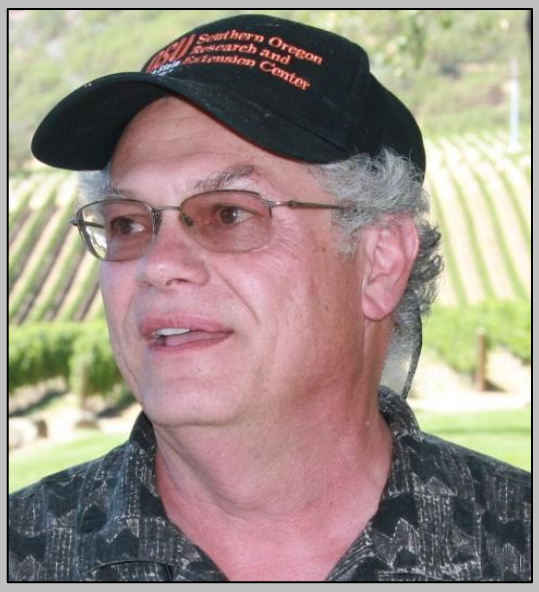
98th Orchard Pest & Disease Management Conference

Keynote address:

On the Road to IPM ~ Moving Towards a More Ecologically Based and Environmentally Friendly Pest Management System



Rick Hilton
Oregon State University

Hilton Portland, Portland, Oregon
January 10th – 12th, 2024

Keynote Speaker: Rick Hilton

Rick received a BA in Biology from Pomona College and a MS from UC Davis in Plant Protection and Pest Management. Upon graduating from UCD in 1987 he began working at the Southern Oregon Experiment Station (now the Southern Oregon Research & Extension Center). It was there that he met Pete Westigard, a great mentor and friend. In 1994, he took over the Entomology and IPM Research Program at SOREC focusing on pests in orchards and vineyards, with an emphasis on pear. Rick was intimately involved in the original Codling Moth Areawide Management Project (1995-1999) which assisted tree fruit growers in the adoption of mating disruption as a key tactic for controlling codling moth. His research included the testing of new management techniques, especially selective or non-disruptive tactics which are compatible with natural biological control agents. He did some early work on the activity of kaolin clay on pear psylla and other pests. The European earwig was a favorite species to study. He tracked resistance development in the major pear pest species and evaluated OP replacement materials. He worked on novel attractants for codling moth that could catch female moths and be used in mating disrupted orchards. Invasive pests have been increasing in importance as Rick has seen the influx of spotted wing drosophila, brown marmorated stink bug, and, most recently, vine mealybug into the Rogue Valley. Rick has been attending the OPDMC for more than thirty years and has thoroughly enjoyed his many collaborations with researchers and growers throughout the western US and beyond. His career allowed him to examine the diversity of life, from plants to insects to people. After retiring this past year, he plans to continue searching for bigfoot in the wilds of the PNW.

Cover art ***Pears and Cherries*** watercolor by Emily Adams.

98th Annual Orchard Pest and Disease Management Conference

Artwork ***Peter's Tree*** by Betty LaDuke Westigard.

Orchard Pest and Disease Management Conference
2024 Agenda

Below is the order in which the sessions will be given and the projected time slot in which they will occur. Note that the agenda is NOT a fixed time schedule and the actual time at which you are called to give your talk may vary.

Talks within each session are listed in order in the Table of Contents.

Wednesday, January 10th	
8:00 – 9:00 AM	**Registration/Name Tag Pickup**
9:00 – 10:00 AM	**Opening Business**—Chris Adams, OPDMC Chair
10:00 AM	Chemical Control / New Products – Chris Adams (Oregon State University)
11:30AM–1:00PM	**Lunch (on your own)**
1:00 PM	Biology / Phenology
2:30 – 3:00 PM	**Coffee Break**
3:00 PM	Biology / Phenology (*cont'd*)
4:00 – 5:00 PM	**Keynote Address:** On the Road to IPM—Moving Towards a More Ecologically Based and Environmentally Friendly Pest Management System Rick Hilton (Oregon State University)
5:00 PM	**Adjourn**
5:00 – 7:00 PM	**No Host Mixer (Hilton Lobby)**
Thursday, January 11th	
8:00 AM	Biology / Phenology (*cont'd*)
8:45 AM	Mating Disruption / SIR
10:00 – 10:30 AM	**Coffee Break**
10:30 AM	Mating Disruption / SIR (*cont'd*)
11:00 AM	Thresholds / Monitoring
11:30AM–1:00PM	**Lunch (on your own)**
1:00 PM	Thresholds / Monitoring (*cont'd*)
1:30 PM	Biological Control
2:30 – 3:00 PM	**Coffee Break**
3:00 PM	Biological Control (*cont'd*)
4:00 PM	**Adjourn**
Friday, January 12th	
8:00 AM	Biological Control (*cont'd*)
9:00 AM	Pathology / Diseases
11:00 – 12:00 PM	**Closing Business** — *Chris Adams, OPDMC Chair; Tobin Northfield, Chair-Elect*
12:00 PM	**Adjourn**

Orchard Pest and Disease Management Conference
Officers for the 2024 Conference

Chair (2024)
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Chris Strohm
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Student Scholarship Awards
Travis Schoenwald
Valent U.S.A.

Program Editing
JoMari Moreno & Daniel Hauser
WSU/USDA-ARS

Web Site and Proceedings
Peter McGhee

For more information, see: http://opdmc.org/

Order of Presentations

FROM THE 98th ANNUAL

ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE

January 10, 11, & 12, 2024

Keynote Presentation: Wednesday, 4:00pm – 5:00pm*

On the Road to IPM —Moving Towards a More Ecologically Based and Environmentally Friendly Pest Management System
Rick Hilton
Oregon State University

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Chemical Control/New Products

Moderator: Chris Adams
(OSU)

Effect of Adjuvants on Immature Life Stages of Spotted Wing Drosophila (SWD)

Chisom I. Molokwu[1], Serhan Mermer[2], Kyoo R. Park[1], Vaughn M. Walton[1]

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Keywords: trisiloxane, surfactants, spotted wing drosophila (SWD)

Spotted wing drosophila (SWD), *Drosophila suzukii*, is an economically important pest that significantly impacts soft-skinned fruit crops. Different management practices have been carried out to control SWD at different life stages. We wanted to study the impacts of adjuvants on the mortality of this damaging insect. A family of trisiloxanes and its impact on egg and early larval life stage of the insect. Our experiment involved using three trisiloxane products, including Syl-coat, Dyne-Amic, and Kinetic, known for their superior spreading and wetting properties that enhance the efficacy of insecticidal treatments. Blueberries exposed to SWDs were treated with surfactants, and the number of adults reared from the egg life stage was compared among treatments. Our results suggest that trisiloxanes impact the early growth stage of SWD by preventing the emergence of adult flies. Incorporating trisiloxane into SWD management practice effectively allows the absorption and efficacy of pesticides, and trisiloxane could be an effective strategy to disrupt the early development of SWD, thereby reducing the excessive use of pesticides. Finally, this approach aligns with integrated pest management (IPM) principles, offering a more efficient use of insecticides and potentially reducing the overall environmental impact. Further research is recommended to optimize application rates and timing for maximal effectiveness.

Attract and Kill as a Strategy to Manage *Drosophila suzukii* Fruit Damage

Vaughn M. Walton[1], Chisom I. Molokwu[1], Ryan B. Chave[1], Serhan Mermer[2], Gabriella Tait[1], Kyoo R. Park[1]

[1]Department of Horticulture, Oregon State University, Corvallis, OR
[2]Department of Toxicology, Oregon State University, Corvallis, OR

Keywords: attract and kill, biorational control

We describe benefits, disadvantages, and efficacy data generated during 2023 for two organic Attract and Kill (A&K) liquid solutions. Data describe relative efficacy with use of conventional insecticides during 10-to-90-day periods, as measured by *Drosophila suzukii* egg laying levels on berries. Overall, A&K is applied at a relatively low conventional insecticide rate and small carrier volume, with the A&K solution directed away from fruit as opposed to being sprayed directly onto fruit.

First, we conducted laboratory trials using actively ventilated arenas. We compared untreated control fruit with that of fruit treated in a full-cover conventional insecticide application and an A&K where no active toxicant or attractant was applied directly on berries. A similar treatment protocol was extended to semi-field conditions where we challenged the respective treatments with high levels of *D. suzukii* introduced to susceptible berries. Finally, we conducted similar treatments in trials on a late variety blueberry field, which is highly susceptible to *D. suzukii* attack under commercial grower experimental conditions. For semi-field and commercial grower treatments we applied A&K as droplets at the rate of 5 gallons per acre, directed towards the base of bushes, away from the fruiting zone.

We demonstrated comparable *D. suzukii* fruit protection to that of full cover insecticide applications in laboratory, semi-field and commercial field settings. This data was only generated for one season, and additional repetition of this work is planned for 2024 to determine consistency. Shortcomings of this technology in its current format include short residual efficacy, dependency on conventional insecticides, and environmental impact. Benefits include ease of application, and the fact that little to no toxic residues are deposited directly on marketable fruit.

Chemical Control of Two-Spotted Spider Mite with a Novel Miticide

Melissa Thayer, Calliope Arkilic, Carina Bachmann, Ethan Lambert, Robert Van Steenwyk

University of California, Dept. of ESPM, Berkeley, CA

Keywords: twospotted spider mite, *Tetranychus urticae*, miticide, Agri-Mek, abamectin, isocycloseram

In 2021, over 1.2 million acres of almonds were treated with abamectin in California. Of those acres, approximately 76%, or 955,000 acres, were treated to control two-spotted spider mite (*Tetranychus urticae* Koch (TSSM)) both preventatively and reactionarily. However, with heavy reliance on one chemical for control, tolerance to abamectin has occurred throughout most of California. To explore a new chemical control option for TSSM control, a field trial was conducted in an almond orchard near Crows Landing, California. Insecticide treatments included two rates of Plinazolin (1.03 fl. oz per acre and 1.55 fl. oz per acre) as well as the grower's standard (Agri-Mek SC at 4.0 fl. oz per acre) and an untreated control. Four treatments were replicated five times. Treatments were applied with a hand-held orchard sprayer operating at 200 PSI with a finished spray volume of 100 gal/acre. To evaluate efficacy on mites, three leaves from each replicate were collected at 1, 7, 14, and 21 days after application (total of 15 leaves per treatment) and brought back to UC Berkeley where they were cut into 4 cm segments, placed on damp cotton rounds in Petri dishes, and infested with 10 TSSM females. The TSSM were checked after 24 hours to determine mortality. All treatments had mortality of TSSM that was significantly higher than the untreated check. Both Plinazolin treatments as well as the Agri-Mek treatment had significantly lower infestation compared to the untreated check and did not significantly differ from one another. However, the Agri-Mek treatment had numerically lower mortality compared to both Plinazolin treatments.

Evaluation of Pyrethroid Insecticides for Walnut Husk Fly Control

Calliope Arkilic, Melissa Thayer, Ethan Lambert, Carina Bachmann, Robert Van Steenwyk

University of California, Dept. of ESPM, Berkeley, CA

Keywords: walnut husk fly, *Rhagoletis completa*, pyrethroid, neonicotinoid, acetamiprid, lambda-cyhalothrin, chlorantraniliprole, thiamethoxam, Endigo, Warrior, Besiege, Assail

The efficacy of Walnut Husk Fly (WHF), *Rhagoletis completa*, control depends on repeated applications of insecticides in affected orchards. Typically, insecticides such as Assail, neonicotinoids and others are used in combination with a feeding stimulant to reduce the adult population. Pyrethroid insecticides offer a different mode of action for management of WHF. In this study, various insecticides containing the pyrethroid lambda-cyhalothrin alone or in combination with chlorantraniliprole or thiamethoxam (Endigo, Warrior, and Besiege) and a feeding stimulant were compared to and used in combination with the grower's standard (Assail). Spray trials were conducted near Hilmar, CA in an orchard with almost 100% infestation in 2022. Six treatments were replicated four times in the randomized block design. The treatments were applied on 18 July, 3, 16, and 29 August. Adult WHF were monitored using a yellow Trécé sticky trap baited with ammonium carbonate from 22 June through 13 September. Mid-season visual evaluation was conducted on 16 August. A minimum of 100 nuts were visually inspected for WHF infestation. The nuts were not removed from the tree as not to influence the final infestation evaluation. The final infestation evaluation was conducted on 14 and 19 September. A maximum of 100 nuts per replicate were evaluated for WHF infestation. The mid-season evaluation showed that the pyrethroid treatments significantly reduced the WHF population compared to the treated check and had numerical reduced WHF infestation compared to the grower standard. The harvest evaluation showed that the pyrethroid treatments significantly reduced the WHF population compared to the treated check, but the grower standard had significantly lower infestation as compared to the pyrethroid treatments.

Early Season Chemical Control of Scales in Walnuts

Melissa Thayer[1], Elizabeth Fichtner[2], Calliope Arkilic[1], Carina Bachmann[1], Ethan Lambert[1], Robert Van Steenwyk[1]

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Keywords: walnut scale, *Quadraspidiotus juglansregia*, frosted scale, *Parthenolecanium pruinosum*, application timing, insect growth regulator, Centaur WDG, buprofezin, Esteem 0.86 EC, pyriproxyfen, Assail 30 SC, acetamiprid, Senstar, spirotetramat

Walnut scale (*Quadraspidiotus juglansregia*) and frosted scale (*Parthenolecanium pruinosum*) are important economic pests of walnut in California. Along with damage to plant tissue, their presence increases the likelihood of fungal infections in walnuts by providing entry points for infection through their feeding. A field trial was conducted in a walnut orchard near Visalia, California to evaluate the effects of variable application timing with multiple insecticides for the control of both scale species. Insecticide treatments included two rates of Centaur WDG (34.5 and 46 oz/ac) and Esteem 0.86 EC (46 fl. oz/ac) applied at delayed dormant timing (February 8, 2023) as well as the same two rates of Centaur WDG, Esteem 0.86 EC, Senstar (18 oz/ac), and Assail 30 SC (9.6 oz/ac) applied at crawler stage timing (April 26, 2023). Treatments were applied using a hand-held orchard sprayer operating at 250 PSI with a finished spray volume of 200 gal/acre. All nine treatments were replicated four times in a randomized complete block design. Each block was established in separate orchard rows and treated trees were separated by two untreated buffer trees along rows to mitigate drift. Prior to delayed dormant application, the density of walnut scale was determined by counting second instar individuals per centimeter in the delayed dormant and the untreated check treatments only. After delayed dormant application, walnut scale and frosted scale population density were determined on April 18, 2023 by counting 100 walnut scale to determine mortality per replicate and counting individual frosted scale per centimeter of twig. From March 8 to October 3, 2023, double sided sticky tapes attached to two limbs of each replicate were monitored and replaced weekly to determine walnut scale crawler populations in all treatments. In the delayed dormant evaluation, both rates of Centaur WDG provided significantly better control of walnut scale compared to the delayed dormant application of Esteem 0.86 EC and the untreated check. All delayed dormant treatments controlled frosted scale density significantly better than the untreated check but did not differ significantly from one another. The mean seasonal total number of crawlers showed all treatments significantly suppressed the walnut scale compared to the untreated check with Centaur at 46 oz/ac applied during the delayed dormant period having significantly lower crawler compared to the Senstar treatment.

Developing Challenge of Managing Codling Moth with Diamides

Greg Krawczyk, Laura Mellott and Josh Gere

The Pennsylvania State University, Department of Entomology, Fruit Research and Extension Center, Biglerville, PA

Keywords: Cydia pomonella, insecticide efficacy, pome fruit, diamide resistance

During the last twenty plus years the management of codling moth (CM) and oriental fruit moth (OFM) in commercial apple orchards in Pennsylvania relied on effective use of various mating disruption products supplemented by judicious use of insecticides. Since the initial introduction, insecticides belonging to two IRAC Groups: diamides (IRAC Group 28) and spinosyns (IRAC Group 5) provided excellent control of both internal fruit feeder species when such additional control was needed. Unfortunately, during the last four years growers reported increased problems with the management of this pest complex, resulting with the presence of CM and/or OFM injured fruit at harvest. During the 2022 season field collected CM population demonstrated multiple folds reduction in sensitivities to various diamide insecticides (e.g., Altacor, Exirel, Verdepryn, Voliam Flexi, Besiege, and Minecto) but no differences in sensitivities to spinosyns (e.g., Delegate).

During the 2023 we collected 12 CM populations, 4 from the same sites as in previous years and 8 from new orchards located across the Pennsylvania using not-destructive traps (e.g., glue-less, Universal traps, Uni-Trap, AlphaScents, West Linn, OR) baited with Pherocon CM 4K lures attracting both moth sexes. When possible, the offspring of collected codling moth adults was used for insecticide sensitivity bioassays utilizing standard diet incorporation bioassay method and CM neonates. The previously tested diamide resistant CM populations maintain low levels of sensitivities to diamides. Only a single new CM population demonstrated diamide resistance, while the remaining were still highly susceptible to chlorantraniliprole. The differences at the LC_{50} and LC_{90} levels (POLO Leora Software) between the most and least sensitive CM populations were at the 39 and 43 folds, respectively. Less than 2-fold differences at both LC_{50} and LC_{90} levels were observed in CM populations susceptibility responses to spinetoram.

Biology/Phenology

Moderator: Erica Moretti
(USDA-ARS)

Calorimetry-Assisted Degree Day Modeling

Lisa G. Neven[1], Fletcher Robbins[2], Emily Bick[2]

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Keywords: degree day model, calorimetry, fruit pests, invasive species

Differential scanning calorimetry is a useful tool to monitor living organism's metabolism at different temperatures and provides vital information related to the ability of the species to survive in novel environments. The information obtained from isothermal and scanning calorimetric experiments on pest insects can provide valuable data that can be used to develop degree day models in a relatively short period of time. The values for lower, optimal, and upper developmental temperatures obtained using calorimetry are close to those values reported by others using laboratory and field data to develop degree-day models. The significance of the relationship between metabolic rates and degree day models are discussed.

Unknown Flatheaded Borer Pest Found in Pear Fruit

Cindy R. Kron[1], Clebson G. Gonçalves[2], Broc Zoller[3], Axel David Gonzalez Murillo[4], J. Kevin Moulton[4], Karla Addesso[5], William E. Klingeman[4]

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[5]Tennessee State University, McMinnville, TN

Keywords: *Chrysobothris mali*, Pacific flatheaded borer, European pear, Bartlett pear

The family Buprestidae comprises over 15,500 species of metallic wood-boring beetles. The genus *Chrysobothris* includes over 690 species with at least 69 of those species found in California. One behavioral trait that these beetles have in common are that their larvae are wood boring. In August 2023, flatheaded borer larvae of an unknown species were found feeding in numerous Bartlett Pear fruits in four orchards in Lake County, CA. Larvae were collected and placed on an artificial diet to rear out to adults. A larval sample that was sent to the California Department of Food and Agriculture was returned with a *Chrysobothris* species ID based upon morphological characteristics. DNA from four larval samples sent to the University of Tennessee were found to be consistent with that of the Pacific flatheaded borer, *Chrysobothris mali*. The Pacific flatheaded borer has a wide host range of at least 70 host species belonging to 40 genera in 21 different plant families. This is the first detection of a Buprestid attacking fruit indicating a possible behavioral shift by this species.

Results of a Weed Survey of Pear Orchards Conducted in Three Pacific Northwest Growing Regions (2022-2023)

Grace Douglas[1], Erica Moretti[1], Christopher Adams[2], Robert Orpet[3], Rebecca Schmidt-Jeffris[1]

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[2]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR
[3]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: weeds, pear, phenology, mallow, clover, dandelion, pigweed, plantain, bindweed, horsetail

Weed Management has a critical role to play in the way common orchard pests are managed. Competing with crop trees for water and nutrients, obstructing irrigation systems, and providing necessary resources for pest arthropods, rodents, and disease-causing pathogens to flourish are several effects of the presence of weeds in orchard systems. In addition to their negative impacts, weeds may provide some positive impacts as well, such as providing shelter and floral resources for pollinators and pest natural enemies. As part of a larger project examining how weed management and natural enemy communities affect populations of pest mites, a survey of broad leaf weeds in pear orchards was conducted in three different Pacific Northwest growing regions during 2022 and 2023. Wenatchee Valley (n=6), Yakima Valley (n=10 in 2022, n=7 in 2023), and Hood River (n=5) growing areas were surveyed from June to September every one to two weeks for both 2022 and 2023. The percentage of ground cover was divided between three categories, grass, broad leaf weeds, and bare ground. Using a quadrat placed one meter from the base of each of five trees within a survey plot, the percentage of each groundcover type was estimated, and the weed species identified. In addition, the herbicide strip width was measured and was found to have a mean of 1.7m (range 0.6-5.5m). During the survey Wenatchee Valley and Yakima Valley orchards contained higher percentages of broad leaf weed cover (15-18%) versus Hood River (5%). Yakima Valley orchards were also observed to have more grass coverage than the other two growing regions (46% versus 9-13%). Dandelion, clover, and mallow were the most common weeds present in Yakima Valley and Hood River pear orchards. In the Wenatchee Valley, bindweed, mallow, horsetail, and dandelion were the most commonly observed weeds. Between the months of June and September 2022 and 2023, fluctuations in the percentages of broadleaf weed species were observed throughout the growing season. Changes in which weed species were present were documented. Data from this survey will be used to determine if weed communities affect the populations of pest mites and their natural enemies present in pear orchard systems.

Pear Psylla Pheno-IPM: Year 2 Success and Areawide Vision

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Keywords: pear psylla, *Cacopsylla pyricola*, biocontrol, IPM

Pear psylla is the most destructive pear pest, especially in the Wenatchee Valley, where broad-spectrum spray programs are expensive and fail to adequately suppress damage. Integrated pest management (IPM) in the Wenatchee Valley may offer a more cost-effective solution to pear growers and result in the same or less damage than conventional spray programs. A pear psylla phenology model that predicts pest stages was used as framework for IPM guidelines tested during 2022–2023. These guidelines provide selective spray materials and timings based on pear psylla degree days to effectively time sprays to vulnerable life stages. In 2023, our study tested IPM guidelines against conventional spray programs at seven paired commercial orchards. Pear psylla damage was on average less in IPM orchards and management costs were lower than conventional during 2023. Due to high psylla populations in conventional orchards at the end of the season, we expect that areawide implementation would allow IPM to be even more successful. We are currently working on promoting the phenology model and IPM guidelines on an areawide scale.

Maximizing Information Yield from Single Trap Multiple Release Experimental Design Data; Estimating Dispersive Distance, Probability of Catch, and Trapping Area

Christopher Adams

Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR

Keywords: trapping, dispersive distance, probability of catch

Single-trap multiple-release marked insect experiments can produce important information about insect movement, the probability of catch in a trap, and the area over which trapping data can be collected, if we understand how to plot and interpret the data. In this talk I provide an overview of the book *Trapping of Small Animals Moving Randomly; Principles and Applications to Pest Monitoring and Management* and the supporting field research published in the *Journal of Economic Entomology*, "Maximizing Information Yield from Pheromone-Baited Monitoring Traps; Estimating Plume Reach, Trapping Radius, and Absolute Density of *Cydia pomonella* (Lepidoptera: Tortricidae) in Michigan Apple". This experimental design and associated graphical data interpretations has been followed by other researchers to measure trapping area and insect movement of spotted wing drosophila (*Drosophila suzukii*) in cherry, Brown Marmorated Stink Bug (*Halyomorpha halys*), Codling moth *(Cydia pomonella*) in Washington Apple, and now the leafhopper (*Euscelidius variegatus*) in Oregon cherry orchards. Understanding how to maximize the information yield from data collected through this simple experimental design will enable future researchers to produce important insights about insect trapping in other systems.

Dispersive Distance of DayGlo Powder Marked *Euscelidius variegates* (Hemiptera: Cicadellidae) in Oregon Sweet Cherry Orchards

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Keywords: leafhopper, *Euscelidius variegates*, vector, cherry X-disease, mark-release-recapture

Mark-release-recapture (MRR) experiments were conducted on *Euscelidius variegates*, the key cherry X-disease vector in The Dalles, Oregon, to evaluate their movement and dispersal in managed cherry orchards. Adult leafhoppers were captured from cherry orchards using reversed leaf blowers, returned to the lab, sorted from bycatch, returned to the field, and marked with fluorescent powder, and released at multiple distances from a central sticky trap in two orchard sites. The marking method did not significantly affect the survival rate of *E. variegates*. The overall release-recapture rate, based on six MRR experiments within a 4-meter range, was 1.25%. The highest recapture rate was observed at 1 meter away from the central trap, followed by a sharp decline in subsequent distances. The estimated maximum dispersal distance of the marked population was determined to be between 6 and 11 meters. Possible effects of drive row ground cover are discussed. This research provides valuable insights into the movement patterns of *E. variegates*, and aids in the development of effective strategies for disease management and future IPM programs in Oregon cherry orchards.

Phenology of *Euscelidius variegates* Reared Under Controlled Conditions

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Keywords: leafhopper, *Euscelidius variegates*, vector, cherry X-disease, life cycle

Several species of leafhopper are able to vector the phytoplasma that causes Cherry X-disease. In the city of The Dalles Oregon where most sweet cherries are grown the most abundant leafhopper species found is *Euscelidius variegates*. Having a better understanding of the phenology of this important species would help with management decisions. Phenology models can be generated by collecting large amounts of insect and weather data and fitting it with modeling software. It can also be done by painstakingly rearing insects under controlled conditions and directly observing and recording their development. Here we describe our methods and findings of this phenology project.

Seasonal Distribution of *Drosophila suzukii* in Relation to Temperature

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Keywords: *Drosophila suzukii*, temperature, distribution, population, spotted wing drosophila

Understanding how population distribution is affected by temperature can enhance pest management strategies, particularly in addressing certain seasons or life stages of insects. *Drosophila suzukii* (Diptera: Drosophilidae) Matsumura, commonly known as spotted-wing drosophila (SWD), is an invasive pest of small and stone fruits. The damage on fruits comes from puncture upon oviposition of females on ripening fruits, leading to secondary damage from bacterial infection; ultimately, causing the fruits to be unmarketable. Current pest management practices focus on controlling pest populations within crop system in summer. However, gaining insights into the seasonal distribution of *D. suzukii* can broaden the scope of management beyond the crop itself to include the surrounding vegetation. Moreover, it may extend the timeframe for effective management after summer. The distribution of SWD population in relation to temperature was investigated in a commercial blueberry farm in Salem, OR. Baited traps were deployed to monitor the fly activity in both environments on a weekly basis for two years. The results indicated a substantial influence of temperature on the shifts in population distribution of *D. suzukii*. As temperature decreased over time, the distribution of *D. suzukii* increased at the ground level within the surrounding vegetation and the crop. The results could enable a more effective approach to control *D. suzukii* in both surrounding vegetation and within the crop for extended period of time.

Predictors of Cherry Susceptibility to Attack by *Drosophila suzukii*

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Keywords: *Drosophila suzukii*, spotted wing drosophila, cherry, orchard crops, Willamette Valley, management, susceptibility

Following its introduction and establishment in the US in 2008, *Drosophila suzukii* quickly became a major pest of numerous soft fruit crops including blueberries, caneberries and cherries. Control is achievable with insecticide sprays, but application timing can be a challenge. This pest also has many alternative hosts and is active year-round, so trap captures do not always equate to crop damage. Cherry growers in the Willamette Valley have expressed dissatisfaction with current recommendations for timing sprays that target this pest. It is recommended that sprays are applied just ahead of fruit becoming susceptible to attack, but this can vary widely between cultivars. The purpose of this 3-year study was to look at the risk of *D. suzukii* attack as a function of fruit physiology and susceptibility in both blush and dark cherry varieties. Beginning in early spring 2021 we collected cherries from 5 different varieties of blush and dark cherries and evaluated their color, firmness, brix, field infestation as well as susceptibility to infestation when exposed to lab-raised *D. suzukii*. We also deployed dataloggers in the field to track temperature and humidity. A FirmTech was used to evaluate fruit firmness, and we found that this followed a well-defined pattern that can be modeled with high confidence. Individual varieties showed distinct trajectories in softening, indicating that risk of *D. suzukii* attack differed by variety. There was a large difference between 2021 and 2022 data. The cooler 2022 season delayed fruit maturation by approximately 3 weeks, showing that optimal spray timing can be affected greatly by environmental conditions. Natural infestations occurred in 2021 and 2022 at the beginning of June, with infestation rate being much higher in 2022 compared with 2021. We did not find any natural infestation in fruit that were collected in 2023 despite being unsprayed, and numerous *D. suzukii* were captured on baited sticky traps. We found that fruit exposed to female *D. suzukii* in the lab had much higher infestation rates compared with naturally occurring attacks. The role of color as a potential predictor for infestation is discussed.

Filbertworm Model Redevelopment

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Keywords: *Cydia latiferreana*, hazelnuts, phenology, degree-days, pest management

The Filbertworm (FBW), *Cydia latiferreana*, is the key pest of hazelnuts in Oregon's Willamette Valley, where 99% of the US crop is grown on roughly 95,000 acres. Adult female FBW moths lay individual eggs on leaves, close to the developing nut clusters. Once the eggs hatch, larvae search out nut clusters, sometimes feeding on foliage along the way. Once on the nut, larvae drill a small entry hole through the micropyle, a small pore on the basal scar of the shell, they begin feeding on the kernels. Low tolerance for damage (<1%) necessitates spray treatments against the pest. While there is a simple degree-day model to guide management timing, our data suggests that it is not performing well, and it also does not predict life stage events after the initial flight period and coinciding egg laying and egg hatch period. Moth flights appear to be occurring both earlier and later in the season than historic norms, and growers particularly need guidance on late-season management. Most growers rely on the trap threshold method to time sprays, though some still use a calendar-based approach. This research examines the viability of FBW degree-day model improvement using flight data from a large smart trap network, intensive field sampling for immature stages, and lab-based temperature-dependent development studies. For this presentation, we focus on flight data collected from 200-300 traps distributed across the Willamette Valley in 2022 and 2023. We examine trap capture data as a reflection on possible FBW bivoltinism, which has not been previously reported but was a preliminary conclusion of our field sampling data. We are also interested in the potential geographic influences on flight patterns, and we report on our comparisons of observed flight compared to flight events predicted by the degree-day model.

Hidden losses: A Look at Filbertworm Damage to Hazelnuts Throughout Nut Development

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Keywords: hazelnut, filbertworm, *Cydia latiferreana*, crop damage, crop stage

Filbertworm (*Cydia latiferreana*) is a key pest of hazelnut production in Oregon. Larvae enter inside nuts to feed, which results in unmarketable crop. The period of FBW flight can last from June through September, and growers have been anxious to know at which points in the season they should be most concerned about FBW damage. To assess the susceptibility of hazelnut clusters to filbertworm (FBW) damage from fertilization through kernel development and shell hardening to harvest, we conducted a semi-field trial on three cultivars on a commercial farm in Albany, Oregon. On June 7, 2023, organza mesh bags were placed on branches with nut clusters to exclude them from FBW naturally occurring in the orchard. We bagged enough clusters of each cultivar to allow for ten treatment replications every week from June 7 to October 4 and an untreated control. Each week, ten bagged clusters of each cultivar were infested with 20 lab-reared FBW eggs. In mid to late September, just before harvest, when nuts had fully matured and dropped from their husks, the bags were collected. In the laboratory, we examined each cluster for evidence of FBW infestation and recorded all defects, including aborted, undersized, shriveled, stuck in husk, blank with or without frass, and infested nuts, then compared the percent of each defect on each treatment date to the control.

Significant differences between cultivars will be discussed in more detail. However, among all cultivars tested, early season infestation (June) was associated with a greater percent of aborted nuts and blank shells filled with frass, many of which were stuck in the husk. Early mid-season infestation (late June to mid-July) was associated with a greater percent of shells stuck in the husk. Late mid-season infestation (late July to August) was associated with a greater percent of shriveled nuts. Mid to late season infestation (late July to early September) was associated with a greater percent of developed nuts with typical feeding damage (frass). Blank shells (without frass) were not significantly associated with FBW infestation on any date. No significant FBW damage was recorded after September 13.

These findings have great significance for hazelnut producers. Most notably, early FBW infestation was not associated with what we typically classify as FBW damage (frass, entry and exit holes in the shell). If we combine all of the non-typical FBW damage (aborted and shriveled nuts, shells stuck in husk, and blank shells filled with frass) and call that ‘hidden’ damage and compare it with typical FBW damage, we see significant effects of both variety and treatment date. ‘McDonald,’ the early-maturing cultivar, was most susceptible to so-called hidden damage, while the late-maturing cultivar, ‘Dorris,’ was most susceptible to typical FBW damage. In all cases, ‘hidden’ damage exceeded typical FBW damage. Additionally, the mean percent marketable nuts was roughly linear in relationship to time of infestation, ranging from 0-14% in clusters that were treated on June 7, to 70-85% in nuts that never treated with eggs. These data indicate that early season damage is much more important for crop success than previously understood."

Assessment of the Filbertworm Phenology Model with Field Sampling of Immature Stages

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Keywords: *Cydia latiferreana*, hazelnuts, pest management, rearing, development

The larvae of filbertworm (FBW), *Cydia latiferreana* (Lepidoptera: Tortricidae), cause severe damage to hazelnuts by penetrating the shell through the micropyle, a small pore on the top of the nut beneath the husk to consume the kernel. Growers have a low tolerance for FBW. There is a phenology model for this pest, but we suspect it is not performing well and does not make predictions after the first flight, yet moths are caught in pheromone traps up to the point of harvest. To learn more about the phenology of the immature stages of FBW, we collected field samples from two high-pressure orchards in the Willamette Valley: the National Clonal Germplasm Repository (NCGR) Corylus germplasm collection near Corvallis and McKenzie Orchard near Deerhorn. At each location every week, we collected 100 shoot samples from different hazelnut varieties at the NCGR and the production variety at the McKenzie Orchard. For each shoot sample, we searched for eggs on the leaves and nut husks under a dissecting microscope and observed damage on nut clusters. Each egg and larva were classified by development stage and immature stages and reared in the lab under constant temperature. We observed that oviposition and larval entry into nuts were occurring earlier than predicted by the model. We observed that moths oviposited on hazelnut trees in the absence of nut clusters early in the season, before nuts developed, and late in the season when nuts had already dropped. We were surprised to find that larvae in the lab could be reared to the adult stage on leaves alone. This could suggest that we may underestimate the threat from early moth flights and that pressure from moths lasts up until the point of nut drop. We also found preliminary evidence of bivoltinism.

Beetle Mania: Prionus Root Borer in Oregon Hazelnuts

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Keywords: decline symptoms, root damage, grubs, phenology

Prionus californicus Motschulsky (Coleoptera: Cerambycidae) is a native longhorned root borer of large stature that has long been known as a pest in hops and tree fruits in the western United States. Recently, this insect has emerged as a pest in European hazelnut (*Corylus avellana* L.) orchards, though it has likely always been present since the earliest days of hazelnut cultivation in Oregon (early 1900s) and grubs have on occasion been noted during orchard removal. However, the Oregon hazelnut industry has undergone an unprecedented expansion and there are new opportunities for pests. Initially, we noted high numbers of *Prionus* adults coming to black panel traps baited with commercial prionic acid lures in old hazelnut orchards that had been devasted by eastern filbert blight, a disease that nearly eliminated the production of hazelnuts in the Pacific Northwest. This was not surprising given that these trees were severely weakened and quite old. However, in 2023 it became clear that younger, well-managed orchards planted with disease-resistant varieties were also heavily infested with the root borer. A common problem in the new orchards can be generally characterized as hazelnut decline. These are trees showing lack of vigor and canopy dieback but no obvious signs of disease. It appears that in some cases, decline symptoms can be linked to root damage from *P. californicus*. Once growers and field consultants got word of this, traps were widely deployed throughout the Willamette Valley and beetle mania ensued. Management strategies and challenges will be discussed along with phenological and other observational data.

Damage Characterization and Monitoring of *Chrysobothris Mali* Horn (Coleoptera: Buprestidae) in California Walnuts

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Keywords: Pacific flatheaded borer, walnut, pest management, monitoring, Buprestidae

Pacific flatheaded borer, *Chrysobothris mali*, has been an increasingly important pest in walnut orchards in California in recent years, potentially due to host abundance and changing environmental factors, including drought. Understanding the pest's biology and infestation behavior is crucial in developing Integrated Pest Management (IPM) practices. We conducted a study to characterize the damage caused by *C. mali* in walnut orchards in California. We collected flatheaded borer-infested branches in-season and during the winter and recorded important parameters: branch size, wound length, feeding channel length, and the number and position of larvae, pupae, and adults in the branch. We collected 15-20 damaged branch pieces (~30 cm long) from the orchard weekly and dissected them to record the parameters mentioned. Branches were collected in February to represent the overwintering period (n=85), and from May through November to represent the seasonal period (n=673). Inactive larval stages were found predominantly during the overwintering period in February. For the seasonal period, predominantly pre-pupal larvae, followed by the pupae, were found in the earlier part of the season (May to mid-June), while predominantly adults recovered during the peak summer (late May to late July). Actively feeding larvae were observed at the beginning of late August. Up until mid-September, 72% of the larvae were found primarily feeding on the cambium layer. However, since late September most larvae (~93%) were found deep into the pith and were inactive. In a separate study, we also evaluated various traps and lures for monitoring adult beetles in the walnut orchards during the season. The greatest number of Pacific flatheaded borer adults were captured in late July in the purple triangular silhouette trap (4-ft tall, 4-inch side width) compared to the rest of the trap/lure combinations. These studies help to better understand this pest's phenology and explore monitoring options for an effective IPM program.

Phenology and Feeding Damage of Brown Marmorated Stink Bug in Almond and Peach Orchards in California

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Keywords: brown marmorated stink bug, *Halyomorpha halys*, almond, peach, phenology

Brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål) (*H*emiptera: Pentatomidae), is an important invasive insect pest that has been infesting peaches and almonds in the Central Valley of California since 2016 and 2017, respectively. During the early BMSB establishment period (2017-2020), we monitored several commercial almond and peach orchards to determine the seasonal phenology of *H. halys* in the central San Joaquin Valley. At each orchard, BMSB populations were monitored using pyramid and clear sticky panel traps baited with the BMSB lure from February/March until October/November. In the spring, overwintering adults were detected in almond orchards as early as mid-March. Early season activity of overwintering adults peaked around late April. The first-generation activity occurred in June-July, followed by the second-generation peak during September-October. Egg masses, predominantly found on the lower surface of leaves but occasionally on fruits, were mainly found in June and July. Sticky panel traps and pyramid traps effectively captured *H. halys*, with sticky panel traps catching more adults than black pyramid traps. In another study, developing almond and peach fruits were collected and assessed for the degrees of damage by BMSB in multiple commercially managed orchards in the region. Study findings are discussed in the context of understanding the potential economic damage by this pest and developing integrated management strategies for *H. halys* in these crops.

Mating Disruption/SIR

Moderator: Calliope Arkilic
(UC-Berkeley)

Performance of Sterile Codling Moth in California Pear Orchards

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Keywords: codling moth, *Cydia pomonella*, pear, sterile insect technique (SIT), mating disruption

Codling moth (CM) is a key pest of pear in California, and addition of least-toxic pest management tactics is desirable to insure against loss of current tools for control. Sterile Insect Technique (SIT) for CM is long established in British Columbia and has been used commercially in Washington State, but more data on the performance and impact of sterile CM are needed for use in more southerly and warmer pome fruit orchards in California. An experiment was conducted in 2023 to examine recovery and dispersal of released sterile CM and the impact on wild CM abundance and fruit damage. Sterile CM from the Okanagan-Kootenay Sterile Insect Release (OKSIR) Program (Kelowna, British Columbia, Canada) were shipped weekly to California for release via uncrewed aerial vehicles (UAVs) in one set of paired orchard plots in Sacramento County, and two blocks of paired plots in Lake County. Moths (800 mixed sex sterile adults per acre) were released evenly over 6-10 acres in an upwind portion of a 16- to 20-acre orchards from April 11 until the end of August. The downwind portion served as a grower standard, receiving the same baseline mating disruption and insecticide treatments. Recapture of CM was examined using 9 traps in an evenly spaced 3×3 grid in each 10-acre plot. Traps were baited with pear ester and acetic acid. The trap overflooding ratio (sterile/wild CM in traps) ranged from 1× to 68× with a median of 2.5× and was highest early in the season. The overall weekly recovery of sterile moths ranged from 1 to 23% with a median of 1.6%. The percent of sterile CM recaptured per week was significantly correlated with the number of wild moths captured that week. The proportion of sterile moths recovered in the adjacent comparison plot ranged from 8 to 33%, indicating a capacity for dispersal. Both abundance and damage from wild codling moth were low in 2023, so little difference was seen between the release and comparison plots. These data serve to document the performance of sterile in California pome fruit orchards, and to provide a basis of comparison for other SIT projects targeting Lepidoptera.

Making Sure the Moths are Sterile: A Look Inside Canada's Codling Moth Facility

Melissa Tesche, Scott Arthur, Evan Esch

Okanagan Kootenay Sterile Insect Release Board, Kelowna, BC

Kewords: *Cydia pomonella*, codling moth, sterile insect release, sterility, apple, pear

The codling moth can be a devastating pest of pome fruit. Sterile insect releases (SIR) have been the primary method of codling moth suppression in the Canadian Okanagan for more than 30 years, with great success: over 90% of the acres in the program's service area had less than 0.2% damage from codling moth in 2023. This success has caught the attention of apple growing regions around the globe where growers are facing climate-driven increases in codling moth pressure with a decreasing number of control options and growing resistance concerns. Sterile moths from the Canadian facility have been shipped around the world for multi-year field trials in South Africa, New Zealand, and Australia and are now being used to supplement mating disruption in a growing number of orchards in the Western United States. Each time codling moth SIR is introduced to a new region, growers have the same question: How do you guarantee that the moths are sterile? The anxiety is understandable given the prospect of releasing tens of thousands of moths per acre every growing season. This presentation takes a virtual tour of the Canadian sterile codling moth rearing facility, highlighting the key radiation biology research, process controls, and QA/QC work that allow the facility to guarantee adequate and ideal sterilization levels.

Modular Rearing with X-ray Sterility to Accelerate the Adoption of the Sterile Insect Technique

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Keywords: codling moth, navel orangeworm, sterile insect technique (SIT), x-ray, modular rearing

Sterile Insect Technique classically relies upon isotopic sources, such as Co-60 and Cs-137 to induce sterility in insect pests. This approach, however, requires complex facilities, incurs high costs for maintaining and recharging isotopic sources, and presents substantial regulatory hurdles. The development of low cost, self-contained X-ray machines presents an opportunity for nascent SIT programs to emerge without dealing with complex facilities and regulations. Here, we present an innovative approach to combine X-ray technology with modular rearing into Area-Wide Integrated Pest Management (AW-IPM) efforts, specifically targeting Lepidoptera pests such as codling moth, *Cydia pomonella* and navel ornageworm, *Amyelois transitella* that pose significant risks to global food and biosecurity. The transition from Mass rearing facilities, to modules, from fixed winged aircraft to drones, and from gamma irradiators to x-ray machines will revolutionize the 50-year-old model of SIT. Modular approaches to SIT using X-ray based sterility not only enhances the sustainability of food production but also aligns with the global shift towards environmentally friendly pest control methods. The successful implementation of this effort seeks to advance the field of pest management, offering a scalable, cost-effective, and efficient solution to global agricultural challenges posed by Lepidoptera pests.

Development of Sterile Insect Technique for Navel Orangeworm in California Orchards

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Keywords: Lepidoptera, orchard, SIT

The navel orangeworm, *Amyelois transitella* Walker, is a major pest of almonds, pistachios and walnuts. Larvae directly feed on nuts and infestation is associated with increased incidence of aflatoxin, a known human carcinogen heavily regulated in key markets. Recently, the pistachio and almond industries started to explore sterile insect technique for *A. transitella*, making use of a mass-rearing and irradiation facility originally developed for another species of Lepidoptera. Here, a series of field and laboratory studies evaluated the initial performance of mass-reared and irradiated *A. transitella* generated by this facility. Field releases of sterile moths took place in a small (<2 ha) almond and pistachio orchard over a 2-year period. Recovery of mass-reared *A. transitella* males was consistently lower relative to locally reared moths. A modified transportation system was developed but did not lead to improved recovery. Changes to the field release methods, including use of a drone, did in some cases lead to higher recovery of mass-reared moths. Finally, recovery of sterile males also varied by time of season and, at times, orchard type, possibly due to changes in abiotic conditions. These findings follow earlier assays and provide further evidence that the current mass-rearing process, which was developed for another species of moth, must be adjusted to better accommodate production of *A. transitella*.

Navel Orangeworm (Lepidoptera: Pyralidae) Responses to Sex Pheromone when Pre-Exposed to Mating Disruption for SIR Applications

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Keywords: almond, *Amyelois transitella*, Cidetrak NOW Meso, navel orangeworm, pheromone, pistachios, Trécé Pherocon lure L2

The navel orangeworm (NOW) is a major pest of tree nuts in California. Recently as part of an areawide management program, the sterile insect release (SIR) is taking place as a tactic for suppression of NOW. The process involves large-scale rearing of navel orangeworm for release of sterile moths in the wild. We tested responses of males and females to a commercial pheromone lure to determine whether pheromones could be used to separate males from females at emergence. We assessed male responses to concentrations of a sex pheromone blend and a commercial mating disruption pheromone through choice experiments with a Y-tube olfactometer. The choices recorded consisted of treatment (pheromone), clean air (control), and no choice when the insects did not move toward the Y-tube arms. Notes were taken on behavioral responses (male fanning and curving body). A series of Chi-squares with Bonferroni corrections were used for statistical analyses. The response of males and females towards a commercial pheromone lure was significantly different. Most males moved to the pheromone (57.4%), followed by no choice (26.5%) and control (16.1%). Most females fall in the no-choice category (47.8%), followed by control (30.6%), and pheromone lure (21.6%). When we explored male responses to a range of concentrations of the pheromone blend (10, 100, 1,000, 10,000, 100,000 ng), the highest responses 66% and 79% to the pheromone blend occurred at 10,000 and 100,000 ng. At these concentrations, we observed higher proportions of males fanning and curving their bodies for copula. Male responses to a pheromone blend, when pre-exposed to a commercial mating disruption pheromone, were lower at 100,000 ng. No differences were found at the other concentrations. At this time, the pheromones are showing potential for separating males from females; however, more research is required to successfully implement these changes at the rearing facility.

Development of a Marking System for Navel Orangeworm Mark-Release-Recapture Research in California Nut Crops

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Keywords: tree nuts, navel orangeworm, *Amyelois transitella*, SmartWater

Navel orangeworm (NOW) (Pyralidae: *Amyelois transitella*) is a key pest of almonds and pistachios in California. Recent studies have been initiated to explore the use of sterile insect technique (SIT) for managing this pest. Establishing a successful SIT program for NOW requires identifying a reliable marker to track released moths. A good insect marker should not cause adverse effects on the insect and must be retained on the insect for a desired period of time. Thus, we evaluated various colors of the SmartWater fluorescent markers for marking NOW, investigating whether (1) they would cause adverse effects on the moths' flight performance, (2) they would lead to significantly higher moth mortality, and (3) they could be present on the moths over time after marking. Our results indicated that green and yellow SmartWaters had the potential to be used as markers for NOW because these two markers did not result in negative effects on the moths' flight performance and did not cause any significantly higher mortality compared to the water treatment. However, our results also revealed that SmartWater markers degraded over time, with 98% of the moths showing positive for the presence of the markers the day after marking and 70% of the moths showing the presence of fluorescent markers 14 days after marking. Future research directions will be discussed.

Radiation Induces Complex and Temporally Attenuating Transcriptomic Shifts for DNA Repair and Cellular Stress Response in Navel Orangeworm

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Keywords: almond, pistachio, walnut, navel orangeworm, *Amyelois transitella*, irradiation, sterile insect technique, DNA damage

The navel orangeworm (NOW) is a key pest of almonds, pistachios, and walnuts across California. Research is presently underway to explore the potential of the sterile insect technique (SIT) for NOW control. In this study, we analyzed the transcriptomic changes in NOW exposed to x-ray radiation to elucidate the molecular response and associated mechanisms. The virgin NOW males were exposed to a dose of 300Gy of x-ray radiation and samples were collected at 6-, 12-, 24-, 48-, and 96-hours post-exposure along with matched controls at each time point. RNA sequencing was carried out and differentially expressed genes were identified between irradiated and control samples at each time point. We found nearly 300 genes showing differential expression at early time points in irradiated NOW. Identity of these genes indicated DNA damage, cellular stress, cell cycle arrest as well as apoptosis regulation responses. Genes related to DNA damage repair showed consistent upregulation across the timepoints. For example, γH2AX, a gene required for the assembly of DNA repair proteins as well as for activation of checkpoints proteins to arrest the cell cycle progression, was highly upregulated at all time points. However, general transcriptomic response of irradiated NOW gradually reduced over time as much fewer genes showed differential expression at later time points. Overall, this study provides extensive molecular insights into radiation response of a lepidopteran adult by tracking gene expression changes across time points. Results of this study will support the development of molecular markers to evaluate mating viability of sterile NOW males for SIT research.

Thresholds/Monitoring

Moderator: Aldo Hanel
(WSU)

Hemipteran Pest Abundance and its Relation to Crop Damage in Almonds

Mahesh Ghimire[1], Sudan Gyawaly[1,2], Chang Vue1 and Jhalendra Rijal[1]

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Keywords: hemipteran pests, brown marmorated stink bug, almond, clear panel traps, damage threshold, IPM

Several hemipteran pests cause economic damage to almonds in California. These pests include leaf-footed bug (*Leptoglossus spp.*), native (green, consperse, red-shouldered, and Uhler's stink bugs) and invasive stink bugs, including brown marmorated stink bug (*Halyomorpha halys*). These pests are active at different times of the season and inflict feeding damage to the developing almond kernels with their piercing–sucking mouthparts resulting in kernel necrosis. Due to the complexity of their biology and phenology within the season, and lack of effective monitoring tools for most of these pests, there are no effective thresholds that guide management decisions. The objective of our study was to conduct season-long assessment of the hemipteran pest population and their damage in almond orchards in multiple years and use the dataset to develop practical thresholds to support integrated pest management (IPM) practice. For sampling, we employed five methods, clear panel sticky traps, yellow sticky traps, beating tray, visual, and sweep net to collect data. In addition, 600-1200 nut samples from each orchard were taken at harvest from the windrows and hand-cracked to assess the hemipteran pest damage. Between 2021 -2023, we collected hemipteran insect data from 20 orchards each year covering major varieties such as Nonpareil, Aldrich, Carmel, Fritz and Monterey from San Joaquin Valley. From these multiyear studies, we found invasive brown marmorated stink bug (BMSB), leaf footed bug, and green stink bug as the most common species. The clear panel efficiently trapped BMSB than other methods used in the study and was successful in capturing a diverse number of hemipterans (>15 species). Comparing damage with seasonal stink bug counts, there was a significant positive correlation between insect counts and harvest damage. Furthermore, we will use regression models to establish damage thresholds for major hemipteran pests in almond orchards and improve the current IPM practices.

Assessing the Performance of a Multimodal Trap for the Brown Marmorated Stink Bug

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Keywords: biotremology, *Halyomorpha halys*, hazelnut, monitoring tools, trap design

The brown marmorated stink bug, *Halyomorpha halys* (Stål), is a highly polyphagous pest of orchard, row, and ornamental crops that has become an economically important invasive species in North America and Europe over the past two decades. Monitoring for *H. halys* relies on synthetic pheromone lures and black pyramid traps that retain insects inside a collection jar. Alternatives to this cumbersome design have been tested, but commercially available options that are 1) easy to deploy and service and 2) limit spill-over injury to crops are lacking. Recent studies have characterized the vibrational signals that *H. halys* emit during courtship, presenting a novel option for monitoring and management. To assess the efficacy of one proposed design, we deployed six vibrating traps and six standard pyramid traps at two hazelnut orchards in the central Willamette Valley, OR from late July to early October 2023 and counted captures twice weekly. Trap performance varied by site, with the vibrating traps catching twice as many insects as the standard trap at one site but an equivalent number at the other. Mean adult captures were higher (1.5-5.5 x) in vibrating traps at both sites, indicating that vibrational signals are a promising tool for attracting and retaining the most destructive life stage of *H. halys*.

Ambrosia Beetle Lure Comparison in Pear Orchards of Hood River

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Keywords: stem borer, apple, pear, attractive lures, AlphaScents

The ambrosia beetle or black stem borer (*Xylosandrus germanus*) has been reported as an emerging pest in tree fruit orchards on the east coast of the United States. These tiny beetles, about 2 mm in length and attack stressed, and sometimes healthy, trees by chewing small entry holes in the bark of young trees. The adult females create galleries under the bark and inoculates the galleries with a fungus (*Ambrosiella hartigii*) as food for the developing larvae to feed on. The tree reacts to the fungus by closing off vascular tissue resulting in symptoms such as wilting, dieback, tree decline and tree death that can be mistaken for fire blight. As the female creates galleries she creates as compressed sawdust “tooth-pick” emerging from the entry hole. These saw dust castings are easily disturbed making detection of an infestation difficult. Monitoring with effective lures is important for early detection. We tested three new lures from AlphaScents™ paired with their hanging panel traps for their ability to attract ambrosia beetles at the border of pear orchards in Hood River Oregon.

Monitoring of Walnut Husk Fly Through the Use of a New Aggregation Pheromone

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Keywords: walnut husk fly, *Rhagoletis completa*, monitoring, delta-heptalactone, delta-hexalactone, ammonium carbonate

Walnut husk fly (WHF), *Rhagoletis completa*, is a significant pest of walnuts and has increased over the past 20 years. WHF control is based on repeated applications of insecticides. The timing and efficacy of insecticide applications is determined by the capture of adult flies. Adult WHF are monitored with yellow panel traps baited with an ammonium carbonate lure. In 2018, a male pheromone (delta-hexalactone and delta-heptalactone) was discovered by a French scientist. This pheromone may provide an improved method for monitoring WHF. Initial field studies of the delta-lactones were conducted in 2022 with promising results. In 2023, delta-hexalactone and delta-heptalactone alone or in combination with one another with or without ammonium carbonate were investigated to find the most effective lure for WHF monitoring. Eight treatments were replicated six times in three different orchards in Stanislaus County, CA. Each lure was attached to a Trécé yellow panel trap. All flies were monitored and sexed weekly for 15 weeks from 7 June to 12 September. Results showed 1) lures containing delta-heptalactone (alone or in combination with delta-hexalactone) captured significantly more WHF than the delta-hexalactone alone, delta-hexalactone with ammonium carbonate, and ammonium carbonate alone 2) delta-hexalactone and ammonium carbonate have similar effectiveness, and 3) delta-heptalactone lures captured WHF earlier than standard ammonium carbonate lures.

Biological Control

Moderator: Adrian Marshall
(USDA-ARS)

Effects of Entomopathogenic Fungus and Nematodes in Walnut Husk Fly Control

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Keywords: entomopathogens, walnuts, *Rhegoletis completa*, walnut husk fly

Walnut husk fly, *Rhagoletis completa* Cresson (Diptera: Tephritidae), is a primary pest of commercial walnuts in California. Female fly deposits eggs inside the fruit pericarp (i.e., husk), and the larvae feed on it. Larval feeding can cause shriveling and darkening of walnut kernels (i.e., seed) or staining of the endocarp (i.e., shell). Walnut husk fly management involves multiple applications of chemical insecticides covering the adult emergence period for 10-12 weeks in the summer, targeting the adults. The frequent use of broad-spectrum adulticides increases the risk of pesticide resistance and secondary pest resurgence and outbreaks. Therefore, we conducted studies to explore the effectiveness of non-chemical pesticide alternatives, i.e., entomopathogens, for the long-term management of walnut husk fly in walnut orchards. In the study, we found that entomopathogenic nematode species caused significantly higher mortality of walnut husk fly larvae compared to the control and entomopathogenic fungus treatment in the laboratory studies. Field-applied entomopathogens persisted in the field for at least four weeks. Field studies using entomopathogens devised to target the recently dropped larvae from the tree for overwintering in the soil in the fall and teneral adults during their emergence in the summer showed a reduction in walnut husk fly populations in treated orchards. The entomopathogenic nematodes showed promise to be included in the integrated pest management strategy in managing walnut husk fly population in walnut orchards.

Exploring Usage of Novel Viruses to Control the Codling Moth

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Keywords: virus, biological control, codling moth, *Cydia pomonella*, apple, CpGV, CrpeNPV

The *Cydia pomonella* granulosis virus (CpGV) has long been used as a biopesticide against codling moth in apple orchards and is a viable solution for organic production systems. However, the first reported case of codling moth resistance to CpGV within USA, sourced to a population from Washington State, was published in 2022. In 2019, A novel virus identified in false codling moth, the CrpeNPV, was reported to also kill codling moth larvae. In research supported by the Washington Tree Fruit Research Commission, we have obtained the CrpeNPV and have conducted preliminary codling moth larval mortality bioassays against specimen from our laboratory colony, which is locally sourced. For these experiments, virus formulations are applied to the surface of standard codling moth artificial diet, and neonate larvae are individually applied to vials containing the diet and allowed to feed unrestricted. Dose-response and time-course effect assays were conducted. These initial experiments confirmed that CrpeNPV kills codling moth larvae in Washington State. We also examined the effects of co-infection with CpGV and CrpeNPV on codling moth larval mortality. We aim to further test the CrpeNPV against local codling moth strains that are resistant to CpGV. Furthermore, efficacy tests will be conducted against other moth pests that impact the tree fruit sector. These results may provide the Washington tree fruit industry with another effective biocontrol product while simultaneously safeguarding against codling moth resistance to the CpGV.

Sharing Earwigs for Inoculation Biocontrol in Apple and Pear

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Keywords: European earwig, *Forficula dentata*, pear psylla, *Cacopsylla pyricola*, woolly apple aphid, *Eriosoma lanigerum*, conservation biocontrol, workshop

A Central Washington earwig transit workshop in July 2023 provided training for European earwig mass-collection from sources where they are unwanted (e.g., peach orchards) and transportation to where they are useful (apple and pear orchards). These activities were motivated by the following observations: 1) presence of European earwigs in a natural enemy complex is associated with successful biocontrol of pear psylla in pear and woolly apple aphid in apple, 2) current standard pear pesticide programs in Washington are incompatible with earwigs and typically extirpate them, 3) earwigs are univoltine resident predators that do not fly, so they cannot quickly recolonize orchards transitioning to organic or soft-conventional pesticide programs; 4) earwigs are easily collected and transported using rolls of cardboard, 5) previous experiments showed successful inoculation biocontrol of pear psylla in Europe and of woolly apple aphid in Washington. Stakeholders (growers, managers, consultants) representing eight pear-growing operations and one apple-growing operation participated in the workshop in 2023. Each person received a free bucket containing >500 earwigs, observed a demonstration of earwig collection, and received educational handouts. In a post-workshop survey, 22% of attendees said they had previous experience monitoring earwigs, 44% said they knew whether their pesticide programs were earwig-safe, and none had transported earwigs before. After the workshop, 100% of attendees said that in 2024 they plan to do all of the following: monitor earwigs with cardboard, modify a spray program to be earwig-safe, improve the advice they give to other producers or professionals, and increase their networking with other professionals. A second set of workshops is planned for Wenatchee, Yakima, and Hood River during 2024. To evaluate project outcomes, workshop attendees will be re-surveyed one year later. Current resources are stored on a project website: https://cahnrs.wsu.edu/tfrec-orpet/earwigs/.

Towards an Earwig-friendly IPM Program in Pome Fruit: Non-target and Sublethal Effects of Pesticides on Earwigs

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Keywords: *Forficula auricularia*, earwigs, integrated pest management, apple, pear, herbicides, insecticides

The European earwig *Forficula auricularia* L. (Dermaptera: Forficulidae) is an important natural enemy of key pests in pome fruit, such as the codling moth, pear psylla, woolly apple aphid, and spider mites. As a univoltine organism (i.e., one generation per year), that spends daytime in refuge spaces, earwigs are not under strong selective pressure for pesticide resistance, thus being considered very susceptible to them. As earwigs are considered augmented and conserved in pome fruit orchards, we need to tailor earwig-specific pesticide recommendations to growers in order to promote their establishment in the field. To do this, we performed non-target and sublethal effects bioassays with residuals of commonly used pesticides on earwigs. For non-target bioassays, we used a Potter Spray Tower to apply the maximum field rate of pesticides in glass petri dishes, let them dry, subsequently adding five female adult earwigs per petri dish and evaluated their mortality at 24 and 48h. Individuals surviving the non-target bioassay were individualized in clean glass petri dishes the following day and observed for 30 minutes using the EthoVision software to evaluate possible sublethal effects on their movement patterns. Finally, we added 10 green peach aphids to each petri dish, and the number of aphids eaten were recorded every 30 minutes until the majority of aphids had been eaten. We found that spinetoram, paraquat and glufosinate are acutely toxic to earwigs. Five insecticides - fenpyroximate, cyantraniliprole, chlorantraniliprole, bifenazate, and novaluron - and two herbicides - glufosinate and halosulfuron - affected earwig movement. Three insecticides - spinetoram, spinosad, and cyantraniliprole - and all herbicides tested reduced aphid consumption by earwigs. Our results highlight the importance of non-target and sublethal effects experiments when developing a natural enemy-friendly spray program for growers.

Lacewing Releases for Aphid Management in Organic Apples

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Keywords: apple, lacewing, *Chrysoperla rufilabris*, *Chrysoperla plorabunda*, *Chrysoperla carnea*, *Chrysoperla externa*, woolly apple aphid, green apple aphid, rosy apple aphid, augmentative biological control

Lacewings are the most common natural enemy to be purchased and released for pest control in apples. Best management practices for conducting releases in orchards are lacking. In 2021-2023, we tested different lacewing species (*Chrysoperla rufilabris, Chryosperla carnea*), life stages (eggs versus larvae), and release methods (drone, cards, sprinkle) for control of aphids. First, we determined that the "*C. carnea*" we purchased were actually "*C. externa*" and "*C. plorabunda*", depending on the original source insectary. In 2021, sprinkle releases of *C. plorabunda* eggs and *C. rufilabris* larvae reduced aphid populations by 50% compared to the control, but *C. externa* larvae and *C. rufilabris* eggs did not. In 2022-2023, none of the lacewing releases resulted in decreased aphid numbers compared to the control, likely because initial aphid numbers were higher. Additionally, recovery of released lacewings was very low in 2023 and the orchard used in 2022-2023 received many more pesticide applications than the 2021 orchard. Across all years, releases of lacewing larvae resulted in higher recapture than releases of eggs. Multi-site studies are needed to fine tune recommendations, but early season (mid- to late April) releases appear to be critical for success.

Augmentative Biocontrol and Predator Recruitment in Tree Fruit

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Keywords: pear, apple, lacewing, minute pirate bug, aphids, pear psylla, methyl salicylate, lure, Artemia cyst, *Ephestia*

Apple and pear growers that release natural enemies to target aphids and pear psylla often have little guidance and are met with varying success, leading to frustration by the lack of augmentative predator establishment. Augmentative biocontrol can also be costly and time consuming, leading growers to seek alternative methods for releasing biocontrol agents and increasing their post-release retention. In 2022-2023, we tested releases of natural enemies (green lacewing - *Chrysoperla plorabunda*, minute pirate bug - *Orius insidiosus*) in three orchards (commercial pear, commercial apple, research apple) in combination with nutritional supplements (Artemia cysts, *Ephestia* eggs) and/or methyl salicylate lures. We monitored aphids by counting colonies *in situ* (apple), pear psylla with leaf brush samples (pear), and thrips with sticky cards (both crops). Beat tray samples and sticky cards were used to monitor both resident and released natural enemies. Lures consistently increased resident *Stethorus* populations and natural enemy releases typically decreased pest thrips, but the effects of the other treatments varied by location and year. Neither the releases nor the retention treatments resulted in improved control of pear psylla, although some of the treatments inconsistently decreased aphid abundance.

Non-target Effects of Orchard Pesticides on *Stethorus pusillus*

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Keywords: *Stethorus pusillus*, *Tetranychus urticae*, non-target effects

Stethorus spp. are members of a small group of coccinellids (Coleoptera) that specialize on spider mites (Tetranychidae). They are voracious spider mite predators in both the larval and adult stages, and because of their high predation rates, longevity, and high reproductive rates they make up an important component of mite biological control in many economically important cropping systems. In the Yakima Valley growing region of Washington state, *Stethorus* spp. are frequently present in orchards and is a valuable element of mite management in tree fruit. However, frequent applications of pesticides and fungicides to manage pests and pathogens can disrupt this predator and lead to secondary pest outbreaks. In order to assess how *Stethorus pusillus* (=*punctillum*) respond to non-target applications of pesticides, we assessed the susceptibility of this predator to 25 different commercially available products, including four fungicides and 21 different insecticides/miticides, spanning 14 known modes of action. We evaluated the effects of these products on adult mortality, locomotion, and predation on both diapausing and non-diapausing *S. pusillus*. Recommendations for compatibility between commercially available pesticides and fungicides and this beneficial insect will be discussed.

Introducing UC's New Resource for Identifying Phytoseiid Mites of California

David Haviland

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Keywords: predatory mite, Phytoseiidae, biocontrol, key

Predatory mites in the family Phytoseiidae are known throughout the world in agricultural crops as important predators of pest mites, especially the spider mites (Tetranychidae), as well as small insects such as thrips, psyllids, scales, aphids, and whiteflies. More than 2,000 species are known world-wide, with more than 320 species belonging to thirty-six genera recognized in the Unites States, of which 46 are known from agricultural crop plants in California.

During the 1960s and 1970s, studies of phytoseiid predatory mites in California agriculture focused on a very few species: *Phytoseiulus persimilis* in berries, *Galendromus occidentalis* and *Neoseiulus californicus* in stone fruit, nuts, and vines, and *Euseius* species in subtropical crops. Between 2001 and 2018, collections of phytoseiids from fifteen tree, vine, and berry crops revealed a much richer diversity of species. Survey results, combined with the lifetime experience of Dr. Jim McMurtry (an emeritus expert in phytoseiids from the University of California), led to the compilation of species that were present in California, and the production of a key to identify them.

The finished key, which was published by the University of California in 2023, contains keys to the genera and species of the 46 species of predatory mites known to be found on California crops. Line drawings are provided for each species to detail characteristics of the dorsal shield (including setal patterns), ventral shields (sternal, genital, and ventrianal), spermatheca and chelicerae. An appendix to the key provides labeled photographs of each of the aforementioned characteristics from slide-mounted specimens of each species.

The 76-page publication, “Key to the Phytoseiid Predatory Mites Found on California Crops”, serves as a highly valuable resource for scientists, students, and pest management practitioners infested in biological control using predatory mites. The key, when combined with high-quality line drawings and photographs, will enable both scientists and non-scientists with a phase-contrast microscope and an ability to make slide mounts an ability to become proficient on the identification of predatory mites.

The full publication, including the 90-page appendix of photographs, is available for free download at the UCANR Publications web site (https://anrcatalog.ucanr.edu).

Eat Your Vegetables: Plant Resource Use by Predatory Mites in Orchards

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Keywords: apple, *Galendromus occidentalis*, *Typhlodromus caudiglans*, *Zetzellia mali*, spider mite, molecular gut content analysis, pollen, trichome

The conservation of predatory mites is critical for maintaining pest mite populations below economic thresholds. *Galendromus occidentalis* and *Typhlodromus caudiglans* are the two most common phytoseiid mites in Washington apple orchards and the stigmaeid mite predator *Zetzellia mali* are also common. Of these, *G. occidentalis* is considered as a fairly specialist predator because it prefers to feed on *Tetranychus spp*. spider mites (e.g., twospotted spider mite), although it will also consume other spider mites (e.g., European red mite) and apple rust mite. While *T. caudiglans* and *Z. mali* will also feed on *T. urticae*, they are considered generalist predators because they prefer to feed on rust mites and non-*Tetranychus* spider mites. They also readily feed on pollen and can sustain reproduction on pollen-only diets (unlike *G. occidentalis*, which is not a pollen feeder). Previous research has shown that generalist phytoseiids, including *T. caudiglans*, may be more abundant on apple cultivars with higher densities of trichomes because these structures trap aerial pollen, increasing the availability of a potential food source. We collected phytoseiids from four different cultivars of apples and the ground cover in a research orchard from 2020-2021. Then, we conducted meta-barcoded gut content analysis of the samples using trnF and ITS gene primers to determine whether plant DNA (potentially from pollen) was present within the guts of collected mites.

Because trnF is present within the chloroplast genome and pollen does not contain chloroplasts, the differences in results between trnF and ITS may be able to serve as a proxy for pollen-feeding; taxa that are detected using ITS are more likely the result of pollen feeding, while those only detected with trnF are more likely to be present due to directly feeding on plant tissue or are the result of consuming a prey item that recently consumed a plant. *G. occidentalis* only tested positive for *Malus* (apple) and only with the trnF gene, supporting this hypothesis.

Typhlodromus caudiglans tested positive for 23 taxa with ITS and 11 taxa with trnF, with the most ITS positives coming from *Malus, Brassica*, *Pinus*, and *Phaseolus*. It tested positive for a greater diversity of taxa when collected from the more trichome-dense varieties than Golden Delicious. It was also more abundant on Gala and Red Delicious. *Zetzellia mali* tested positive for 9 taxa with ITS and 11 taxa with trnF, with the most ITS positives coming from *Malus*, *Phaseolus*, and *Brassica*. It was more abundant on Fuji and Gala. Because it is an intraguild predator of *T. caudiglans*, the high abundance of *Z. mali* on Fuji may have resulted in the low abundance of *T. caudiglans*.

This study provides preliminary evidence that leaf trichome density may affect the pollen diet and abundance of *T. caudiglans*. This supports previous survey work which found that *T. caudiglans* is rare in Golden Delicious orchards.

Predators in a Pear Tree: Winter Predation of Pear Psylla

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Keywords: pear psylla, *Cacopsylla pyricola*, biocontrol, winter, predator, pear, brown lacewing, Hemerobiidae, running crab spider, Philodromidae, minute pirate bug, *Orius*

Pear psylla, *Cacopsylla pyricola* (Foerster) (Hemiptera: Psyllidae), is a key pest of pears in the Pacific Northwest. They have a winter form adult that overwinters in reproductive diapause but are intermittently active throughout the winter, moving around and feeding, when temperatures are warm enough. Winter form pear psylla seek refuge inside cardboard bands around pear trees in the winter, which have also been shown to provide refuge for predators. We placed cardboard refugia around the base of pear trees in WA before winter and returned in January to collect them. Arthropods were removed from the bands, identified, counted, and subsampled for molecular testing. We tested 299 predators using primers designed for detection of pear psylla DNA to see if they had recently eaten pear psylla. The majority of predators found in these bands were spiders, followed by brown lacewings, and true bugs. Of the specimens tested for pear psylla DNA, the group that tested positive most often were brown lacewing (Hemerobiidae) adults, followed by running crab spiders (Philodromidae) and minute pirate bugs (*Orius* sp.). This study shows that there is substantial predation of pear psylla happening in winter refugia, and Philodromidae and Hemerobiidae both seem to be important predators of pear psylla during these cold months.

Survey of Ground Dwelling Spiders Within Managed Pear Orchards in Hood River

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Keywords: pitfall trapping, spiders, natural enemies, pear orchards

In the Hood River area, pear growers rely heavily on natural enemies to control pear psylla (*Cacopsylla pyricola*). With funding from WTFRC we have been trying to measure the quantity and diversity of arthropod natural enemies found in managed pear orchards throughout the growing season, using lure baited yellow sticky cards. Spiders are among the many arthropod species collected but are caught infrequently on sticky cards. When caught they are difficult, or impossible, to accurately identify because of the adhesive. To address this challenge, we deployed pitfall traps within the drip line of trees containing our lure baited yellow sticky cards. While these traps are collecting arthropods of the ground dwelling community, and not the arboreal invertebrate community where pear psylla are found, there is value in knowing more about this important group of natural enemies. This base-line survey of spiders yielded over 170 specimens from 9 different families in the order Araneae. Understanding the diversity and life history of natural enemies present in managed pear orchards will help us better understand the level of ecosystem services currently available to growers and help guide management strategies designed to conserve them.

Nontarget Host Identification of the Samurai Wasp, a Biological Control Agent of Brown Marmorated Stink Bug

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Keywords: invasive pests, nontarget effects, native species, egg parasitoids, integrated pest management

The brown marmorated stink bug, *Halyomorpha halys*, is an invasive pest that has caused significant damage to economically important crops throughout the Willamette Valley and across the globe. While chemical control of this pest can be unsustainable and harmful to integrated pest management programs already in place, biological control is a viable and cost-effective alternative. The samurai wasp, *Trissolcus japonicus*, is an egg parasitoid and highly efficient biocontrol agent of *H. halys*, with parasitism rates of over 90% in its native range. Since discovery of this adventive wasp in the field in Portland, our lab and corresponding research stations have performed mass releases of *T. japonicus* throughout the state of Oregon. As with any sustainable form of integrated pest management, research on nontarget effects of biological control is essential, including identification of nontarget host species. Previous research has shown a host preference by *T. japonicus* for *H. halys*; however, recent studies in situ show less specification, and it is unclear how these results apply to field settings. In this study, we identified fatty acid profiles of *H. halys* and native host species of *T. japonicus*, including *Thyanta custator*, *Chlorochroa ligata*, and a known predator of *H. halys*, *Podisus maculiventris*. We then used these fatty acid profiles to identify the host species of field-caught *T. japonicus* adults. Our results demonstrate that identification of fatty acid profiles can be used to identify (and potentially quantify) nontarget effects of this biological control agent, which can aid in growers' decision-making when developing integrated pest management programs for the invasive brown marmorated stink bug.

Pathology/Diseases

Moderator: Melissa Thayer
(UC-Berkeley)

Optimizing X-disease Management

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Keywords: X-disease phytoplasma, vector, pathogen, leafhopper, cherry

X-disease, a widespread plant disease critically impacting stone fruit across the United States, is caused by a phytoplasma that infects the phloem in trees and causes fruit to be small, bitter and unmarketable. A small group of leafhoppers vector the X-disease phytoplasma and acquire the pathogen during feeding on infected trees or weedy hosts that act as pathogen reservoirs. The phytoplasma replicates before it can be transmitted during subsequent feeding, so leafhoppers may acquire and transmit the causal phytoplasma between weeds and trees over an entire season. Methods to slow disease spread include tree removal, use of clean plant material during grafting, control of insect vectors, and control of weedy host reservoirs. In the past few years, greater attention has been brought to management of broadleaf weeds found in orchard cover, but it is unclear whether managing weeds or leafhoppers is most beneficial in slowing X-disease spread. To evaluate multiple strategies over long time periods, we developed and analyzed a mathematical model comprising a series of differential equations. We use the model to predict acquisition and transmission of X-disease in leafhoppers, broadleaf weeds, and trees by manipulating three management strategies: control of weeds, control of immature leafhoppers, or control of adult leafhoppers. The model identifies when it is more effective to apply herbicides versus insecticides. In addition, we find that it is often more effective to target insecticides towards adult, rather than immature, vectors. The model serves as a tool to simulate the use of pesticides at varied timepoints and reveal the impact of applications on disease spread.

Getting Into (or out of) the Weeds of X-disease: Groundcover Management for Reducing the Spread

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Keywords: X-disease, *Candidatus* Phytoplasma pruni, stone fruit, alternative hosts, ground cover management, cultural control, chemical control, herbicide

X-disease, a disease caused by a phytoplasma, has caused an epidemic in Washington for the first time in more than 60 years and is critically impacting the stone fruit industry once again. The phloem-limited phytoplasma that causes this disease is spread to Prunus trees by leafhopper feeding and can also be transmitted to and from alternative hosts within the orchard groundcover. Most prominent broadleaf weeds in the orchard groundcover have been found to host the X-disease phytoplasma and also serve as feeding and reproductive hosts for vectors. Thus, these weedy hosts may serve as sources of disease for leafhopper vectors to spread to and from trees, as well as promote vector abundance. Here, we evaluate two methods of groundcover management, using horticultural fabric and reducing abundance of broadleaf weeds, to determine their impact on key leafhopper vectors in WA. Both methods significantly reduced leafhopper vector abundance. In combination with removing diseased trees, managing alternative hosts may be a key component of X-disease management.

Cultivating a Cultural Control Complex to Coexist with X-disease

Adrian Marshall[1], Abigail Clarke[2], Tawnee Melton[2], Cesar Reyes-Corral[2], Tobin Northfield[2], W. Rodney Cooper[1]

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Keywords: X-disease, leafhopper, *Colladonus*, cultural control, ground cover, Phytoplasma pruni, stone fruit

Prunus X-disease, a re-emerged leafhopper-vectored disease caused by *Candidatus* Phytoplasma pruni, is devastating commercial stone fruit (cherry, peach, nectarine) production in the Pacific Northwest region of the United States. At least six leafhopper species transmit X-disease phytoplasma, but recent surveys found the most abundant vectors in Washington orchards are in the genus *Colladonus*. Common groundcover weeds such as clover and dandelion are hosts for the pathogen and *Colladonus*, suggesting that groundcover weeds can promote disease prevalence in orchards. From 2020-2023 we evaluated cultural control and groundcover management methods to reduce vector abundance and dispersal. Cultural controls included sucker removal, Extenday, or kaolin clay treatments, while groundcover management included use of broad-leaf herbicides, grass planting mixtures, or application of *Beauveria bassiana* through orchard irrigation systems. *Colladonus* populations were monitored using yellow sticky cards placed near the ground cover or in the canopy throughout the growing season. Most of the cultural and groundcover management tactics reduced *Colladonus* abundance within the block (Extenday and grass planting mixtures) or at the canopy level (kaolin clay and sucker removal). These results provide season-long cultural controls that can be used in integrated pest management programs for leafhopper vectors of X-disease to reduce insecticide input and disrupt the source-sink dynamics of X-disease phytoplasma.

Translating Symbiont Technology from Citrus to Cherry: A Novel Strategy for Combatting Phytoplasma

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USDA-ARS, Temperate Tree Fruit and Vegetable Research Unit, Wapato, WA

Keywords: delivery system, novel, symbiont, cherry, citrus, phytoplasma

The devastating impact of *Candidatus* Liberibacter asiaticus (CLas) on citrus plants has prompted the development of innovative solutions such as Symbiont technology. While CLas poses a significant threat to citrus, phytoplasma represents a parallel challenge in cherry cultivation. Leveraging the successes in citrus against CLas, this study explores the adaptation of Symbiont technology to combat phytoplasma in cherry trees. Symbiont technology directly delivers biological active compounds into host plants and offers a promising avenue for addressing phytoplasma-related challenges in cherry cultivation. Symbiont technology, a crucial component of a $15 million NIFA grant awarded to develop solutions for citrus greening disease, will be adapted from citrus to cherry, streamlining the deployment of effective molecules against phytoplasma, overcome manufacturing difficulties, regulatory hurdles, and delivery complexities under field conditions. As we navigate the translation of Symbiont technology from citrus to cherry, this study provides insights into the potential applications and advancements in diverse crops, contributing to the broader field of plant disease management. The ongoing research focuses on optimizing the adaptation process and further enhancing the efficacy of Symbiont technology in cherry orchards, with the ultimate goal of providing a sustainable and environmentally friendly alternative for combating phytoplasma.

Management of Apple Powdery Mildew in Organic and Conventional Orchards

Achour Amiri, Jani Fomba, Clayton Haskell

Washington State University, Tree fruit Research and Extension Center, Wenatchee, WA

Keywords: powdery mildew, phenological stages, chemical control, organic

Powdery mildew of apple and pear is caused by the *Podosphaera leucotricha* and is an important preharvest pathogen of apple in central Washington and pear in south Oregon. The fungus overwinters in dormant buds or as chasmothecia (sexual fruiting bodies) on shoots from the previous season and infect newly emerging leaves and shoots in the spring and early summer. Infections are mostly driven by optimal temperature in early season when management is also critical especially in susceptible cultivars. Several conventional and organic materials have been tested in the last four years on Granny Smith and Jonagold, two cultivars highly susceptible to powdery mildew. Materials were sprayed at different stages from green tip stage to third spray cover at the Washington State University experimental orchard in Rock Island, WA and randomized complete block with four replicate trees per treatment. Materials were compared to a non-treated control and either a conventional or organic standard treatment consisting of fungicides with different modes of action rotated throughout the season. Ten days after the last spray was applied, 10 new shoots were assessed in each replicate, i.e., shoots from different sides and canopy levels of the tree. Collected data included disease incidence as the number of leaves infected by shoot and disease incidence expressed as the area of the leave covered with the mycelial of powdery mildew. Data were analyzed with One-Way ANOVA and Student's or Tukey's mean separations. Efficacy of the different materials will be discussed by cultivar, year, and type of fungicide to provide science-based information on best management approaches of powdery mildew.

Sensitivity to Post-harvest Fungicides of Several *Penicillium* Species Causing Blue Mold of Pome Fruits in Pacific Northwest

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Keywords: *Penicillium*, post-harvest, pome fruit

The post-harvest disease blue mold poses a significant threat to apples and pears in storage and represents up to 50% of total post-harvest decays in the Pacific Northwest (PNW). Although the primary causal species for blue mold is believed to be *Penicillium expansum*, several other Penicillium species have been identified and estimated to make up to 25% of the *Penicillium* population in the PNW. Four post-harvest fungicides are registered for the control of blue mold and other post-harvest diseases. These fungicides include thiabendazole (TBZ), pyrimethanil (PYR) and fludioxonil (FDL) which have been used for decades, whereas difenoconazole (DIF) was registered in 2017. Frequent use of the same fungicides has led to the emergence of *P. expansum* resistant strains. Worrisomely, strains of several other *Penicillium* species, named "non-expansum", were found to be tolerant to FDL, PYR and TBZ in vitro in recent surveys in the PNW. The reason behind such tolerance to fungicides among the non-expansum species is unknown, so is their sensitivity to the label rates of the four registered fungicides. In this research study, 168 strains from 15 different *Penicillium* species were assessed for their in vitro sensitivity to FDL, PYR, TBZ and DIF to determine effective concentrations inhibiting 50% (EC50) mycelial growth and germination. Our preliminary results confirm the high tolerance of most of the "non-expansum" species tested with many showing EC50 values >500 μg/ml for FDL and TBZ and >100 μg/ml for PYR. Representative strains, with different EC50 values, from each species were tested on detached apples sprayed with the label rates of each fungicide to assess their ability to control the highly in vitro-tolerant non-expansum strains. If found tolerant to the four post-harvest fungicides on fruit, these *Penicillium* species may cause a serious risk and a challenge for blue mold management in this already challenging disease but will also provide clues for better control.

Evaluation of a Novel In-field Applicator to Apply Post-harvest Fungicides on Apples

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Keywords: post-harvest decay, food safety, application technology, apple, themonebulization

At harvest, it is common in the Pacific Northwest to protect fruit from storage decays by drenching apples with fungicides as they arrive at the packing house and are still in bins on the semi-truck. The drench is applied in a 'shower-down' fashion with high volumes of water to penetrate through the bins. The run-off water from the bins and truck is recycled back into the treatment tank to cover approximately 500-800 bins. This process may contribute to spread of decay and food borne pathogens. Additionally, because apple bins are stacked with the drench applied from the top, there are concerns about adequate coverage in the lowest positioned apples. A novel applicator was developed that can be used in-field with lower volumes of water for non-recycling and only single bin stacks. A comparison between the in-field and packing house drenchers was completed for two harvest seasons to assess spray coverage, food safety organisms, and post-harvest decay. For spray coverage, bins were modified with small tunnels to insert collection devices into the top and bottom zones of a bin filled with apples. Pyranine tracer was used to assess deposition in both drencher types. For food safety experiments, apples were collected pre- and post- drench as well as water from the run-off through the bins. Water and apples were tested for Coliform and *Escherichia coli*. For fungicide trials Honeycrisp apples from four lots (4 bins each) treated with themonebulization and an untreated control were sampled from different positions within the bins to analyze fungicide residue levels and surface microflora. Additionally, 100 apples were collected per treatment and stored at 2.7°C and inspected monthly for post-harvest diseases. There were some significant differences between coverage in the top versus bottom of the bins however the level of tracer was still high in the lowest regions of stacked bins from the packing house. Higher levels of colony forming units (cfu) for Coliform and *E. coli* were only seen in the recycled water in the packing house. However, the cfu on apples was magnitudes less which is likely due to the waxy cuticle of apples. Lastly, the field applicator resulted in lower disease incidence compared to the packing house drencher. This new applicator could open new opportunities to reduce fungicide input and increase packouts while increasing food safety measures.

Rapid and Specific Detection of Major Quarantine Post-Harvest Pathogens of Pome Fruit

Arild Ranlym Arifin, Achour Amiri

Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: isothermal amplification, loop-mediated isothermal amplification, LAMP, point-of-care

The post-harvest pathogens *Phacidiopycnis washingtonensis*, *Phacidiopycnis pyri*, *Sphaeropsis pyriputrescens* and *Neofabraea kienholzii* are emerging quarantine pathogens of pome fruit industries in the U.S Pacific Northwest. Morphological and conventional detection of these pathogens are difficult because of their morphological similarity and no visible symptoms during harvesting period. Therefore, a DNA-based diagnostic assay based on loop-mediated isothermal amplification (LAMP) is being developed for each pathogen. LAMP method is highly specific, sensitive, and rapid compared to traditional DNA-based assays, such as polymerase chain reaction (PCR), and suitable for point-of-care detection. In this study, four sets of primers which are specific to each pathogen were designed to identify these pathogens using LAMP. The designed LAMP primer sets have been found to be specific in detecting genomic DNA of the four abovementioned pathogens under 30 minutes and able to detect as low as 10 pg/µl of DNA. A colorimetric LAMP assay has also been developed for detection of these pathogens to render future detection effort easier at points of care. Work is ongoing to validate the primers set for detection on artificially inoculated fruit. Once developed, LAMP assays will enable faster and efficient detection to prevent significant economic losses and ease exports.

Minutes of the 97th Annual Meeting

Orchard Pest & Disease Management Conference
Hilton Hotel, Portland, Oregon

2023 Meeting Minutes (submitted by Alix Whitener and Rebecca Schmidt-Jeffris)

I. Call to Order

The opening business meeting of the 97th Annual OPDMC Meeting was called to order by Chair Walston at 9:06 am (PST) on January 11, 2023. Chair Walston welcomed approx. 140 attendees to the joint entomology and plant pathology session who presented 50 papers, which is similar to previous years. Chair Walston asked for attendees to stay for the remainder of the meeting to participate in the Golden Apple Award, Rubber Chicken Award, and the close of business meeting. Chair Walston announced some safety updates including exits, restrooms, and asked the audience to silence their phones. Walston also made announcements about OR, WA, ID, CA, and CCA credits. Alison also asked for attendees to make a brief introduction.

The sessions and moderators:

Mating Disruption/SIR Implementation	Chris Adams Heather Andrews
Thresholds/Monitoring	Allison Walston
Biology Phenology	Josh Milnes
Pathology/Diseases	Maryna Serdani
Invasive Species	Aldo Hanel
Chemical Control/New Products	Amanda Koppel
Biology/Phenology	Kadie Britt

II. Old Business

A. Treasurer's Report: Treasurer Nik Wiman presented the 2022 Treasurer's Report (see Treasurer's Report posted at the end of the minutes). There was a call for questions; there were none. It was moved, seconded, and voted to approve the 202022 treasurer's report.
B. Approval of the 2022 Minutes: Secretary Whitener announced that the 2022 minutes were posted on the OPDMC website and printed in the back of the abstract booklet. She asked for amendments. There were none. It was moved by Chris Adams, seconded by Josh Milnes, and voted to approve the 2022 minutes.
C. Chair Walston recognized industry donors to the Student Scholarships – Silver, Gold and Bronze contributors include:
    a. Funding helped student scholarship recipients attend this years' meeting – recipients include Molly Sayles, Dowen Jocson, and Jon Puglisi.

III. New Business

A. Chair Walston recognized those members we lost in the last 3 years including Larry Gut, Tom Peerbolt, and Bill Barnett.
B. Chair Walston announced Keynote Speaker Don Thomson's talk will be this evening followed by a mixer.
C. Chair Walston asked Executive Director Peter McGhee for any updates – there were note at this time.
D. Chair Walston reminded attendees about the Golden Apple Award and the Rubber Chicken Award, and encouraged everyone to come up with nominations.
E. Chair Walston asked Scholarship Committee if they had a successful pledge drive this year and submissions.
F. Committee Assignments:
    a. Nominations: Josh Milnes, Tobin Northfield, and Reed Britt
    b. Audit: William Walker
    c. Resolutions: Lisa Neven, Josh Reger, Josh Adkins
G. Chair Walston asked for further new business from Executive Director Peter McGhee.
    a. Pete summarized the hardships OPDMC has experienced over the past 2 years – planning the meeting takes a lot of work from the Executive Director and Program Chair.
    b. ED McGhee reminded people that following deadlines for abstract submission is extremely important. Chris Adams and Executive Director McGhee collect abstracts, develop the Program, etc. – and a Program Chair is greatly needed on the board to serve for multiple years. McGhee summarized that two people are not enough to sustainably organize the meeting.
H. At 9:40am, Chair Walston asked for a motion to close – Chris Adams moved, Josh Milnes and Pete McGhee seconded, and the meeting was closed.

Chair Walston read through notes for speakers and reminded those submitting talks next year to shrink the resolution of their slides. She also reminded attendees to silence their cell phones. Chair Walston asked for any other announcements, and the talks began at 9:43am.

At the conclusion of the morning session, the Scholarship and Nominations Committee met to discuss development of the on-going Scholarship Committee. The following recommendations were stated:

-Single committee composed of representatives: 2 industry, 2 academic, 2 field consultants, and 1 student. The student member will engage in the scholarship plan and call for nominations, but not in the student selection process.

-Each member serves a 3-year term.

-2 of 6 members replaced annually to stagger member tenure.

-Student member replaced annually

IV. Closing Business Meeting

Chair Walston called the closing business meeting to order on January 13, 2023.

Treasurer's Report:
Executive Director Peter McGhee gave a summary treasurer report in the absence of Treasurer Nik Wiman:

- ~15,000 USD in registrations
- 5,000 in PayPal, 6,000 in bank
- ~140 registrants
- 13 students
- 130-140 attendees in the room at a time

Gabriel Zilnik motioned to accept, Chris Adams seconded, motion passed. Treasurer's report declared fuzzy but good.

New Business

1. **Abstract books:**
   The price will be increased to $15-20 based on increased printing costs. Only a few extra books beyond pre-orders will be printed for onsite registration. Reminders were issued to please register for one if attendees want to purchase a physical book and that it is electronically available if they would like to print their own.
2. **Relocation of the OPDMC Meeting versus continuing to hold the meeting in Portland, OR:**
   We are contracted through 2024, it would cause money to break the contract. We are tied to the IPM meeting and they are also considering relocating. The Hilton would like us to start considering 2025 soon.
   A discussion followed of the information available and pros and cons of staying in Portland. General consensus was that those who would like to change locations need to assemble a relocation investigation committee and obtain financials.
   Motion to stay through 2024, assemble a relocation investigation committee, have Peter McGhee extend into 2025, and then hear results from the committee.
   Ron Brett motioned, Rodney Cooper seconded, motion approved.
3. **Registration cost increase:**
   OPDMC needs a new laptop. Renting projector from hotel costs $500-600 per day, so we may need to purchase one. The executive committee proposed to raise registration to $150, keep students free. The goal is to maintain registration costs at this level for ~5 years. There is also a goal to break down registration rates to $150 for early bird, $200 onsite and $0 student early bird, $50 student onsite.
   Tianna DuPont motioned. Brock Zoller approved. Seconded by Melissa Thayer. Approved.
4. **Discussion regarding the program:**
   In the absence of obtaining a program chair that compiles the program book and obtains pesticide credits, Peter suggested we forgo CECs altogether, get rid of the hard copy of the program, only accept abstracts that are submitted and formatted correctly OR people bring the copies of their own abstracts. The task of obtaining CECs and putting together the program book is intensive, he estimated 70 or more hours total. He said we might go back to just using USBs to run presentations, instead of the organized slide deck. Without a program chair, all of these changes will have to happen.

Melissa Thayer asked if the program chair roles could be broken up for multiple people to accomplish. She volunteered to help with the CECs. Rebecca Schmidt-Jeffris volunteered to collect the program materials and make the program book if Melissa Thayer does the CECs. Chris Strohm volunteered to help with CECs.

5. **Committee Reports:**

Nominations. Josh Milnes chair, Tobin Northfield presenting.

Tobin ended up being nominated by the audience for chair-elect during his report and accepted the nomination.

All else as written in the report.

Resolutions. Lisa Neven presenting.

In addition to the written resolutions, Allison Walston and Peter McGhee would like to thank Dowen Jocson and Molly Sayles for working the registration table, and Tianna DuPont for bringing the projectors.

Auditing. William Walker presenting. No additional notes beyond the handwritten sheet.

6. **Rubber Chicken Award**

There were six nominees for the award. After a runoff vote due to a tie, Dave Crowder was declared the winner. He was nominated by Lisa Neven, for interrupting himself with himself during his own talk by unintentionally leaving in a Zoom-based recording of himself on one of his slides.

7. **Chair Walston called for nominations for the Golden Apple Award.**

There were five nominees for the award. Yan Yan received the majority of votes to win, after a double-nomination by both Chris Adams and William Walker.

Closing. Chair Walston thanked all of the volunteers that made the meeting successful. She offered to allow Rodney Cooper to use the gavel at this time, which he declined. Upon being informed that she would not be gaveling out the meeting, she called Chris Adams up to the podium to begin his term as Chair. In order to get one more round of gaveling in, she thanked Chris with an enthusiastic series of gavel-strikes.
Chris Adams closed OPDMC meeting.

Respectfully submitted,
Rebecca Schmidt-Jeffris, Interim-Secretary for the closing meeting
Alix Whitener, Secretary
Orchard Pest and Disease Management Conference, January 1-13, 2023

Orchard Pest and Disease Management Conference, January 8-10, 2023

Treasurers Report 2021 (meeting cancelled) but we still incurred expenses with website, bank account	**NO report**
Treasurers report 2022	**(Report Missing)**

Treasurers' Report 2023

Opening Business Meeting:	
Total Cash and Paypal Balance (as of 31 December 2021):	$11,595.51
Total Income from 2022:	$6,329.88
Total Expenses of 2022:	$8,853.72
Total Cash and Paypal Balance (as of 31 December 2022):	**$9,071.67**
Closing Business Meeting:	
Total Cash and Paypal Balance (as of 31 December 2022):	**$9071.67**
Total number of Registrations (as of 10 January 2023):	150
Total Income from 2023: (estimate as Treasurer absent)	~$15,000.00
Total Cash and Paypal Balance (as of 10 January 2023):	**$24,071.67**
Expenses Estimate for 2023:	$17,000.00
Estimated Balance 1/30/2024	**$7071.67**

Respectfully submitted,
Alix Whitener, Secretary
Orchard Pest and Disease Management Conference, January 8-10, 2023

The Rubber Chicken Award

An enduring tradition of informality is the nomination, voting, and awarding of the Rubber Chicken to one of the presenters during the closing business meeting. The Rubber Chicken may be awarded for a variety of reasons, but egregious behavior in some aspect of presenting a scientific talk is the underlying theme: too long, too short, poor organization, illegible slides, and over-spinning research results are frequently cited.

Notables who have received the award include:

- **Clancy Davis**, Berkeley, California for his quiet, sober, professional demeanor on all occasions.
- **Stan Hoyt**, Wenatchee, Washington for failing to enliven methods of presentation of papers.
- **Don Berry**, Medford, Oregon for never having made a single comment over 20 years.
- **Pete Westigard**, Medford, Oregon for returning from a sabbatical with 400 color slides (all failures) and a new child (a success).

'**Winners' in the Modern Era** (following about a 15-year hiatus, the award was revived during the 75th anniversary meeting):

- **Doug Light (2003)**, USDA, Albany, California, for showing incomprehensible data slides again and again and again. (Chemists…)
- **Stephen Welter (2004)**, University of California, Berkeley, for inappropriate behavior by leaving the meeting prior to giving his presentation.
- **Bob Van Steenwyk (2005)**, University of California, Berkeley; Bob suffered at the hands of technology and he could have been forgiven for these technical glitches; however, the membership was in a surly mood after the prolonged business meeting.
- **Alan Knight (2006)**, USDA-ARS, Wapato, Washington, for not submitting a talk.
- **Andy Kahn (2007)**, Wenatchee, Washington, for giving a much too long presentation and refusing to yield the podium - Andy subsequently decapitated our alopeciate friend.
- **Jim Miller (2008)**, Michigan State University, for attempting to coerce the entire membership into his cult of the pheromone, and for admitting to having intimate relations with codling moths; Jim was responsible for the demise of yet another unfeathered friend.
- **Peter Shearer (2009)**, Oregon State University, Hood River, for forgetting, like Dorothy, that he was not in Rutgers anymore (For those of you not present, he gave his talk as the new director of the Hood River Station MACAREC, using the Rutgers template).

- **Harvey Reissig (2010)**, Cornell University, Geneva, for his presentation that introduced a new web based IPM decision support system for NY apple growers that was actually a chemical spray calendar disguised as an IPM program (well played, Harvey, well played).
- **John Dunley (2011)**, Wilbur-Ellis, Cashmere, Washington, for not being present each morning to turn on the lights, the projector, and the laptop computer before the meeting began.
- **Larry Gut (2012)**, Michigan State University, for now conducting research on pheromone puffers (and finding them effective) after 'pooh-poohing' them for many years.
- **Don Thomson (2013)**, DJS Consulting Services, for delivering the keynote speaker's address in his introduction of Camille before she had a chance to deliver her own presentation.
- **Doug Light (2014)**, USDA ARS, Albany, California, for blatantly promoting his own product during his presentation.
- **Brad Higbee (2015)**, Paramount Farms, CA, for delivering an extended talk under false pretenses, breaking the new OPDMC computer, and bragging about his 40-acre research plots.
- **Betsy Beers (2016)**, Washington State University, Wenatchee, for the incompatibility of the slideshows presented by herself and her students despite the fact that she keeps the meeting computer.
- **Lisa Neven (2017)**, USDA-ARS, Wapato, Washington, for submitting her talk late, two times, and including incorrect information on Okanagan Co. in her presentation.
- **Lucia Varela (2018)**, University of California Cooperative Extension, Santa Rosa and Napa, for claiming that she had not seen the slides prior to the presentation; however, she was second author on the presentation; for making personal statements without supporting data; for claiming to have visited every backyard in Chile to see that all had grapevines; and she requested to the audience – "shoot me".
- **Rick Hilton (2019)** was nominated for false advertising because he signed up for BMSB talk in the Invasive Species section of the conference, but then proceeded to spend half of his presentation talking about codling moth.
- **Greg Krawczyk (2020)** for showing upside-down videos, the modern version of upside-down slide carousels.
- **COVID-19 (2022)** for being generally awful!
- **Dave Crowder (2023)** for interrupting himself, with himself, during his own talk by unintentionally leaving in a Zoom-based recording of himself on one of his slides.
-

Travel Scholarships for Students

INDUSTRY SPONSORS

For many years, industry participants of OPDMC have asked for a way to lend financial support to the event. We have established the Student Travel Scholarship fund to help support both OPDMC and the next generation of IPM specialists!

Industry contributions will be accepted in any amount, and sponsors will be recognized in the following categories: Bronze (up to $250), Silver ($251-$499), and Gold ($500+). Contributing organizations will be recognized in the conference program, as well as in the opening and closing business meetings.

INTERESTED STUDENTS

To qualify for the scholarship, students **must**:

1. Submit a complete application.
2. Attend OPDMC and present a talk.
3. Be available to help at the registration table on the first day of the meeting.

The selection committee will review applications and select award recipients from qualified applicants. The number and value of scholarships awarded will depend on the total amount of donations received.

FOR MORE INFORMATION

Visit https://opdmc.org/home/scholarships/

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