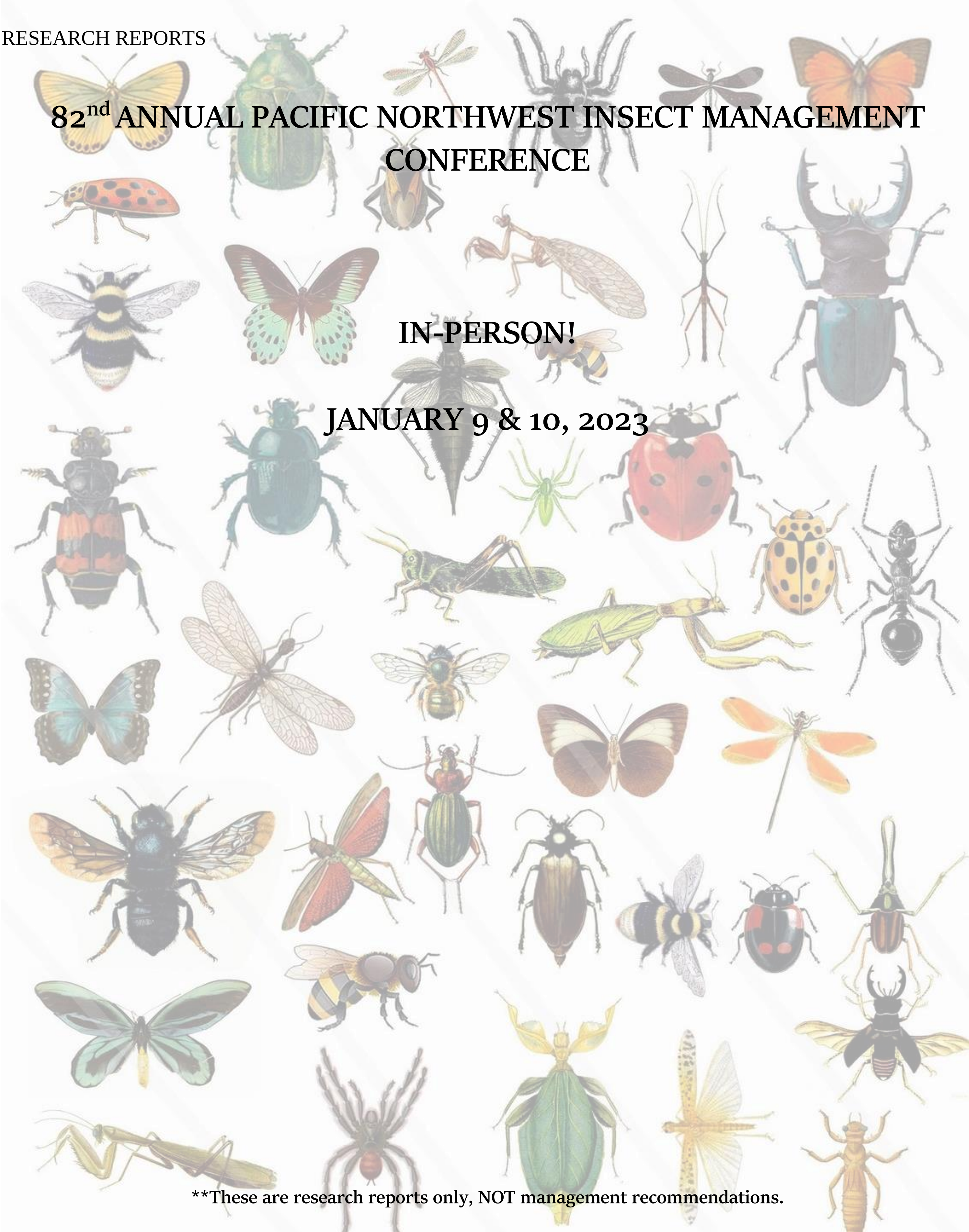

82nd ANNUAL PACIFIC NORTHWEST INSECT MANAGEMENT CONFERENCE

IN-PERSON!

JANUARY 9 & 10, 2023

**These are research reports only, NOT management recommendations.

TABLE OF CONTENTS

82nd ANNUAL PACIFIC NORTHWEST INSECT MANAGEMENT CONFERENCE
January 9 & 10, 2023

SECTION V: Potato Pests

SECTION VI: Small Fruits, Tree Fruits and Nuts

SECTION VII: Pests of Turf and Ornamentals

SECTION VIII: New and Current Product Development

SECTION IX: Extension & Consulting: Updates & Notes from the Field

AGENDA

82nd ANNUAL

PACIFIC NORTHWEST INSECT MANAGEMENT CONFERENCE

January 9 & 10, 2023

(*EACH PRESENTATION IS ALLOTTED 15 MINUTES*) MONDAY, JANUARY 9TH	
SIGN-IN	*9:30 Am*
CALL TO ORDER BUSINESS MEETING *(JUDGES FOR STUDENT COMPETITION; TUMBLEBUG COMMITTEE, RECOGNITION TO SPONSORS)*	10:00 Am
SECTION I (7 REPORTS)	10:15 Am
BREAK/LUNCH	12:00 Noon
SECTION I (3 REPORTS) SECTION II (1 REPORTS) SECTION III (1 REPORT) SECTION IV (3 REPORTS)	1:00 Pm
BREAK	3:00 Pm
SECTION V (2 REPORTS) SECTION VI (5 REPORT)	3:15 Pm
TUESDAY, JANUARY 10th	
CALL TO ORDER	8:00 Am
SECTION VII (3 REPORTS) SECTION VIII (1 REPORT) STUDENT PRESENTATIONS (4 REPORTS) BREAK	8:00 Am 9:00 Am 10:00 Am
STUDENT PRESENTATIONS (5 REPORTS) SECTION IX (1 REPORT) FINAL BUSINESS MEETING ADJOURN	10:15 Am 11:30 Am 11:45 Am

SECTION I
Invasive Pests, Emerging Pests, and Hot Topics of Interest

DEVELOPMENT OF TRAPPING SYSTEMS FOR THE INVASIVE NORTHERN GIANT HORNET IN WASHINGTON STATE

Jacqueline Serrano[1] and Chris Looney[2]

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[2]Washington State Department of Agriculture, Pest Program, Olympia, WA, USA

The northern giant hornet (NGH), *Vespa mandarinia* Smith 1852 (Hymenoptera: Vespidae), is a new invasive insect in Washington state that is semi-specialized predator of other social Hymenoptera. The presence of NGH poses a risk to honey bees, an important pollinator of many specialty crops. Several published modeling efforts show that NGH has the potential to establish populations and spread outside of where it was first detected, in Whatcom County. In 2020, a trapping program was implemented by the Washington State Department of Agriculture and the United States Department of Agriculture, with the goal of detection and eradication of NGH populations. Trapping efforts over the last three years have heavily relied on "generic" baits including orange juice and rice wine, and other semiochemical lures developed for other vespids. These generic trapping systems have helped capture some hornets since efforts began, but they also catch many non-target insects and are not effective enough for eradication efforts. Research into better and more species-specific attractants is ongoing and here we will discuss our current efforts. These efforts include field testing a variety of different lures, including based on prey volatiles and other reported *Vespa* attractants. In addition, we tested a lure that contained components of the NGH alarm pheromone, which were previously identified in 2003. Studies were also conducted to reexamine the alarm pheromone and assess similarities and differences between previously identified compounds and hornets found Washington state. Results and limitations of field tests will be discussed, along with future directions.

UPDATES AND IMPLEMENTATION OF A SPATIALIZED PHENOLOGY MODEL FOR EMERALD ASH BORER

Brittany Barker[1,2], Len Coop[1,2], Alyssa Rosemartin[3], and Theresa Crimmins[3,4]
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[3]USA National Phenology Network, Tucson, AZ
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We developed and evaluated the predictive performance of a phenology model and climatic suitability model for emerald ash borer (EAB), *Agrilus planipennis,* for use in the DDRP (Degree-Days, Risk, and Pest event maps) platform (Barker et al. 2020). DDRP is a spatial modeling platform that was designed to produce timely predictions of the phenology and risk of establishment (based on climatic suitability) of invasive insect pests (Barker et al. 2020). We are using DDRP to produce regularly updated forecasts for 16 invasive insect species including EAB for the continental U.S. (CONUS), available at http://uspest.org/CAPS. The primary objective of this study is to provide decision-makers with accurate and timely forecasts of EAB adult emergence and egg-laying. This information can help guide decision-making related to surveillance and management.

We capitalized on a large body of published literature and hundreds of field observations for EAB from across its worldwide range (Asia, Europe, and North America) to update the DDRP model and evaluate its performance. Predictive accuracy was assessed using presence records and phenological observations that were not used for model calibrations. For example, we used 66 observations collected in the eastern U.S. between 2003 and 2022 to evaluate the accuracy of predictions for first pupation, first adult emergence, peak adult emergence, peak adult activity (egg-laying), first egg hatch, and first J-larval development. This analysis revealed good predictive performance for adults, with a mean absolute error of *ca.* 7 days for emergence events and peak activity (Fig. 1). Predictive accuracy was low for first J-larval development; however, difficulty in detecting this stage in the field could partly explain model under-predictions.

In early 2023, we will start delivering and communicating model forecasts for EAB in a range of user-friendly, readily accessible formats at the USA National Phenology Network's website (https://www.usanpn.org/data/forecasts) to enable wide adoption. Additionally, we will begin soliciting phenological observations of EAB collected by citizen scientists, collaborators, and other stakeholders to conduct additional forecast validations. Until then, potential map-users can find static maps (PNG files) and gridded model outputs of EAB model forecasts for CONUS at http://uspest.org/CAPS. Interactive versions of these maps for Oregon are available at https://uspest.org/CAPS/EAB_OR/home.html.

Acknowledgments

This research was supported by funding from USDA-NIFA-AFRI (Agriculture and Food Research Initiative), USDA-NIFA-CPPM-EIP (Extension Implementation Program), Western IPM Center, APHIS-PPQ-CPHST (Center for Plant Health Science and Technology) & CAPS, and DoD SERDP (Strategic Environmental Research and Development Program).

References

Barker, B. S., L. Coop, T. Wepprich, F. Grevstad, and G. Cook. 2020. DDRP: real-time phenology and climatic suitability modeling of invasive insects. PLoS ONE 15:e0244005.

Figure 1. Scatterplot showing the relationship between the observed and predicted days of year (DOYs) for seven phenological events for EAB. Estimation errors were calculated by subtracting observed DOY from the estimated ones. Line represents a 1:1 relationship between field- and model-predicted DOYs. MAE = mean absolute error.

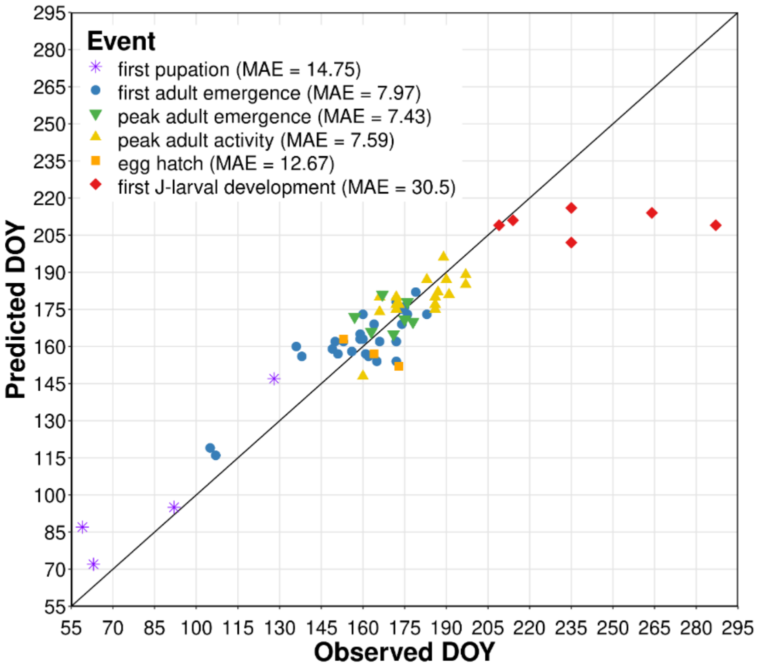
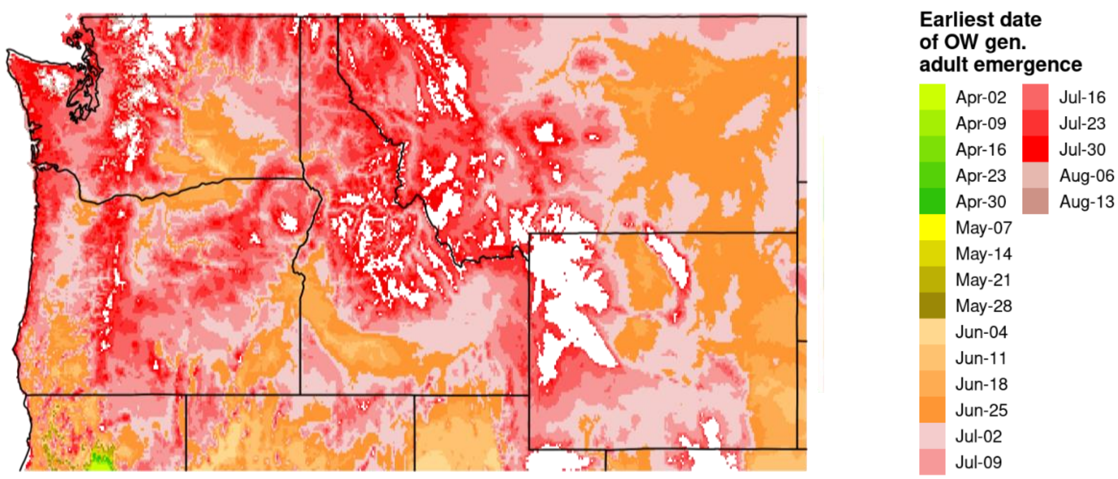


Figure 2. Map of first adult emergence of EAB in the Pacific Northwest for 2022 produced by DDRP. Adult insects were found in Forest Grove, OR, on June 30, 2022.



STUDENT

Section I: Invasive Pests, Emerging Pests, and Hot Topics of Interest

The effects of erythritol, an experimental treatment for Spotted-wing drosophila, on treated plants

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Spotted-wing drosophila (*Drosophila suzukii*) is a vinegar fly and an invasive pest of small and stone fruits, especially caneberries, cherries, and blueberries. Due to its ability to oviposit in ripening fruit rather than overripe or rotten fruit, *D. suzukii* has caused significant economic damages to growers since its arrival on the West Coast in 2008. Erythritol, a naturally occurring artificial sweetener, has been shown to increase mortality at a dose-dependent rate in both *D. suzukii* adults and larvae when ingested. Non-target species such as honeybees and yellow jackets do not appear to be negatively affected by erythritol exposure. Also, fruit quality is not impacted by the erythritol treatments, making erythritol a candidate for wider testing. However, erythritol solutions have been observed to damage plants, causing desiccation and spotting on 1-17% of treated leaves inconsistent with mold, diseases, or other insect damage. Therefore, our objectives to were to compare if spotting symptoms occurred and the impact on plant function with varying formulations using purified or bulk erythritol, and combined with the insect phagostimulant sucrose or sucralose; 4 treatments and a control. Potted blueberry plants were treated first with erythritol formulations to detect if various formulations affect chlorophyll fluorescence, stomatal conductance, osmotic potential, and visual damage on leaves. Next, treatments were tested in the field by spraying blueberry bushes, cherry trees, and blackberry hedges and monitoring the same parameters. Differences will be quantified in combination testing of treatment conditions to evaluate both the mechanism of leaf damage and effects on the condition of the whole plants.

Section I: Invasive pests, emerging pests

***Trissolcus japonicus* incurs reduced fitness when developing in nontarget hosts**

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A key step in evaluating a biological control agent is determining the risk of nontarget attacks. The samurai wasp, *Trissolcus japonicus,* is an egg parasitoid currently being employed for the biological control of the brown marmorated stink bug (BMSB), *Halyomorpha halys,* a major agricultural pest. Populations of these wasps have established in much of the Pacific Northwest and have prompted questions about nontarget interactions. Understanding the developmental success and adult fitness of samurai wasps reared in native, nontarget stink bug eggs will help to determine the long term risk of samurai wasps to nontarget populations. Lab reared samurai wasps were allowed to parasitize the egg masses of three stink bug species found in Oregon as well as BMSB. Once the wasps developed and emerged, eggs were dissected to record egg acceptance and successful emergence rates. The emerged wasps were frozen and their body size and the number of eggs in their ovaries (egg load) was recorded. Preliminary analysis indicates mixed developmental success in nontarget hosts. Lower acceptance of eggs was seen in all three nontarget hosts compared to BMSB and decreased emergence success was recorded in two of the three nontarget hosts. Wasps that had emerged from nontarget hosts had smaller body sizes and a reduced egg load when compared to those reared in BMSB eggs; however, samurai wasps can successfully develop in all nontarget species tested. Given these results, we hypothesize that the ability to successfully develop in nontargets is not likely to impact the long term population sizes of Oregon stink bugs. These results could also indicate that wasps may be able to persist at low levels if BMSB populations are reduced.

Evaluating SmartWater® as a visual marker for parasitoid mark-release-recapture

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Understanding the dispersal ability of natural enemies is a key component of evaluating their potential in biological control. Often, this requires the use of a marker that can be used in mark-release-capture studies to track insect movement in the field. For very small natural enemies, such as parasitoids, this can be challenging as markers may be difficult to apply or adversely affect behavior. Recent studies have shown promise for the use of SmartWater fluorescent liquid as a marker for a range of insects. We tested the effectiveness of this maker on three small parasitoid species – *Pachycrepoideus vindimae, Trissolcus japonicus*, and *Ganaspis braziliensis.* For each species, we evaluated the long-term detectability of the fluorescent marker and the effects of marking on various fitness parameters. Marked and unmarked individuals were tested for parasitism ability, activity patterns, flight capability, and longevity. Marking was assessed for each individual using both qualitative and quantitative methods. For qualitative assessment, wasps were viewed with a microscope illuminated with a NIGHTSEA UV LED and scored for percentage fluorescent coverage. Quantitative fluorescence measurements were taken using a 96-well plate reader with excitation wavelength of 370 nm and relative fluorescent units measured at 540 nm.

Overall, this marker shows great potential for use with small parasitoids. Marked individuals showed clear fluorescence (Figure 1) up to several weeks later and showed little adverse effects from the marking process. Qualitative assessment was sufficient to detect markers for all parasitoid species, even outperforming quantitative reads at some time points. To test the effectiveness of the marker in the field, several thousand *T. japonicus* were released in a hazelnut farm. Using yellow sticky traps, we successfully recaptured several marked *T. japonicus*, providing evidence that the markers can be used for field applications. Thus, SmartWater may be a viable marking tool for testing the spatial movement of parasitoids in the field.

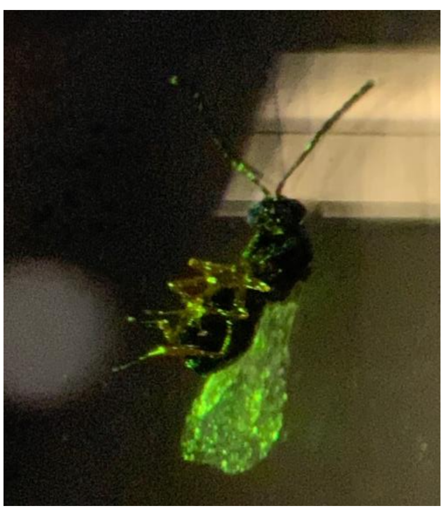

Figure 1: *Ganaspis braziliensis* marked with SmartWater cartax fluorophore viewed using NightSea 360-380nm UV LED. Photo by Saliha Voyvot.

NANO-INJECTION METHODOLOGY FOR MICRO INSECTS USING WESTERN FLOWER THRIPS

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Micro-injection techniques are invaluable in entomological research as they allow for direct delivery of biological compounds into the hemocoel of insects at controlled volumes. Typically, injections are easily done with larger insects using sedative techniques to immobilize the insect, such as CO_2 anesthesia, cooling, or physically holding the specimen. For insects smaller than 3 mm in total body length, these methods may be difficult to perform or result in injury to the specimen, necessitating a new methodology for the injection of nano-volumes of media.

Our lab has used western flower thrips (WFT), *Frankliniella occidentalis*, as a representative specimen of insects under 3 mm for developing a novel nano-injection technique. Our technique involves the immobilization of the target using vacuum suction on a customizable screened-vacuum stand, allowing the target to be held in place for injection without harmful or difficult immobilization techniques mentioned earlier. Here, we present an integrative method of the customizable screened-vacuum stand construction (Figure 1), nano-injection tools and techniques, and a simple survivorship assay to assess the viability of nano-injections using female WFT as a model. Our assay involved comparison of a non-injected control group with 10 nL injections of pure nuclease-free water in both the thoracic and abdominal regions of WFT, measuring survivorship over a 48-hour period (Figure 2). Our results showed that thoracic injections (Figure 3), resulted in minimal detriment, with no statistical difference from the control group. However, abdominal injections resulted in a much lower survivorship, thus it is not recommended as a delivery site for biological compounds in WFT.

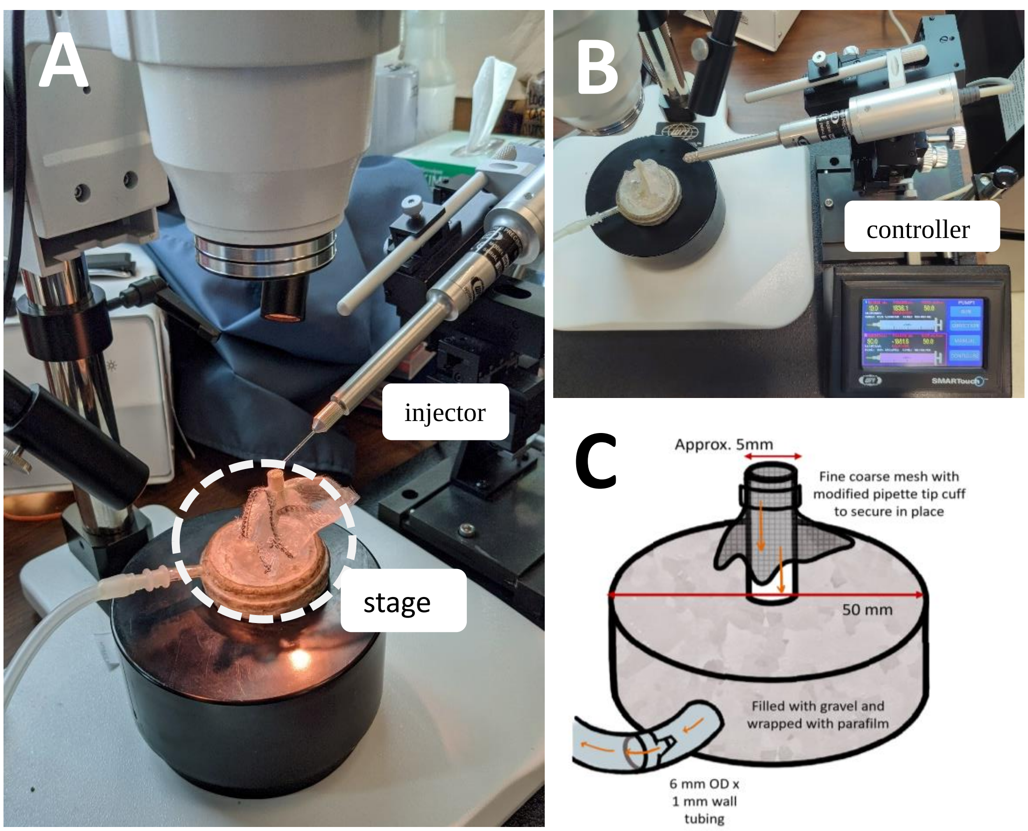

Figure 1: Nano-injection system: Stereomicroscope, customizable screened vacuum stage, and NANOINJECTOR 2020 (A), closer view of the NANOINJECTOR 2020 and MICRO2T SMARTTouch™ controller (B), diagram of screened vacuum stage (C). Photo taken from Raffin et al. 2022.

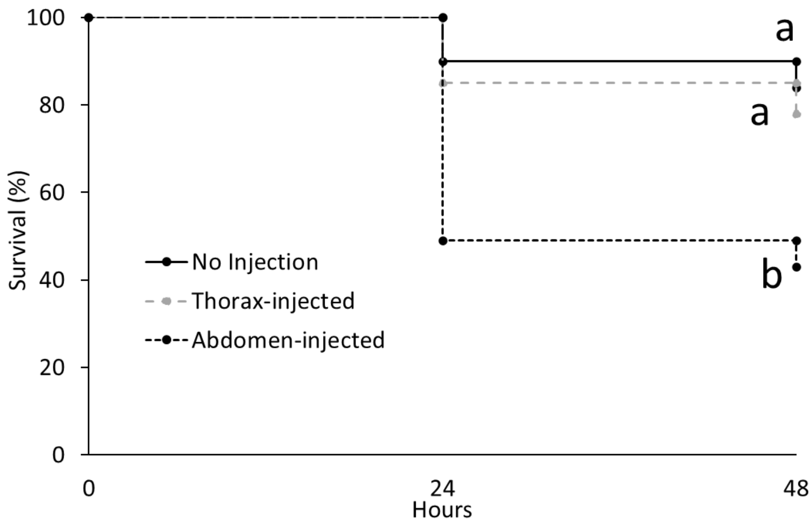

Figure 2: Kaplan-Meier survival curves of female *Frankliniella occidentalis* injected with water in thoracic or abdominal region. Each replicate contained ten thrips and all treatments were replicated ten times across several trial dates. Survival of individuals at 24h and 48h were compared by log-rank analysis. Different letters denote statistical significance by adjusted Šidák p-value ($P<0.05$). Graph taken from Raffin et al. 2022.

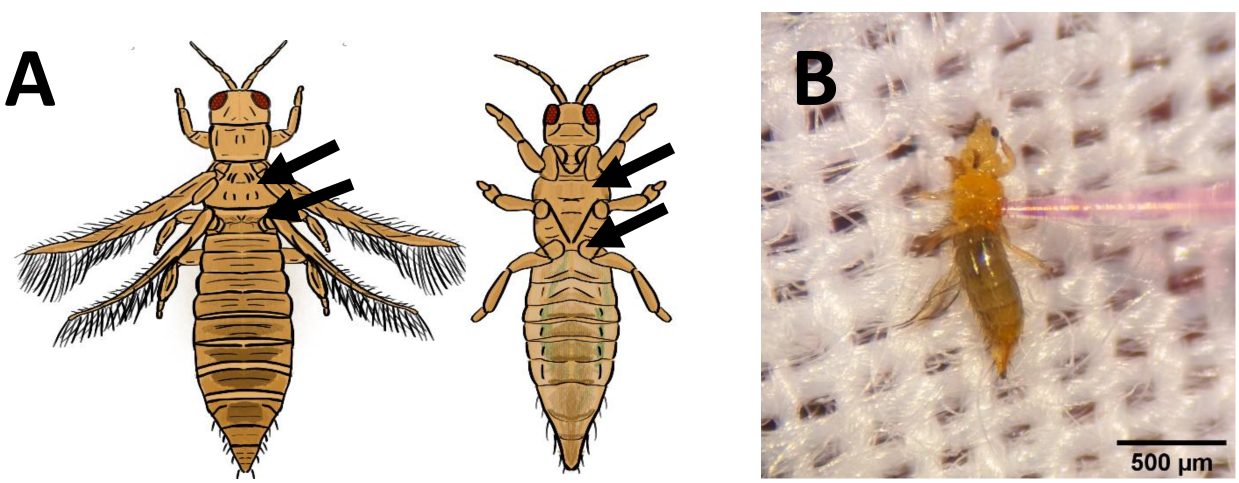

Figure 3: Dorsal and ventral diagram of *Frankliniella occidentalis* female with arrows representing suitable sites for thoracic injection (A). Photo of live thrip during thoracic injection using 0.04g/mL acid fuchsin dye for demonstrative purposes. Photo taken from Raffin et al. 2022 (B).

INSIDE LOOKING OUT: A PROACTIVE APPROACH TO INVASIVE ORCHARD PESTS

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While the apple maggot (AM), *Rhagoletis pomonella*, has never been found in a commercial fruit operation in eastern Washington State, the WSDA Apple Maggot Survey has monitored this invasive fly for over 40 years. In the past, state legislation has adjusted the AM Quarantine multiple times to help protect the apple industry from this pest. In this presentation, we will highlight some of the changes and findings of the Apple Maggot Survey program over the past four years. A key focus of the presentation will be what orchard managers and pest consultants can do to help better protect orchards from the invasive AM and emerging pest problems. This proactive approach involves looking out from the orchard at the surrounding landscape with the awareness that key pest problems will likely emerge from outside the commercial orchard. For example, emerging problems with codling moth and shot-hole borer from abandoned orchards, backyard or feral fruit trees could be a precursor to problems from invasive pests like the apple maggot and little cherry virus, or European cherry fruit fly and spotted lanternfly should either of these invasive insects reach the PNW. The probability of these pest invasions could certainly be impacted by the services provided by County Horticultural Pest Boards whose mission it is to find and remove potential host sources of emerging and invasive pest species.

I will be attending student competitions.

CHARACTERIZATION OF DIURETIC HORMONES IN SPOTTED-WING DROSOPHILA

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Diuretic hormones (DHs) are neuropeptides that are produced in the central nervous system (CNS) to regulate osmotic and ionic homeostasis with diuresis in insects. In *Drosophila*, there are two DH peptides, DH31, and DH44, which are consisted of 31 or 44 amino acids, and they are similar to vertebrate calcitonin gene-related peptide (CGRP) and corticotropin-releasing factor (CRF), respectively. In this study, we characterized the two DHs in spotted-wing drosophila (SWD) *Drosophila suzukii* (Diptera: Drosophilidae), an invasive insect from East Asia and one of the top-priority dipteran pests in the small fruits industry.

Diuresis is the physiological mechanism that excretes unnecessary substances to maintain the water and ion balance in the fly body, and that is initiated by DHs binding their DH receptors (DH-Rs) in the digestive tract. The diuresis occurs mainly in the hindgut and Malpighian tubules which mediates fluid secretion and ion homeostasis. Malpighian tubule membrane consists of two types of cells, principal and stellate cells. We found DH-Rs are expressed on the principal cell, and when DHs bind to DH-Rs, it activates various ion pumps and channels, facilitating diuresis. We ran qPCR to check the relative expression of *dh* mRNAs in *D. suzukii* tissues. In addition, we injected DHs into SWD adults and found that DH31 is more dominant in facilitating diuresis than DH44 by counting the excretion drop numbers. DHs and DH-Rs are essential physiological components in the endocrinal system of SWD, which are the potential biological target for developing new pest management methods for SWD.

OREGON DEPARTMENT OF AGRICULTURE INVASIVE INSECT SURVEY PROGRAM: Updates from the 2022 Survey Season

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Each year the Oregon Department of Agriculture's Insect Pest Prevention and Management (IPPM) Program conducts statewide surveys for a variety of invasive insect pests. The main goal of these surveys is to detect, delimit, and eradicate any novel introductions before any new populations become established in the state. This report provides an update of the IPPM Program's 2022 survey program activities.

In 2022, IPPM insect surveys targeted 38 invasive species and placed roughly 27,500 total traps statewide. Of the target taxa, the largest focus is on Japanese beetle, *Popilla japonica*, and two subspecies of *Lymantria dispar* (*L. d. dispar and L. d. asiatica*). This is primarily due to a large ongoing delimitation and eradication effort for *P. japonica* in the Beaverton-Hillsboro area, and several delimitations and a high-risk introduction pathway along the Columbia shipping lanes for both target subspecies of *L. dispar.* This past survey season, IPPM placed 12,693 traps for *P. japonica*; *8,616 L. d. asiatica* traps; and 3,725 *L. d. dispar* traps. These numbers include both detection and delimitation traps placed in response to positive catches. While IPPM has separate surveys and slightly different delimitation survey methods for each subspecies of *L. dispar*, the traps and lures are identical in nature and are effective at catching both.

The 2022 survey resulted in six positive *L. d. dispar* catches; one single moth in each of the following regions: Warrenton, OR; St. Helens, OR; Beaverton, OR; Sherwood, OR; Corvallis, OR; and Monroe, OR. It is worth mentioning that one moth was actually caught in a trap intended for *P. japonica*; a true testament to the effectiveness and longevity of the *L. dispar* pheromone lure. Due to catch timing, add-on traps could only be placed in Clatsop and Washington counties, which yielded no additional catches. A delimitation trapping grid will be centered around each positive site in 2023. Delimitations that carried over from 2021 for both subspecies of *L. dispar* have also been negative for new detections. Next survey season will be the final year of the Sauvie Island *L. d. asiatica* delimitation carried over from 2020.

The past field season, 3,254 *P. japonica* were trapped. All of which were within known infestation areas that are currently part of the large-scale delimitation and eradication effort for Japanese beetle. Sadly, this is only a 10% reduction from 2021, however, a large percentage of the beetles trapped occurred from a single property. The IPPM eradication team is already working on how to include this property in the 2023 treatment effort. In conjunction with IPPM's trapping efforts, the eradication team treated several thousand properties with Acelepryn G (Chlorantraniliprole, granular) and several hundred targeted properties also received a subsequent foliar treatment later in the summer. Each treatment area is then included in high-density mass trapping of 150 traps/mi² which is roughly triple the density of the innermost delimitation area for *P. japonica*. While there was some spread of the population, 2022 was the first year that the treatment area was reduced in size since treatment for Japanese beetle first began in 2017.

Numerous other specialty surveys are also carried out by IPPM each year. In 2022, IPPM conducted several other delimitation surveys for light brown apple moth (*Epiphyas postvittana*), Gill's mealy bug (*Ferrisia gilli*), apple maggot (*Rhagoletis pomonella)*, and an extensive grasshopper and Mormon cricket suppression effort in response to a population outbreak in 2021. Other commodity and specialty surveys included: orchard, oak, Solanaceous, exotic wood boring beetle, and Vespa surveys, as well as a visual survey for spotted lanternfly (*Lycorma delicatula*). Samples from the 2022 surveys are still being screened at this time, however, several notable detections include 9 species that are either established or status unknown in Oregon (Table 1); the most notorious of these being the emerald ash borer (*Agrilus planipennis*).

Table 1: New insect species detected and presumed established or status unknown in Oregon from IPPM's 2022 invasive insect survey season. Yellow shading indicates that the species is determined to be a significantly detrimental pest. Blue shading indicates that the species is not considered a known pest even though it is non-native.

Species	Common Name	Native Range	Host	Detection Site
Semanotus sinoauster	longhorned beetle	China	Cupressaceae	Aurora airport
Desmocerus palliatus	eastern elderberry borer	eastern N.A.	elderberry	Umpqua, Douglas Co.
Ips grandicollis	eastern 5-spined pine engraver	eastern N.A.	pines	Marion County
Agrilus planipennis	emerald ash borer	eastern N.A. and Asia	ash	Forest Grove
Eupteryx filicum	leafhopper	Europe, WA, Canada	ferns	Eugene
Centrocoris variegatus	leaf footed bug	CA, Europe	tumbleweed and others	Portland
Copidosoma floridanus	biocontrol polyembryonic wasp	Europe, CA	caterpillars of Plusiinae & Heliothidinae	Jackson County
Amynthas agrestis	Asian jumping worm	SE US, Asia	organic material in soil	Multnomah Co.
Pristiphora geniculata	mountain ash sawfly	Europe	mountain ash, hawthorn	Portland

Emerald Ash Borer and Oregon's Response to Detection

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In 2022, *Agrilus planipennis*, or Emerald Ash Borer (EAB) was detected in Oregon for the first time. EAB is known to cause severe economic and environmental damage. The purpose of the presentation is to provide an overview of EAB, its hosts, impact on Oregon, and the response plan formed by Oregon Department of Agriculture alongside cooperating entities.

Emerald Ash Borer (EAB, *Agrilus planipennis*) is an invasive phloem-feeding boring beetle in the family Buprestidae, detected in Forest Grove, Oregon, in late June 2022. Native to Asia, this destructive forest pest first established in North America in Michigan in 2002. In the 20 years since initial introduction the insect has spread to 36 states and 5 Canadian provinces. The detection of EAB in Oregon is the first detection West of the Rocky Mountains and the first on the West Coast.

EAB attacks all species of ash (genus *Fraxinus*). Native Oregon Ash (*F. latifolia*) is a dominant component of riparian forests in Oregon. Ash species differ in their susceptibility to EAB; in no-choice tests Oregon Ash is very susceptible to EAB (Siegert, *et al.* 2014), confirmed by preliminary field surveys in 2022. Impacts of EAB invasion of riparian forests in Oregon will include increases in water temperature due to loss of tree canopy, increase in turbidity and concomitant decrease in water quality, and loss of regulation of the water table in areas prone to flooding.

Response to the recent discovery of EAB in Oregon includes the following:

Visual surveys to identify currently infested areas and three strategies to create a "buffer zone" between the known infested area and the river (after McCullough, *et al.* 2009; McCullough, *et al.* 2016):

1. Spring-girdle trees along a corridor to increase their attractiveness to ovipositing EAB. These "trap trees" will be removed and destroyed in fall.
2. In addition, selected trees in highly attractive positions within the spring-girdled corridor will be girdled and also trunk-injected with insecticide to create trap trees lethal to EAB larvae.
3. Selected mature seed-producing trees will be trunk-injected to maintain seed production and regeneration at the site.

Trunk-injection treatments are compatible with biocontrol release at nearby sites closer to Forest Grove. EAB parasitoids require healthy larvae for oviposition and will not oviposit in lethal trap trees. Treatments will utilize emamectin benzoate, applied by independent certified contractors.

References:

McCullough, Deborah G., Therese M. Poland, and Phillip A. Lewis. 2016. Lethal trap trees: a potential option for emerald ash borer *(Agrilus planipennis* Fairmaire*)* management. *Pest Management Science* 72 (5): 1023–30. https://doi.org/10.1002/ps.4083.

McCullough, Deborah G., Nathan W. Siegert, and John Bedford. 2009. Slowing ash mortality: a potential strategy to SLAM emerald ash borer in outlier sites. 2009 USDA Research forum on invasive species.

Siegert, Nathan W., Andrew R. Tluczek, and Deborah G. Mccullough. 2014. Susceptibility of selected Asian, European, & North American ash species to Emerald ash borer: Preliminary results of no-choice bioassays. Emerald Ash Borer Research and Technology Meeting at Wooster, OH. October 2014. Siegert, Nathan W., Rodrigo J Mercader,and Deborah G. McCullough. 2015. Spread and dispersal of emerald ash borer (Coleoptera: Buprestidae): estimating the spatial dynamics of a difficult-to-detect invasive forest pest. *The Canadian Entomologist*, 147: 338 - 348.

Where Are The Applied Agricultural Researchers?

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Pacific Northwest agriculture has more than 400 crops each of which have their own set of insect, weed, disease, nematode, viral, rodent and other pests. The majority of these crops are relatively high value with minimal tolerance of pests. In order for these crops to be successful it requires a substantial investment into research. The majority of pest management research is conducted by Land Grant Colleges. Private sector researchers collectively complete the rest of pest management research that is accomplished. There is evidence that the capacity to conduct applied pest management research in PNW agriculture has declined significantly.

In 2009, the Washington State Commission on Pesticide Registration (WSCPR) received 46 research proposals, but the number of proposals has declined over time. In 2022, only 27 proposals were submitted. For the past three years, the Washington Blueberry Commission has not received enough proposals to match their research budget or research needs. There is no longer any applied researchers in the Pacific Northwest working on asparagus in the Land Grant System. The Washington, Oregon and Idaho potato commissions are concerned that there are fewer proposals being submitted than there is research funds available. A number of commodities have no research or extension support.

Identification and characterization of bioactive peptides in the western flower thrips

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Abstract: Insect neuropeptides (NPs) represent neurotransmitters, neuromodulators, or neurohormones that regulate various physiological functions and behaviors during immature and adult stages. The PRXamide family peptides are well-characterized and classified into three subfamilies: capability (CAPA) peptides, pyrokinin (PK) peptides including pheromone biosynthesis activating neuropeptides (PBAN), diapause hormone (DH), and ecdysis-triggering hormone (ETH). The peptides in this family have a common amino acid motif, PRXamide (X, a variable amino acid), in the C-terminal end, which is conserved for diverse functions across Insecta. Insect CAPA and PK subfamily peptides are produced from *capa* and *pyrokinin* genes. We identified and characterized the two genes and seven NPs encoded by the genes in the western flower thrips (WFT), *Frankliniella occidentalis*. Multiple potential endoproteolytic cleavage sites were presented in the prepropeptides from the *pyrokinin* gene, creating ambiguity to predict mature peptides. To solve this difficulty, we used three receptors for these NPs, and evaluated binding affinities of the peptides. The binding activities showed that each subfamily of peptides exclusively bind to their corresponding receptors, and were significant for determining the CAPA and PK peptides. Our biological method of using specific G protein-coupled receptor (GPCR) systems will be a valuable tool for determining mature peptides, particularly with multiple and ambiguous cleavage sites in those prepropeptides.

Both *capa* and *pyrokinin* genes were clearly expressed during most of the life stages. Whole-mounting immunocytochemistry revealed that neurons contained PK and CAPA peptides throughout the whole-body: four to six neurosecretory cells in the head, and three and seven pairs of immunostained cells in the thorax and abdomen, respectively. Notably, the unusual PRXamide profiles of Thysanoptera are different from the other insect groups and might provide opportunities to develop novel management strategies.

A New Insect Pest of Blueberry: Blueberry Gall Midge

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Justification and Background. Originally this proposal was directed towards blueberry tip midge, *Prudiplosis vaccinia*, which was thought to be the target midge species in Washington blueberries. Data generated by this research project in 2020 and 2021 found that the blueberry gall midge (BGM), *Dasianeura oxycoccana*, appears to be the pest species in this state. BGM was first identified as a new species in 1989. It was first detected in Washington and Oregon in 2004. Due to its small size and cryptic life cycle, it likely has been here for quite some time and just not been noticed, and its symptoms were often attributed to other issues such as nutrient deficiencies. In the Northwest, BGM causes aborted and blackened shoot tips as well as distorted developing leaves. In heavily infested fields, a witch's broom symptom may occur. Damage caused by BGM in commercial fields can be confused with boron deficiency or even with the black tip stage of plant development. It is unknown whether the blueberry tip midge is a pest in Washington. However, our DNA analysis data from the 2020 and 2021 field seasons has shown there is a second genetically distinct population that could be a second species of midge are infested blueberry fields in Whatcom County.

Gall midge was first recognized by the Washington Blueberry Commission as a pest in 2018. There has been intra industry discussion of whether this was a pest before 2018. Growers in northwest Washington believe this has become a very serious pest of blueberries. Early in the season the larvae of this species burrow into the blueberry terminal causing it to die. Growers have started to commonly treat for this pest. Schreiber conducted a very small efficacy trial against what he believed to be tip midge in April/May of 2019.

The BGM was recognized as a pest of blueberries in Oregon and southwest Washington in 2004. WSU's Tanigoshi and Gerdeman conducted some basic lifecycle and limited efficacy research on the gall midge in northwest Washington in 2010. Their work was conducted in late summer.

Gall midge has recently been recognized as a pest of wild blueberries in eastern Canada and Maine and of highbush blueberries in southeastern U.S., Michigan, British Columbia, and Oregon. Tip midge has been recognized as a pest in some of these locations. The adult is a very small fly about 1 to 3 mm long and has reddish in color. Larvae are white to orange, very small and difficult to see with the unaided eyes. Finding the larvae requires dissection of an infested terminal.

At this time, little is known to distinguish the two populations however, it seems clear that the midges, regardless of the species, feed on the terminals and seem to be active during any flush of growth where terminals are actively growing. Growers time their applications around these flush of growth. It is likely that contact insecticides may be less effective than systemic insecticides.

Research funded by the WBC and the Washington State Commission on Pesticide Registration in 2020 found that most midges were BGM but 21 of 96 samples were genetically distinct from BGM albeit closely related. DNA analysis of results from 2021 are not yet fully completed but the first set of samples indicate similar results as in 2020, where two distinct populations in the sampled fields were found. It is not clear if these specimens are a closely related species or just a genetically distinct population of BGM. Sampling indicated populations were heavily present by June and reached a seasonal peak by late July with populations declining in early August and eventually no midges detected by early September. Trapping for the seasonal phenology portion of this research did not start as early as planned (April) due to Covid 19 restrictions on field research by WSU. Field efficacy trials indicated that Malathion and Mustang Maxx are the best control options for midge in 2020, however midge populations were quite low in this trial location. In 2021 an unexpected and unknown application of Platinum (thiamethoxam) for root weevil was applied three weeks in advance of trial which resulted in no midges being detected during the course of our efficacy trial. While this loss of data was extremely disappointing, it does suggest a means (thiamethoxam) for control midge that has previously not been examined.

Materials and Methods

Efficacy trial. Research staff at Agriculture Development Group, Inc. conducted a research trial in 2022 to further study and compare the efficacy of 15 different products (Table 1) for control of blueberry gall midge (BGM). There were two locations at west site of Washington. The experimental design for this trial was a RCB with 4 replications and plot sizes of 30 feet by 1 foot (12 blueberry pots in a row). Applications for this trial were made with a backpack sprayer with single 8002 nozzle to apply treatment spray at 75 gallons per acre (Photo 1). Three applications were made on July 2 (A), July 26 (B), and August 26 (C).

For each location, number of damaged terminals for each plot was recorded on July 19, August 19, and October 2. Number of terminals in the distal 12 inches of the three largest whips were counted for each of the middle 10 blueberry plants, and the average number was calculated for each location.

Table 1. Treatment list for different insecticides.

Trt No.	Treatment Name	Rate	Rate Unit	Appl Code
1	Untreated check			
2	Assail 30 SG	5.3	oz/a	ABC
3	Actara	4	oz/a	ABC
4	Platinum	12	fl oz/a	A
5	Exirel foliar	20.5	fl oz/a	ABC
6	Exirel drip	20.5	fl oz/a	ABC
7	Harvanta	16.4	fl oz/a	ABC
8	Movento	10	fl oz/a	ABC
9	Mustang Maxx	4	fl oz/a	ABC
10	Malathion 8 Aquamul	20	fl oz/a	ABC
11	Lannate LV	0.375	gal/a	ABC
12	Altacor	3.5	oz/a	ABC
13	Aza-Direct	30	fl oz/a	ABC
14	Imidacloprid 4F	3.2	fl oz/a	ABC
15	Asana XL	7	fl oz/a	ABC

Survey. Traps for BGM were placed in northern (Burlington), central (WSU Research station) and south Skagit County (Lenning) and in central Snohomish County. We took 50 blueberry tip samples for four locations on June 20 and 27, July 4, 11, 20, and 25, August 1, 8, 15, 22, and 30, and September 8. The GPS for the four locations are as below. The data are showing in figures 3 and 4.

48.4961624, -122.3864541 North Skagit County (Burlington)

NWREC: 48.4403275, -122.3973234 Central Skagit County (WSU Mt Vernon)

48.3682703, -122.4212551 South Skagit County

48.2005264, -122.2254056 (not collecting tip samples until July 20) Central Snohomish County.

Results and Discussion

Efficacy trial.

No phytotoxicity was observed for all treatments at any point of the trial.

The number of damaged terminals were none for majority treatments and extremely low (up to 0.3 for location 1 and up to 0.5 for location 2) for some treatments for all evaluation dates for both locations, and untreated check had 0 for all evaluation dates for both locations, so the data are not useful.

Therefore, the terminal counts were conducted for each of the 10 plants on the last evaluation date on October 2. Treatments of Actara, Platinum, Exirel foliar, Mustang Maxx, and Imidacloprid 4F showed 27%, 30%, 23%, 25%, and 18% significantly less total terminal for the three largest whips per plant compared to untreated check, respectively, for location 1. Location 2 did not show statistical differences among treatments. However, treatments of Assail 30 SG, Actara, Platimum, Exirel foliar, Exirel drip, Harvanta, Movento, Mustang Maxx, Malathion 8 Aquamul, Lannate LV, Altacor, Aza-Direct, Imidacloprid 4F, and Asana XL had 31%, 9%, 28%, 25%, 26%, 22%, 29%, 30%, 22%, 14%, 35%, 28%, 20%, and 26% numerically less total terminal for the three largest whips per plant compared to untreated check, respectively, for location 2.

The results indicated that Actara, Platinum, Exirel foliar, Mustang Maxx, and Imidacloprid 4F may have potential for reducing gall midge in blueberries, leading to reduced terminals in blueberry plants. Future research was needed to confirm the results/further evaluate the efficacy of these insecticides on blueberry gall midge.

Table 2. ANOVA table showing treatments effect on damaged terminals on July 19, August 19, and October 2, and average number of terminals in the distal 12 inches of the three largest whips on October 2 for 2 locations.

Means followed by same letter or symbol do not significantly differ (P=.05, LSD).

Rating Date				Jul-19-2022	Aug-19-2022	Oct-2-2022	Oct-2-2022	Jul-19-2022	Aug-19-2022	Oct-2-2022
Rating Type				L1-da ter	L1-da ter	L1-da ter	L1-tot ter	L2-da ter	L2-da ter	L2-da ter
Rating Unit/Min/Max				Number, -, -	Number, -, -	Number, -, -	Number, -, -	Number, -, -	Number, -, -	Number, -, -
Number of Subsamples				1	1	1	1	1	1	1
Days After First/Last Applic.				382, 327	413, 358	457, 402	457, 402	382, 327	413, 358	457, 402
Trt-Eval Interval				382 DA-A	413 DA-A	457 DA-A	457 DA-A			
Number of Decimals							2			
Trt No.	Treatment Name	Rate	Rate Unit / Appl Code	1*	2*	3*	4*	5*	6*	7*
4	Platinum	12	fl oz/a A	0.0a	0.0a	0.0a	1.28e	0.0a	0.0a	0.0a
3	Actara	4	oz/a ABC	0.0a	0.0a	0.0a	1.34de	0.3a	0.0a	0.0a
9	Mustang Maxx	4	fl oz/a ABC	0.0a	0.0a	0.0a	1.38de	0.0a	0.0a	0.0a
5	Exirel foliar	20.5	fl oz/a ABC	0.3a	0.0a	0.0a	1.41de	0.0a	0.0a	0.0a
14	Imidacloprid 4F	3.2	fl oz/a ABC	0.0a	0.0a	0.0a	1.5cde	0.3a	0.0a	0.0a
15	Asana XL	7	fl oz/a ABC	0.0a	0.0a	0.0a	1.52b-e	0.3a	0.0a	0.0a
12	Altacor	3.5	oz/a ABC	0.3a	0.0a	0.0a	1.53b-e	0.0a	0.0a	0.0a
2	Assail 30 SG	5.3	oz/a ABC	0.0a	0.0a	0.0a	1.54b-e	0.0a	0.3a	0.0a
8	Movento	10	fl oz/a ABC	0.0a	0.0a	0.0a	1.56b-e	0.0a	0.5a	0.0a
6	Exirel drip	20.5	fl oz/a ABC	0.0a	0.0a	0.0a	1.58b-e	0.0a	0.0a	0.0a
7	Harvanta	16.4	fl oz/a ABC	0.0a	0.0a	0.0a	1.63a-d	0.0a	0.0a	0.0a
13	Aza-Direct	30	fl oz/a ABC	0.0a	0.0a	0.0a	1.63a-d	0.3a	0.0a	0.0a
10	Malathion 8 Aquamul	20	fl oz/a ABC	0.0a	0.0a	0.0a	1.8abc	0.0a	0.5a	0.0a
1	Untreated check			0.0a	0.0a	0.0a	1.83ab	0.0a	0.0a	0.0a
11	Lannate LV	0.375	gal/a ABC	0.3a	0.0a	0.0a	1.91a	0.0a	0.0a	0.0a
LSD P=.05				0.32	.	.	0.321	0.36	0.46	.
Standard Deviation				0.22	0.00	0.00	0.225	0.26	0.32	0.00
CV				443.65	0.0	0.0	14.4	382.66	383.96	0.0
Levene's F^				0.684	.	.	1.397	0.611	1.113	.
Levene's Prob(F)				0.777	.	.	0.194	0.842	0.373	.
Shapiro-Wilk^				0.6964*	.	.	0.9737	0.7308*	0.7392*	.
P(Shapiro-Wilk)^				0.0*	.	.	0.2212	0.0*	0.0*	.
Skewness^				2.3001*	.	.	-0.1271	1.9342*	2.3318*	.
P(Skewness)^				0.0*	.	.	0.6893	0.0*	0.0*	.
Kurtosis^				7.807*	.	.	-0.8679	4.9044*	11.6772*	.
P(Kurtosis)^				0.0*	.	.	0.1692	0.0*	0.0*	.
Replicate F				1.242	0.000	0.000	1.527	1.366	1.465	0.000
Replicate Prob(F)				0.3066	1.0000	1.0000	0.2214	0.2663	0.2378	1.0000
Treatment F				0.871	0.000	0.000	2.547	0.805	1.279	0.000
Treatment Prob(F)				0.5935	1.0000	1.0000	0.0098	0.6591	0.2603	1.0000

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 2-continued.

Rating Date					Oct-2-2022
Rating Type					L2-tot ter
Rating Unit/Min/Max					Number, -, -
Number of Subsamples					1
Data Entry Date					Dec-2-2022
Days After First/Last Applic.					457, 402
Trt-Eval Interval					
Number of Decimals					2
Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	8*
1	Untreated check				2.17a
2	Assail 30 SG	5.3	oz/a	ABC	1.49a
3	Actara	4	oz/a	ABC	1.97a
4	Platinum	12	fl oz/a	A	1.57a
5	Exirel foliar	20.5	fl oz/a	ABC	1.63a
6	Exirel drip	20.5	fl oz/a	ABC	1.60a
7	Harvanta	16.4	fl oz/a	ABC	1.69a
8	Movento	10	fl oz/a	ABC	1.55a
9	Mustang Maxx	4	fl oz/a	ABC	1.51a
10	Malathion 8 Aquamul	20	fl oz/a	ABC	1.69a
11	Lannate LV	0.375	gal/a	ABC	1.86a
12	Altacor	3.5	oz/a	ABC	1.42a
13	Aza-Direct	30	fl oz/a	ABC	1.56a
14	Imidacloprid 4F	3.2	fl oz/a	ABC	1.73a
15	Asana XL	7	fl oz/a	ABC	1.60a
LSD P=.05					0.525
Standard Deviation					0.368
CV					22.06
Levene's F^					2.902*
Levene's Prob(F)					0.003*
Shapiro-Wilk^					0.9819
P(Shapiro-Wilk)^					0.5141
Skewness^					0.3215
P(Skewness)^					0.3136
Kurtosis^					-0.3984
P(Kurtosis)^					0.5254
Replicate F					0.240
Replicate Prob(F)					0.8681
Treatment F					1.165
Treatment Prob(F)					0.3360

Means followed by same letter or symbol do not significantly differ (P=.05, LSD).

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Figure 1. Effect of insecticides on number of terminals in blueberry at location 1.

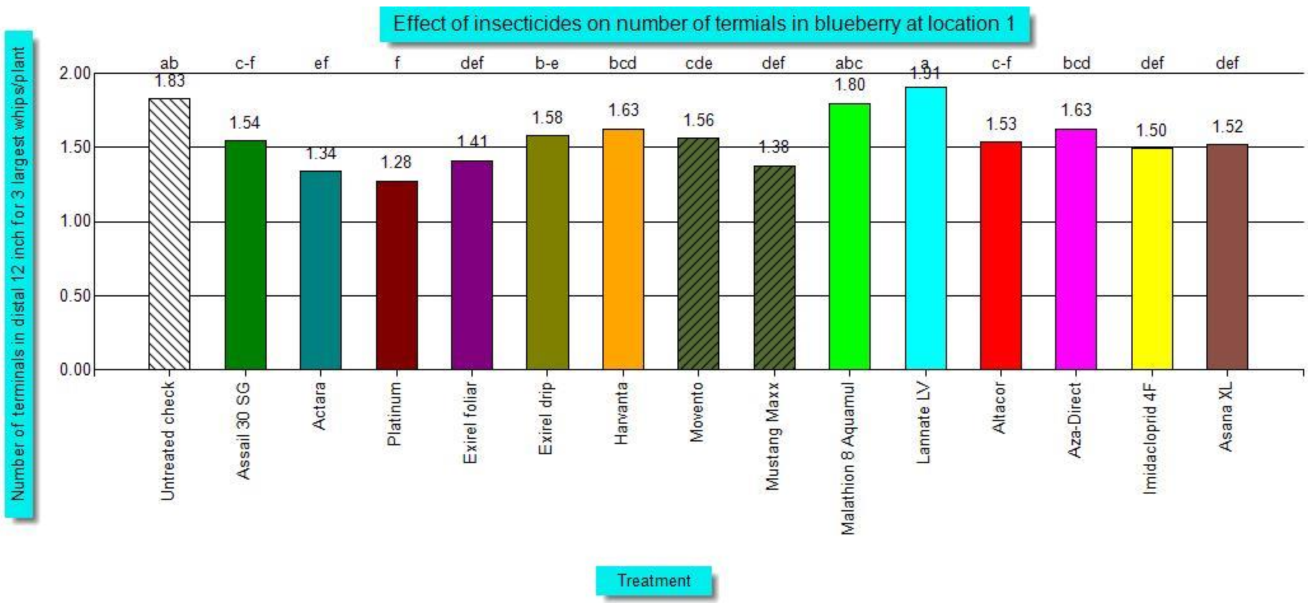


Figure 2. Effect of insecticides on number of terminals in blueberry at location 2.

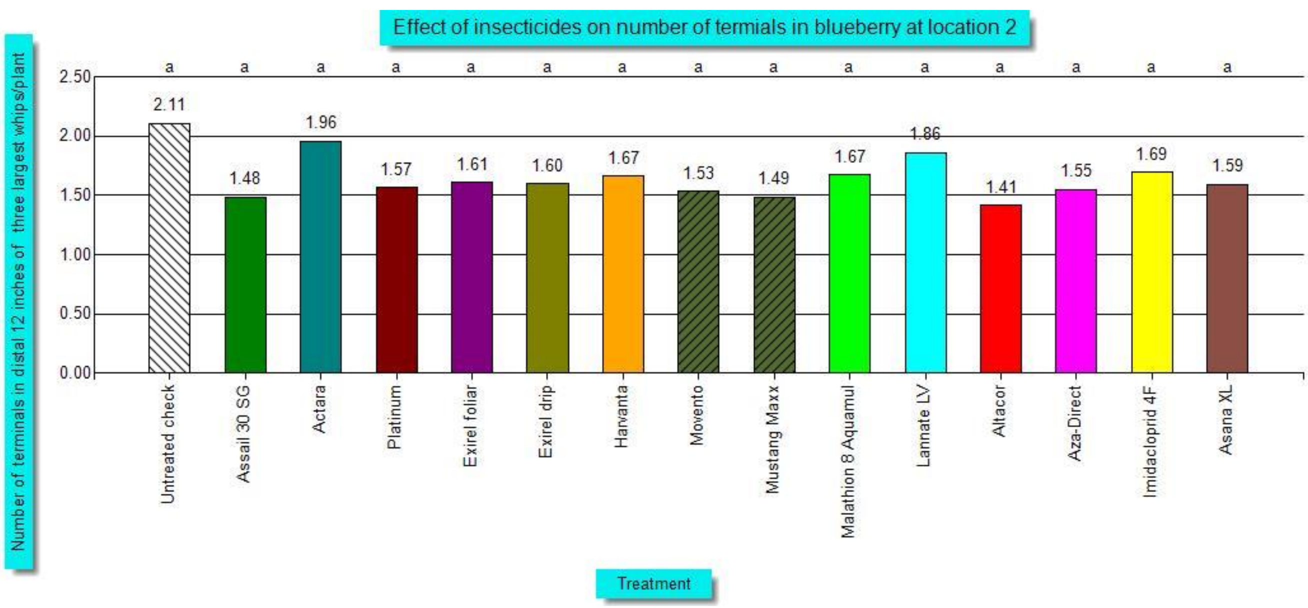


Photo 1. Overall plots photo showing trial site.

Photo 2. Representative photos showing more terminals (left) and less terminals (right) for blueberry plants.

Survey.

The blueberry gall midge eggs and larvae population build over time for the four locations. The highest numbers are shown on August 22 and September 8. The blueberry gall midge has short generation cycle, and there are several generations per season. We found the blueberry gall midge commonly in four locations in Skagit and Snohomish counties. It is likely that midge is probably located all over western Washington.

Figure 3. Blueberry gall midge larvae per 50 tips of blueberry at four locations.

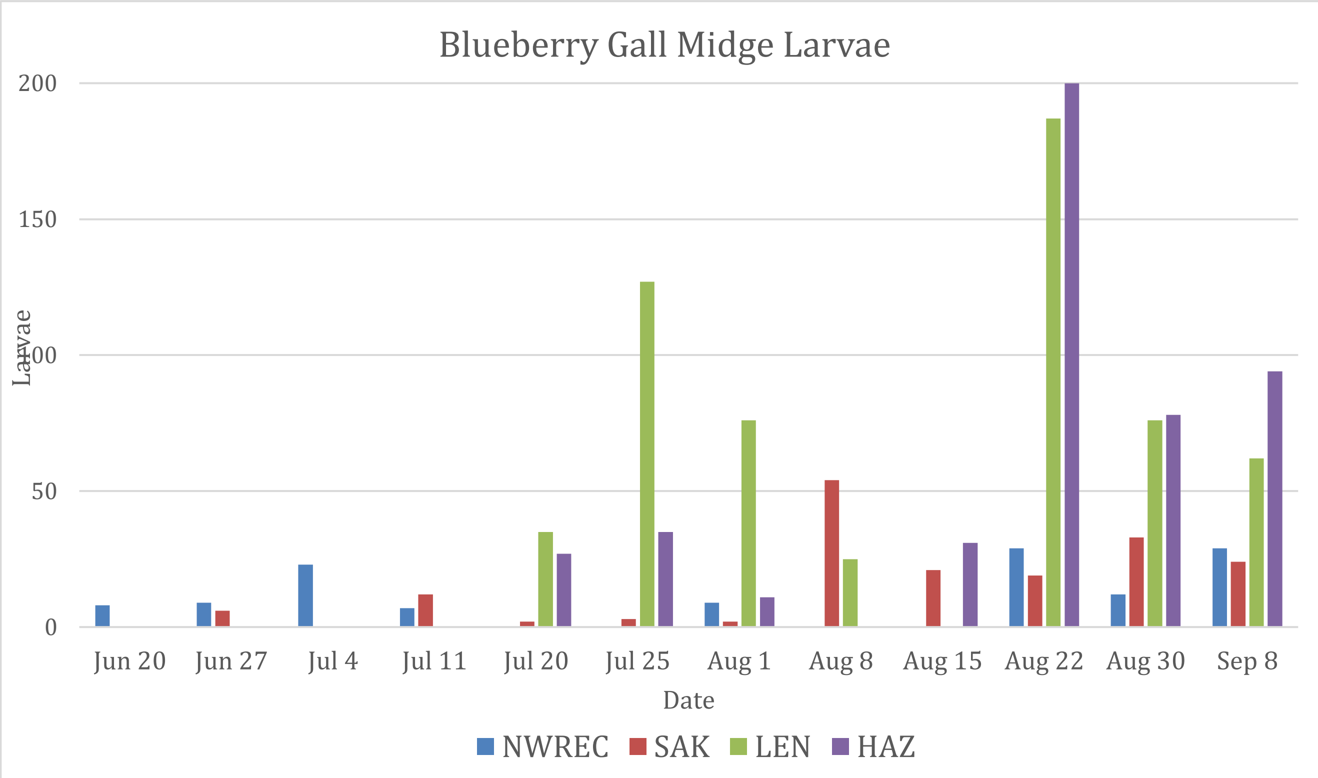
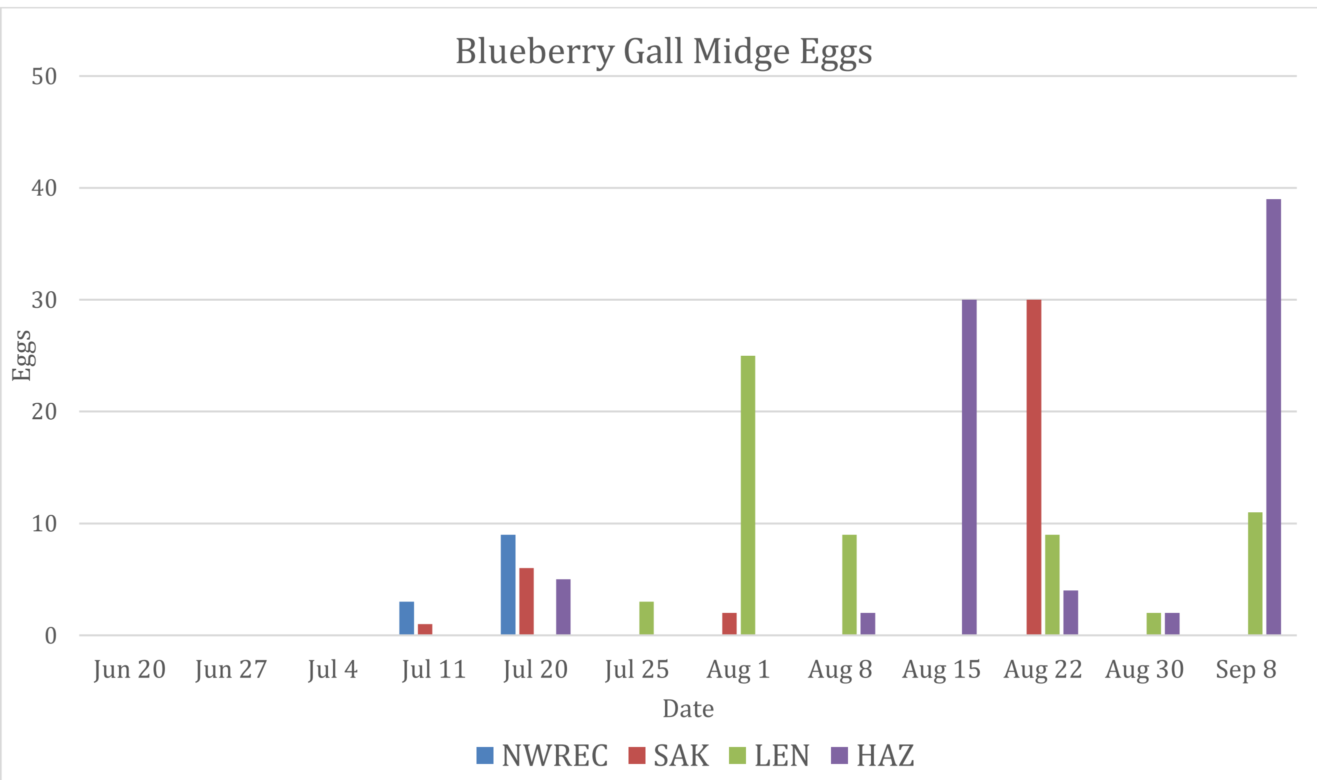


Figure 4. Blueberry gall midge eggs per 50 tips of blueberry at four locations.



SECTION II
Bees and Pollinators

I am a student and I want to be included in the competition

Evaluating the efficacy and safety of oxalic acid vaporization method to control a honey bee pest *Varroa destructor.*

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Beekeepers around the world have been facing the challenges of controlling *Varroa destructor*, a devastating parasitic mite of the honey bee (*Apis mellifera)*. Oxalic acid (OA) is a natural chemical that has been used by beekeepers to control *Varroa* mite. Recently, the vaporization method of OA has been gaining popularity among beekeepers. Only a few studies have investigated the efficacy of the oxalic acid vaporization method in *Varroa* control and its safety to honey bee larvae in the USA.

We evaluated three different doses of oxalic acid (1g, 2g, and 4g) and a control group (no OA) per brood chamber in 2021 and, in 2022, we evaluated two different doses of oxalic acid (3g and 4g) and control group per brood chamber to assess the efficacy and safety of OA. OA was applied once a week for three weeks. We counted deceased *Varroa* mites on the sticky boards daily. We also assessed any potential negative impacts on open larvae and adult bees for both years. In both 2021 and 2022, the 4g treatment had higher *Varroa* mortality than the other groups and did not have any significant effects on adult bee population and brood rearing. To better understand the effects of OA on developing larvae, we monitored larval mortality after the 4g and 3g OA applications in 2022. Our results show that the 4 g OA dose resulted in higher larval mortality compared to 3g OA and control (no OA) in our 2022 experiment.

Based on our results it appears that 3g OA treatment may be the ideal dose, as it provides optimal *Varroa* control and is relatively safe to larvae.

SECTION III
Environmental Toxicology and Regulatory Issues

PESTICIDE DECLINE CURVES IN BLUEBERRIES TO MEET MRLs

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Maximum Residue Limits (MRLs) continue to be an important factor when exporting commodities. A 3-year study was conducted to evaluate insecticide/miticide and fungicide degradation curves in blueberries and generate guidance to meet MRLs of target countries.

Field sites included: California Coast, California Valley, Oregon, Michigan, Eastern and Western Washington. All treatments were replicated 4X with airblast and over-the-row sprayers. Samples were taken once dry on the day of application, then at 1, 3, 5, 7, 14 and 21 days. Analyses were performed by Synergistic Pesticide Laboratory, LLC in Portland, OR.

Target export countries include Australia (AU), Canada (CA), European Union (EU), Japan (JA), Korea (KO), Philippines (PH), Singapore (SG), Taiwan (TA) and Vietnam (VN). MRLs based on www.bcglobal.bryantchristie.com database, are current as of 11/11/2022.

Five miticides, 13 insecticides and 13 fungicides were evaluated as listed below.

Trt No.	Type	Treatment Name	AI	Form Type	Rate	Rate Unit	Amt Product to Measure	PHI
1	INSE	Agri-Mek*	Abamectin	L	3.5	fl oz/a	5.703 mL/mx	
	FUNG	Quadris Top	Azoxystrobin, Difenconazole	L	14	fl oz/a	22.81 mL/mx	7
	FUNG	Captan 4L	Captan	L	48	fl/oz		0
	INSE	Magister	Fenazaquin	L	36	fl oz/a	58.66 mL/mx	7
	INSE	Knack	Pyriproxyfen	L	16	fl oz/a	26.07 mL/mx	7
	INSE	Confirm	Tebufenozide	L	16	fl oz/a	26.07 mL/mx	14
	INSE	Movento	Spirotetramat	L	10	fl oz/a	16.29 mL/mx	7
2	INSE	Kanemite	Acequinocyl	L	31	fl oz/a	50.51 mL/mx	1
	INSE	Talus 70DF*	Buprofezine	D	14	oz/a	21.87 g/mx	
	INSE	Fujimite	Fenpyroximate	L	2	pt/a	52.14 mL/mx	1
	FUNG	Luna Tranquility	Fluopyram, Pyrimethanil	L	27	fl oz/a	43.99 mL/mx	1
	INSE	Sivanto 200SL	Flupyradifurone	L	14	fl oz/a	22.81 mL/mx	3

	FUNG	Proline	Prothioconazole	L	5.7	fl oz/a	9.287 mL/mx	7
3	INSE	Assail 70WP	Acetamiprid	D	2.3	oz/a	3.592 g/mx	1
	INSE	Altacor	Chlorantraniliprole	D	4.5	oz/a	7.029 g/mx	1
	INSE	Beleaf*	Flonicamid	D	2.8	oz/a	4.373 g/mx	
	FUNG	Captan 80 WG	Captan	D	2	lb		0
	FUNG	Merivon*	Pyraclostrobin, Fluxapyroxad	L	10.3	fl/oz/a		
	FUNG	Kenja 400SC	Isofetamid	L	15.5	fl oz/a	25.26 mL/mx	7
	FUNG	Quash	Metconazole	D	2.5	oz/a	3.905 g/mx	7
	INSE	Bexar	Tolfenpyrad	L	27	fl oz/a	43.99 mL/mx	3
4	INSE	Acramite*	Bifenazate	D	1	lb/a	24.99 g/mx	
	INSE	Verdipryn 100SL	Cyclaniliprole	L	11	fl oz/a	17.92 mL/mx	1
	INSE	Diazinon AG500	Diazinon	L	2	qt/a	104.3 mL/mx	5
	FUNG	Prolivo	Pyriofenone	L	5	fl oz/a		0
	INSE	Rimon 0.83EC	Novaluron	L	30	fl oz/a	48.88 mL/mx	8
	FUNG	Cevya	Mefentrifluconazole	L	5	fl oz/a		0
	FUNG	Fontelis	Penthiopyrad	L	24	fl oz/a	39.1 mL/mx	0
	INSE	Transform	Sulfoxaflor	D	2.75	oz/a	4.295 g/mx	1

Select Product Declines

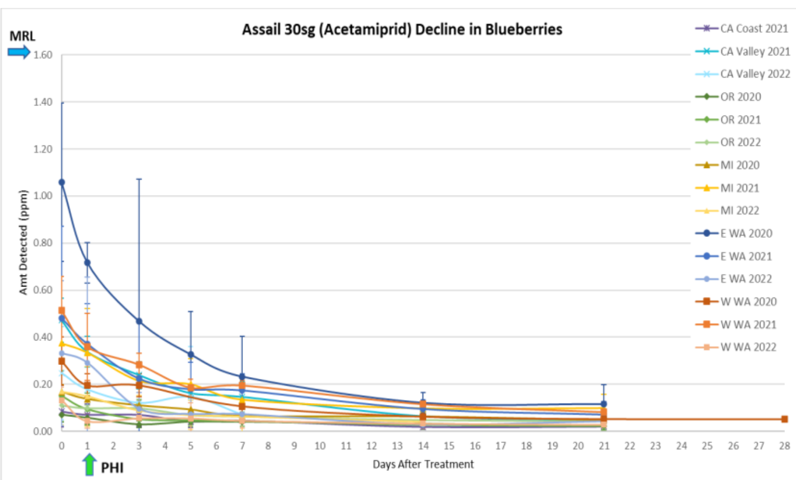

Fig. 1. Acetamiprid Decline in Blueberries

Residues for the insecticide Assail (acetamiprid) were well below the US tolerance of 1.6 ppm at the Pre-Harvest Interval (PHI) of 1 day. Most export markets have MRLs harmonized with the US or higher with the exception of Korea at 0.5 ppm. With only one set of residues higher than the Korean MRL at the PHI, this would be considered moderate risk whereas waiting until 3 days after application would be low risk for export.

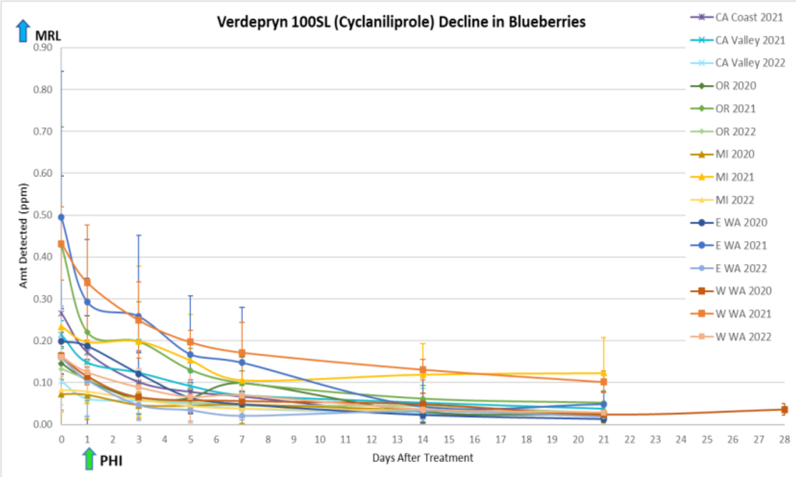

Fig. 2. Cyclaniliprole Decline in Blueberries

Similarly, most markets have favorable MRLs for the insecticide Verdepryn (cyclaniliprole) at the PHI except for the EU defaulting to 0.01 ppm and both Taiwan and Vietnam with a zero tolerance policy.

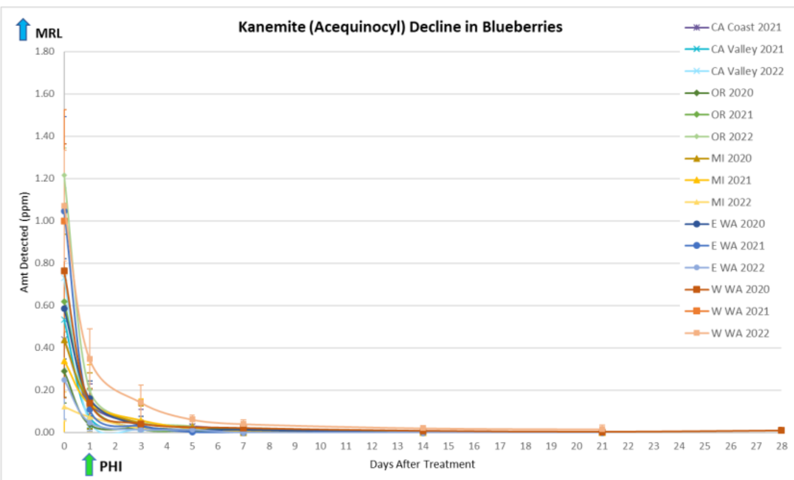

Fig. 3. Acequinocyl Decline in Blueberries

Kanemite (acequinocyl) is an example of a pesticide that degrades rapidly. However, few MRLs have been established for this miticide in blueberries. Only Australia and Korea are harmonized with the US tolerance of 3 ppm.

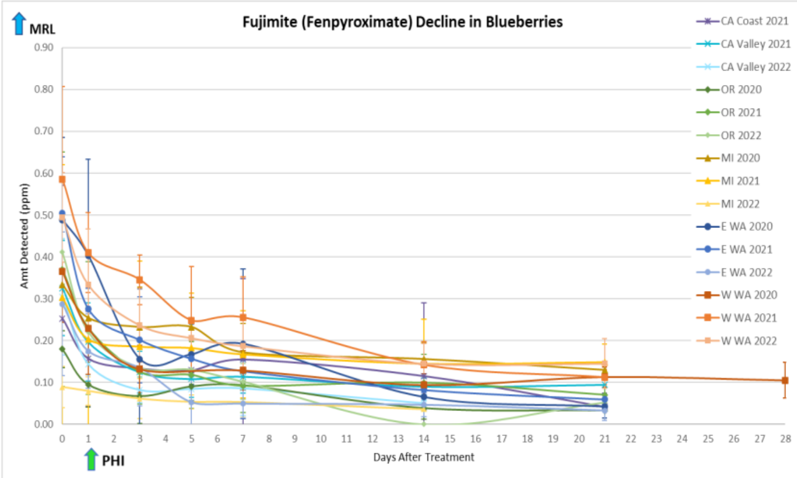

Fig. 4. Fenpyroximate Decline in Blueberries

The miticide Fujimite (fenpyroximate) has longer lasting residues and no harmonized MRLs. Exporting at the PHI to Taiwan with an MRL of 0.5 ppm would be low risk, and to the EU with an MRL of 0.4 ppm would be moderate risk. Meeting the Korean MRL of 0.3 ppm may take an additional few days. All other markets have MRLs below the observed residues and exporting to these markets is considered high risk until MRLs are established or change.

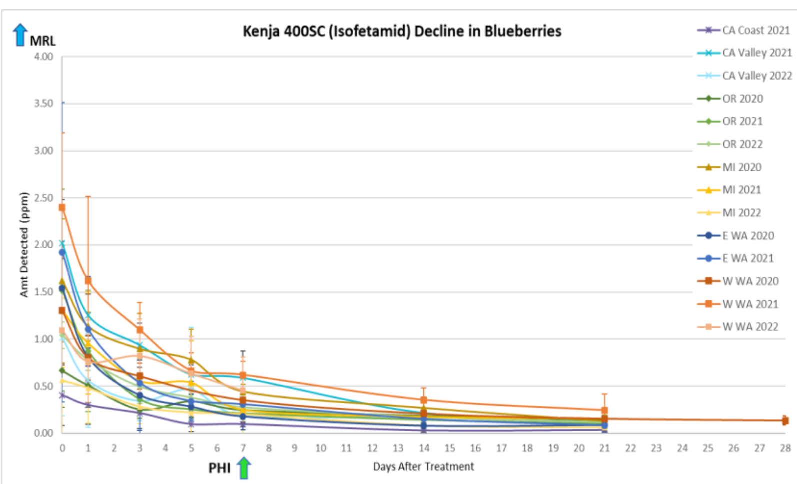

Fig. 5. Isofetamid Decline in Blueberries

Despite the slow decline of the fungicide Kenja (isofetamid), export is not an issue for most markets with mostly harmonized MRLs.

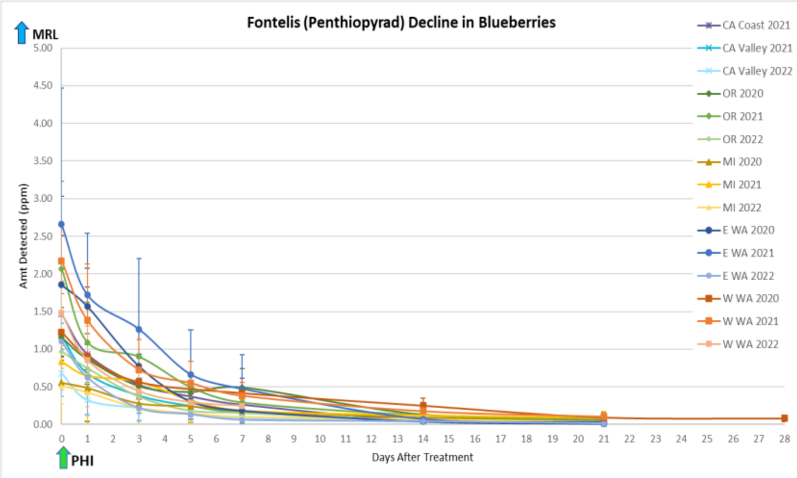

Fig. 6. Penthiopyrad Decline in Blueberries

For the fungicide Fontelis (penthiopyrad), most export markets are achievable at the PHI. With residues detected frequently above 0.01 ppm out to day 21 and beyond, it is considered high risk to export to the EU with an MRL of 0.01 ppm, Korea with an MRL of 0.07 ppm, or Taiwan or Vietnam with zero tolerance policies.

SECTION IV
Field Crop Pests

BEET LEAFHOPPER AND BEET CURLY TOP VIRUS IN HEMP: A RESEARCH UPDATE

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The beet leafhopper *Circulifer tenellus* Baker (Hemiptera: Cicadellidae) is a generalist leafhopper that feeds and reproduces on many crops including sugar beet, potato, tomato, cucurbits, spinach, and wild hosts such as tumble mustard, pigweed, lambsquarters, wild radish, redstem filaree, and various thistle species. This leafhopper is associated with three important pathogens: the *Beet Curly Top Virus* (BCTV), a phytoplasma known as beet leafhopper-transmitted virescence agent (BLTVA), and the spiroplasma *Spiroplasma citri.*

In some areas of the United States, including Oregon, the beet leafhopper is considered an emerging pest of hemp (*Cannabis sativa* L.) because of its ability to transmit the BCTV, a *Curtovirus* belonging to the Geminiviridae family. The BCTV is transmitted in a persistent circulative (non-propagative) manner during feeding. Symptoms caused by BCTV infection include yellowing and stunting, up-curled leaf, flat stem, central branch symptomatic, side branches with normal growth, and twisting (Figure 1).

Figure 1. Hemp plant infected with BCTV (A) and magnification of symptoms (B).
Photos: T. Oppedisano (IAEP-OSU)

So far, little information is available about the mechanisms of BCTV acquisition and transmission in hemp, hemp varieties' susceptibility to the BCTV, and effective strategies against the insect vector. Since the production of hemp has a tight regulatory procedure, chemical control is limited. Thus, there is a heavy reliance on the use of alternative approaches to keep pests under control. Because of all these reasons, in the past three years, our program has focused on researching the biological and ecological relationship between the beet leafhopper and hemp.

This report will include two studies: (1) BCTV transmission and (2) evaluation of biopesticides in controlling the beet leafhopper.

Our first aim was to identify the ability of the beet leafhopper to transmit BCTV in two hemp varieties. Cherry Blossom was selected based on a previous field study where beet leafhoppers showed a preference for this variety compared to other hemp varieties, including Cherry Wine, which was the second variety selected for this study.

Infected and non-infected beet leafhoppers were maintained in colonies in our laboratory and kept at 26 +/-2 °C, 16:8 L:D photoperiod, and 40-50% RH. For this experiment, BCTV-infected beet leafhoppers adults and nymphs were released in cages containing a single healthy hemp plant (Figure 2). After a week of exposure, beet leafhoppers were recollected and tested with PCR analyses using specific primers, while plants were kept in the greenhouse for six weeks to monitor the presence of BCTV symptoms; plants were also molecular tested. In general, plants exposed to nymphs presented a higher transmission rate in Cherry Blossom, while the transmission rate was similar with both insect stages in Cherry Wine.

Figure 2. Single-caged hemp plants were set up in the greenhouse. BCTV-infected beet leafhoppers were confined onto healthy plant for a week, and recollected after one week of exposure. Plants were tested six weeks later. Photo: T. Oppedisano (IAEP-OSU)

Our second greenhouse experiment tested the efficacy of four biopesticides against beet leafhopper adults and nymphs. The biopesticides tested included *Chromobacterium subtsugae*, *Burkholderia* spp., *Chenopodium ambrosioides*, and azadirachtin. The biopesticides were applied to the foliage using a calibrated hand sprayer; once the biopesticides dried out, beet leafhoppers were released into clip cages (Figure 3). In all experiments, four cages were clipped to each plant (four plants/treatment) for a total of 16 replicates per treatment. To evaluate the potency of the products, leafhoppers were released 1 h after treatment, and mortality was assessed 1, 3, and 7 days after treatment (DAT). The residual effect was measured after beet leafhoppers were rereleased 7 DAT. Mortality was assessed 1, 3, and 7 days after rerelease, corresponding to 8, 10, and 14 DAT. Our results showed that *Burkholderia* spp. had the greatest potency against beet leafhopper adults 7 DAT, while *C. ambrosioides* and azadirachtin highly affected the mortality of nymphs at 1 and 3 DAT, respectively.

Figure 3. Foliage application of biopesticides (A); each hemp plant was infested with five beet leafhopper adults or nymphs per clip cage as shown in figure (B). Photos: T. Oppedisano (IAEP-OSU)

CORN EARWORM POPULATION IN HEMP AS AFFECTED BY CORN PLANTING DATES

Tiziana Oppedisano[1], Philippe Thuillier[2], Daniel I. Thompson[1], and Silvia I. Rondon[1,3]
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Industrial hemp or hemp (*Cannabis sativa* L.) is a valuable crop worldwide. It is mainly cultivated for medicinal or recreational purposes or used for fiber, seed, and oil production. Hemp is quickly becoming a well-established crop in the US Pacific Northwest, especially in Oregon, where the climate is suitable for growing hemp. However, several arthropod pests affect hemp, including mites, leafhoppers, and the corn earworm (CEW) *Helicoverpa zea* Boddie (Lepidoptera: Noctuidae).

Corn earworm is a common pest affecting corn, cotton, soybeans, and several vegetable crops worldwide. CEW has been observed affecting hemp in all US states where hemp is cultivated. The life cycle of the CEW consists of an egg, five larval instars, a pupa, and an adult. CEW overwinters as pupa into the ground, and adults emerge during spring. Phenology models using degree days have been developed to predict CEW emergence at different life stages; details can be found on the Oregon IPM Center website (https://uspest.org/dd/model_app). Larvae present a diverse coloration, where young larvae are often darker in color with prominent black bristles, while later instars are lighter in color with pink, yellow, green, or two-toned coloration. The moths are easily recognized for the presence of two dark dots in the forewings. In hemp, all immature stages of CEW can devour floral buds and tunnel through plant tissue, thus reducing yields. Population size and damage can vary significantly from season to season and by location. Damage from CEW can be easily observed due to the presence of frass, tunneling on the buds, and wilting and dead of the leaves and tissue surrounding the affected area. Limited or no data are available regarding the response of hemp varieties to CEW injury, and there is no established economic threshold or economic injury level for CEW in hemp.

The proximity to corn, the primary host of CEW, can be fundamental in the intensity of CEW pressure in hemp. Thus, this study evaluated the incidence of CEW in four commercial hemp varieties, including Cherry Blossom, Cherry Wine, Cottonwood Candy, and Willow Berry, and one experimental variety ‘L1019’ as affected by corn planted at different dates. Both crops were managed following standard agricultural practices. Hemp plants were planted from transplants following a Latin Square design. Each block consisted of six plants; a 3-meter buffer was kept between the blocks. Sweet corn var. GH6462 was planted after hemp establishment. Corn was planted one week apart on 7/13, 7/20, 7/27, and 8/03, respectively, on each side of the square. The CEW adult population was monitored weekly using a pheromone placed in a Hartstack trap located in a corner of the field (Figure 1A). The location of the trap was on the prevailing wind. The presence of CEW larvae in corn was monitored weekly through visual inspections of 15 plants randomly selected on each corn-planting block, including inspections of tassels, ears, silks, and kernels (Figure 1B). In hemp, six flower buds/plant were visually inspected for a total of 36 flowers/plot (Figure 1C). Hemp was taken to yield. To evaluate the yield, a subsample of three plants/block was taken; we collected data from primary colas (central flower cluster) and secondary colas. A cola is a cluster of buds, from nodes where buds form, that grow together on female hemp plants; it is the part of the plant that contains CBD, terpenes, THC, etc. After collection, the fresh weight of primary and secondary colas was taken, and, after a drying time of a week period, dry weight was taken as well.

Our results showed that early-planted corn was severely damaged by CEW and served as an early source of CEW for hemp; late-planted corn presented the lowest CEW infestation. Even though we found CEW infesting all hemp cultivars at the flower maturation stage, we observed a gradual colonization of CEW in hemp from early to late hemp varieties. Cottonwood Candy had the highest yield in terms of fresh weight, while ‘L1019’ had the highest yield in terms of dry weight, even though this variety was the most CEW-infested variety.

Our preliminary results showed that the selection of late corn planting and late hemp varieties could be used as a tool to reduce CEW damage, especially in areas with a history of CEW.

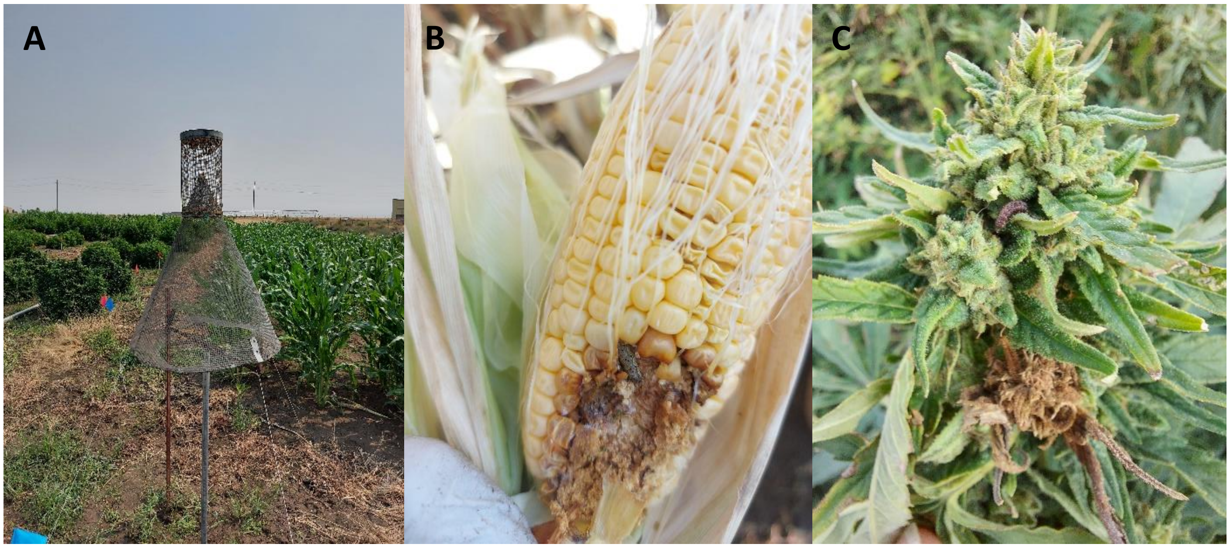

Figure 1. Adult population of CEW was monitored during the whole field study by using a pheromone Hartstack trap (A); Damage and presence of CEW in corn (B) and hemp flower (C). Photos: T. Oppedisano (IAEP-OSU)

I am a student.

Detection of Bifenthrin Resistance in White Clover Seed Weevil

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Clover seed weevil (CSW), *Tychius picirostris* Fabricious is a key insect pest in white clover seed production in Oregon. CSW larvae feed on developing clover seeds, causing significant yield losses. Since 2017, growers and crop consultants have observed poor efficacy with pyrethroid insecticides causing severe economic loss, and limited alternative control measures are available. In this study, a series of dose-response bioassays were conducted using technical grade and formulated bifenthrin for four Oregon CSW populations and one Canadian CSW population collected from commercial white clover seed production fields. We also screened two phase I detoxification enzymes, including a mixed-function oxidase inhibitor (piperonyl butoxide) and an esterase inhibitor (S,S,S-tributyl phosphotrithioate), and one phase II detoxification enzyme, a glutathione S-transferase (GST) inhibitor (dimethyl maleate) to evaluate synergic activity with bifenthrin and potential mechanisms of insecticide resistance development to pyrethroid insecticides. Moribundity was determined at 24 h for all assays and probit analyses were performed to generate LC_{50} and RR_{50} values. Elevated resistance levels to bifenthrin were detected in CSW populations collected from Oregon (LC_{50} = 3.70-21.94) when compared to a susceptible Canadian population (LC_{50} = 0.02-0.04). Mixed function oxidase (SR_{50} = 175- 407.69) and esterase (SR_{50} = 177.31-837.31) inhibitors had synergistic effects on bifenthrin for Oregon CSW populations. This study is the first documentation of CSW insecticide resistance development. Alternative control strategies including refining sampling techniques and targeting larval stage to manage this pest in Oregon clover seed production system are being explored.

Abstract submission by Adeetje Bouma (student, Oregon State University)

Section VI: Pests of Wine Grapes, Orchards, & Small Fruits

Monitoring and Organic Management of Filbertworm (*Cydia latiferreana*) in Pacific Northwest Hazelnuts

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Filbertworm, *Cydia latiferreana* (Walsingham), is the primary insect pest of hazelnut (*Corylus avellana* L.) orchards in Oregon which is the third largest hazelnut producer worldwide. Kernel damage occurs when FBW larvae burrow into developing hazelnuts to feed. Conventional growers manage FBW with one or two pyrethroid applications, and organic growers manage the pest with repeated applications of spinosad and other biologically derived insecticides. Broad spectrum pesticides such as these are harmful to natural enemy populations, potentially inducing secondary pest outbreaks, and resistance may occur due to repeated applications. With consideration to this need for additional management chemistries, we tested several products for efficacy in controlling FBW.

DEVELOPMENT OF PHEROMONE BASED TOOLS FOR WIREWORM MANAGEMENT

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Wireworms (Coleoptera: Elateridae) are serious pests of many crops in the United States, including those that are important for food security such as cereals and vegetables. In the Pacific Northwest, growers are susceptible to wireworm damage from several different species and are heavily reliant on insecticides to manage existing populations. However, recent deregistration of effective pesticides has resulted in a resurgence of populations, leaving growers with minimal options for wireworm management. The below ground life of wireworms makes them difficult to detect, and there has been minimal research into detection of the adults (click beetles). Thus, it was important to research alternative methods to detect and manage wireworms.

Until recently, there were no pheromone tools available for use in managing wireworms in the U.S., excluding the three invasive *Agriotes* species (*A. sputator*, *A. lineatus*, and *A. obscurus*). The need for such tools resulted in collaborative research that has led to sex pheromone and sex attractant identifications of many species across nine genera, including pest species in the genera *Limonius*, *Melanotus*, and *Selatosomus.*

Research on elaterid pheromones began by field-screening dozens of published and unpublished pheromones of click beetles from Eurasia and North America. These field tests were conducted in several locations throughout the Columbia Basin, in both Oregon and Washington state. Additional applied research on *Limonius* species was also done to optimize trapping, which included lure type, trap type, and trap placement. The results of this research are promising and can be incorporated into additional studies for wireworm management in the PNW.

SECTION V
Potato Pests

HOW WILD POTATO SPECIES CAN CHANGE THE STRATEGIES IN MANAGING COLORADO POTATO BEETLE

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The Colorado potato beetle, *Leptinotarsa decemlineata* Say (Coleoptera: Chrysomelidae), is one of the most harmful and persistent insect pests of potato (*Solanum tuberosum* L.). *Leptinotarsa decemlineata* has developed resistance to more than 50 different insecticides, representing nearly all insecticidal modes of action. Current efforts focus on finding new genetic material to be incorporated into potato breeding programs.

The potato crop is vegetatively propagated, highly heterozygous, and a tetraploid plant. For many years, potato breeding has been by way of phenotypic selections. However, because of this crop's tetraploid nature, plant breeders could not successfully eliminate deleterious alleles and add desirable traits. Some authors suggest that the next step in potato breeding is the return to adopting diploid potato species from wild potato species to combine desirable traits in *S. tuberosum* through hybridization. Since the potato crop is well known for being susceptible to many insect pests and diseases above and below ground, breeding efforts could be powerful tools for long-term sustainable pest management.

The main characteristics and traits from the wild species of potato that we want to aim for are mainly the chemical and morphological traits which, according to different authors, they will give the plant-insect resistance or tolerance characteristics. These traits include glycoalkaloids, glandular trichomes, and Volatile organic compounds. Each of these traits can affect the physiology and behavior of the Colorado potato beetle at different levels. For instance, Glycoalkaloids in potato leaves induce cell membrane lysis and are acetylcholinesterase inhibitors, causing constant nerve firing and, therefore, nervous system disorder in the insects. Trichomes exhibit antixenosis and antibiosis for feeding insects. Studies show that Trichome-mediated resistance in wild potato species protects against the Colorado potato beetle.

Identification and integration of these traits from wild species to cultivated species will provide the potato industry with new powerful strategies to add to Integrated Pest Management models and potentially slow down the development of insecticide resistance in the Colorado potato beetle.

Investigating Synthetic Defense Elicitors on Potato Crops for the Management of the Colorado Potato Beetle

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Abstract

In response to early evidence of insecticide resistance developing in populations of Colorado potato beetle *Leptinotarsa decemlineata Say* (Coleoptera: Chrysomelidae) in the western United States, this study evaluated commercially available chemical elicitors of plant defense responses for their ability to affect beetle fitness and fecundity. Trials using salicylic acid and jasmonic acid based elicitors were conducted on potato plants var. Ranger Burbank. The resiliency of elicitor treatments was further tested against host phenology and signal interference from the salicylic acid induction caused by co-infection of the green peach aphid *Myzus persicae* Sulzer (Hemiptera: Aphididae). Initial data suggested that elicitors, particularly those that induce a jasmonic acid-dependent response, can affect beetle fitness.

Introduction

The Colorado potato beetle, *Leptinotarsa decemlineata* Say (Coleoptera: Chrysomelidae), is one of potato crops' most significant defoliators in North America and Europe. This key pest has displayed the ability to rapidly develop resistance to pesticides. For instance, Colorado potato beetle populations in the eastern part of the U. S. have been reported to have resistance to all current insecticidal modes of action and there is some evidence of resistant populations developing in the western potato growing regions. Thus, new management tools for this pest should be investigated. Synthetic elicitors of plant defenses are an emerging tool for crop protection that can be applied as a foliar spray or root drench. Previous studies on elicitors have illustrated their ability to affect insect fitness, fecundity, and behavior. However, whether these effects are beneficial or deleterious to the targeted pest appears to be dependent upon several key factors encompassing the cultivar-pest interaction and signal interference. Thus, it is necessary to evaluate elicitors' efficacy on a cultivar-pest-elicitor interaction basis using multiple pest fitness parameters and under testing conditions that model the host response under controllably diverse signal conditions.

Materials and Methods

In 2021 and 2022, two separate studies were conducted at the Hermiston Agricultural Research and Extension Center in Hermiston OR. The first study evaluated the effects of three doses of elicitors on Colorado potato beetle adult fecundity. Salicylic acid (SA) and jasmonic acid (JA) dependent elicitors were tested in a field-to-lab study. Adult beetles were field collected and moved into containers in the laboratory. Beetles were kept at 21°C ± 2°C and 75% RH ± 5%. Blocks of plants (n=12) were sprayed in the field using a CO_2 backpack sprayer for 6 elicitor treatments and one control (Table 1). Twenty-four hours after application, leaves (n=20) were collected and moved to the laboratory where they were placed in containers. Twelve Colorado potato beetle adults were released per container and allowed to feed and oviposit for 72 hours. Egg clutches were collected and the percentage of hatch eclosion was determined.

A second study evaluated the effects on larval fitness of an SA elicitor, JA elicitor, and one elicitor reported to have dual (SA-JA) activity in the greenhouse. Groups of plants (n=30) were grown to either the leaf development stage or the flowering stage. Plants were sprayed (Table 2) with elicitors and half (n=15) received a cohort of green peach aphids (n=5) in a clip cage. Neonates (n=6) of the Colorado potato beetle were added to the plants and allowed to feed for 7 days. The defoliation rate was measured daily. At the end of 7 days, the beetles were removed and weighed. Instar stages were estimated from measurements of head width and body length.

Treatment	Low (1/2)	Recommended	High (2x)
Actigard 50 WG (SA)	25 µl/L	50 µl/L	100 µl/L
Methyl Jasmonate (JA)	0.37 mg/L	0.75 mg/L	1.5 mg/L
Tap Water (control)	N/A	N/A	N/A

Table 1. List of treatments used in the first experiment.

Treatment	Dose
Actigard 50 WG	75 mg/ L
Actigard 50 WG	100 mg/L
Regalia	10 ml/L
Blush 2x	2 ml/L
Tap Water	N/A

Table 2. List of treatments used in the second experiment.

Results & Discussion

Of the doses we tested for Actigard and Methyl jasmonate, we found only Actigard at a dose of 0.75 mg/L affected fecundity. However, all elicitors affected larval fitness, and these effects were at least partially dependent on the presence of aphids and the plant phenology (Fig. 1). The presence of aphids in particular seemed to have the greatest effect on elicitors function and efficacy. This data is still undergoing statistical analysis, and further results are expected to be published in 2023.

Conclusions & Future Work

Preliminary information suggests that elicitors can impact the fitness of the Colorado potato beetle. This potentially reduces or increases the beetles' subsequent impacts on defoliation and tuber yield. Further studies are planned to assess if the change in defoliation rate is responsible for the observed differences in weight gain and developmental time or if elicitors are rendering host nutrients less bioavailable to the pest. We also plan to examine the biomechanical property of work to shear for leaves exposed to elicitor treatments. This will help in determining if the changes in defoliation rate are due to structural or biochemical defenses.

Treatments			Development time	Weight gain	Total defoliation
Actigard high (SA)	Aphids present	Flowering	↑	↑	↓
		Leaf dev.	↑	↓	↓
	Aphids absent	Flowering	↓	↓	↑
		Leaf dev.	↑	↓	↑
Actigard low (SA)	Aphids present	Flowering	↓	↑	↓
		Leaf dev.	↑	↓	↓
	Aphids absent	Flowering	↓	↓	↓
		Leaf dev.	↑	↓	↑
Regalia (SA & JA)	Aphids present	Flowering	↓	↑	↓
		Leaf dev.	↓	↓	↓
	Aphids absent	Flowering	↑	↓	↑
		Leaf dev.	↑	↓	↑
Blush 2x (JA)	Aphids present	Flowering	↓	↑	↓
		Leaf dev.	↑	↓	↓
	Aphids absent	Flowering	↑	↓	↓
		Leaf dev.	↑	↓	↑

Fig. 1 Directionality of elicitor effects on measurements of larval fitness relative to the control group

EFFECTS OF PESTICIDES ON PREDATORY INSECTS

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In 2011, Zebra Chip disease was detected in the Columbia Basin of Oregon and Washington for the first time. This ushered in a paradigm shift in potato-integrated pest management programs for the region as growers implemented a zero-tolerance policy on potato psyllids starting pesticide applications at the first detection. In 2014 and 2015, the HAREC-IEAP in cooperation with researchers across the region engaged in a research project to assess the efficacy of commonly used pesticides on potato psyllid; a secondary goal was to assess the effects on predatory insects, which will be the focus of this report.

In mid-April, Ranger Russet potatoes were planted following spring wheat. Plots were 3.5 x 7.6 m long with a 23 cm plant spacing. All standard commercial practices were used, except we did not use insecticides at planting. At the first detection of potato psyllids, sprays were initiated and each insecticide was sprayed on a 14-day schedule for the duration of the growing season. Treatments were applied using a tractor-driven CO2-powered boom sprayer with TeeJet AI11002 nozzles at 40 psi solution, and 30 gpa. The list of treatments can be seen on (Tables 1&2.) The groups of predatory insects that were surveyed were Coccinellidae, Anthocoridae, Nabidae, Geocoridae, and Reduviidae. Insects were sampled weekly using an inverted leaf blower; samples were then frozen for 48hrs in the lab to allow enough time for insects to died, and then species/orders were sorted, and data tabulated.

In 2014 (Figure 1), Reduviidae and Coccinellidae were the most prominent groups in July and August, respectively. In addition, in August, the total number of Coccinellidae in plots where Brigade was sprayed, was significantly different than counts in all other treatments including the check. In 2015 (Figure 2), Reduviidae, Anthocoridae, and Coccinellidae total counts were significantly different in the months of, July–August, July, and August, respectively. Significant differences were noted in the total number of Nabidae per month in Sep. In some beneficial groups, like Geocoridae in 2015, the effect of pesticides may be evident.

Table 1. List of treatments 2014.

	Treatment	Rate oz/a
T1	UTC	
T2	Abamectin+Movento Movento	6 5
T3	Abamectin	6
T4	Exirel	13.5
T5	Transforn WG	1.5
T6	Aza-Direct	24
T7	Beleaf	2.85
T8	Brigade	6.4
T9	Torac	14
T10	Sivanto	10.5

Table 2. List of treatments 2015.

	Treatment	Rate oz/a
T1	UTC	
T2	Abamectin+Movento Movento	5
T3	Abemectin	6
T4	Aza-direct	24
T5	Beleaf	2.8
T6	Brigade	6.4
T7	Torac	14
T8	Sivanto	10.5
T9	Admire Pro	8.7

Fig. 1. Mean predatory Insects per month, Hermiston 2014.

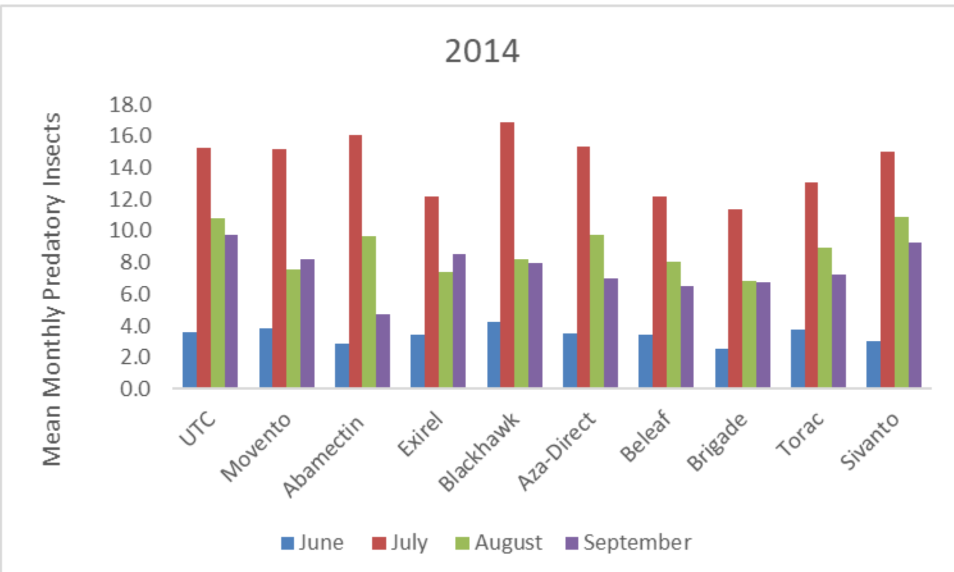
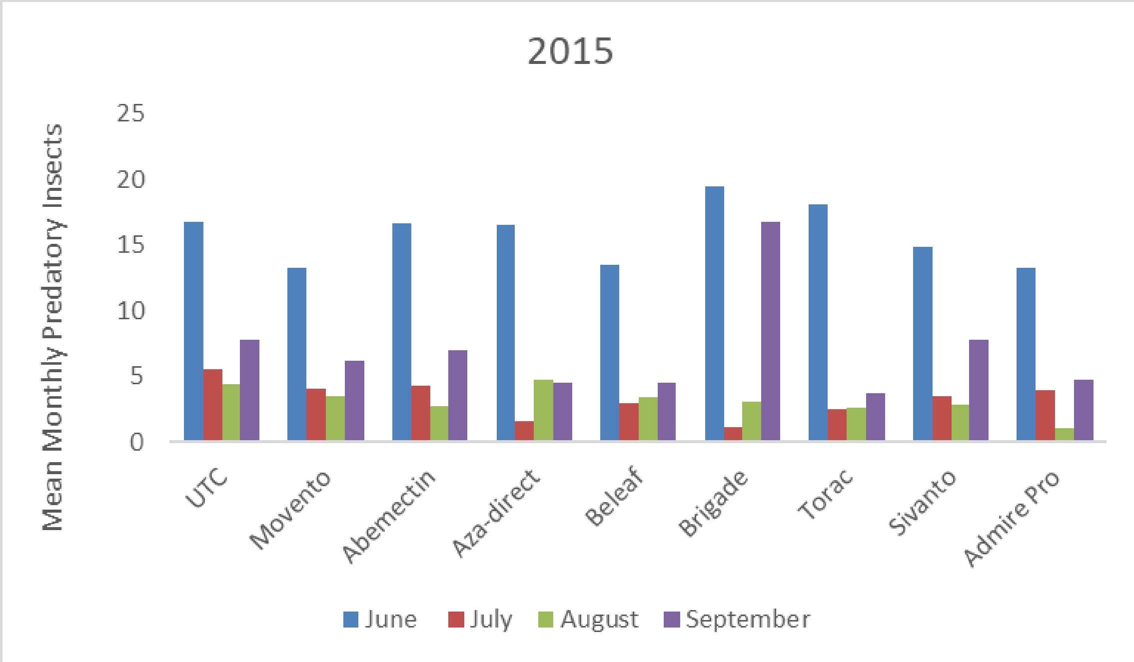


Fig. 2. Mean predatory Insects per month, Hermiston 2015.



UNEXPECTED INSECT PESTS REPORTED FROM POTATO IN WASHINGTON

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The insect and mite management guidelines for potatoes for the Pacific Northwest lists Colorado potato beetle, aphids, aphids on seed potatoes, two-spotted spider mite, cutworm, armyworm, cabbage looper, beet leafhopper, potato tuberworm, thrips and potato psyllid as pests. The Pacific Northwest Insect Management Handbook has a longer list of potato insect pests including blister beetle, cucumber beetle, flea beetle, garden symphylan, grasshopper, leather jacket, slug, stink bug, white grub and white fly. Several of these pests are west of the Cascade pests including cucumber beetle, flea beetle, leather jacket and slugs.

Unusual insect pests reported as afflicting potatoes in Washington included blister beetle, cucumber beetle, garden symphylan, grasshopper, leather jacket, slug, stink bug, white grub and white fly.

This report covers three of these pest species; stink bug, white fly and white grub and a fourth species, leaf cutter bees.

SECTION VI
Small Fruit, Tree fruits and Nuts

A sticky situation: aphid phenology and control trials in Pacific Northwest hazelnuts

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Two species of aphids (Hemiptera: Aphididae) affect hazelnuts in the Pacific Northwest (PNW), filbert aphid *Myzocallis coryli* (Goetze), and hazelnut aphid *Corylobium avellanae* (Schrank). Both species are found around the world, where European hazelnut (*Corylus avellana* L.) is cultivated. While *M. coryli* has probably been present in the PNW since the industry was established with European stock in the late 1800's, *C. avellanae* is a more recent arrival. Egg hatch of overwintering eggs is synchronized with bud break in spring, and populations can rapidly rise. Heavy infestations result in reduced nut fill and size, and action thresholds for *M. coryli* based on leaf samples were developed prior to the arrival of *C. avellanae*. Experienced growers are relatively tolerant of aphids and rely on delayed classical biological control from the introduced specialist parasitoid *Trioxys pallidus* (Haliday). However, recent heavy infestations of aphids in new hazelnut varieties have called into question relevancy of the old action thresholds, and the excessive use of fertilizer or insecticides targeting other pests such as filbertworm (*Cydia latiferreana*) or brown marmorated stink bug (*Halyomorpha halys*) can exacerbate the problem. These aphid infestations are sometimes leading to late treatments that we suspect are very hard on the natural enemy community. Additionally, some growers are applying prophylactic treatments of imidacloprid, clothianidin, or sulfoxaflor.

The goal of our research is to gain a better understanding of aphid and natural enemy population dynamics over the whole growing season so that we can update action thresholds and IPM guidance to account for *C. avellanae* and new disease-resistant hazelnut varieties that now dominate the industry. We also want to examine potential key timings for treating aphids while minimizing nontarget effects. In 2022 we conducted a trial testing early applications of a variety of products to eliminate early aphid populations including the viviparous fundatrices that cause rapid population increase, while reducing nontarget effects on natural enemies. MBI-306 is a new insecticide/miticide produced by Pro Farm Group Inc. whose active ingredient is based on inactivated *Burkholderia rinojensis* strain A396 cells and spent fermentation media. Transform contains the active ingredient sulfoxaflor, and is touted as being effective against a variety of insect pests including aphids while being soft on natural enemies. All treatments reduced aphid populations compared with the UTC 7 and 14 DAT (Figure 1).

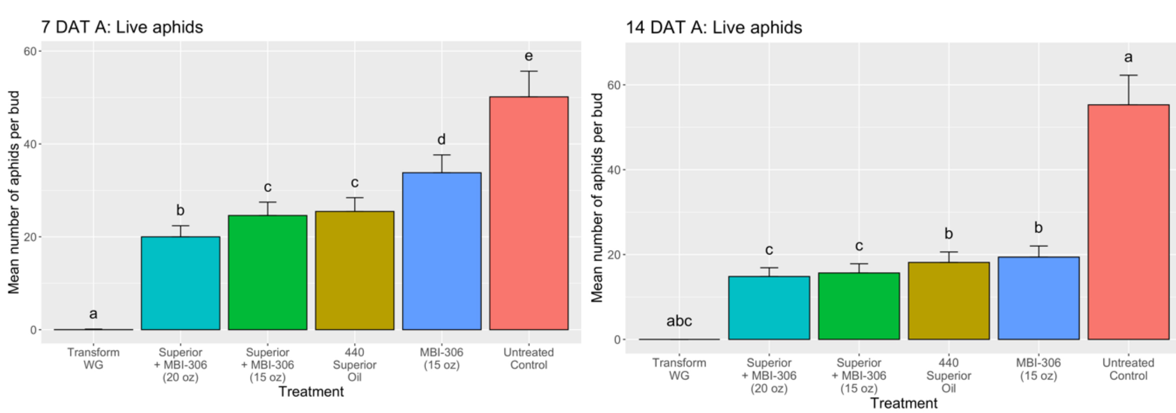

Figure 1. Treatment effects on aphid density at 7 and 14 days after initial application.

Treatment effects continued to be similar in later samples after the second spray application, with less difference between rates as time went on (Figure 2.). Throughout the trial, oil appeared to enhance the efficacy of MBI-306 compared to either MBI-306 or oil alone.

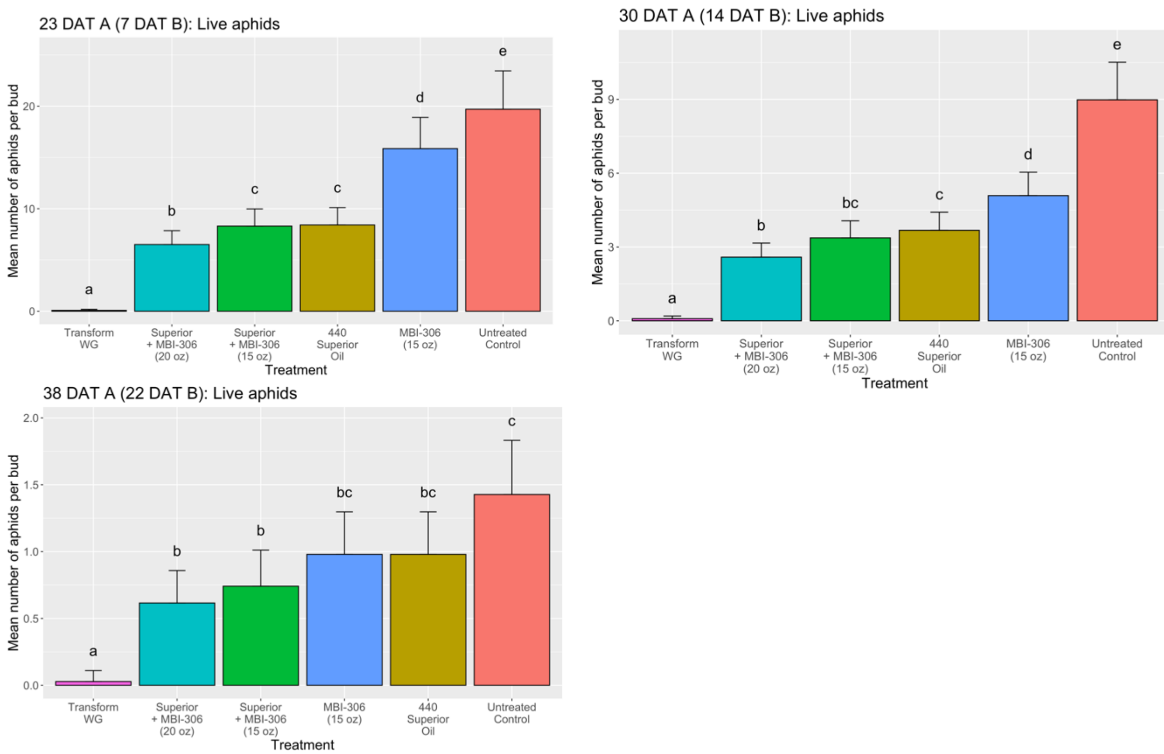

Figure 2. Treatment effects at 23, 30 and 38 days after initial application (7, 14 and 22 days after second application).

Additionally, natural enemies including syrphids, lacewings, predatory mites, spiders and ladybird beetles were present and active across all treatment, although there were fewer in the conventionally treated trees likely due to significantly lower aphid populations (Figure 3).

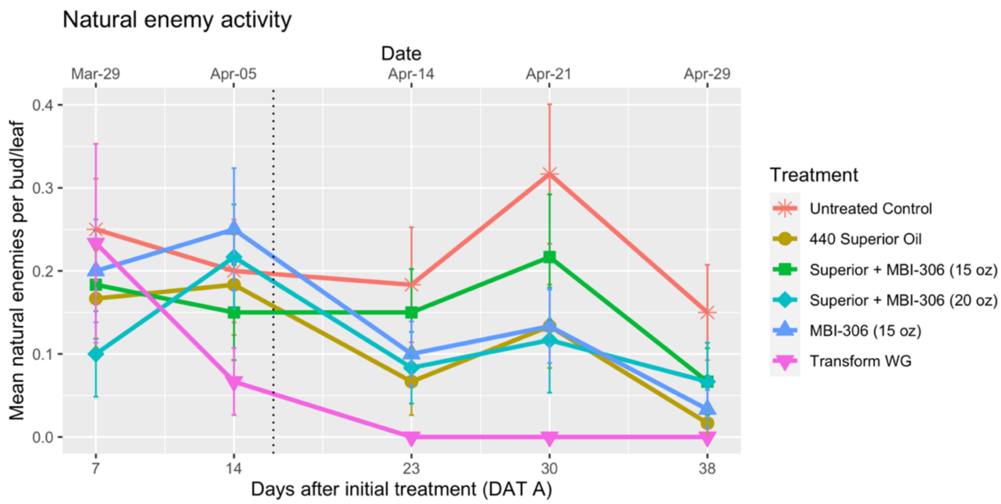

Figure 3. Activity of predators across the different treatments. The dotted line represents the second spray application.

Treatments also affected activity of the aphid parasitoid *Trioxys pallidus* (Figure 4.). It is interesting to note that we saw increased parasitism when aphids were treated. Aphids that were weakened or intoxicated by treatments may have been more susceptible to attack. Over time parasitoid activity declined, which mirrored aphid populations.

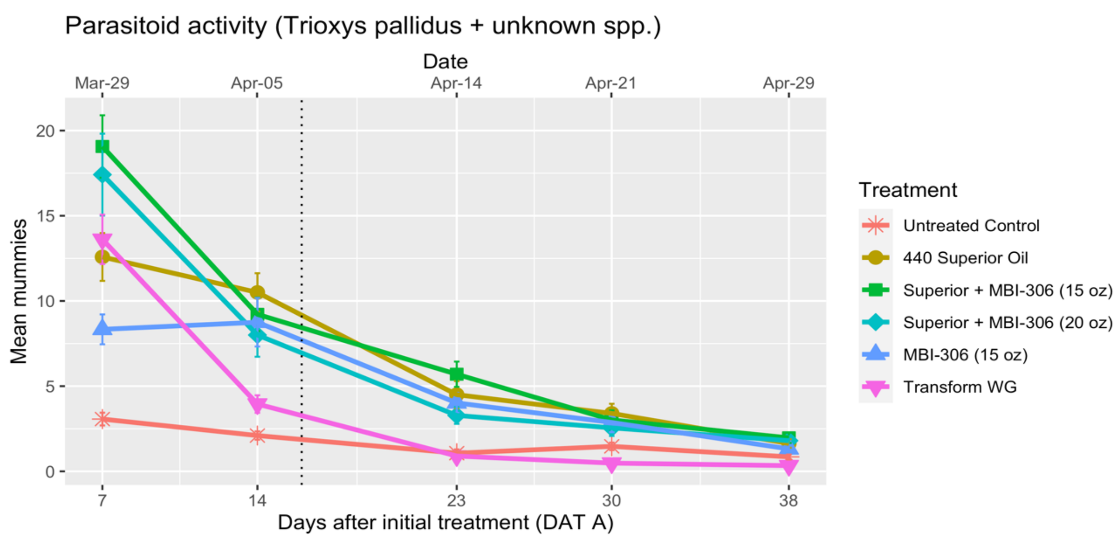

Figure 4. Parasitized aphid trends following treatment. The dotted line represents the second spray application.

The Presence of *Wolbachia* in West Coast *Trechnites insidiosus*

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Trechnites insidiosus are the key parasitoid of pear psylla, the most important pest of western U.S. pears. Little is known about its biology, making it difficult to develop conservation recommendations for growers. It is unknown if, or to what extent, *T. insidiosus* are infected with Wolbachia; discovery of male *T. insidiosus* is rare. If Wolbachia infestation is prevalent, this could have important implications for pest control. Female-biased sex ratios could increase biocontrol. Wolbachia could also impact population dynamics.

Trechnites spp. were collected from 55 western pear orchards in 2021 using 3D-printed cylinder traps and identified to species. Up to 10 individuals from each location were used in the study. We extracted DNA from individual *T. insidiosus* and amplified a *Wolbachia* ~610 bp surface protein sequence using universal *Wolbachia* primers (WSP-81F and WSP-691R). Eight positive samples were direct sequenced to confirm the DNA as Wolbachia. Sequences were aligned with existing Wolbachia supergroups in Geneious Prime.

Wolbachia is present in *T. insidiosus* across the western US. *Wolbachia* infection rates vary by region and decrease along a north to south latitudinal gradient (Figure 1). This north to south gradient may be associated with cooler north temperatures. *Trechnites insidiosus Wolbachia* belong to the *Wolbachia* Supergroup A. Thus, it is unlikely that horizontal transmission from pear psylla is responsible for *T. insidiosus* infection with *Wolbachia*. Infection rates could have an impact on pear psylla biological control with *T. insidiosus.* Further, climate change may impact *Wolbachia* infection and disrupt *T. insidiosus* biological control services.

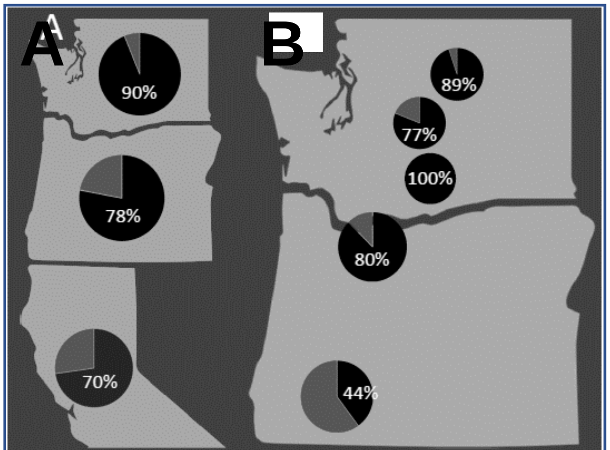

Figure 1. Black portion indicates percent *Wolbachia* positive samples (A) by state and (B) by region. Samples were collected, from north to south, in: Chelan (*n* = 9 individuals), Wenatchee (8), and Yakima Valley (10), WA; Hood River (10) and Medford (9), OR; and Mendocino Co., CA (10).

Comparing monitoring methods for leafhopper species that vector Cherry X-disease in sweet cherry orchards of Hood River and Wasco counties.

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Cherry-X disease has been a devastating problem for cherry producers since its discovery in California in 1931. This disease causes cherry trees to produce small, bitter, unmarketable fruit, and will eventually kill the tree. Cherry-X is caused by a phytoplasma, which is plant-pathogenic, phloem-inhabiting bacteria that are transmitted from plant to plant by eight known leafhopper species in the Pacific Northwest. There is currently no treatment to kill the phytoplasma in the trees, therefore it is important to determine what leafhopper species are in your cherry orchard, when they are present, and where they are located. Best monitoring practice varies by species. Monitoring techniques include placing sticky cards, sweep netting, and vacuuming. Each technique has varying strengths and weaknesses. Implications and recommendations are discussed.

Areawide management of Spotted-wing drosophila

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Spotted-wing drosophila (SWD), *Drosophila suzukii*, is a serious global invasive pest that attacks small fruits and cherries. Currently, SWD management focuses on within-crop management, but SWD can develop on many wild and ornamental species in the surrounding landscape. Biological control is appropriate for the Areawide program because it is sustainable, often host-specific, and can be implemented over large areas. Our Areawide project consists of 8 labs/organization working together. We aim to: 1) reduce SWD populations in the landscape with sustainable tools, 2) establish parasitoids, and 3) increase grower adoption of sustainable tools reducing pesticide use and managing resistance. We compare four large-acreage paired 'implementation' and 'control' sites in Washington cherry, Oregon blueberry, and California blackberry-raspberry. To achieve our goals, we are using sustainable tools such as Decoy to attract and arrest female SWD to laying eggs into a gum matrix rather than the crop. Though not significant, SWD infestation was 50% lower in blueberry from Decoy-treated rows than controls. We also released the imported parasitoid *Ganaspis brasiliensis* at the implementation sites. The parasitoid was recovered in one site 4,000 ft away from the release point. We also recorded adventive *Leptopilina japonica* at two implementation and two control sites in Oregon blueberries. Insecticide resistance was not apparent at one of the paired sites, and lower than prior years.

MATING DISRUPTION: THE SUCCESS OF LOW RATE FILBERTWORM, *Cydia latiferreana* (LEPIDOPTERA: TORTRICIDAE), PHEROMONE DISPENSERS IN HAZELNUT

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Keywords: filbert worm, mating disruption, HSW Flex dispenser, hazelnut pest, integrated pest management

Abstract

Hazelnut is an economically important crop that provides significant income to growers in Oregon, USA. Filbert worm (FBW), *Cydia latiferreana,* is one of the economically crucial pests in hazelnut production resulting in injured and unmarketable nuts. Hatched larvae burrow inside the nut and feed throughout the season. Several insecticides are in use to control damaging FBW populations. Insecticide use may cause secondary pest resurgence and reduce the biological agent populations in the orchard. Mating disruption is a method to minimize insecticide use while reducing pest damage. In the present study, low rate of ISOMATE HSW Flex pheromone dispensers were deployed to evaluate the efficacy of FBW mating disruption in hazelnut orchards. Experiments were conducted in eight hazelnut orchards. ISOMATE HSW Flex dispensers were evenly deployed in the field with application rates of 0, 10, 20, 20C, 30, 50, and 100/ acre in 2021 and 0, 5, 10, 15, 30/ acre in 2022. In addition, 0.5 and 1 m ring dispensers were used as a standard mating disruption application. Dispensers were applied to the upper 1/3 of the canopy approximately 3-4 m above the ground level. Male FBW counts were checked weekly by placing two pheromone-baited delta traps in treated each plot. The results indicate that low-rate dispensers disrupt equally compared to standard mating disruption application. Additional research is necessary to better understand low-rate treatments in a large-scale field scenario and determine their costs and benefits.

SECTION VII
Pests of Turf and Ornamentals

TREATMENT OPTIONS FOR GARDEN SYMPHYLAN SUPPRESSION

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The garden symphylan, *Scutigerella immaculata* Newport, is a serious agricultural pest in Oregon. *S. immaculata* is a soil arthropod pest whose root-feeding affects the yield potential and survival of several high-value crops, especially during crop establishment. The broad host range includes grasses grown for seed, vegetable seed crops, and other specialty crops such as peppermint and strawberries. Symphylan management is costly to growers and requires soil sampling and treatment with Lorsban (chlorpyrifos) as pre-plant incorporation (PPI), which will be phased out due to environmental consequences. This leaves growers with only pyrethroids for chemical control, which have been ineffective at controlling symphylans, and no clear path for registration exists for alternate chemistries (e.g., Mocap and Ethoprop).

The aims of this study are first, to evaluate the efficacy of new and existing insecticides at treating garden symphylans as a preplant application. Second, as new promising chemistries immerge, the data will be utilized in promotion and support of the product registration process. The study has been conducted over two seasons (spring and fall planting) at the Oregon State University, Hyslop Research Farm in Corvallis. Two fields with pre-existing symphylan-infested area were selected for this study. Efficacy trials were conducted in tall fescue grown for seed in a randomized complete block design, with four replications. Plot sizes were 30 ft long x 12 ft wide, with a 30-foot border of untreated fescue surrounding each replication. Plots were treated using a CO_2 pressurized backpack sprayer at a spray volume of 20 gal/acre at 22 psi through AM11002 nozzles using treatments listed in Table 1 on April 8, 2022 and October 20, 2022. After soil application, treatments were incorporated with tillage into the top 2 inches of soil using a tractor-mounted rototiller. Tall fescue (var. 'Titanium G-LS') was planted at a 9 lb/acre seeding rate with a 13-inch row spacing and approximately 0.5 inches depth. Data were recorded on symphylan abundance (number of symphylans counted on each bait) using the potato bait method by deploying two bait stations per plot at 10, 14, and 25 DAT in spring and 8, 13, and 33 DAT after fall planting. Plant density was measured in each plot at 45 DAT by counting the number of emerged plants in a randomly selected row of 1m length. Spring data have been analyzed using ANOVA, and means were separated using Fisher's protected LSD ($P \leq 0.05$).

At first inspection of bait traps in spring, at 10 DAT (days after treatment), both Torac and Capture LFR demonstrated significant suppression compared to control plots which contained an average of 9.25 symphylans per plot. Vantacor treated plots contained an average of 4.25 symphylans, followed by treatments BAS4007I and A21377X, having an average of 0.75 and 2.5 symphylans, respectively. At 14 DAT, a similar trend existed for Capture LFR and A21377X which had no symphylans present and had significant suppression compared to Vantacor which hadan average of 3 symphylans per plot. At 25 DAT and 32 DAT, symphylan counts for any treatment were significantly different than the untreated control. At 39 DAT, plots treated with Capture LFR had zero symphylans, but were not significantly different than the control plots with 3.5 symphylans per plot or other insecticide treatments (Figure 1).

Overall, Capture LFR was found to be a promising candidate providing symphylan suppression during early root development of tall fescue. Although no statistical differences were detected in plant density among treatments, the plots treated with Capture LFR resulted in slightly higher stand counts when compared to control plots.[1]

[1] This research was supported in part by industry gifts of pesticides and/or research funding.

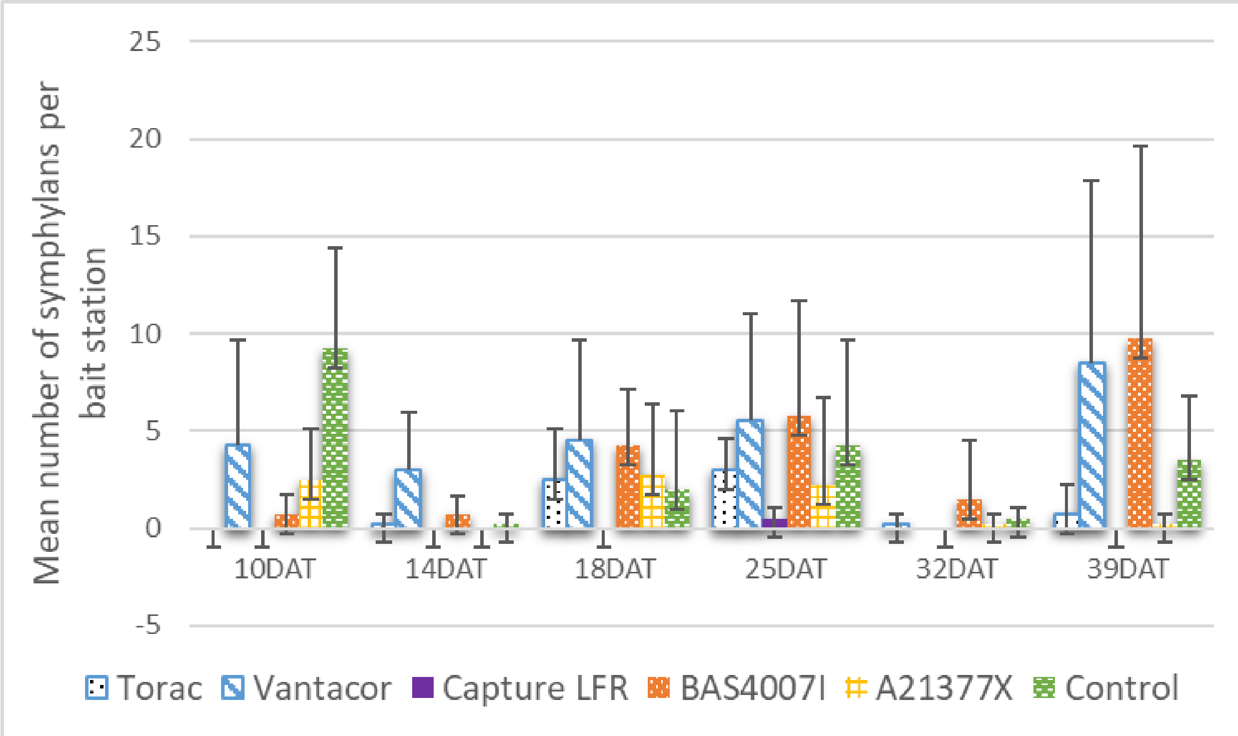

Figure 1. Average number of garden symphylans found during weekly bait checks (Spring 2022).

Early-season cover crop effects on pest and beneficial insect assemblages in red maple shade tree production

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Use of cover crops has been used successfully to manage soil erosion, reduce nutrient loss and enhance beneficial aspects of overall soil health (Clark, 2012). In nursery and woody ornamental production, cover crops have been shown in recent studies to potentially reduce the risk of damage by providing a visual and physical barrier, limiting access of the pest insect to the host. In particular, the use of winter and early season cover crops to impair host selection from boring beetles, e.g. Pacific Flathead Borer and Flatheaded Apple Borer, has shown to be an effective way of limiting female beetle access to oviposition sites (Dawadi et al. 2019). In 2020, Carson et al. showed that early season cover crops additional attract a greater abundance and diversity of natural enemies of pest insects in cotton crops, especially natural enemies of thrips species- a common pest in nursery shade tree production. Even more recent work has shown that use of early season cover crops can me more effective in an integrated pest management program than insecticidal application (Rowen et al., 2022).

Over the spring and summer of 2022, four cover crops we assessed to determine the relative assemblages of pest insects and natural enemies in red maple nursery production: vetch, oat grass, red clover, and unmanaged weeds. The covers were assessed every other week over four months to capture all of the vegetative growth stages of the cover crops during the growing season for red maple most pressured by pest insects – tip feeding insects in the spring and early summer, boring beetles (*Chrysobothris sp.)* in the early and mid-summer weeks. Each plot was sampled in 50-ft lengths using a sweep net, and the captured insects identified and counted for comparison. For the purposes of this study, insect pollinators in the Apidae family were not included in the analysis.

Results show that use of cover crops with more variable seasonal presentation (e.g. punctuated flowering versus continuously flowering) hosted more beneficial insects, with unmanaged weeds providing refuge for the most different types of natural enemies. There were many species of weeds producing flowers, and thus pollen and nectar, at times of the growing season, providing plentiful alternate food resources for predators. In addition, the complex habitat structure created by the unmanaged weeds created patches of diverse refugia also beneficial to increase diversity and abundance of beneficial insects. The fewest beneficial insects were found in the oat grass cover crops, which has high numbers only of small piercing-sucking phytophagous insects.

References:

Bowers, Carson, Michael Toews, Yangxuan Liu and Jason M. Schmidt. 2020. Cover crops improve early season natural enemy and pest management in cotton production. Biological Control Vol 141 February 2020. DOI: 10.1016/j.biocontrol.2019.104149

Clark, Andy. ed. 2012. Managing cover crops profitably, 3rd edition. SARE Outreach, College Park, MD.

Dawadi, Sujan, Jason B. Oliver, Paul O'Neal and Karla M. Addesso. 2019. Management of flatheaded appletree borer (Chrysobothris femorata Olivier) in woody ornamental nursery production with a winter cover crop. Pest Management Science. 75: 1971–1978. DOI 10.1002/ps.5310.

Elizabeth K. Rowen, Kirsten A. Pearsons, Richard G. Smith, Kyle Wickings, John F. Tooker. 2022. Early-season plant cover supports more effective pest control than insecticide applications. Ecological Applications Vol 32:5. DOI: 10.1002/eap.2598

MORTALITY OF *DEROCERAS RETICULATUM* AND ANNUAL RYEGRASS CROP PROTECTION CONFERRED BY THREE SPECIES OF *PHASMARHABDITIS* NEMATODES

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The nematode *Phasmarhabditis hermaphrodita* is a commercially available biological control agent for pest slugs in Europe, and the congeners *Ph. papillosa* and *Ph. californica* cause mortality in various pest slug and snail species. The Gray Fieldslug (*Deroceras reticulatum*) is one of the most damaging invasive gastropod species in the world. In Oregon, this species causes an estimated $100 million worth of annual damages to the grass seed industry

Here, we evaluate Annual Ryegrass (*Lolium multiflorum*) crop protection conferred by three species of *Phasmarhabditis* nematodes on *D. reticulatum* in a microcosm. We compare crop protection to a common chemical molluscicide (liquid metaldehyde), as well as to positive control (no slugs) and negative control (only slugs)

We report a significant difference in slug mortality between nematode treatments throughout much of the experiment duration. All nematode treatments resulted in significantly higher slug mortality than metaldehyde and negative control treatments throughout most of the experiment. Mortality in the metaldehyde treatment did not significantly differ from the negative control throughout this research. All treatments conferred more crop protection than the negative control. That amount of crop protection conferred by *Ph. hermaphrodita*, *Ph. papillosa*, and liquid metaldehyde did not significantly differ from each other or from the positive control for the majority of this experiment; all three of these treatments conferred more crop protection than *Ph. californica* throughout most of the experiment (Figure 1). These data highlight the potential for using *Ph. hermaphrodita* and *Ph. papillosa* as biological control agents. However, before we can make an informed decision on their use in pest management it will be critically important to conduct comprehensive host range testing incorporating native gastropod species.

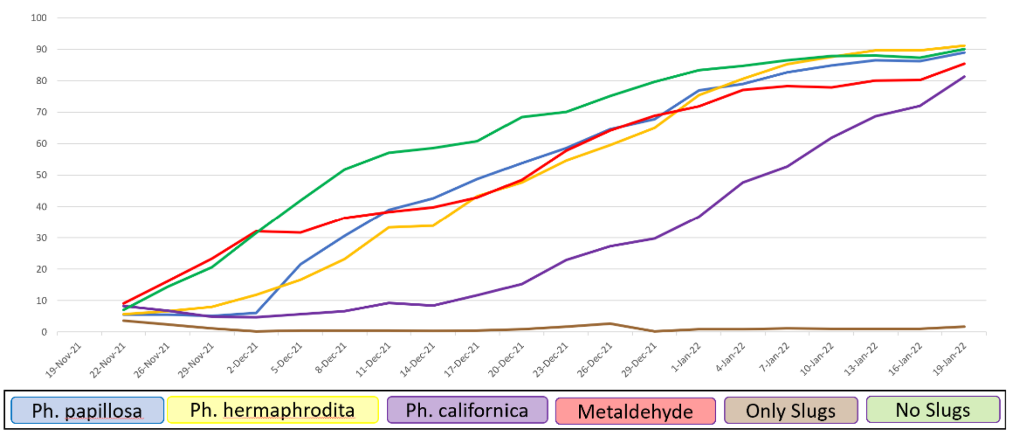

Figure 1. Average percent grass cover over time by treatment.

SECTION VIII
New & Current Product Development

Truepest: A smart phone application that counts and identifies pests on yellow sticky traps using artificial intelligence.

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Introduction: Integrated Pest Management (IPM) is a decision-making process that makes the best use of all available cultural, physical, biological, and chemical tools for sustainable and cost-effective pest control that minimizes adverse effects on the environment and human health. Accurate pest monitoring is the cornerstone of any successful IPM programme in order to decide when, where, and how to implement control measures. Coloured sticky traps are used around the world to monitor a wide range of flying pest populations in a variety of crops. Effective monitoring of sticky traps relies on correct species identification, which is time-consuming and requires expert knowledge and is therefore expensive. Artificial intelligence-based monitoring of pests can increase precision and speed up the process of identifying and counting while decreasing human error. The purpose of this study was to develop an AI system to detect and count the numbers of spotted wing drosophila (*Drosophila Suzukii*) males and females; glasshouse whitefly, vinegar fly (*Drosophila melanogaster)* and non-target species (all other types of insects) on yellow sticky traps.

Materials and Methods: We selected yellow-coloured sticky traps from (Impact traps, Russell IPM Ltd, UK) for this study because they are generally attractive to a wide range of leaf-feeding species. A variety of mobile models were used to collect images in order to capture images with a range of resolutions. In addition, a variety of illumination conditions (sun-exposed, partially, or entirely shadowed) were used to photograph the sticky traps placed outside and in semi-protected crops (strawberry, raspberry, blackberry, and blueberry), to create a robust system with accurate detections and counting, which are realistic for field environments. All the images were taken automatically via our AI-based mobile application. We have used more than 1500 static images of sticky traps. A team of Entomologists at Russell IPM Ltd identified, counted and labelled every single image, labelling five types of insects: SWD males, SWD females, whiteflies, and *Drosophila melanogaster* as well as non-targets by drawing rectangular boxes around them with at least 10,000 annotations for each insect. We have used 80% for training and 20 % for validation.

Results: Using a mobile application based on artificial intelligence to identify and count different types of insects automatically with yellow sticky boards were investigated and evaluated in this study. A total of 120 static images of sticky traps were captured on an iPhone 13 pro max to test our artificial intelligence system. It has been demonstrated that spotted wing drosophilas (Drosophila suzukii), glasshouse whiteflies, vinegar flies (Drosophila melanogaster), and non-target species can all be identified and counted with high accuracy, which is 97.55% and lower accuracy is 93.99% compared to manual counting for each type of insect. Using AI-based deep learning integrated with a mobile application to provide support for farmers shows the huge potential of using AI in agriculture.

Conclusion: In our study, the use of AI-based deep learning was found to be effective in monitoring different types of insects. Further, the results demonstrate the potential of a mobile monitoring application based on artificial intelligence to monitor insect traps which could be valuable for the development of autonomous insect monitoring systems and integrated pest management. We will continue to test more images using different types of phones as well as, we will include more types of incest, such as Thrips.

Expressing G Protein-Coupled Receptors in an Insect Cell System

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While broad-spectrum insecticides are extremely versatile when it comes to targeting a variety of insect pests, there is a desire from many growers and environmentalists for more pest-specific options. Recently, a variety of "-omics" tools such as genomics, proteomics, and metabolomics have been explored to identify pest-specific biological targets. G Protein-Coupled Receptors (GPCRs) gained popularity back in the early 2000s as a molecule of interest for next-generation pesticides [1]. They are known for passing through the cell membrane in seven spots, creating a complex shape that allows them to couple and associate with many different types of G proteins and signaling molecules [2]. Their involvement in crucial physiological processes in insects—such as feeding, metamorphosis, molting, pheromone production, mating, water regulation, muscle contraction, etc.—makes them a fantastic biological target [3]. The pharmaceutical industry has long since recognized this common protein as one of the most crucial receptors in all of biology.

Studying these receptors requires a system in which this transmembrane protein is easily accessible to its exterior environment. Here we present a well-studied system, which involves mutating a Lepidopteran cell line, referred to as "Sf9," to functionally express GPCRs *in vitro*. The Sf9 cell line has a positive reputation for easy transfection of foreign genes, efficient expression of glycosylated proteins, fast doubling time, and flexibility between adherent and suspension growth styles, making it an excellent model for GPCR studies [4]. The comprehensive methodology offered in this presentation will describe the process of maintaining the cell line, the role of the pIB/V5 expression vector in stably transfecting the cells to express the GPCR gene, and testing for binding strength with corresponding neuropeptides using FLIPR Calcium 6 assays.

By using recombinant GPCR Sf9 cells, cloned from an insect pest of choice, the effects of certain neuropeptides, both endogenous and synthetic, can be explored. With this technique, we can identify and characterize the function of a focal receptor in order to develop biological compounds that can stimulate or disrupt important physiological processes.

References

[1] R. S. Hewes and P. H. Taghert, "Neuropeptides and Neuropeptide Receptors in the *Drosophila melanogaster* Genome," *Genome Res.*, vol. 11, no. 6, pp. 1126–1142, Jun. 2001, doi: 10.1101/gr.169901.

[2] U. Gether and B. K. Kobilka, "G Protein-coupled Receptors," *J. Biol. Chem.*, vol. 273, no. 29, pp. 17979–17982, Jul. 1998, doi: 10.1074/jbc.273.29.17979.

[3] N. Audsley and R. E. Down, "G protein coupled receptors as targets for next generation pesticides," *Insect Biochem. Mol. Biol.*, vol. 67, pp. 27–37, Dec. 2015, doi: 10.1016/j.ibmb.2015.07.014.

[4] E. H. Schneider and R. Seifert, "Sf9 cells: A versatile model system to investigate the pharmacological properties of G protein-coupled receptors," *Pharmacol. Ther.*, vol. 128, no. 3, pp. 387–418, Dec. 2010, doi: 10.1016/j.pharmthera.2010.07.005.

SECTION IX
Extension & Consulting:
Updates and Notes from the Field

USING VIDEO AS AN OUTREACH AND ENGAGMENT TOOL FOR IPM EDUCATION: EXAMPLES AND EXPERIENCES FROM THE PAST TWO YEARS

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As videography technology has rapidly gotten more accessible, more people are thinking about how to use video as an outreach, education and engagement tool. With the most basic videography equipment in your pocket via smartphones and multiple outlets for sharing content through social media, YouTube, and online meetings, the opportunities to take advantage of the medium have never been greater. Over the last year, the Oregon IPM Center has been experimenting with different ideas for how to use video to address some of the needs of their audiences.

Due to the COVID pandemic, many conferences and events that had normally taken place in person were shifted online. While this had many advantages in terms of planning, travel and events costs, and protecting attendees health, it was challenging to create engaging and useful content for the attendees. This is especially true when it came to events such as farm walks, hands-on trainings, and learning events designed to be interactive. For our event, the 2022 Biodiversity on Western Farms May 24 and 25, 2022, we were forced to move this event to an online format when normally it is a large and lively in person gathering. In order to give attendees the feel of an in-person farm visit, we shot video footage of interviews and techniques for enhancing conservation biological control on location of our presenters in the months before the meetings. The videos were then edited and used to illustrate the presenters talks during the meeting, allowing them to discuss what was in the videos. The feedback on this approach from attendees was incredidly positive. While the labor involved in producing the videos was high, there was the added benefit of spending time with the video subjects and learning first hand about their farms and practices by the video producers. The videos can also be accessed after meeting for use in other educational venues.

The Oregon IPM Center also produced a series of videos to highlight pollinator protection in ornamental nursery and blueberry systems. These videos highlighted the experiences of the pest managers in an interview format to have more of a “peer-to-peer" feel rather than a lecture. While we were satisfied with the final products, the challenge has been how to use and distribute the videos effectively to their intended audiences. Animation and voice-over are also used throughout.

Videos can be accessed at https://www.youtube.com/@oregonipmcenter