CLIMATE CHANGE ADAPTATION PROGRAM

Vancouver Island Pest, Pollinators and Beneficials Project

Project Report

Funding for this project has been provided by the Governments of Canada and British Columbia through the Canadian Agricultural Partnership, a federal-provincial-territorial initiative. The program is delivered by the Investment Agriculture Foundation of BC.

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Investment Agriculture Foundation

FUNDING PROVIDED BY

CANADIAN AGRICULTURAL PARTNERSHIP

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Acknowledgements

This report was prepared for the Islands Agriculture Show Society in partnership with the BC Climate Change Adaptation Program.

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All photos in this report taken by Bonnie Zand unless otherwise noted.

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Vancouver Island Agricultural Adaptation Working Group including representatives from:

- Comox Valley Farmers Institute
- Mid-Island Farmers' Institute
- Cowichan Agricultural Society
- Alberni Farmers' Institute
- Peninsula & Area Agricultural Commission
- Island Milk Producers
- Island Egg Producers
- Wine Island Growers Association
- Regional District of Nanaimo
- Comox Valley Regional District
- Alberni-Clayoquot Regional District
- Cowichan Valley Regional District
- Capital Regional District
- BC Ministry of Agriculture and Food
- BC Climate Change Adaptation Program

In addition, the project team would like to thank the agricultural producers in the Comox and Cowichan regions for data collection completed on their farms, as well as hosting on-farm workshops.

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Tables and Figures

Overview

The Vancouver Island Pests, Pollinators and Beneficials Project (VIPPB) had its first season in 2021. This BC Climate Change Adaptation Program (CCAP) project had the overarching goal of increasing grower knowledge and engagement with Integrated Pest Management (IPM). IPM is an important tool that can be used to improve pest management in the face of many changing factors, including climate change and the introduction of new pests, as well as allowing for the management of existing pests in a more sustainable way. This project was also a response to a lack of Vancouver Island wide monitoring of current pests and the beginning of a knowledge baseline for Vancouver Island pests and beneficial insects. In future years this baseline will be crucial in understanding how insect populations are changing.

To achieve these goals VIPPB initiated a three-part project:

- Part 1: Pest monitoring.
  Monitoring sites were established on multiple farms and to monitor multiple crops (berries, tree fruit, and vegetable). Sites were in the Comox and Cowichan Valleys and were monitored biweekly over the season (June to September), using a variety of trapping techniques, in addition to field walks, to detect pest and beneficial insects.

- Part 2: Beneficial insect monitoring.
  Citizen scientists (gardeners, farmers, naturalists) were recruited to join a project on the citizen science platform iNaturalist, and to record findings of any arthropods they found in agricultural setting on Vancouver Island (including pests, pollinators and beneficials).

- Part 3. Outreach / communications.
  A biweekly newsletter kept growers up to date on the findings of the project and informed their own monitoring and management efforts. Workshops were held in multiple communities, and over Zoom, introducing growers to the project and teaching IPM skills.

The 2021 project was successful and collected a large amount of useful baseline data. Future monitoring efforts in 2022 and beyond can build on this success and continue to educate growers and gather more information about the pests and beneficial insects present on Vancouver Island.

Pest monitoring methods and results

Over the course of the 2021 season twelve farms were monitored, six in the Cowichan Valley and six in the Comox Valley. Each farm was visited every other week throughout the 16-week season. Farms ranged from very small organic market gardens to large scale conventional farms.

The first farm visits occurred during the week of May 17th, with all farms receiving monitoring by the first week of June. The field season ended on September 10th.

Multiple monitoring types were used on each farm to gather data on wide diversity of pests. These included yellow sticky cards, pheromone traps, vinegar traps, and field walks. Details are provided below on the specific monitoring methodology for each crop, as well as a summary of the most relevant

monitoring results for each crop. Four crop types were surveyed: Brassicas, Carrots, Berries (Blueberry, Strawberry, Raspberry), and Apples.

Carrots:

Yellow sticky trap for carrot rust fly

The main arthropod pest of carrots in the Vancouver Island growing region is the carrot rust fly (*Psila rosa*). This pest is best monitored during the adult flight stage using yellow sticky traps. The number of rust fly present on traps corresponds to the relative risk to the crop, with a suggested threshold of 0.1 -0.2 rust fly / trap / day.

Sticky traps were placed on the edges of the carrot fields, at a rate of two to four per field, depending on the size of the field. Traps were attached to stakes just above the level of the crop and were collected during each visit. Rust flies were counted on each sticky card and the cards were labeled, wrapped in saran wrap and stored in a freezer. Carrots were monitored at five Comox and four Cowichan sites.

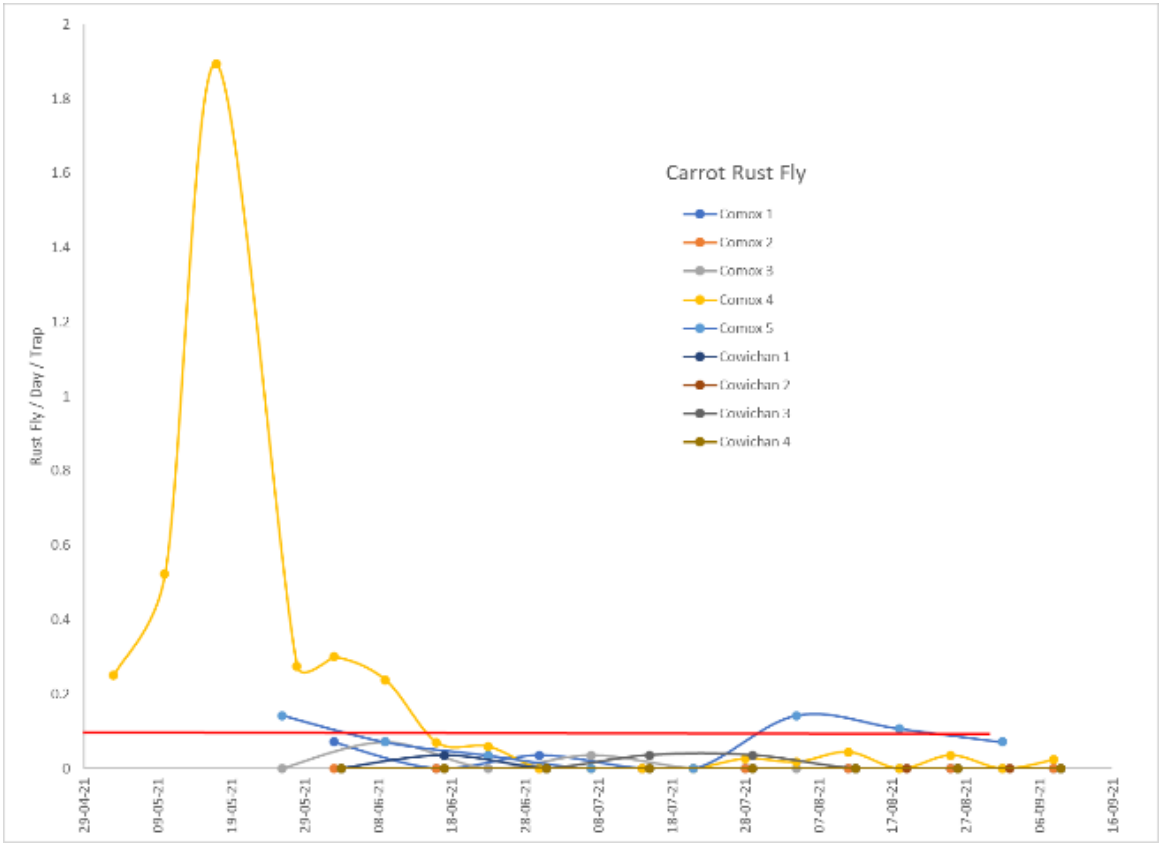

Figure 1. Rust fly levels on nine Vancouver Island farms during the 2021 growing season. The red horizontal line depicts a recommended action threshold for carrot rust fly levels. The Comox 4 farm was also monitored using the same protocols before the VIPPB season began.

Data Collected: Number of rust fly per card.

Results: Carrot rust fly levels were below a threshold of 0.1 rust fly / card / day for most farms through the survey period. Additional data is included here from a farm that was monitored using the VIPPB protocols starting prior to the VIPPB survey period. This farm (Comox 4 in figure 1) had rust fly levels high above threshold, suggesting that in 2021 the VIPPB survey missed the highest rust fly levels. Many of the farms where monitoring occurred were using row cover as a year-round method of excluding the rust fly; however, based on our 2021 data that protection was not required on any farm in our study from mid June to late July. This data can help growers to make decisions about removing row covers, timing of planting, and timing of harvesting.

Brassicas:

A wide variety of brassica crops are grown on Vancouver Island, ranging from baby salad greens to long season cabbages to root brassicas. Brassicas can be in the ground throughout the season. Many different pests impact brassicas, with their relative importance depending on crop timing, seasonal weather conditions, and crop type. The main crops monitored included kale, broccoli, cauliflower, cabbage, and brussels sprouts, although other varieties were also monitored occasionally.

Brassicas were monitored on five Comox Valley farms and four Cowichan Valley farms regularly, while one Cowichan farm had brassicas monitored once. Monitoring consisted of field walks, with one to two passes through each planting, checking five sites per pass. At each site three to five plants were inspected for pests (five plants per site when plants were not touching, or three plants when they were touching). For each plant the top and bottom sides of leaves were inspected, as well as growing points. When plants were small and stems were accessible, the soil at the base of the stem was also examined for evidence of cabbage maggot eggs. Plants that were visibly wilted were pulled to look for root maggot. In mixed fields, samples were targeted across the range of cultivars and ages.

On many of the farms, brassica crops were planted sequentially, with multiple crop varieties and stages present at the same time. Management strategies varied widely between growers. Because of this level of variability, there was also considerable variation in pest levels between farms and generational trends were often not detectable. However, trends in presence and absence of pests were observed.

Data Collected:

- Aphids:
    - Cabbage, or Green
    - Low (<5), medium (5-50), or high (50+) populations
- Caterpillars (eggs, small, medium, or large larva, pupae, number of larvae, species). Presence of adult cabbage white.
- Number of plants with flea beetle (low (1-2), medium (2-10), high flea beetle (10+)), as well as presence of flea beetle feeding damage.
- Additional notes were taken on other pests observed.

Results:

Cabbage Maggot

Cabbage maggot (*Delia radicum*) eggs and larval infested plants were present at the beginning of the monitoring period; however, after early June no further plants were observed with larval damage. Cabbage maggot eggs continued to be periodically observed at very low levels throughout the summer but if these eggs survived the heat, the larva did not produce sufficient plant damage to be noticeable. In 2021 the damage caused by this pest appeared to be restricted to the early season. It would be beneficial to growers to see how this could change during a cool wet summer (compared to the hot and dry summer of 2021).

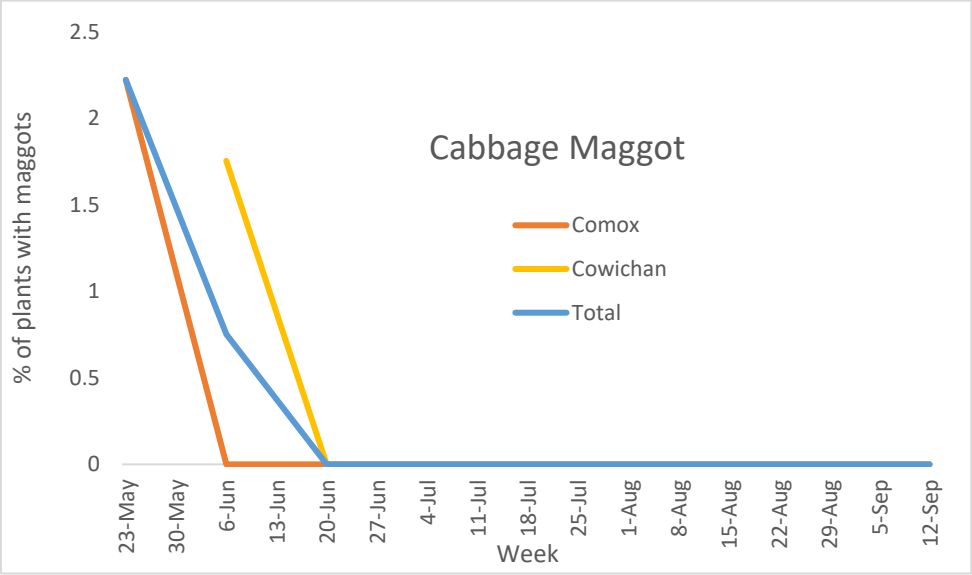

Figure 2. Percentage of brassica plants in samples visibly infested

Cabbage aphids:

Cabbage aphids (*Brevicoryne brassicae*) can be a major pest for brassica growers, contaminating crops even at low levels, and causing cupped and distorted leaves at higher densities. If left unmanaged there are many natural enemies of cabbage aphids that will bring populations levels back down, however, damage has often already occurred by the time the population is under control.

In 2021 the first detection of cabbage aphid occurred on June 16th and average levels increased steadily after that point. However, there was substantial variation between farms, with one farm having no detections of cabbage aphids throughout the season, while other farms had 100% infestation levels at some points during the season. Within farms levels varied from week to week based on management strategies, beneficial levels, crop varieties and crop stages.

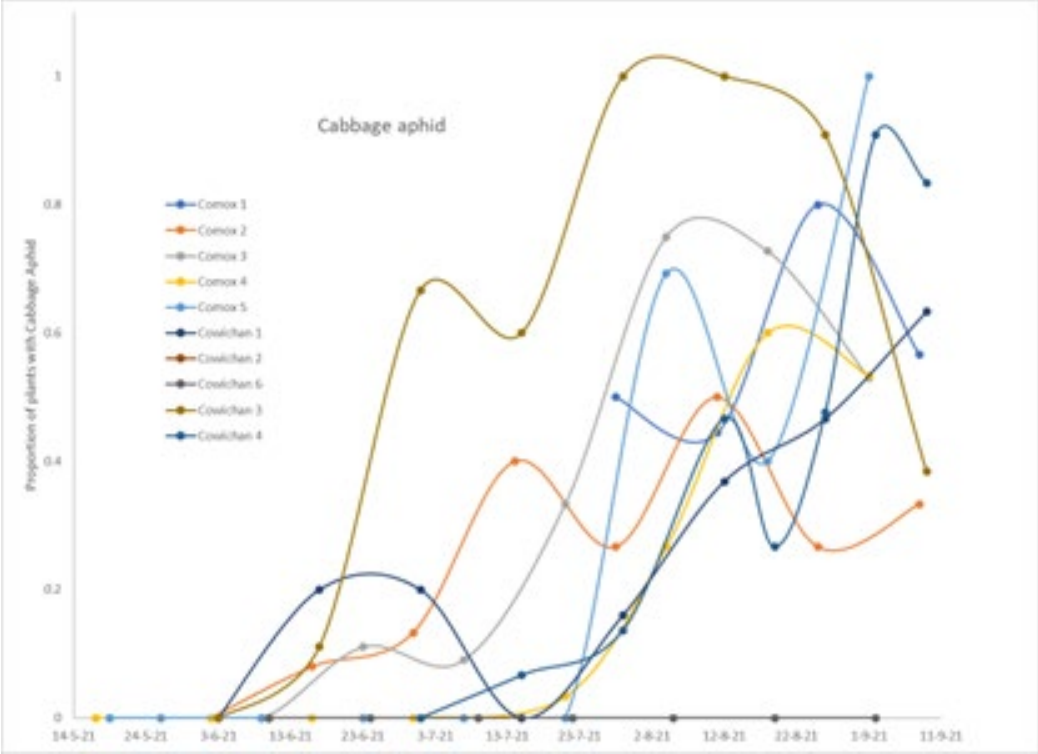

Figure 3 - Proportion of plants infested with cabbage aphids.

Caterpillars:

Three main species of brassica eating caterpillars were monitored in 2021, the imported cabbage worm (*Pieris rapae*), the diamondback moth (*Plutella xylostella*) and the cabbage looper (*Tichoplusia ni*). The most common of these was the imported cabbage worm, which was present throughout the monitoring season and was present on all regularly monitored brassica plantings.

Small cabbage aphid colony and a medium sized imported cabbage worm caterpillar on a brassica leaf

Diamond back moth caterpillars were first detected the week of July 18th and continued to be present until the end of the season. They were observed at all five Comox Valley farms, but only three Cowichan Valley farms. Cabbage loopers were also first detected the week of July 18th and were present only on three Comox Valley farms and two Cowichan Valley farms and at much lower levels that the other two species (figure 4). Overall, caterpillar levels varied greatly from farm to farm, due to the same factors that impacted cabbage aphid levels.

Data on which caterpillar species are currently active is helpful to growers because it allows them to know what species to watch for and to adjust their management accordingly. However, given the great variation in caterpillar numbers between farms (figure 5), reporting absolute numbers is not likely to be helpful to growers.

In addition to the three main species, various cutworm species and egg masses were occasionally observed on brassica plants.

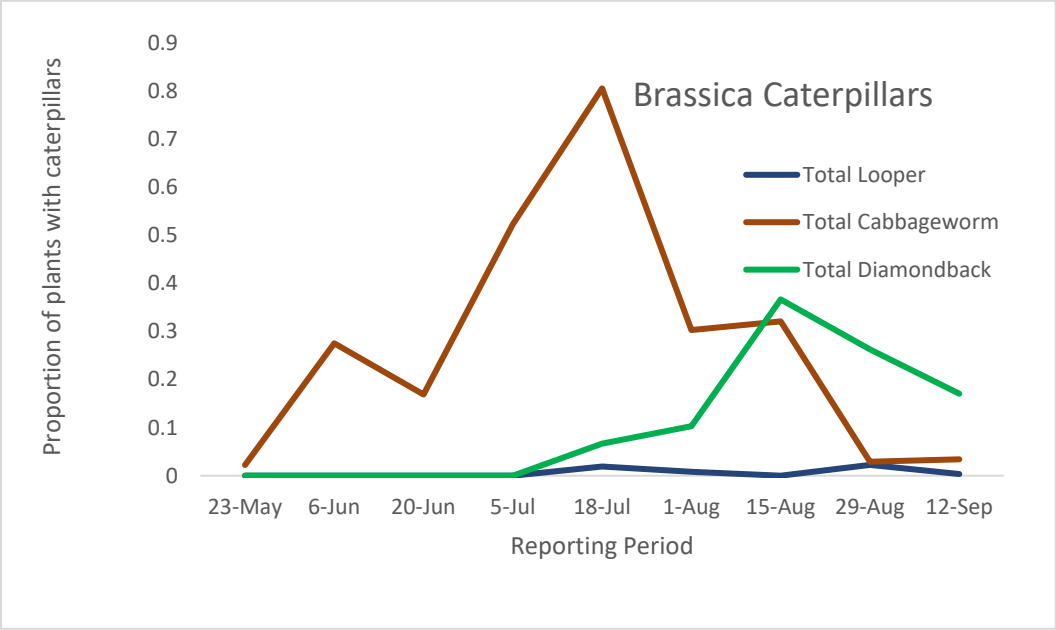

Figure 4. Average proportion of plants infested with the three major caterpillar species.

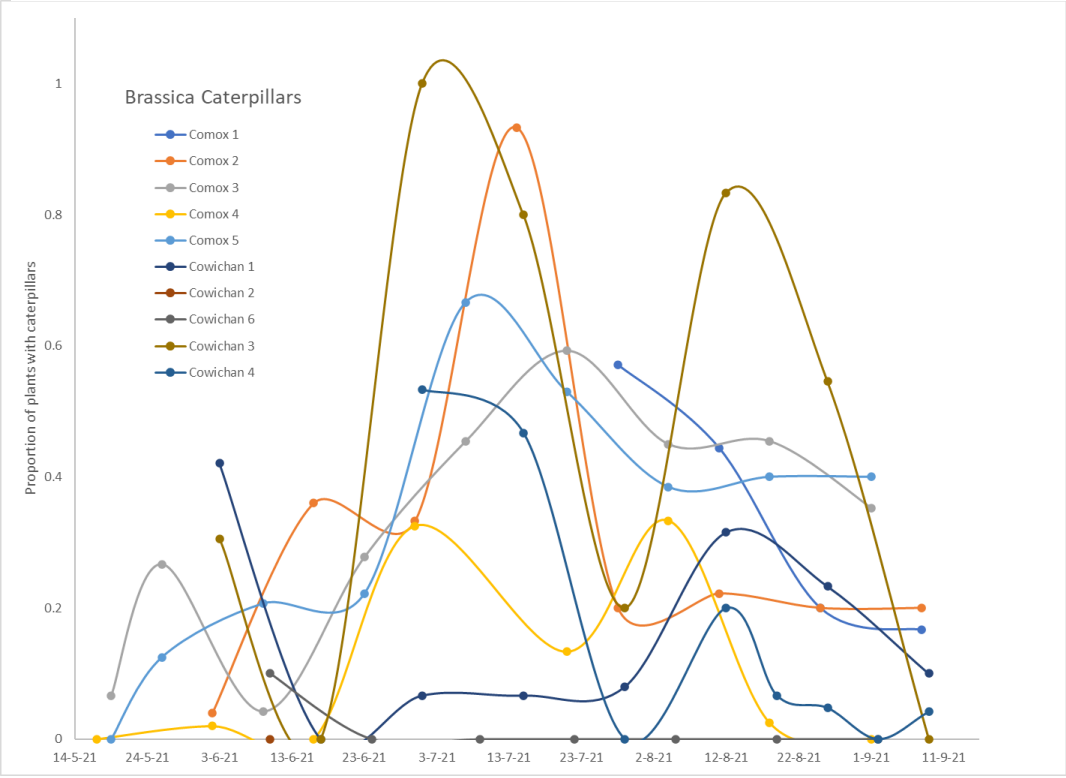

Figure 5 - Proportions of plants infested with at least one of the three main caterpillar species.

Flea Beetle:

Crucifer flea beetle (*Phyllotreta cruciferae*) was another pest present in brassicas throughout the season. This pest occurred on four Comox and three Cowichan farms. Among farms with the pest present, there was variability in the levels of infestation. Some farms had high levels of flea beetles (up to 100% infestation) for 8 out of 9 weeks of the monitoring season; other farms had low to moderate levels a few times a year. Variation in flea beetle levels was likely due more to management strategies and crop age than to distinct pest generations.

Crucifer flea beetle on brassica plant.

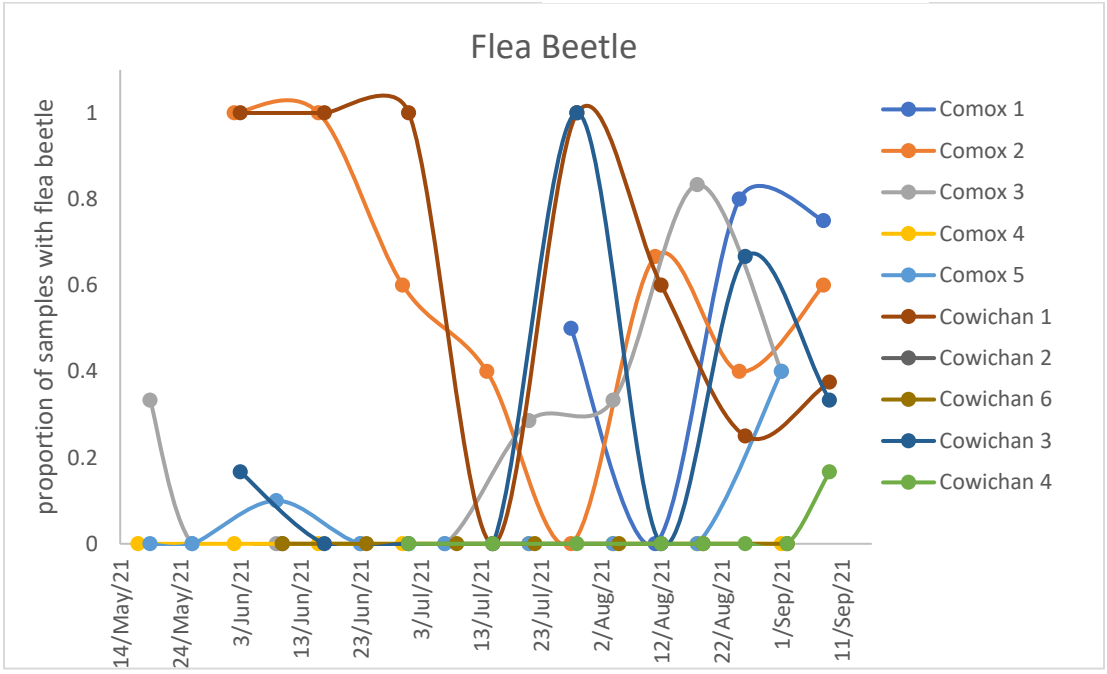

Figure 6. Crucifer flea beetle infestation levels on ten Comox and Cowichan Valley Farms during the 2021 season.

Thrips damage on a brassica leaf. Photo by Natasha Tymo.

Additional pests:

Thrips were observed on brassicas beginning on July 15th and remained present until the end of the season. They were observed on four Cowichan Valley farms and four Comox Valley farms and became present in large and damaging numbers on some farms (see photo below).

Sporadic spider mite infestations were observed on a few farms, but this never became a large-scale problem, and appeared to be due to movement into the brassicas from other infested crops.

Apples:

There are several pests of apples present on Vancouver Island. The foliage and blossoms can be attacked by multiple caterpillar species, mites, leafhoppers, and aphids. The fruits are attacked by two main pests: the codling moth and the apple maggot. Pheromone traps were used to record male codling moth activity, while red spheres coated in tangle foot and baited with 100% ammonium acetate were used to detect apple maggots. These traps were checked during regular monitoring visits.

Pheromone traps were first placed during the weeks of June 23rd, while sticky spheres were first placed during the weeks of June 9th. The bait and tanglefoot were replaced on an as needed basis over the summer, while the codling moth pheromone plugs were replaced once during the summer. Delays in shipping meant that pheromone traps were not in place early enough to capture data for the full season. Trap catches were confirmed by inspecting apples for signs of damage. Foliage pests were monitored by checking five leaf and five blossom clusters per tree (up to two trees per farm). Apples were present on four Comox and four Cowichan farms, however only 2 farms in each region were actively managed orchards, while the remainder of the apple sites were largely unmanaged trees.

Red spheres coated in tanglefoot and baited with ammonium acetate were used to monitor apple maggot.

Data Collected:

- Number of coddling moths per trap
- Number of apple maggot per trap.
- Number of leaves with aphids (<5, >5, winged)
- Number of leaves with spider mites (low 1-5, medium 5-10, high 11+)
- Number of leaves with predators (type and quantity)
- Number of leaves / flower clusters with caterpillars, type present (leafroller vs spanworm), average size of caterpillars.
- Number and type of damaged fruit.

Results:

Apple maggot: The first detection of apple maggot (*Rhagoletis pomonella*) occurred on July 29th in the Cowichan Valley and August 4th in the Comox Valley. All farms with apple trees had detections of apple maggot, and apple maggot damage was observed in fruit. Numbers varied greatly between farms, with maximum levels on some farms of 9-10 adults / trap / week, while other farms had maximums of less than 1 adult / trap / week. Apple maggot continued to be present until the end of the monitoring period. Several growers expressed concern about the impact of apple maggot on their crops and the project data can assist growers in knowing if apple maggot adults are currently active in their region.

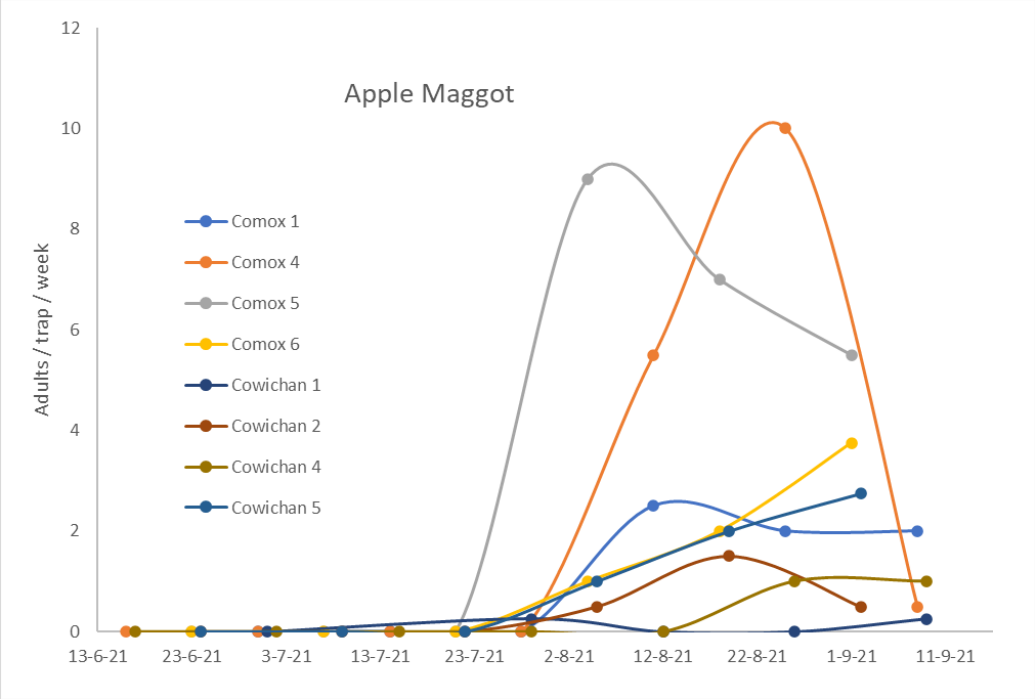

Figure 7. Quantity of apple maggot adults caught per trap per week.

Codling moth: Adult male codling moth (*Cydia pomonella*) catches began immediately after traps were placed and continued until the end of the survey period. It was clear that the traps were placed during the end of a peak in codling moth activity (Figure 8). As well, codling moth damage in fruit was detected starting on June 2, before traps were placed.

Codling moth larva feeding damage to a young apple. Photo by Natasha

While codling moths were detected on all farms, levels in the Cowichan Valley were higher than those in Comox Valley. The Cowichan Valley farms also experienced an additional peak of codling moth activity during mid-August, which was did not occur in the Comox Valley (see figure below). Although codling moth data collection did not start until after codling moth flight had begun, in future years it could be helpful to growers to provide a confirmation of the start of codling moth flight, to accompany degree day-based management strategies and to determine if the Cowichan Valley continues to have an additional codling moth generation compared to the Comox Valley.

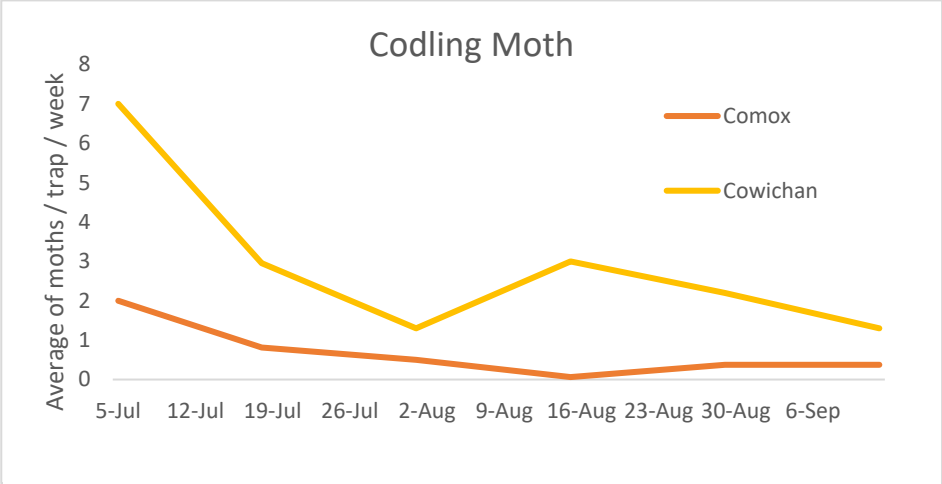

Figure 8. Average number of adult codling moth caught in pheromone traps each week

Additional pests:

Additional pests detected in apples included aphids, leafrolling midge, thrips, leaf hoppers, leafrolling caterpillars, apple leaf skeletonizer, cherry slug sawfly, and leafminers.

Berries:

VIPPB monitored three fields each of blueberry, raspberry, and strawberries in the Comox Valley, and two fields of each berry type in the Cowichan Valley. In addition, the MAFF regional agrologist placed spotted wing drosophila (SWD) traps in blueberry and raspberry fields and hedgerows in the Victoria and Saanich area, providing SWD data for that region.

Berry crops share several generalist pests, as well as each having their own pest complexes. VIPPB berry monitoring consisted of field walks to monitor for a wide variety of caterpillars, aphids, and mites, as well as vinegar traps for SWD placed in crops and in hedgerows. Monitoring was slightly different for each crop, as follows:

Strawberries: Make one to two diagonal passes through the field, inspecting four sites per pass. At each site inspect five plants for caterpillars, and pick five mature, fully opened leaves to inspect for aphids, spider mites, and predators. Place SWD trap and collect weekly / biweekly.

Blueberries: Inspect minimum four sites per field, spaced apart. For fields greater than ten rows, inspect two rows (four sites each). For each site inspect ten leaf and ten flower/fruit clusters. Place SWD trap and collect weekly / biweekly.

Raspberries: Inspect minimum four sites per field, spaced apart. For fields greater than ten rows inspect two rows (four sites each). For each site inspect ten leaf and ten flower/fruit clusters. Place SWD trap and collect weekly / biweekly.

SWD trap placed in blackberry bushes in a

Spotted wing drosophila monitoring occurred on all farms, including those without berry crops. Each farm (six in each region) had a trap baited with apple cider vinegar and unscented dish soap placed in the field margin, near blackberry bushes or wild habitat. Those farms with berry crops had an additional pair of traps in berry fields. Where multiple berry crops were present on the same farm one trap was placed in each crop.

Data collected:

- Number of leaves with aphids (<5, >5, winged).
- Number of leaves with spider mites (low 1-5, moderate 6-10, and high 11+).
- Number of leaves with predators (type and quantity).
- Number of leaves / flower clusters with caterpillars, type present (leafroller vs spanworm), average size of caterpillars.
- Presence / absence and sex of SWD in traps within berry fields.
- Number and sex of SWD in hedgerow traps.

Results:

Spotted Wing Drosophila: There were strong seasonal, regional and crop specific patterns to SWD (*Drosophila suzukii*) occurrences. The pest showed up earliest and in the greatest numbers in raspberries, then in blueberries. SWD did not appear in strawberries until the end of the monitoring season.

There was also large difference between the three regions. Victoria consistently had the highest SWD presence, then the Cowichan Valley and then the Comox Valley. As SWD is a critical berry pest, providing this information to growers allowed them to better understand their current level of risk, based on their region, crop and seasonal progress. While BIPPB did not regularly do fruit test, information on this testing method was provided to growers to assist them with monitoring their own fruit.

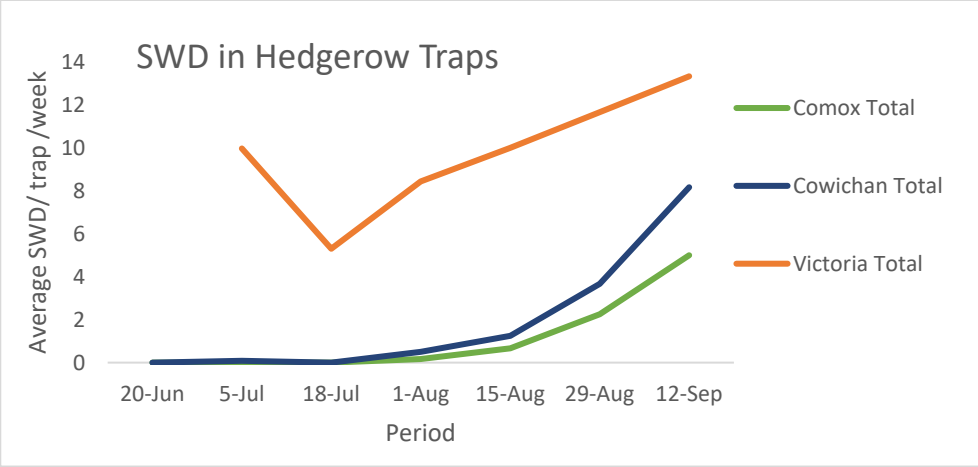

Figure 9 - Average numbers of SWD in hedgerow traps.

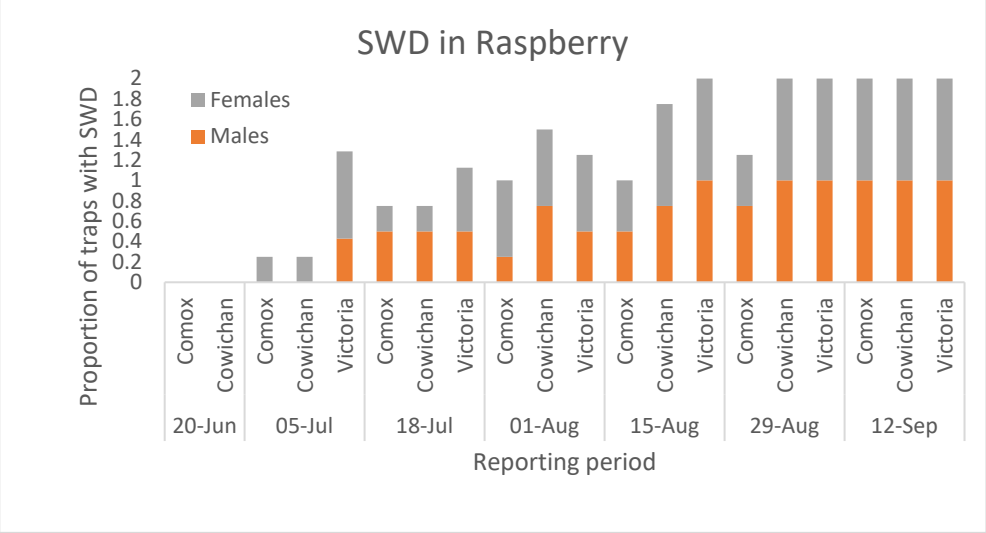

Figure 10 - Proportion of SWD traps in raspberry detecting SWD.

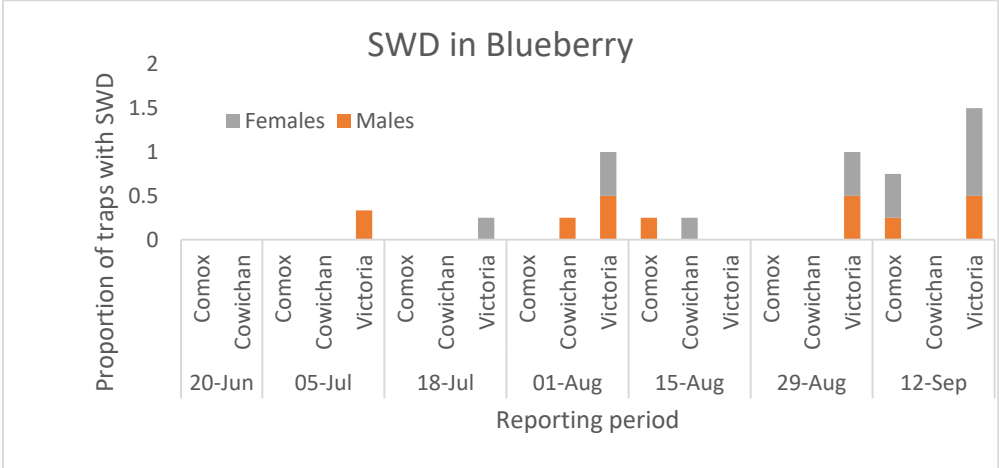

Figure 6. Proportion of SWD traps in strawberry detecting SWD

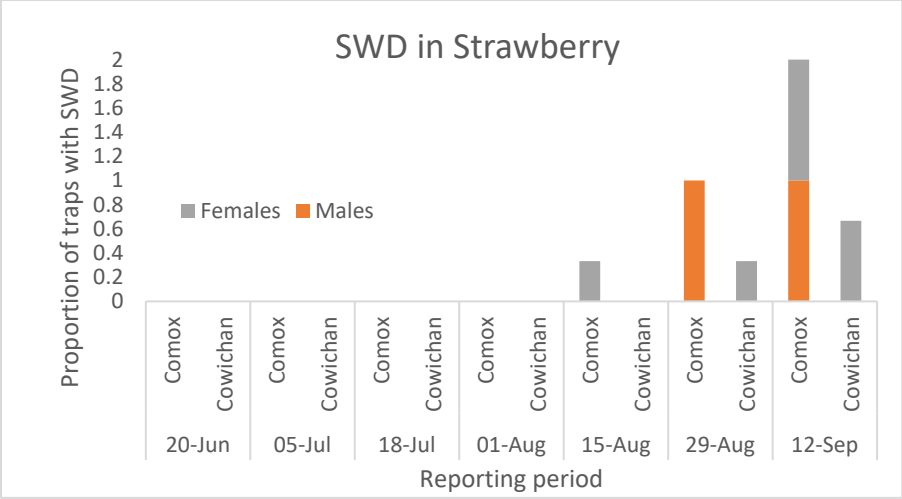

Figure 7. Proportion of SWD traps in blueberry detecting SWD

Two Spotted Spider Mites:

Strawberries had the largest spider mite (*Tetranychus urticae*) populations, with spider mites present at moderate (six-ten mites per triplet) populations in most farms during at least one point over the season. Two farms had high mite populations (eleven+ mites per triplet), while one farm had almost no mites. The general trend was that mite levels rose in the spring, peaked in early to mid July, and then fell before increasing again in September.

The drop in numbers of mites was likely due to a combination of mowing of the most heavily infested June bearing strawberry leaves after harvest, and an increase in the presence of mite predators (predatory mites, Orius sp.; spider mite destroyer; lady beetles) that were also seen in August.

Spider mite levels were lower in raspberries than strawberries, remaining below five mites per triplet in all but one farm, and spider mite predators were also observed. No spider mites were observed in blueberries.

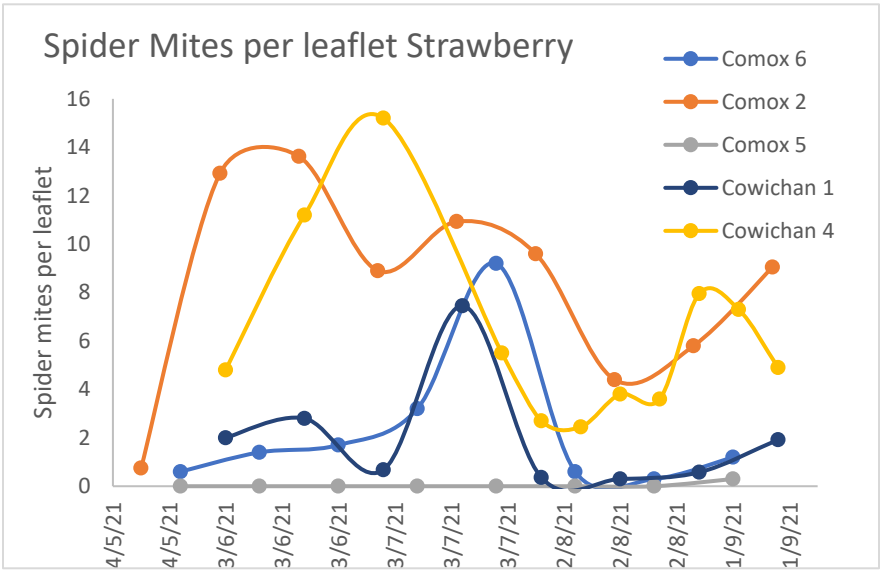

Figure 8. Average spider mites observed per leaflet in strawberry plantings

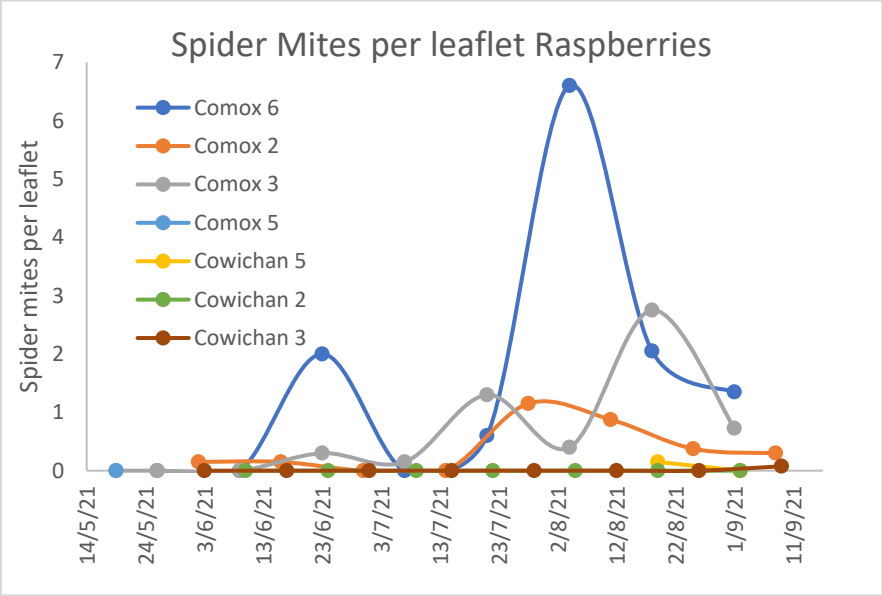

Figure 9. Average spider mites observed per leaflet in raspberry plantings

Caterpillars: The primary caterpillar pests observed during the monitoring period in all berries were leafroller caterpillars. In raspberries leafrollers were only observed early in the season, while blueberries had an early and mid-season peak. There were three peaks in leafroller activity in strawberries: in the spring, mid-season and again in the fall. However, in all three crops caterpillar activity was low, with typically less than 1% of leaves infested. Monitoring began too late to detect spanworm, although some chewing damage was present on leaves and flowers in the early season, which may have been due to spanworm.

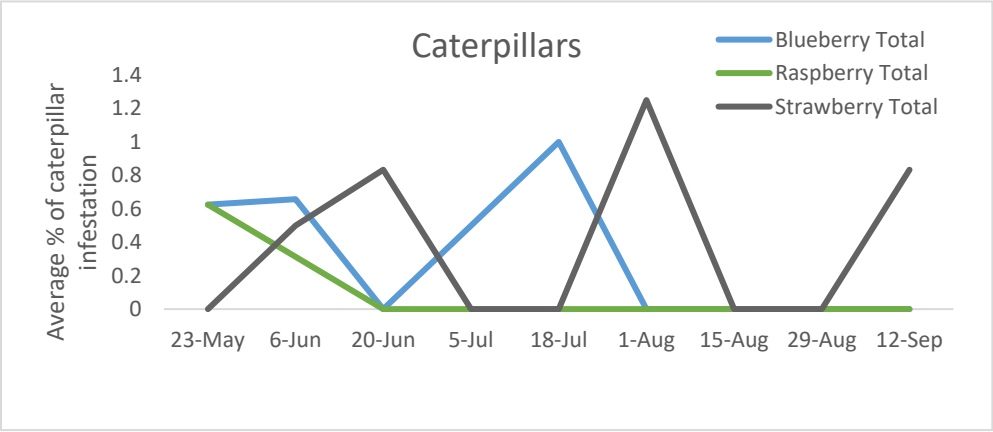

Figure 10. Average percent of leaf clusters infested with caterpillars in berry crops.

Aphids: Aphids of various species were present in all berry crops. Numbers were low at the start of the monitoring season, rose during the mid-season, and were dropping again at the end of the season. The aphid populations in strawberries rose to the highest levels, averaging over 35% leaves infested in June and July before dropping in August. Aphid presence in blueberries peaked later in the season, in July, before dropping and remaining low for the rest of the season. Raspberry aphid levels were low for most of the season, with a high of 12% in August. Many beneficial insects appeared in berries as the season progressed, including parasitoid wasps, hoverfly larva and ladybeetles.

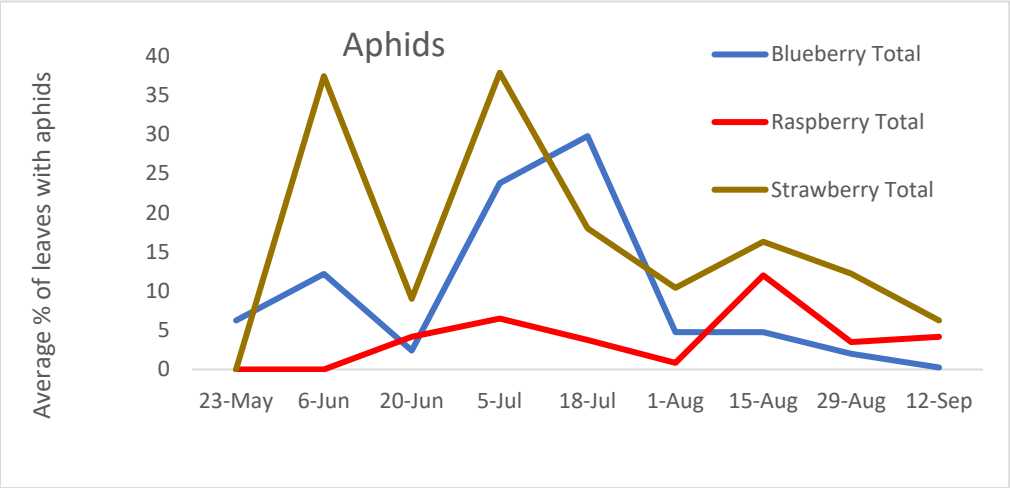

Figure 11. Percent of leaf clusters infested with aphids in berry crops.

Additional pests: Over the course of the season other berry pests observed included spittlebugs, raspberry sawfly, leafhoppers, Lygus, stink bugs, raspberry crown borer, thrips, blueberry tipworm, earwigs, cyclamen mites, whitefly, fleabeetles, and slugs.

Beneficial insects

Pollinators, predators, and parasitoids are all important beneficial insects to agriculture, but they are often overlooked. This part of the project set out to document the diversity of beneficial insects present in agricultural settings by engaging the producers and the broader public through the citizen science platform iNaturalist. Gardeners, farmers, and naturalists were recruited to join the project and were invited to add photos of insects they observed in agricultural settings to the project.

During the process of adding observations, the participants were also encouraged to report the agricultural scale, the type of farming practices, the crop, and any additional notes they had on the observation. The VIPPB project team also documented insects observed during crop monitoring on the iNaturalist project.

Fifty-nine people joined the VIPPB project as members and 32 added observations. As of October 25th, 2021, the project had a total of 825 different observations and 234 different iNaturalist members had contributed identifications to the project. A total of 277 different species / groups had been observed. Observations and identifications have continued to be added to the project since this date.

Results

iNaturalist records as “research grade” only those observations that have been identified to species level by at least two different (and agreeing) members. Many insects are not able to be identified to species level, and therefore all observations are reported here, rather than just research grade observations.

Commonly reported taxa included bees (198 observations), beetles (130 observations), flies (111), bumble bees (100), Lepidoptera (90), Hemiptera (81), lady beetles (70), wasps (Ichneumonoidae 23, Vespoidea 28, Crabronidae 14), Hover flies (47), hairy belly bees (37), spiders (34) butterflies (32), stink bugs (24), sweat bees (22), leaf beetles (16), lacewings (14), aphids (14), ground beetles (12), slugs / snails (11) and leafhoppers (10).

The greatest number of observations were found on hobby farms and in gardens, and there was good uptake of the program with garden groups and naturalists.

Table 1. VIPPB iNaturalist data accessed on October 25, 2021

Group	Observations all	Species All	Observation Research Grade	Observations Hobby Farm / Garden	Observations Small – Large Scale Agriculture	Observations Non-Agricultural
All observations	825	277	356	529	264	25
Bees all	198	36	91	139	45	13
Bumble bees	100	8	56	63	29	7
Flies all	111	51	46	75	37	0
Hover fly	47	18	29	37	11	0
Beetles all	130	40	66	63	56	13
Lady Beetle	70	11	44	33	30	4
Ground Beetles	12	7	6	7	4	1
Spiders	34	15	15	25	9	0

Outreach:

Since the main focus of the project was to disseminate information to growers, outreach was an important element of the project. The data collected from monitoring was used to support growers in IPM and decision making in real time. The five main methods of grower outreach were:

- A biweekly newsletter
- Social media
- The iNaturalist platform
- On-farm IPM workshops / events
- Farmer-led monitoring

Newsletter:

A biweekly newsletter was published nine times over the 2021 season, with the first edition on May 25th and the last on September 14th. Each edition reported on the monitoring data collected over the previous two weeks. The newsletter was Initially distributed by email to 54 contacts, including local farmers' institutes (14) and growers' associations (23). It was also promoted over social media (twitter and Facebook). By the last newsletter there 143 email subscribers, which resulted in 258 separate "opens" through our subscribers (some subscribers were forwarding the email), and 185 "clicks" from social media (mostly Facebook).

The information provided in the newsletter varied over the season. In addition to monitoring reports on the crops and regions being monitored, each newsletter also provided some elements of a beneficial insect focus, a pest insect focus, an IPM principal, an iNaturalist update, information on upcoming

events and a report from the MoAFF. All newsletters have been archived and can be viewed at: https://drive.google.com/drive/folders/1eVTZGi1v5Mt5vSx4NHeHDnweCh3oP7pV?usp=sharing.

Social Media:

The VIPPB project managed two social media accounts, one on twitter and one on Facebook. The Facebook page[1] **Error! Hyperlink reference not valid.** had 38 posts over the season, and the page had 144 followers, 99 likes, and had reached 10,000 + people by the end of the season. Our last newsletter post on Facebook reached 1,799 people and had 44 link clicks.

The project twitter account[2] had 24 tweets and 10 followers.

At least one post per week went out on both accounts, either a link to the current newsletter or a link or information note about a pest of interest. iNaturalist and beneficial insect updates also went out on the Facebook page, as well as information about upcoming on-farm workshops. The Facebook page had much more engagement than the twitter feed and was shared to multiple farming and gardening pages and to Vancouver Island farmers' institutes. The iNaturalist updates and beneficial insect topics were the most popular posts and some were widely shared. The most popular post highlighted beneficial ground beetles, and reached 3,000 people, with 58 likes and 131 link clicks.

iNaturalist:

The iNaturalist project was promoted via email to multiple garden groups, bee clubs, and farmers' institutes on Vancouver Island. An introductory online training / webinar was well attended, with 30 "live" participants and the link to the recording was also sent out to all registrants (71 registrants). While some people only participated in the iNaturalist portion of the project, some participants also opted to receive the newsletter and follow the Facebook page.

There is a journal feature on iNaturalist which was used to create six journal posts, some of which also became Facebook posts and Beneficial Insect Features in the newsletter. Notifications about the journal posts were sent to all the members of the project and were used to highlight some of the diversity of insects found by project participants. The journal posts that were shared on Facebook were the most widely shared and liked posts. iNaturalist does not provide any statistics around engagement with journal posts.

Workshop / Events:

Three on-farm workshops occurred over the summer of 2021. At these events participants were introduced to IPM principals, and then monitoring techniques were demonstrated in the field. Depending on the host farm's crops, participants had the opportunity to see some combination of saw codling moth pheromone traps, SWD traps, and yellow sticky cards. Samples of pest and beneficial insects were presented, and participants undertook field walks through various crops, learning to observe and identify pests and beneficial insects present.

During the winter of 2021 /2022 one presentation was delivered to the Mid Island Farmers' Institute, providing a summary of the monitoring data collected over the summer and promoting the newsletter and iNaturalist projects. Information was provided on how growers can use the area wide monitoring

[1] https://www.facebook.com/VIPestspollinatorsandbeneficials
[2] https://twitter.com/VI_PPB

data to enhance their own management. Covid postponed other presentation opportunities and additional knowledge transfer events are expected in the spring of 2022.

Table 2. Outreach and knowledge transfer events occurring in the 2021 season.

Date	Event	Attendance
10-Jun	iNaturalist webinar	30
08-Jul	Comox Valley IPM Workshop	14
14-Jul	Saanich IPM Workshop	12
28-Jul	Cowichan IPM Workshop	12
15-Nov	Mid Island Farmers' Institute meeting	12

Farm-Led Pest Monitoring:

In addition to the official monitoring carried out by the VIPPB project team, growers were also encouraged to submit data about pests observed on their own farms through a google form, for use in the newsletter and as an engagement tool. It was hoped that the farm-led monitoring would support growers in their own monitoring by allowing growers to submit photos for pest confirmation. This program was promoted during the workshops, in the newsletter, and to the farmers' institutes.

Growers were able to sign up to receive reminders to monitor, and twenty-one people signed up. However, only seven people sent data through the form. Several other people sent queries or photos directly for ID assistance. During the end of season survey a high proportion of respondents wanted the project to provide confirmation of pests from photos.

Successes, challenges, and future considerations:

Pest Monitoring:

Successes: The VIPPB project was able to provide comprehensive monitoring on a broad suite of pests, in multiple crops. Information on pest timings provided information to growers about which pests were currently active, had potential to simplify pest monitoring for growers, and increased awareness of possible issues. By monitoring each crop on multiple farms per region, between farm variability was observed. The data provided was particularly important for new entrant growers, who may not have been as familiar with the variety of pests present.

Challenges: A relatively late Spring project start combined with supply chain issues meant that traps did not arrive for the start of the season – SWD and apple maggot traps were in place starting June 9th, while codling moth traps were not placed until June 23rd. For both SWD and codling moth, detections began immediately after traps were placed, indicating that the pests were active prior to traps placement.

Some pests were also missed due to the project monitoring start and end dates. For example, no spanworms were detected, and most of the first generation of carrot rust fly was missed.

Many pests were highly variable between farms and were impacted more by management actions than by seasonal progression. This was especially true in annual crops such as brassicas, where crops were planted and harvested continually throughout the season. It was difficult to present data on variable

pests in a format that was useful to all growers. Having multiple examples of each crop was integral to understanding the differences between farms.

There was no data gathered for Victoria / Saanich peninsula farms. While the Cowichan Valley farms were similar in latitude to the Saanich Peninsula, there were large differences in SWD numbers between the two regions. It is possible that other pests may also vary between regions. A lack of monitoring sites in the Saanich Peninsula may have also led to reduced engagement with those growers.

Future recommendations:

- Lengthen the season to include data for more pests, and to understand when pests emerge in the spring and how long they remain active in the fall.
- Shift to a presence / absence monitoring scheme for some pests (aphids, caterpillars, fleabeetles, spider mites), rather than determining precise infestation levels for individual farms.
- Ensure earlier project start date to have trapping supplies on hand at the beginning of the season.
- Consider options to incorporate monitoring sites on the Saanich Peninsula to provide data for a wider area (and better engage producers in this part of the region).

Beneficials and citizen science:

Successes: An excellent start was made on beneficial insect data collection, with good data on bees, hoverflies, ladybeetles and other large, easily identified taxa. There was good engagement with gardeners and some small-scale farmers. This part of the project can continue to collect data with minimal inputs of project team time.

Challenges: Most of the participants were non-farmers, and therefore the data collected may not accurately represent the diversity found on larger farms. The project's late start meant that many growers were already busy as the project was rolling out and didn't have time to learn the system and join the project.

Some insect groups (hemipterans, larval insects, flies) did not receive much attention from experts, due to small size, and to a lack of experts in the group that are active on iNaturalist. As well, many experts do not have time to assist with identification during the summer field season, and so there is a time lag before observations are identified. This can be discouraging to participants.

Many insects cannot be reliably Identified to species from photos (many bees, for example), and therefore the iNaturalist project will never be able to fully document the species level diversity of those groups.

Future recommendations:

- Outreach to growers during the winter and early spring may increase grower use of the iNaturalist component of the project and increase the number of observations made on mid and large-scale farms.
- Continued outreach to iNaturalist identifiers may result in more observations being identified.

- Samples of pollinators and other insects were collected during the 2021 crop monitoring. Future examination and identification of these samples could provide another source of information on the beneficial species present in Vancouver Island agro-ecosystems.

Communication / Outreach:

Successes: The newsletter was well received and was reaching 143 email subscribers by the end of the production season. The Facebook group had 144 followers, and a season long reach of over 10,000 people. On-farm workshops provided IPM skill building and opportunities to see monitoring techniques in action to 38 participants. iNaturalist journal posts shared information on beneficial insects with at least the 59 people directly participating in the project, as well as the Facebook group.

An end of year survey promoted through farm participants, the newsletter and on Facebook received 13 responses, with 54% from farmers. 82% of respondents received the newsletter, 45% interacted with the Facebook page and 36% interacted with iNaturalist project.

According to survey respondents the most valuable section of the newsletter was the pest insect highlights, followed closely by the monitoring reports and the beneficial insect highlights. 80% of participants found the monitoring data helpful and interesting, while 90% wanted even more details on the pest management.

Overall comments from workshops, Facebook, participating farms, and the survey were positive, with statements from survey participants such as: “very interesting and I often follow the links”, and: “good work, keep it up”.

Challenges: There were some early season challenges with the format of the newsletter. The VIPPB project has since moved to Mailchimp, which greatly improved the newsletter. Because of the large number of crops and pests monitored, it could be challenging to keep the newsletter short and readable.

Outreach over social media had the potential to reach large numbers of people, however, building an audience took time and effort. The Facebook page was successful in gaining an audience, but Twitter was not as effective. Managing multiple platforms requires time and energy that could be better spent growing the audience with one platform.

Many growers also mentioned not having time to read the emails with the newsletter, or not getting around to signing up for the newsletter during their busy summer season.

The time constraints of growers also impacted attendance at the on-farm events. While growers were enthusiastic about the on-farm events, they had difficulty making time during the growing season. Several growers cancelled at the last minute.

Very few growers contributed their monitoring data to the farm-led monitoring program. This could be due to a lack of time during the season, or because growers were unaware of the program.

Future recommendations:

- Continue to produce the newsletter at biweekly intervals using Mailchimp.

- Facebook could be used to produce more short posts, pest alerts, and connections to resources that don't fit in the newsletter, or to address issues that arose between newsletters.
- The twitter account could be dropped to streamline and focus on effective communication.
- Marketing the newsletter to grower groups and farmers' institutes *before* the production season starts should increase engagement during the season.
- The farm-led monitoring program should either be aggressively promoted over the winter with workshops and online events or dropped from the project.
- Winter events and workshops may be better attended than summer on-farm events, although they do not provide the same hands-on support as the on-farm events.
- Attending or sharing information through events in the early spring of 2022 may lead to increased engagement with all programs over the summer of 2022.