds, not a low spot, not a high spot.
2. Choose 10 random uprights. A safe way to do this is to choose the first 10 your hand finds, so you are not drawn to the furthest-ahead or furthest-behind uprights.
3. Count the number of pods (unopened flowers) on your 10 uprights.
4. Count the number of open flowers on your same 10 uprights.
5. Write down the number of flowers. Write down the total of pods + flowers.
6. Divide flowers by total (pods + flowers). Multiply by 100 to get % in bloom.

Calculating % in Bloom

Cranberry growers today calculate % in bloom following the same time-tested calculation we've been using for generations. Because % in bloom is the best way to time disease protection, we're providing a refresher article for easy access and to share with workers new to the beds.

$$\frac{\text{flowers}}{\text{pods + flowers}} \times 100\% = \%\text{ in bloom}$$

An example, if you have 34 pods and 31 flowers:

$$\frac{31 \text{ flowers}}{34 \text{ pods} + 31 \text{ flowers}} = \frac{31}{65}$$

$$\frac{31}{65} = 0.476$$

$$0.476 \times 100\% = 48\% \text{ in bloom}$$

Who is Pollinating the Cranberries? Find Out with 2+ Years of Data from WiBee!

By Eliza Pessereau

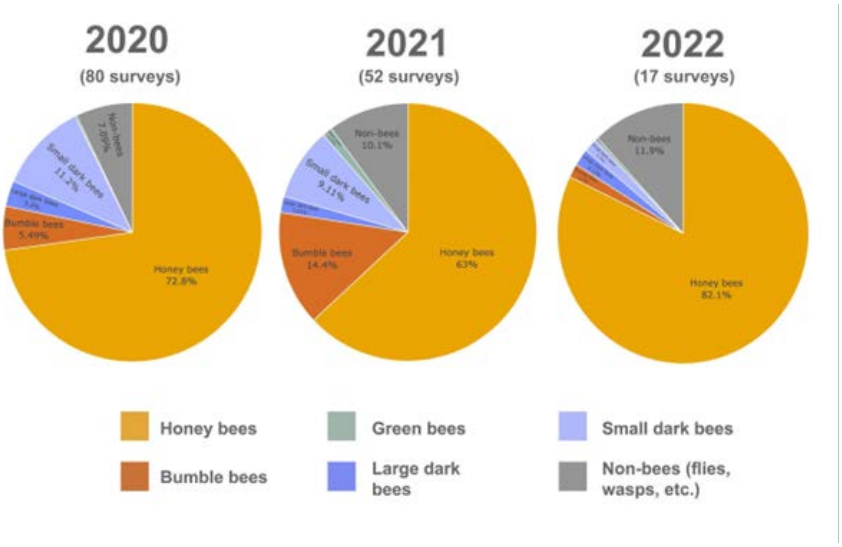
This is our third year of collecting data with the WiBee app! Thank you to all of the growers and scouts who have participated so far!

The WiBee, or Wisconsin Wild Bee, app was developed by the Gratton Lab in 2019 to answer grower's questions about pollination from wild bees. Using the app, growers, scouts, and gardeners can conduct simple, short pollinator surveys during crop bloom to better understand which wild bees are pollinating their crops. Aggregated survey data is publicly available online at https://data-viz.it.wisc.edu/wibee/.
Data is skewed by the number of surveys done, so every survey helps!

Tracking pollinator activity can help us understand which insects pollinate Wisconsin cranberries, and how we might support those communities. Download the WiBee app from the App Store or Google Play or visit www.pollinators.wisc.edu/wibee to learn more.

Thank you and we look forward to seeing your surveys!

Over the past 3 years of data collection, we have had 149 surveys conducted by cranberry growers and scouts. Surveys show that most cranberry bogs have bee hives nearby, so the majority of pollination is from honey bees. Bumble bees, small dark bees (which include carpenter and sweat bees, among others), and non-bees (like wasps or flies) also provide some pollination services.



Update from the Wisconsin Cranberry Research Station

By Wade Brockman

As of today we are about 50% in blossom at the station and with great weather in the forecast hopefully setting fruit by the weekend. The water control structure is about 80% complete with pretty much just landscaping left. Lots of mowing and weed eating in preparation for the August 10th field days.

Meet Stephanie Plaster, the New Extension Farm Management Outreach Specialist

By Stephanie Plaster

Hello everyone, I am Stephanie Plaster the new Extension Farm Management Outreach Specialist. The Farm Management Outreach Specialist position is a new, exciting position in the UW-Madison Division of Extension. This position will identify needs and provide outreach education to find solutions to the most critical issues facing Wisconsin agricultural producers in the areas of farm financial and strategic business management including:

Identifying and evaluating opportunities for agricultural businesses to meet their mission and goals and enhance their competitive position.
Identifying challenges to these opportunities resulting from variability of prices received, access to new markets, prices of inputs, and new technologies and practices affecting both yield and quality.
Whether beginning, early career, or established commodity or specialty crop operations are looking to grow, transition, or diversify their enterprises or invest in new ideas or technology, successful businesses utilize strategic business information, resources, and tools to make informed decisions.

So, how did I find myself in this awesome new position? I grew up in Cedarburg, Wisconsin on a ranchette where we raised horses and hunting dogs and then went to UW-Madison where I received a BS in International Agriculture and Natural Resources focusing on Animal and Dairy Science. While at Madison, I worked at the US Dairy Forage Research Center, competed at the National Meat Animal Evaluation Competition, researched feedlot steer welfare, and studied dairying systems in Mexico. I then completed a Master of Agriculture from Colorado State University in Integrated Resource Management where I worked with beef and sheep grazing and feedlot systems. After graduating, I came back to Wisconsin and worked at an urban aquaponic farm with both non-profit and for-profit entities.

I joined Extension in 2013 as the Langlade County Agriculture Agent where I ran the Langlade Potato Research Station. I transferred to Southeast Wisconsin where much of my family is to become the Ozaukee/ Washington Agriculture Educator and Regional Farm Management Educator for Ozaukee, Washington, Fond du Lac, and Sheboygan Counties. Throughout my career in Extension, I have focused on improving business development and transition skills to help folks make better, stronger decisions which enhance their business vitality and sustainability. You might remember me from my presentation at the Cranberry Virtual Brown Bag in February 2021.

I started this new role as a state outreach specialist on May 16th. In this role, my work will add value to that of partner organizations and community members through collaborations to develop and deliver educational programs for ag commodity and specialty crop industries across Wisconsin. I'm looking forward to meeting you at the Summer Field Day at the Wisconsin Cranberry Research Station. Please feel free to contact me directly via email at stephanie.plaster@wisc.edu or phone 262-277-6809 (call/text). My office is located at the Extension Ozaukee County office at 121 W Main St in Port Washington. Learn more about my work at https://farms.extension.wisc.edu/author/plaster/

Grower Updates

Vilas 51

By Jeremiah Mabie

We are off to the races up north! Things have moved along quickly as they usually do. I believe all planting is done and all growers have their bees. Mother nature has still been battling us with difficult conditions but luckily, we have not had any bad storm damage! Most vines are in full hook and opening fast, my Stevens that were behind the pace this spring have begun to catch up and I'm hopeful that bloom will not be scattered across the varieties. Won't be long and we will be looking at little berries! Let's hope for good bee working weather and I hope everyone has a wonderful Fourth of July!

Flying Dollar Cranberry

By Seth Rice

Hello everybody! Things are really ramping up here in the central Wisconsin cranberry crop. We have the pollinators working hard on the beds both bumblebee and honeybees. It's nice to see some pinheads come through in our early varieties but the Steven's are getting into decent bloom. Most growers have applied some sort of fungicide and and fertilizer as well to help out the vines. Most new plantings should be wrapped up by now from new bed planting to renovation projects. Busy, busy, busy! Stay safe.