2023

Orchard Pest & Disease Management Conference

The 97th Conference is pleased to announce our keynote speaker:

Don Thomson

Pacific Biocontrol

Keynote address:

Pheromone-mediated Pest Management; Understanding Insect Biology, Physiology & Behaviour is Critical to Success!

Hilton Portland, Portland, Oregon
January 11th – 13th, 2023

Keynote Speaker: Don Thomson

Don began working on codling moth mating disruption (CM MD) at Agriculture Canada in Summerland, BC after finishing his master's degree in Biology and Insect Pest Management from Simon Fraser University in 1987. For the next 4 years, he worked closely with approximately 10 organic pome fruit growers in the Okanagan Valley to incorporate CM MD into their pest management practices. Within 2 years, CM populations in most of these orchards fell to very low levels. The lessons learned from working with these organic growers made a lasting impression on Don. In January 1991, he moved to Sacramento, California to work at Pacific Biocontrol Corporation (PBC). Don took over responsibility for the research, development, and commercialization of ISOMATE C+ for mating disruption of codling moth in the Pacific Northwest and then throughout the USA and Canada. He worked to expand sales of CM MD not only in the USA but also in other countries such as Chile, Argentina, Uruguay, Mexico, and South Africa. Don led OPDMC for 18 years, from 1998-2016, taking over for Bill Barnett. Don was instrumental in holding this ragtag group of scientists, PCA's, industry representatives, and graduate students together to share and discuss research. In 2000 he moved OPDMC from the Imperial Hotel to the Hilton. OPDMC grew dramatically during these years with increased presentations, attendance, and coffee breaks! He lives in Calgary, Alberta, Canada with his wife Jessica and 2 children, Sasha and Pasha. Don will retire in December 2022 and is learning Spanish as he prepares for winter travel to Mexico during retirement. Outside of work, Don loves music, hiking, squash, travel and meeting and learning from people.

97th Annual Orchard Pest and Disease Management Conference

In Memoriam

Tom Peerbolt, founder of Peerbolt Crop Management and the Northwest Berry Foundation passed away on Friday, November 18th at the age of 71. A Holland, Michigan native, Tom often spoke of Japanese Beetle picking in the MI berry fields growing up and loved to visit Lynden, Washington which reminded him so much of his Dutch heritage. After receiving a horticulture degree at UC Davis he opened a small tree and shrub nursery in Winters, CA which he ran for several years before moving to Oregon in 1990.

His connection to the NW Berry industry was born when the late Jerry Dobbins pulled him under his wing, introducing him to the SW Washington berry community in 1990. With the help of his wife, Anna, he ran a successful berry crop consulting business, Peerbolt Crop Management (PCM), for 30 years. After a few years working with growers, he realized the importance of a strong berry community in the Pacific Northwest, and so his vision of connecting the berry industry began. In 2000, he created the Small Fruit Update which he faxed out to his regional network of growers. Little did he know that it would reach nearly 1,800 people industry wide like it does today!

He was a firm believer in communication, technology, and on-farm research. He developed AgReports software to ease the flow of information to his PCM grower group. He also collaborated on countless research projects across the Pacific Northwest to ensure applied results and farm connection were prioritized. In 2014, he realized that his broader regional efforts needed their own space so, with the help of his wife, they established the Northwest Berry Foundation.

He was instrumental in shaping the PNW berry community. His introduction and community building helped nurture many budding careers and a sense of belonging in the Pacific Northwest. He jumped at any opportunity to show a new industry member around the fields ensuring they understood the end goal: successful PNW berry production and grower support.

The Northwest Berry Foundation continues Tom's vision of communication within the PNW berry industry. Tom was also a firm supporter of *Sisters of the Road* and *Northstar Village* if you would like to donate in his memory.

Orchard Pest and Disease Management Conference
2023 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 11th	
8:00 – 9:00 AM	**Registration/Name Tag Pickup**
9:00 – 10:00 AM	**Opening Business—**Allison Walston, OPDMC Chair
10:00 AM	Biology / Phenology – *Moderator:* Kadie Britt (UC Riverside)
11:30AM–1:00PM	**Lunch (on your own)**
1:00 PM	Biology / Phenology – *Moderator:* Kadie Britt (UC Riverside) *(cont'd)*
1:45 PM	Mating Disruption / SIR – *Moderator:* Chris Adams (OSU)
3:00 – 3:30 PM	**Coffee Break**
3:30 PM	Mating Disruption / SIR – *Moderator:* Chris Adams (OSU) *(cont'd)*
4:00 – 5:00 PM	Keynote Address: Pheromone-mediated Pest Management; Understanding Insect Biology, Physiology & Behaviour is Critical to Success! Don Thomson (Pacific Biocontrol)
5:00 PM	**Adjourn**
5:00 – 7:00 PM	**No Host Mixer (Hilton Lobby)**
Thursday, January 12th	
8:00 AM	Implementation – *Moderator:* Heather Andrews (OSU)
8:45 AM	Thresholds & Monitoring – *Moderator:* Dani Lightle (OSU)
10:00 – 10:30 AM	**Coffee Break**
10:30 AM	Thresholds & Monitoring – *Moderator:* Dani Lightle (OSU) *(cont'd)*
11:15 AM	Biological Control – *Moderator:* Robert Orpet & Christopher McCullough (WSU)
11:30AM–1:00PM	**Lunch (on your own)**
1:00 PM	Biological Control *(cont'd)*
2:30 – 3:00 PM	**Coffee Break**
3:00 PM	Biological Control *(cont'd)*
3:30 PM	Pathology / Diseases – *Moderator:* Maryna Serdani (Marrone Bio)
4:30 PM	**Adjourn**
Friday, January 13th	
8:30 AM	Invasive Species – *Moderator:* Aldo Hanel & Paul Bergeron (WSU)
9:30 AM	Chemical Control / New Products – *Moderator:* Amanda Koppel (Corteva)
11:00 – 12:00 AM	**Closing Business** — *Allison Walston, OPDMC Chair; Chris Adams, Chair-Elect*
12:00 AM	**Adjourn**

Orchard Pest and Disease Management Conference
Officers for the 2023 Conference

Chair (2022)
Allison Walston
Valent U.S.A.
PO Box 1976
Hood River, OR 97031

Phone: 503-867-1749

Chair-Elect (2023)
Christopher Adams
Oregon State University
Mid-Columbia Ag. Research & Ext. Ctr.
3005 Experiment Station Drive
Hood River, OR 97031
chris.adams@oregonstate.edu
cell 248-850-0648

Executive Director
Peter McGhee
OPDMC Executive Director
4815 NW Bruno PL
Corvallis, OR 97330

Phone: 517-331-1816
Email: executivedirector@opdmc.org

Program Chair

Secretary
Alix Whitener
Technical Services Manager
FMC
Malaga, WA 98828

Phone: 509-669-1656
Email: alix.whitener@fmc.com

Treasurer
Nik Wiman
North Willamette Research & Extension Center
15210 NE Miley Rd
Aurora, OR 97002

Phone: 503-678-1264
Email: nik.wiman@oregonstate.edu

Web Site and Proceedings
Peter McGhee
OPDMC Executive Director
4815 NW Bruno PL
Corvallis, OR 97330

Phone: 517-331-1816
Email: executivedirector@opdmc.org

Past Chair (2019)
Rodney Cooper
USDA-ARS
Yakima Ag. Research Laboratory
5230 Konnowac Pass Rd
Wapato, WA 98951
Phone: 509-454-4463
Fax: 509-454-5646
Email: rodney.cooper@ars.usda.gov

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

Order of Presentations

FROM THE 97th ANNUAL

ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE

January 11, 12, & 13, 2023

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

Pheromone-mediated Pest Management; Understanding Insect Biology, Physiology & Behaviour is Critical to Success!

Don Thomson

Pacific Biocontrol

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Identification of Non-Crop Hosts of Leafhopper Vectors of Cherry X-Disease by Molecular Gut Content Analysis

W. Rodney Cooper[1], Heather Headrick[1], Scott Harper[2], Cody Molnar[2], Madalyn Shires[2,4], Tobin Northfield[3], Adrian T. Marshall[3], Tawnee Melton[3]
[1]USDA-ARS, Wapato, WA; [2]WSU IAREC, Prosser, WA; [3]WSU-TFREC, Wenatchee, WA; [4]South Dakota State University, Brookings, SD

Keywords: Colladonus, X-disease, little cherry disease, Phytoplasma pruni, host plants

Abstract: The ongoing epidemic of X-disease (aka, Little Cherry Disease) threatens the cherry and stone fruit industries of the Pacific Northwest. This disease is caused by a phloem-limited bacterium, "*Candidatus* Phytoplasma pruni", that is transmitted to trees by several leafhopper vectors, especially *Colladonus reductus* and *C. geminatus*. Leafhoppers likely acquire Phytoplasma from weeds before transmitting the pathogen to trees, yet it remains uncertain which weedy hosts are most important in X-disease epidemiology. Molecular gut content analysis uses plant sequence data obtained from leafhopper guts to identify their dietary history and to infer how they moved across the landscape prior to capture. Researchers at the USDA-ARS in Wapato WA and from Washington State University in Wenatchee and Prosser WA are using gut content analysis to identify non-crop sources of Phytoplasma-infected leafhoppers in orchards. They found that both *C. reductus* and *C. geminatus* generally feed on a large diversity of plant species, but mostly feed upon dandelion and other common broadleaf weeds that occur within orchards. These results provide a better understanding of the biology and host-plant associations of *Colladonus* vectors of the Phytoplasma pruni and will aid in development of integrated pest management tools to control X-disease

Investigating Host Use of X-disease Vector *Colladonus montanus reductus*

Abigail E. Clarke[1] and Tobin D. Northfield[1]
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: Colladonus montanus reductus, X-disease, *Candidatus* Phytoplasma pruni, stonefruit, cherries, peaches

Abstract: X-disease (XD), 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 phytoplasma that causes this disease is spread into the phloem of Prunus trees by root grafting and leafhopper feeding (Hemiptera: Cicadellidae). XD can frequently cause underdeveloped and misshapen fruit on economically important crops: cherries, peaches, and nectarines. Here, we evaluate feeding preference by a key vector, *Colladonus montanus reductus* (Van Duzee) including fruit trees that are impacted by XD (cherry and peach) and common orchard weeds; mallow, alfalfa, dandelion, and clover. We also considered oviposition on clover and alfalfa, as well as grasses. All plant species provided were fed on, with the mallow and alfalfa being the species with highest feeding rates. Additionally, all plants were capable of hosting eggs with a potential oviposition preference in grasses. Information about feeding and oviposition locations of these leafhoppers is important as it can be used to coordinate management strategies to stop the spread of XD. Knowing alternative hosts for the leafhoppers may allow us to focus management efforts on removing these plants to reduce leafhopper populations and remove sources for the phytoplasma.

Filbert Worm Grab Bag: a Selection of Trials to Improve Rearing and Management of *Cydia latiferreana* in Hazelnut Orchards

Betsey Miller[1], Serhan Mermer[1], Greg Krawczyk[2], Vaughn M. Walton[1]
[1]Horticulture Department, Oregon State University, Corvallis, OR,
[2]Fruit Extension and Research Center, Pennsylvania State University, Biglerville, PA

Keywords: Filbrert worm, *Cydia latiferreana*, hazelnut, rearing, diet formulation, crop damage, automated traps, pheromone lure

Abstract: Filbertworm is a native tortricid and a key pest of hazelnuts in the Pacific Northwest. In the pursuit of improving management options for hazelnut producers, we have established a laboratory colony. Though oviposition in the colony is strong, larval mortality is high. We conducted a series of trials to test how rearing unit and diet effect larval survival in hopes of improving the efficiency of our rearing methods. Results indicate that rearing larvae in single cells results in much higher survival than rearing on trays. Improved diet formulations will also be discussed. The abundance of eggs in our colony allows for a range of field trials related to crop damage. Growers have expressed concern over how late season catches in pheromone traps are correlated with crop damage. In semi-field trials, we placed filbertworm eggs onto mesh-enclosed hazelnut clusters once per week from 23 August to 20 September, approximately three to seven weeks before harvest. Results indicated that larvae hatched from eggs placed as late as four weeks before harvest were able to injure the crop and significant damage occurred from eggs placed between five and seven weeks before harvest. Given that optimum temperatures for mating and oviposition are becoming more common in the late season, shell maturation is likely the predominant factor mitigating late season crop damage. Last, but not least, automated traps have become of great interest to the hazelnut industry in recent years, primarily due to reduced labor required to check traps and more accurate timing of management strategies. Unfortunately, traps still require monthly servicing to replace pheromone lures. We are working on developing a 6-month lure so automated traps can be truly hands-off for the growing season. The current status of this research will be reported

Genetic Deep-Dive Towards a Better Understanding of the Biology ofColladonusLeafhoppers that Transmit X-Disease Phytoplasma

William B. Walker III[1], W. Rodney Cooper[1], Robert S. de Moya[1],
Tobin D. Northfield[2], and Cesar A. Reyes Corral[2]
[1]USDA-ARS, Temperate Tree Fruit and Vegetable Research Unit, Wapato, WA
[2]WashingtonState University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: Colladonus reductus, *Colladonus geminatus*, X-disease, leafhoppers, phytoplasma, cherry, stone fruit, genetics, genomics

Abstract: X-Disease is caused by phytoplasma bacteria transmitted to stone fruit trees by the leafhopper vectors, *Colladonus reductus* and *Colladonus geminatus*, and is fatal to the fruit trees. Currently there are no direct treatments to control X-disease, so growers rely upon the removal of infected trees and prophylactic insecticide applications to suppress vector populations. Very little is known about the genetics of the *Colladonus* leafhoppers and the X-disease phytoplasma. Genetic interactions between phytoplasma and its leafhopper vectors are being investigated. The genomes of the primary leafhopper

vectors of X-disease phytoplasma have been sequenced. Catalogues will be developed of all genes expressed by leafhoppers and phytoplasma during infection of leafhopper and these will be analyzed to identify the genes that may mediate X-disease phytoplasma interactions with their hosts. This project will allow researchers to adapt novel genetically-based control methods being developed for other plant pathogen diseases to immunize cherry trees against the X-disease phytoplasma

Potential Treehopper Vectors of Grapevine Red Blotch Virus in Southern Oregon Vineyards: In Vitro Transmission Testing and the Effect of Groundcover Management

Rick Hilton, Mariana C. Stowasser, and Ricky Clark
Oregon State University, Southern Oregon Research & Extension Center, Central Point, OR

Keywords: three cornered alfalfa hopper, *Spissistilus festinus*, buffalo treehopper, Stictocephalabisonia, Tortistilussp.

Abstract: Treehoppers suspected of being vectors of grapevine red blotch virus (GRBV) were collected in Southern Oregon vineyards and an in vitro technique was employed to see if they were viruliferous. The two treehoppers most often seen in vineyards are *Stictocephala bisonia*, the buffalo treehopper, and a *Tortistilus* species. *Spissistilus festinus*, the three cornered alfalfa hopper, is a known vector of GRBV and is also found in Southern Oregon vineyards but, for the most part, not in high abundance. In the in vitro technique, the treehoppers are placed in a tube and allowed to feed on a sucrose solution through a parafilm membrane. Then the solution is tested for presence of GRBV. A positive test indicates that the insect transmitted GRBV via feeding into the solution. Treehoppers collected from highly infected vineyards were often able to transmit GRBV to the solution. Over half of the *Tortistilus* that were collected from a heavily infected vineyard and which fed on the solution transmitted GRBV. However, attempts to infect GRBV-free insects by putting them on infected vines and observe in vitro transmission were largely unsuccessful. Only two out of seventy-six *S. festinus* transmitted GRBV to the solution and zero out of twenty-five *Tortistilus.* An acquisition period of seven days was most commonly used and this may have been insufficient. Given the positive results from the in vitro testing and the test's relative simplicity, this method could prove to be a useful research tool in examining some of the outstanding questions regarding vector transmission of GRBV. The effect of clean cultivation on treehopper feeding activity was examined in two replicated trials. The first trial was conducted in a commercial vineyard in 2019 and compared cultivation with standard mowing practice. The second trial was established in a research vineyard and compared clean cultivation to a planted cover crop; data were collected from the research vineyard in 2021 and 2022. The effect of clean cultivation was inconsistent. While the clean cultivated plots had lower levels of treehopper feeding in each of the three years, the effect was variable, with the level of reduction ranging from 20% to 70% as compared to the vegetated plots, and in only a single year, 2022, was a statistically significant difference observed.

Getting Meta with Navel Orangeworm: Determining Larval Diet With Untargeted Metabolomics

Joshua Reger[1] and Houston Wilson[1]
[1]Department of Entomology, University of California, Riverside

Keywords: navel orangeworm, *Amyelois transitella*, almonds, pistachios, walnuts

Abstract: Understanding the movement and energy use of small insect pests in agricultural systems is critical to the development of area-wide integrated pest management strategies. For many insect pests, little is known about their dispersal dynamics at the landscape level. Navel orangeworm (NOW) (Pyralidae: *Amyelois transitella*) is a pest of almonds, pistachios, and walnuts in California. Tracing NOW intra-and inter-orchard movement is a challenge due to the high dispersal capacity and broad host range of this moth. To trace host plant origin of adult NOW, here, we employed an LC/MS untargeted metabolomics approach to investigate the unique intrinsic signatures of larval diet on the adult NOW metabolite profile. It revealed the presence of unique metabolites of five food sources (artificial diet, mature almonds, mature pistachios, green almonds, and green pistachios) and freshly emerged adult NOW reared from these food sources. Additionally, the profiles of moths from each diet that flew ≥8 km in a single night on a flight mill were analyzed to measure the effect of flight. Future validation and optimization of this approach has potential to provide a novel tool to study the movement ecology of this economically important insect pest

Biology of Native Gray Ant in California Table Grape Vineyards

David Haviland, Chelsea Gordon, Stephanie Rilland Minerva Gonzalez
UC Cooperative Extension, Kern Co., Bakersfield, CA

Keywords: Sugar-feeding ants, biology, *Formica aerata*, biology

Abstract: Native gray ant, *Formica aerata*, is the primary species of sugar-feeding ant in table grape vineyards in the lower San Joaquin Valley. It feeds primarily on honeydew of vine mealybug and is highly disruptive to biological control organisms, including the primary parasitoid in the system, *Anagyrus pseudococci*. Prior to our project, very little was known about the basic biology of this ant species. Our project t rectified this situation through field trials to evaluate ant distribution, evaluate foraging activity at different times of the year, and determine minimal temperature thresholds for ant foraging activity. Studies were done following trials that identified cotton balls saturated with 25% sucrose solution as an effective method to monitor for and quantify ant activity. Results of these studies are being used to inform decisions about ongoing research regarding the use of hydrogel baiting systems.

The Phenology-Based Pear Psylla IPM Program, Why it's Needed, and How it Works

Robert Orpet[1], Molly Sayles[1], Chris Sater[1], Chris McCullough[1], Louie Nottingham[2]
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA;
[2]Northwestern Washington Research and Extension Center, Mt. Vernon, WA

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

Abstract: Pear psylla is an intractable problem in Pacific Northwest pear production, especially in the Wenatchee Valley, where costly spray programs are failing to prevent pear psylla honey dew damage. This problem is partly due to pesticide resistance and disruption of biocontrol. Multiple projects prove integrated pest management (IPM) programs are cheaper and result in similar or less pear psylla damage than conventional programs that over use insecticides. To aid in implementing IPM programs, our team used a recently completed pear psylla phenology model as a framework for new phenology-based management guidelines. Our guidelines give pesticide spray selections and timings on a degree-day basis to conserve biocontrol and avoid unnecessary applications. We partnered with growers and consultants to test these guidelines versus conventional pesticide overuse at eight paired pear orchards in 2022. Pear psylla damage was on average the same between management styles, IPM spray programs were cheaper, and conventional orchards had few biocontrol agents. We think areawide adoption of the guidelines would make IPM work even better, as conventional orchards lacking biocontrol agents are the source of exorbitantly high pear psylla adults in fall, which mix and disperse to orchards in spring. The phenology-based management guidelines exist publicly online and on the Decision Aid System. We will continue to refine and promote them with the expectation that mass-adoption will alleviate high areawide pear psylla pressure

Linking Pest Phenology and Population Dynamics with the WSU Decision Aid System

David Crowder[1], Stefano Borghi[1], Liesl Oeller[1]
[1]Washington State University Entomology

Keywords: Pest Management, Codling Moth, Ecology, Phenology, Trapping, Monitoring

Abstract: Proper timing of insecticide applications is central to effective management of codling moth, pear psylla, and other insect pests of tree fruits. Phenology models are one tool that can aid in predicting the development of key life stages of pest insects and planning insecticide sprays. However, phenology models often fail to capture ecological factors that affect pest population dynamics, which can complicate efforts to manage pests. Here we discuss how advancements within the WSU Decision Aid System can allow growers to compare pest population dynamics (from trapping) with data from phenology models. We also discuss advancements in presenting data at a regional perspective to allow for a proactive assessment of where and when pests are likely to occur. Finally, we discuss new tools that can be used to plan pesticide applications based on phenological models. Over-all we show how data from orchards along with models can be used to guide more effective and economical pest management for many orchard pests.

Mating Disruption/SIR—

Moderator: Chris Adams (OSU-MCAREC)

The Success of Low Rate Filbertworm, *Cydia latiferreana* (Lepidoptera:Tortricidae), Pheromone Dispensers in Hazelnut

Serhan Mermer[1], Betsey Miller[1], Peter McGhee[2], Chris Adams[1,3], TJ Hafner[4], ArielGelman[4], Danielle Mendez[4], Gabriella Tait[1], Vaughn M. Walton[1]
[1]Oregon State University, Department of Horticulture, Corvallis, OR
[2]Pacific Biocontrol Corp., Vancouver, WA
[3]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR
[4]Agricare Inc., Jefferson, OR.

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

Abstract: Hazelnut is a specialty crop providing significant agricultural revenue in Oregon, USA. Filbert worm (FBW), *Cydia latiferreana*, is one of the detrimental pests in hazelnut production resulting in dockage at the receiving station for unsaleable nuts. Hatched larvae penetrate inside the nut and feeding causes unmarketable crop. Insecticides application is the primary method to manage damaging FBW populations. Repeated use of insecticides may however result in secondary pest resurgence and disrupt natural enemies of other pests in the orchard. Mating disruption with sex pheromone is an alternative control method to minimize insecticide use while reducing pest damage. In the current study, a range of pheromone dispenser densities were deployed to evaluate the efficacy of FBW mating disruption in hazelnut orchards. Experiments were conducted in eight hazelnut orchards consisting of ~20acre. ISOMATE HSW Flex dispensers were evenly placed in the field with application rates of 0, 10, 20, 20C, 30, 50, and 100/acre in 2021 and 0, 5, 10, 15, 30/acre in 2022. In addition,0.5 and 1 m ring dispensers were used as a grower standard mating disruption application. Dispensers were applied to the upper1/3 of the canopy approximately 3-4 m above the ground. Male FBW counts were checked weekly by placing two pheromone-baited delta traps in each plot. The results indicate that low-rate dispensers provided equal disruption compared to standard commercially used rates. Further research is needed to implement low-rate treatments in a large-scale field scenario and determine their economic benefit.

Effective Organic CM Management: Areawide Mating Disruption or Exclusion Netting

Alan L. Knight[1], Esteban V. Basoalto[2], Michele Preti[3]
[1]Instar Biologicals, Yakima, WA, [2]Austral University, Valdivia, Chile; [3]Astra Innovazione, Italy

Keywords: Cydia pomonella, sex pheromone, pear ester, Megalure 4K, monitoring, immigration

Abstract: We have monitored with the Megalure 4K lure 128 apple and pear organic and conventional orchards treated with mating disruption (MD) situated in 27 contiguous areas over the past two years to measure the proportion of unmated female codling moths and establish factors which influence the relative success of MD technology.MD technology included six types of hand-applied dispensers, aerosols, and sprayables. In addition, we evaluated the success of single-row exclusion netting as the ultimate approach to establish codling moth-free orchards. The impact of female moth immigration into each of these contiguous areas was the key factor affecting the proportion of unmated females. The proportion of unmated females varied from 0.3–0.9 among areas. Proportions of unmated females later in the season was always lower, likely due to longer moth flights with the warmer weather. We demonstrated in these areas that the suppression of male catch in 1X pheromone lures was not correlated with the proportion of unmated females. Levels of fruit injury was also not closely associated with the proportion of unmated female codling moth, but instead was dependent on the associated spray programs. Our data clearly demonstrates that organic spray programs have much greater difficulty than conventional spray programs in managing codling moth. We demonstrated that the proportion of unmated female codling moth can be increased in the first generation if conventional orchards are managed with Altacor sprays. We also demonstrated that the addition of DAMEC with Altacor can further increase the proportion of unmated females. DAMEC is widely used with granulosis virus and spinosyns in organic orchards and was also effective in increasing the proportion of unmated females in these orchards as well. During 2021 we found that the unintended combined use of aerosol dispensers together with hand-applied dispensers resulted in proportions of unmated female codling moth > 90%. Single-row exclusion netting was evaluated in Bartlett pear and Honey Crisp, Ambrosia, Golden Delicious, and Pink Lady apples. Tree canopy architecture isa key factor influencing moth behaviors inside the nets. Netting placed over high-density narrow canopies is ideal to prevent mating, while V-trellis canopies are open in the middle and more conducive to moth mating. First generation fruit injury can occur inside nets if the block has an overwintering population; but no new injury was recorded later in the season. Exclusion netting also eliminated bird injury which can be an important cull factor for Honey Crisp and all apples late in the season. Netting also reduced culls from sunburn, except for apples on the outside of the canopy touching the netting. No secondary pest problems occurred due to netting in these blocks.

Shaking Up Oriental Fruit Moth with a New Mating Disruption Product in Peaches

Melissa R. Thayer, Julia M. Perbohner, Robert A. Van Steenwyk,
Stephen R. Peters-Collaer, and Skylar S. Sherbrooke
University of California, Dept. of ESPM, Berkeley, CA

Keywords: Oriental fruit moth, *Grapholita molesta*, mating disruption, pheromone attractant, peaches, pump dispenser

Abstract: A field study was conducted in three peach orchards near Yuba City, CA to evaluate a new pheromone pump dispenser for Oriental Fruit Moth (OFM) control over two field seasons (2021 and 2022). Four treatments were replicated in each orchard, and each replicate was over five acres in size. The four treatments were the treated control, 200 dollops/ac from pump dispensers (Corteva Agriscience), 250 dollops/ac from pump dispensers, and the 100 Isomate Oriental Fruit Moth TT (Pacific Biocontrol Corp.) with each treatment including the grower's standard insecticide program. The efficacy of the treatments was monitored weekly by Trécé L2 pheromone lures and Combo lures (L2 + acetic acid) in Trécé Pherocon VI traps. OFM infested shoots (strikes)were monitored weekly from 10 center trees in each plot. No significant difference was found in strike presence due to a great deal of variation among the orchards. Male moths captured in the L2 pheromone traps were numerically suppressed in both the low and high rates of the Corteva OFM experimental pheromone as well as the Isomate OFM TT treatment when compared to the treated control. However, only the second year of the study showed a statistically significant difference. In the Combo traps, moths in the high and low pheromone were significantly suppressed compared to the treated control both years. Although, there was no significant difference among the sex ratios for the Combo trap, the numerical difference provided an indication of the efficacy of the four treatments. Both the high and low rates of Corteva OFM experimental pheromone performed as well or better than the grower standard Isomate OFM TT in the first year of the study while they performed about the same in the second year. Both Corteva OFM experimental pheromone and Isomate OFM TT outperformed the insecticide only treatment.

A New Walnut Husk Fly Aggregation Pheromone

R. Van Steenwyk[1], S. Walse[2], M. Thayer[1], and D. Kuzmich[2]
[1]University of California, Dept. of ESPM, Berkeley, CA
[2]USDA-ARS, Parlier, CA

Keywords: Walnut husk fly, *Rhagoletis completa*, Aggregation pheromone, Monitoring

Abstract: Walnut husk fly (WHF) is a significant pest of walnut and has increased in importance over the past 20 years. Control of WHF is based on repeated applications of insecticides to control the adults. Initiation of the spray program and monitoring the efficacy of the spray program is based on captures of adult flies in yellow panel traps baited with an ammonium carbonate feeding lure. An improvement in monitoring through increased fly catches would aid in determining the proper time to initiate an insecticide control program and aid in determining the efficacy of the control program. Sarles et al. (2018) discovered a male produced WHF pheromone (δ-hexalactone and δ-heptalactone). The pheromone is produced in a ratio of 40 to 60 (δ-hexalactone and δ-heptalactone) from the head of male WHF. Field evaluations of a lure produced by Sarles et al. resulted in a significant increase in trap catch as compared to blank (unbaited) traps. However, Sarles et al. did not evaluate the new lactone lure against a standard ammonium carbonate lure. Also, Sarles et al. did not sex the captured flies and thus it is unknown if the lactones are aggregation or sex pheromones. Studies on δ-hexalactone and δ-heptalactone and combination of both in polymeric plugs and septa, the load rates of δ-hexalactone in polymeric plugs, the combination delta-hexalactone and ammonium bicarbonate, and the longevity of δ-hexalactone in polymeric plug lures will be reported.

Impacts of X-ray Irradiation on Survival, Flight, and Mating for Navel Orange worm and Codling Moth

Dylan A. Tussey[1], Tzu-Chin Liu[1], Sarah Meierotto[1], Charles Burks[2], & Houston Wilson[1]
[1]University of California Riverside, Department of Entomology.
[2]United States Department of Agriculture, San Joaquin Valley Agricultural Science Center.

Keywords: Sterile Insect Technique,Amyelois transitella,Cydia pomonella, X-ray, navelorangeworm, codling moth.

Abstract: Navel orange worm (NOW) and codling moth (CM) are among the most destructive pests of California tree nuts, which account for an annual value of over $6 billion, and 16% of the total agricultural value generated in the state. Recently, the pistachio and almond industries invested in the development of sterile insect technique (SIT) for NOW. SIT typically relies on the use of gamma irradiation, but there is interest in the development of alternative forms of irradiation, in particular x-ray irradiation machines. This work focused on assessing the effects of x-ray irradiation on the survival, flight ability, and reproductive output of both NOW and CM. Moths were exposed to either 0, 100, 150, 200, 250, or 300 Gy using an X-ray irradiator to determine dose response on flight capability, longevity, and induced sterility. After radiation exposure, 10 males and 10 females from each treatment dose were assessed for flight ability across 48 h. Moths, kept separated by sex, were placed in flight cylinders to assess flight ability. Longevity of moths was also assessed daily. Male and female sterility was determined by using single pairs of radiation treated moths paired with a non-irradiated moth of the opposite sex. Eggs were collected daily and allowed to develop. Total eggs, percent hatch, and mature larvae were counted to assess residual fertility of irradiated moths.

Potential Use of Acoustic Communication for Pear Psylla IPM

Dowen Jocson[1], Mark Gonzales[1], David Horton[2], LouisNottingham[3],
Tobin Northfield[4], Elizabeth Beers[4], and David Crowder[1]
[1]Washington State University, Pullman, WA, [2]USDA-ARS, Wapato, WA
[3]WSU-NWREC, Mount Vernon, WA, [4]WSU-TFREC, Wenatchee, WA

Keywords: Pear psylla, mating disruption, *Cacopsylla pyricola*, vibrational communication, acoustics

Abstract: Animals use many ways to communicate including acoustically. Insects are no exception. Acoustic communication encompasses both air-borne vibrations as well as the more innocuous substrate-borne vibrations. This talk will focus specifically on substrate-borne vibrations of a pear pest, the pear psylla (*Cacopsylla pyricola*). Pear psylla uses vibrational communication to search for and attract mates. Interestingly, there has not been any hard evidence of what these vibrational songs sound like until recently. These vibrational songs are dynamic and can be affected by some environmental factors. Recording pear psylla mating behavior and aspects of how they find mates show potential in using acoustics as a way to disrupt mating and reduce populations in pear orchards. Some potential evidence can be seen in a smaller-scale greenhouse experiment using potted pear plants and vibrational playback devices. There should be further exploration of this signal modality because it can have broader impacts on the way we develop integrated pest management strategies.

Recent Field Challenges with Management of Codling Moth in Pennsylvania

Greg Krawczyk, Laura Mellott and Josh Gere
The Pennsylvania State University, Department of Entomology,
Fruit Research and Extension Center, Biglerville, PA 17307; e-mail: gxk13@psu.edu

Keywords: Cydia pomonella, insecticide efficacy, mating disruption, pome fruit

Abstract: 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 and judicious applications of insecticides. Since the initial introduction, insecticides belonging to two IRAC Groups: diamides (IRAC Group28) and spinosyns (IRAC Group 5) provided excellent supplemental control of both internal fruit feeder species when such additional control was necessary. Unfortunately, during the last three to four years some growers started reporting increased challenges with the management of this pest complex, resulting with the presence of CM and/or OFM injured fruit at harvest. To assess the potential factors affecting the CM and OFM management in apple orchards we evaluated and re-evaluated numerous commercial and experimental mating disruption products as well as the sensitivity of field collected codling moth populations to some diamide and spinosyns insecticides. The field effectiveness of mating disruption was evaluated by comparing seasonal moth captures in traps baited with various pheromone lures and in-situ fruit evaluations. Despite utilization of mating disruption programs, the monitoring traps baited with both commercial (e.g., Pherocon CM L2, Pherocon CM DAC-P or Pherocon CM 1X) and experimental (e.g., Pherocon CM Megalure 4K) lures were able to capture CM adults throughout the entire growing season and injured fruit were present at harvest. When possible, codling moth larvae originated at multiple locations were collected and used for insecticide sensitivity bioassays. When compared to a sensitive, field collected CM population, the insecticide bioassays utilized standard diet incorporation method conducted on CM neonates from various populations demonstrated multiple folds reduction in sensitivities to all tested diamide insecticides (e.g., Altacor®, Exirel®, Verdepryn™, VoliamFlexi®, Besiege®, and Minecto®) but no differences in sensitivities to spinosyns (e.g., Delegate™).

Implementation—

Moderator: Heather Andrews (OSU NWREC)

Establishing Postharvest Cultural Controls for X-Disease Vector Management

Adrian Marshall, Tawnee Melton, and Tobin Northfield
Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: X-disease, *Colladonus*, Cultural Control, Ground Cover, Phytoplasma pruni

Abstract: X-disease, a re-emerged leafhopper vectored disease caused by the phytoplasma *Candidatus* Phytoplasma pruni, is jeopardizing commercial stone fruit (cherry, peach, nectarine) production in the Pacific Northwest region of the United States. Common groundcover weeds such as clover and dandelion have been shown to be both disease and leafhopper feeding hosts, suggesting that groundcover weeds can promote disease prevalence in orchards. From 2020-2021 we evaluated two methods, plastic groundcover and particle film sprays, to reduce vector abundance and dispersal. Leafhopper densities were significantly lower in both treatment plots than controls each year. Furthermore, trap counts suggest greater movement in the treated blocks in the ground cover at (0.5m) rather than at tree canopy heights (2m), whereas in control plots we observed high leafhopper capture in 2m traps. No-choice laboratory assays determined leafhoppers will land on clay covered cherry leaves, suggesting that leafhoppers can recognize and feed on leaves coated with particle film, so field effects are likely driven by deterrent effects than an inability to recognize and locate plants. These results demonstrate the potential of two season-long cultural techniques for improving control of the leafhopper vectors and disrupting the source-sync dynamics of X-disease phytoplasma.

A New Application Technique to Increase Spray Coverage Using Opposing Synchronized Air-Blast Speed Sprayers

R. Van Steenwyk[1], R. Ehsani[2], A. Toudeshki[2], S. Peters-Collaer[1], S. Sherbrooke[1], F. Niederholzer[3], L. Milliron[4] and J. Perbohner[1]
[1]University of California, Dept. of ESPM, Berkeley, CA;
[2]University of California, Dept. of Mechanical Engineering, Merced, CA;
[3]University of California, Cooperative Extension, Colusa and Sutter/Yuba, CA;
[4]University of California, Cooperative Extension, Butte County, CA

Keywords: Air blast speed sprayers, Spray coverage

Abstract: At the 93rd OPDMC, a study was reported on spray drift mitigation using opposing air-blast sprayers. In the 93rd OPDMC study, it was found that spray drift was mitigated using opposing air-blast sprayer as compared to the conventional spray technique. It was also observed that spray coverage was improved using opposing air-blast sprayer as compared to the conventional spray technique. This study was followed-up the next season with a study reported at the 94th OPDMC that specifically addressed improved coverage in tall (greater than 40 ft.) walnut trees. In the 94th OPDMC study, there was improvement in spray coverage at all heights of the walnut trees. A major problem in both of the studies was the synchronization of the spray manifolds of the two air-blast speed sprayers. This researcher and others had to run alongside the speed sprayers to keep the speed sprayers in synchrony, which was only partially successful. Also this researcher is getting far too old for such nonsense. Thus, a study was conducted this past summer to develop a method to synchronize the speed sprayers. Results of this study will be reported.

Need For Proof: Combining Decision-Maker Interviews and Insect Monitoring Data to Increase IPM in Wenatchee Valley Pears

Molly Sayles[1], Louis Nottingham[2], Robert Orpet[1]
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA
[2]Washington State University, Northwestern Washington Research and Extension Center, Mount Vernon, WA

Keywords: Pear psylla, *Cacopsylla pyricola*, integrated pest management, interviews

Abstract: Pear psylla (*Cacopsylla pyricola*) has been a destructive pear pest in the Pacific Northwest for decades. In the Wenatchee Valley, WA, one of the major pear growing regions, pear psylla have historically been managed conventionally, using broad-spectrum insecticides. Pear psylla have evolved resistance to these chemicals, causing management to consist of low efficacy expensive sprays that eliminate biological control and result in high pear psylla pressure every season. Contrastingly, other major pear growing regions have adopted IPM and have seen more success in controlling pear psylla. We aim to understand if the high pear psylla pressure in the Wenatchee Valley is due to a lack of adoption of integrated pest management (IPM) programs, which reduce broad spectrum materials to conserve natural enemies. We also intend to understand the factors that have led to the discrepancy in IPM adoption among regions. We combine quantitative insect monitoring data in conventional and IPM pear orchards to document IPM efficacy, with interviews of pest management decision-makers of those orchards to reveal perceptions of IPM. Results from monitoring data indicate that IPM orchards performed on average the same as conventional orchards throughout the season, but after harvest conventional orchards had vastly more psylla adults. Interviews revealed that many pear stakeholders believe that IPM has potential to be more successful than conventional management, but financial risk and lack of peer support diminish confidence in adoption. Next steps involve interviews with decision-makers in major IPM-focused pear growing regions to elucidate differences in management perceptions.

Thresholds & Monitoring—

Moderator: Dani Lightle (OSU-NWREC)

Error Associated with Pheromone Trapping of Sterile Codling Moth

Elizabeth H. Beers, Adrian Marshall, and Tobin Northfield
Tree Fruit Research and Extension Center, Washington State University,
Wenatchee, WA, 98802, United States.

Keywords: Pheromone, codling moth, action thresholds

Abstract: Pheromone trap capture of wild codling moth is presumed to depict the variability in underlying distribution of CM in an orchard, and are used to trigger pesticide treatments. However, there are a variety of other factors known to affect trap counts. Releasing known quantities of sterile moths lets us examine trap capture where factors such as density, distance, and direction of the population are known, allowing us to explore the contribution of other sources of variability, primarily weather and random error. Placing confidence intervals around trap catch will help us manage risk associated with using traps for treatment thresholds.

Psylla and Natural Enemy Thresholds for Integrated Pest Management in Pears

Tianna DuPont[1], Chris Strohm[1], Clark Kogan[2], Rick Hilton[3], Louis Nottingham[4], Robert Orpet[1];
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA
[2]Stats Craft LLC, Spokane WA;
[3]Oregon State University, Southern Oregon Research and Extension, Central Point, Oregon;
[4]Washington State University, Mt Vernon Research and Extension Center, Mt Vernon, WA

Keywords: pear psylla

Abstract: The objective of this study is to quantify economic injury thresholds for pear psylla based on objectively determined economic injury levels which include pest population phenology, predicted pest population growth rates, and natural enemy predation rates. The relationship between pear psylla adult and nymph densities and fruit downgraded due to psylla honeydew marking is used identify to injury levels from eighty-six site years. Assumptions about delays in management tactics are used to designate timings for management interventions assuming that pest advisors will have to make control recommendations approximately seven days before management application dates. Pear psylla phenology information predicting psylla degree day calculations and population models are used to predict pest population dynamics.

Monitoring Navel Orangeworm in Tree Nuts With or Without Mating Disruption

Charles Burks[1], David Haviland[2], Jhalendra Rijal[3], and Houston Wilson[4]
[1]USDA. Parlier CA, [2]UC Extension, Bakersfield CA
[3]UC Extension, Bakersfield CA, Prosser, WA, [4]UC Riverside, Riverside CA

Keywords: navel orangeworm,Amyeolis transitella,attractant,bait

Abstract: Mating disruption for navel orangeworm (NOW) is widely used in California tree nuts. Capture in traps baited with pheromone monitoring lures is greatly suppressed by mating disruption, even in neighboring orchards. Attraction of gravid females to traps using natural materials is not affected by mating disruption. Two types of traps for females are used to identify moth flights and inform spray decisions: 1) egg traps, which use oviposition of eggs to monitor NOW populations, and 2) ovibait traps, in which pouches of natural material are used to lure females into sticky traps. Egg traps have a longer history of use in California tree nuts, whereas ovibait traps are simpler to use and less prone to loss of data from egg hatch. In the present study we used randomized complete block experiments to compare seasonal phenology in pistachio orchards as determined with egg and ovibait traps. We also compared combinations of food material and almond oil enhancers. Both egg and pistachio traps had similar phenological profiles for the first flight (overwinter, March-May) and second flight (first generation, mid-June to early July). In egg traps ground pistachios attracted more eggs than two different almond meal formulations. Added almond oil (30%) enhanced egg-laying for one of the almond formulations, but not for the other almond formulation or for ground pistachios. More females were trapped in sticky traps with ground pistachios than with ground almond formulations and added oil did not affect capture of females in sticky traps. These data provide pest managers with information to select which of these monitoring methods best suits their needs.

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

Adeetje Bouma, Heather Andrews, Matthew Pedersen, Tatum Keyes, Kody Transue, Nik Wiman
Oregon State University, North Willamette Research and Extension Center

Keywords: filbertworm, *Cydia latiferreana*, hazelnut, *Corylus avellana* L., organic pest management

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

Using Lure Baited Monitoring Traps to Measure Natural Enemies of Pear Psylla

Christopher Adams[1], Maggie Freeman[1],
[1]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR

Keywords: Pear psylla, natural enemies, pears, IPM

Abstract: Pear psylla (Cacopsylla pyricola) is an important pest of pear production in Oregon. Excessive amounts of honeydew, produced as a biproduct of feeding, can lead to black sooty mold and russeting on fruit. Using lure baited monitoring traps to collect various natural enemies of pear psylla we hope to improve monitoring efficiency, provide action thresholds, and improve confidence in management decisions, specifically when it is safe to withhold pesticide applications.

Differential catch by height of *Euscelidius variegatus* on yellow sticky cards in The Dalles OR.

Yan Yan[1], Maggie Freeman[1], Kelsey Galimba[1], Christopher Adams[1]
[1]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR

Keywords: Euscelidius variegatus, leafhoppers, trapping, monitoring, cherry

Several leafhopper species are known to vector the Phytoplasma that causes Cherry X-Disease. A key question we will be measuring is how far to leafhoppers move within the orchard. Before we can measure leafhopper movement, we need to understand how to optimize catch using yellow sticky cards. To evaluate this, we placed yellow stick cards at various heights within sweet cherry orchards in The Dalles, OR. Significantly more *Euscelidius variegatus* were caught at ground level than at any other height tested. These results will help us optimize data collection in upcoming leafhopper movement research and has possible implications for how crop consultants deploy yellow sticky card monitoring traps.

Comparing Monitoring Methods for Leafhopper Species that Vector Cherry X-disease in Sweet Cherry Orchards of Hood River and Wasco Counties.

Maggie Freeman[1], Louis Nottingham[2], and Chris Adams[1].
[1]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR
[2]Washington State University, Tree Fruit Research & Extension Center, Wenatchee, WA.

Keywords: leafhoppers, cherry-x disease, monitor

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

Real Time Automated Pest Monitoring with Pseudo-Acoustic Sensors - Will You Miss Sticky Cards?

Shailendra Singh[1], Eamonn Keogh[1], Cliff Kitayama[1], Leslie Hickle[1]
[1]FarmSense, Inc., Riverside, CA

Keywords: Insect Sensor, Navel Orangeworm, *Amyelois transitella*, real-time data, pest management, pest models, IPM, pest monitoring

Abstract: The use of sticky cards has been an anathema to those of us dependent on understanding what insect pests are doing in our fields. The time spent driving to traps, replacing sticky cards, and engaging in the brain numbing exercise of counting deformed long dead insects is an arguably futile exercise in developing accurate real-time assessments of populations and their economic impacts. Yet, until recently, sticky cards were still the only option in both cardboard delta traps and camera-based systems. There is now a "non-sticky" alternative. A novel automated smart sensor for Navel Orangeworm has been developed and tested in California nuts and provides comparable data to delta sticky traps. We will discuss the implications, benefits and future prospects when using real-time pest data.

Biological Control—

Moderators: Robert Orpet & Christopher McCullough (WSU-TFREC)

Augmenting Predators for Pest Control in Tree Fruit

Rebecca Schmidt-Jeffris[1], Daniel Hausler[1,2], Erica Moretti[1], Robert Orpet[2], Louis Nottingham[3]
[1]USDA-ARS, Temperate Tree Fruit and Vegetable Research Unit, Wapato, WA
[2]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA
[3]Washington State University, Northwestern Washington Research & Extension Center, Mt. Vernon, WA

Keywords: mealybug destroyer, lacewing, *Cryptolaemus montrouzieri*, *Chrysoperla rufilabris*, *Chrysoperla carnea*, *Chrysoperla externa*, grape mealybug, woolly apple aphid, green apple aphid, rosy apple aphid, pear psylla, *Orius insidiosus*, release, drone, UAV, organic, apple, pear, insectary, food supplement, lure, methyl salicylate, *Artemia*, brine shrimp cyst, *Ephestia* eggs

Abstract: Organic apple growers in Washington are experimenting with releasing natural enemies purchased from commercial insectaries. Unfortunately, release recommendations are typically based on greenhouse use, in crops with small canopies, and in environments with higher humidity and lower temperatures than in central Washington. In 2020-2022, we tested various rates, timings, and methods (drone versus ground) of release of mealybug destroyers for control of grape mealybug in organic apple. In 2021-2022, we also tested two species (*Chrysoperla rufilabris* versus *C. carnea*), life stages (eggs versus larvae), and methods (drone, cards, sprinkle) of lacewings for control of aphids. Releases of minute pirate bug and lacewing eggs were tested for efficacy against pear psylla in 2022. We also tested lures and supplementary food products for increasing retention and recruitment of natural enemies.

In 2020, mealybug destroyers released on the ground reduced mealybug populations, although between-plot variation was high and the differences were not statistically significant. The mealybug destroyers were highly dispersive and difficult to find within plots. The 2021 trial, which included a drone release at dusk, did not find differences between treatments, likely because mealybug populations were too low to sustain the predators. 2022 releases were immediately followed by a fire blight spray and mealybug destroyers were not recovered after release. In 2021, releases of *C. carnea* eggs and *C. rufilabris* larvae reduced aphid populations by 50% compared to the control, but the other two treatments did not. The shipment of *C. carnea* larvae was found to contain *C. externa* instead, which may be responsible for the poor efficacy of this treatment. In 2022, none of the lacewing releases resulted in decreased aphid numbers compared to the control. Releases in pear were not effective at reducing pear psylla abundance. In the trial testing retention methods, lacewing releases decreased aphid populations, but the retention methods did not improve control. However, the lures did recruit some natural enemies, including *Stethorus*, that may assist with mite management. Across all experiments, drone deployment did not result in successful pest control and predator retention was very low.

Results from year-to-year were highly variable and emphasize the difficulty of optimizing predator performance. These results and future work will be used to create scientifically-based recommendations for releasing natural enemies in orchards.

Earwigs Provide Control of Aphids, Mites, and Pear Psylla in Pome Fruit

Aldo Hanel[1], Robert Orpet[1], Rick Hilton[2], Louis Nottingham[1], Tobin Northfield[1], Rebecca Schmidt-Jeffris[3]
[1]Washington State University, Department of Entomology, Pullman, WA
[2]Oregon State University, Southern Oregon Research and Extension Center, Central Point, OR
[3]USDA-ARS, Temperate Tree Fruit and Vegetable Research Unit, Wapato, WA

Keywords: biological control, augmentation, earwigs, *Forficula auricularia*, apple, pear

Abstract: The European earwig (*Forficula auricularia*) is considered a minor pest in stone fruit but plays an important role as a natural enemy of key pests of pome fruit. It is known to feed on different aphid species on apple, such as the woolly apple aphid, and two of the main pests of pears, including pear psylla and spider mites. In this project, we aimed to evaluate the potential of earwigs in reducing key and secondary pest pressure on pome fruit, evaluating two different methods of augmenting earwig populations, a mass release early in the season or five releases done every other week. Earwigs used for augmentation were captured in stone fruit orchards using rolled cardboard strips, which proved to be a successful source of earwigs throughout the season. On pome fruit, results varied by year, crop, and treatment. There was no difference between treatments or release and control areas on pears. On apple, one mass release of earwigs increased earwig numbers in 2021, but not 2022. Overall numbers were higher in 2022 when compared to 2021, in both treatments and control or release plots. For pest control, we found that one mass release of earwigs early is preferred over multiple releases, mainly on apples. Augmentation of earwigs on pome fruit helped reduce the number of woolly, rosy and green apple aphid colonies on apple, and pear psylla and European red mite counts on pear. Numbers of brown mites, two-spotted spider mites, and pear rust mites were highly variable, leading to possible local extinction, likely due to abiotic factors (e.g., heat dome event in 2021). Given that earwigs have a low dispersal capability and are easy to both capture and release, a mass-trapping and augmentation protocol can be an innovative augmentation strategy for tree fruit orchard biological control.

Potential Biocontrol Agents for X-Disease Vectors

Reyes Corral CA[1], Smytheman P[1], Cooper WR[2], Skevington J[3], Marshall AT[1], Clarke AE[1], Melton T[1], Northfield T[1]
[1]Tree Fruit Research and Extension Center, Washington State University, Wenatchee, WA 98801, USA
[2]USDA-ARS, Temperate Tree Fruit and Vegetable Research Unit, Wapato, WA 98951, USA
[3]Agriculture and Agri-food Canada, 960 Carling Ave, KW Neatby Building, Ottawa, ON K1A 0C6, CAN

Keywords: cherry, leafhopper, X-disease, biological control, parasitoid, entomopathogen, *Pipunculidae, Dryinidae*, *Hirsutella*

Abstract: The production of cherry, peach, and nectarine in the Pacific Northwest has been severely affected by X-disease phytoplasma (*Candidatus* Phytoplasma pruni). This plant pathogen associated with X-disease – a condition that causes cherry trees to produce small, misshapen, and bitter fruit – is spread by a small number of leafhopper species. The key vectors in the Pacific Northwest are thought to be *Colladonus montanus reductus* and *C. geminatus*. X-disease has no cure, and once a tree is infected, it remains infected for the life of the tree. Therefore, current management options rely on swift identification and removal of infected trees as well as timely pesticide applications to control leafhopper

populations. Unfortunately, little is known about the natural enemies of these vectors. Here, we document parasitism of *Colladonus* spp. leafhoppers by an entomopathogenic fungus, a parasitic fly (*Pipunculidae*), and at least one species of parasitic wasp (*Dryinidae*) in Central Washington. An ongoing survey will evaluate how widespread these beneficial species are, illuminating the potential for biological control in Washington orchards. A better understanding of the life history and parasitic activity of these prospective biocontrol agents could potentially lead to the adoption of integrated pest management practices in cherry orchards and help reduce the use of excessive pesticide applications.

Biological Control of Aphids in Willamette Valley Hazelnut Orchards

Matthew Pedersen, Adeetje Bouma, Erica Rudolph, Tatum Keyes, Heather Andrews, NikWiman
Oregon State University, North Willamette Research and Extension Center,Aurora, OR

Keywords: biocontrol, *Myzocallis coryli*, *Corylobium avellanae*, phenology, natural predators.

Abstract: Two species of aphids affect hazelnut production in Oregon's Willamette Valley. The filbert aphid, *Myzocallis coryli* (Goetze), feeds primarily on leaves, while the hazelnut aphid *Corylobium avellanae* (Schrank) (Hemiptera: Aphididae), prefers to feed on petioles, husks, and peduncles, depending on the developmental stage of the host plant. Severe infestations of filbert and hazelnut aphids are known to reduce kernel fill, affect yield, and encourage sooty mold growth on honeydew, thereby impacting photosynthetic capacity of the orchard. In the 1980s the importation and release of *Trioxys pallidus* (Haliday) (Hymenoptera: Aphididae) against filbert aphid initiated a classical biological control program that has been highly successful. Industry perceptions about severe aphid impacts and perceived lack of biological control suggest that the established action thresholds for aphids should be updated and biological control needs to be reassessed. In this research we found that *T. pallidus* activity remains strong and other natural enemies also play a key role in reducing aphid impacts. Additional biocontrol agents, such as cecidomyiids, hemipterans, and braconid wasps have been shown to positively impact aphid control in previously undescribed ways. This study describes our efforts to re-examine the phenology of the two aphid species along with a revised understanding of natural enemy populations in Willamette Valley hazelnut orchards.

Insecticide Impact on the Pear Biological Control Agent *Trechnites insidiosus*

Gabriel Zilnik[1], Rebecca Schmidt-Jeffris[1]
[1]USDA-ARS, Wapato, WA

Keywords: pear psylla, *Cacopsylla pyricola*, *Trechnites insidiosus*, off-target impact, insecticide, biological control

Abstract: Trechnites insidiosus is the most common parasitoid of pear psylla, Cacopsylla pyricola. Trechnites insidiosus can parasitize up to 80% of pear psylla in orchards managed with a soft spray program. Very littles is known about T. insidiosus's biology including susceptibility to commonly used insecticides. In this study, we report the impact on T. insidiosus mortality when exposed to twelve registered insecticides including conventional and organic compounds. Trechnites insidiosus were collected from grower orchards in Hood River, OR and Naches, WA. We exposed three- to seven-day old T. insidiosus adults to individual insecticides in glass vials and monitored mortality at 24h and 48h. All insecticides tested showed clear evidence of increased mortality in T. insidiosus. Rimon (Novaluron), Altacor (Chlorantraniliprole) had the least impact on T. insidiosus mortality. Neemix (Azadirachtin) was the only organic compound that did not result in 100% mortality (65% and 75% mortality at 24h and 48h, respectively). Further investigation of insecticide impacts at different T. insidiosus life stages could help growers make more informed choices to preserve pear psylla biological control.

Beneficial Invertebrate Communities of Cherry Orchards and Associated Habitats in The Dalles, Oregon

Scott Mitchell[1], Sandra DeBano[1], Christopher Adams[2], Andony Melathopoulos[3], Tucker Hoffman[4],
[1]Oregon State University, Hermiston Agricultural Research and Extension Center, Hermiston OR
[2]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR
[3]Oregon State University, Department of Horticulture, Corvallis, OR
[4]Utah State University, Department of Wildlife Biology, Logan, UT

Keywords: beneficial invertebrates, wasps, Hymenoptera, Apocrita, green lacewings, Neuroptera, beetles, Coleoptera, biological control

Abstract: Beneficial invertebrates include a broad range of taxa that offer a wide range of ecosystem services to agricultural ecosystems. In the Mid-Columbia Basin, an ecosystem service of particular interest to cherry growers is biological pest control provided by wasps, lacewings, certain beetles, and other taxa. In the summers of 2021 and 2022, we surveyed various beneficial taxa using pitfall traps, yellow sticky cards, and baited delta traps to understand how habitats in and around orchards can support beneficial invertebrate communities. In particular, we were interested in how cover crops can be used in non-productive orchards (e.g., fallow or newly planted orchards). We also sampled beneficial invertebrate communities in remnant oak-scrub habitats around orchards to understand how these areas may contribute to landscape-level pest control. We found that a diverse range of taxa are supported in all habitat types and that there were differences between habitats in terms of the abundance and type of invertebrates. We also found that beneficial invertebrate communities varied throughout the spring and summer (April – August). Variability of beneficial invertebrate communities between habitats and within the growing season may have implications for biological control and integrative pest management plans in and around orchards.

Survey for Parasitoids of Apple Maggot Complex (Diptera: Tephritidae) in Washington State

Joshua M. Milnes[1], Wee L. Yee[2], and Michael R. Bush[1]
[1]WA State Dept. Agriculture-Plant Protection Division,
21 North 1st Avenue, Suite 103 Yakima, WA 98902, U.S.A.
[2]USDA-ARS, Temperate Tree Fruit & Vegetable Research Unit,
5230 Konnowac Pass Road, Wapato, Washington 98951, U.S.A.

Keywords: Apple maggot, *Rhagoletis pomonella*, survey, biological control

Abstract: The Rhagoletis pomonella complex of flies (including the apple maggot (AM) or R. pomonella, and snowberry maggot, *R. zephyria*) provides a compelling example of sympatric host shifting that led to distinct forms of Rhagoletis flies that preferentially attack apple, hawthorn, or snowberry. Immature stages of both fly species infest the host fruit and are, in turn, attacked by small wasp parasitoids in the families Braconidae, and to a lesser extent, Pteromalidae. To minimize the impact that AM can potentially have on the apple industry, Washington State Department of Agriculture (WSDA) in collaboration with the United States Department of Agriculture-Agricultural Research Service (USDA-ARS) are currently investigating biological control options for the *R. pomonella* complex by conserving/encouraging the establishment of parasitic wasps. This project not only complements current *R. pomonella* detection and quarantine programs, but provides a control option that can be encouraged throughout Washington regardless of whether the area is pest-free (but threatened by *R. pomonella*) or quarantined for *R. Pomonella*

General Theory for Biopesticide Resistance Management

Jeremy Roberts[1], Tobin Northfield[1,2]
[1]Tree Fruit Research and Extension Center, Washington State University,
Wenatchee, WA, 98802, United States.
[2]Centre for Tropical Environmental Sustainability Science, James Cook University,
Cairns, QLD 4878, Australia.

Keywords: entomopathogen, pesticide, insecticide resistance, biological control

Abstract: Insecticide resistance evolution is becoming increasingly problematic globally. With chemical insecticides, attempts to combat resistance involves developing compounds with novel modes of action, or increasing rates to overcome partial resistance. While pests can develop resistance to pathogens used as biopesticides, these parasites or pathogens that serve as key components of the pesticides can be subjected to evolutionary selection pressure as well and may be able to adapt countermeasures to overcome pest resistance. Here, we consider two scenarios: 1) an evolutionary arms race between pest and parasite, and 2) a scenario where a true pathogen (e.g., a virus) is used, and hosts can evolve resistance or tolerance to the pathogen. Considering the parasite scenario, the evolving parasite is able to overcome resistance in the pest population and effectively suppress pest population abundance. In this case, overcoming biopesticide resistance may be possible from parasite evolution to resistant hosts. In contrast, in an epidemiological model describing a pathogen that limits pest abundance, the host may become either tolerant of the pathogen, or become resistant to infection. Pathogen-tolerant hosts are particularly detrimental to control programs, because they can quickly outcompete wild types by

promoting infection in wild type populations. Furthermore, because evolution of pathogen-tolerance in pests can benefit pathogens through increasing infection prevalence, we do not expect pathogen evolution to improve control. Thus, the keys to biopesticide management depend on the type of biopesticide (e.g., parasite or pathogen), and how the host evolves to best defend itself against a pathogen.

Insecticide Impacts on Pear Psylla Natural Enemies

Rob T. Curtiss[1], Christopher McCullough[1], Robert J. Orpet[1], Louis B. Nottingham[2]
Washington State University
[1]Tree Fruit Research and Extension Center, 1100 N Western Ave, Wenatchee, WA 98801
[2]Mount Vernon Northwestern Research Center, 6650 WA-536, Mount Vernon, WA 98273

Keywords: Pear Psylla, *Cacopsylla pyricola*, Insecticides, Natural Enemies

Abstract: Pear psylla, *Cacopsylla pyricola* (Förster) (Homoptera: Psyllidae), is the key pest of pears in the Pacific Northwest. Control, traditionally, has been with pesticides, but chemical control programs often fail due to development of insecticide resistance and destruction of the complex of natural enemies found in pear orchards. There are currently several insecticides available for use in pears against pear psylla that may variably impact natural enemies. Natural enemies in pear orchards are key to mid-and late-season control of psylla populations, and conservation is key to successful integrated pest management programs. To transition traditional pear psylla control programs to more integrated approaches that conserve natural enemies, we endeavored to understand the impact of alternative chemistries on the complex of natural enemies found in Pacific Northwest pear orchards. The objective of this study was to compare natural enemies' mortality among several commonly used pear psylla insecticides.

Pathology/Diseases—

Moderator: Maryna Serdani (Marrone Bio Innovations)

In Vitro and *In Vivo* Phenotypic Characterization of Fitness Cost in Fungicide-Resistant *Penicillium expansum* Isolates

Jonathan Puglisi and Achour Amiri
Tree Fruit Research and Extension Center, Washington State University, Wenatchee, WA 98801

Keywords: pome fruit, *Penicillium expansum*, blue mold, fungicide-resistance, postharvest

Abstract: Blue mold (BM), primarily caused by *Penicillium expansum*, is the most important postharvest disease of apple and pear worldwide and in the Pacific Northwest (PNW). Fungicide applications at harvest and sanitation are key for adequately managing BM. In response to regular applications of a limited number of postharvest fungicides, *P. expansum* has begun to exhibit resistance to the three most used postharvest fungicides registered in the PNW: thiabendazole (TBZ), pyrimethanil (PYR), and fludioxonil (FDL). The evolution of fungicide resistance in *P. expansum* may affect the ability of fungicide-resistant isolates to compete with sensitive isolates in storage. To better understand the effect of fungicide resistance evolution on resistant populations ability to cause epidemics of BM, several fitness parameters were evaluated in *P. expansum* isolates with different fungicide resistance phenotypes to TBZ, PYR, and FDL. Isolate fitness was assessed in vitro for spore germination, mycelial growth, sensitivity to reactive oxygen species, osmotic stress, and resistance stability, while virulence, sporulation, and resistance stability were assessed in vivo. Preliminary in vitro trials at 1°C showed reduced conidial germination in many dual- and triple fungicide-resistant isolates, and susceptibility to osmotic stress in triple-resistant isolates. Resistant isolates showed virulence levels similar to those of sensitive isolates in vivo on detached fruit after 3 months in cold storage. Our preliminary findings indicate that while some fungicide-resistant phenotypes of *P. expansum* may incur fitness costs, their ability to cause BM in cold storage may not be affected. We hope to help the packers make better fungicide resistance risk assessment and mitigation.

Characterization of Fungal Species Associated with Patulin Contamination of Processed Apple Products in Washington State

Mustafa O. Jibrin and Achour Amiri
Washington State University, Tree Fruit Research and Extension Center, Wenatchee

Keywords: mycotoxin, patulin, processed apples, fungal species, survey, characterization

Abstract. Patulin is a mycotoxin that is regulated in many foods, including apples. Most global regulatory agencies, including the FDA, allow 50 µg/g in processed foods. In Washington State, patulin contamination caused by *Penicillium expansum,* as the causal agent of blue mold, on symptomatic apples is well-known. In 2018 and 2019 however, unusual high levels (>200 µg/kg) of patulin were reported by apple fruit processors in the state, i.e., in asymptomatic apples. This report was important given the position of Washington State as the apple production capital of the United States providing more than 30% of national value of processed apples. We therefore sought to identify the mycoflora associated with patulin contamination apples used for processing. During the 2021-22 season, 11 lots of apples used for fruit processing were surveyed and fungal isolates were recovered from both asymptomatic and symptomatic apples. Recovered isolates were confirmed through molecular methods by sequencing partial sequences of the ITS, Calmodulin, RPB2, and β-tubulin genes as necessary. While most of the recovered isolates were *P. expansum,* isolates belonging to other *Penicillium* species as well as other fungal species were identified. Work is ongoing to assess the ability of the recovered species to produce patulin and their role in the whole contamination process.

Managing Postharvest Diseases in Organic Pome Fruit Systems: Challenges and Current Approaches

Achour Amiri and Janis Fomba
Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: pome fruit, diseases, preharvest, postharvest, management, organic

Abstract: Washington State provides nearly 100% of organic apple and pear grown in the United States with a farm gate value of over $500 million. Once fruits are harvested and stored in cold rooms, decay rates can overwhelm packers who can lose up to 50% of their crop after 5 months. This makes organic disease management critical to ensure sustainable organic production. The sharp increase in organic acreage resulted in a significant increase in the crop volume stored. However, effective organic pre and postharvest management approaches have been lacking and required strong research efforts to generate science-based knowledge to help packers store organic fruits adequately. Over the last three years, several research projects have been conducted to fill the gap and develop effective organic management approaches. Herein, we report on the large screening of several new organic materials, i.e., biologicals and GRAS products for preharvest applications to mitigate infections caused by pathogens or postharvest diseases. More than 15 organic materials were screened *in vitro*, *in vivo*, and in field conditions and were compared to a conventional fungicide in controlling postharvest diseases. Our results indicate variable efficacy against different pathogens but open several opportunities to alternate organic materials preharvest to mitigate postharvest diseases in storage.

X-Disease and Little Cherry Virus: Updates from the LCD Taskforce

Tobin Northfield,
Washington State University

Keywords: X-disease, Little cherry virus, leafhoppers, vector management, plant pathogen

Abstract: "Little cherry disease," a term often used colloquially to describe symptoms caused by X-disease and Little cherry virus 1 and 2, is currently at epidemic levels in Washington orchards growing cherries and other stone fruits. While all three pathogens are present in Pacific Northwest orchards, recent test results suggest the majority of diseased trees are infected with X-disease phytoplasma rather than Little cherry virus 1 or 2. The epidemic is leading to removal of entire orchard blocks, and prevalence is increasing rapidly in the region. There is no treatment for X-disease, and management options include removing infected trees and controlling vectors. In 2019 the Little cherry disease taskforce was formed in response to the need for a coordinated approach to reduce damage caused by these pathogens, as well as in response to the paucity of research conducted in the Pacific Northwest since the previous outbreak sixty years ago. Here, I will summarize the activities and findings of the LCD taskforce that includes members from government, industry, and state universities in Washington and Oregon.

Invasive Species—

Moderator: Aldo Hanel & Paul Bergeron (WSU-TFREC)

Adapting IPM Approaches for Spotted Wing Drosophila (*Drosophila suzukii*) Management to Eastern Washington State

Dylan J. Beal[1], Peter Smytheman[1], Tobin D. Northfield[1], Gwen A. Hoheisel[2], and Elizabeth H. Beers[1]
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA
[2]WSU Extension, Prosser

Keywords: spotted wing drosophila, *Drosophila suzukii*, cultural control, biological control

Abstract: Spotted wing drosophila (SWD), *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae), has been an important pest of sweet cherry (*Prunus avium*) orchards in Washington since its detection in 2009.The establishment of SWD in berry and cherry growing regions has led to widespread adoption of prophylactic insecticide applications. However, recently there has been considerable research and grower interest in the development of a more sustainable integrated pest management approach. Patterns of SWD occurrence and pressure in Washington vary greatly depending on whether they are located east or west of the Cascade Mountains. In Western Washington, SWD presence is more closely related to the prevalence of non-crop hosts and their distance to susceptible crops. The semi-arid, cold winter climate and scarcity of wild hosts has made pest pressure lower and more sporadic in Eastern Washington. Despite this, the low economic threshold for this internal-feeding pest has driven an aggressive response. This response is triggered in part by treatments during the same period for another internal pest, western cherry fruit fly, which is also a quarantine pest. Given these challenges, we have worked to develop management practices that provide control of both pests, while avoiding unnecessary treatments. We present the preliminary results of 2021-2022 laboratory and field studies to assess the use of biological control, biorational/cultural control, and behavioral control strategies for SWD management in Eastern Washington.

Using eDNA to Play 'Wack-a-Mole' with Invasive Species in Green Yard Waste

Lisa G. Neven[1], William Walker III[1], and Juli Carrillo[2]
[1]USDA-ARS, Temperate Tree Fruit and Vegetable Research Unit, Wapato, WA;
[2]Plant-Insect Ecology & Evolution Lab, University of British Columbia, Vancouver, B.C., Canada.

Keywords: Environmental DNA, green yard waste, invasive species, DNA barcoding

Abstract: As large cities begin to overrun their landfill capacities, they begin to look for alternative locations to handle the waste stream. Seeing an opportunity to bring in revenue, rural communities offer to handle municipal waste in their landfills. Unfortunately, many rural communities are also locations of agricultural production, which are vulnerable to attacks by invasive species. When this situation involves the movement of the waste stream across international borders, things become very complicated. We used a combination of ecological niche modeling and eDNA to determine whether green yard waste could be a pathway for invasive species to enter and establish in the landfill-receiving agricultural community. We identified several target species that could be in green yard waste coming from Vancouver, BC to Central Washington State. We sampled green yard waste from 4 locations every 2 weeks from June-October in 2019 and 2020. DNA was extracted from the nearly 400 samples and subjected to amplification with COI barcoding primers followed by sequencing to identify insects in the samples. Sequence analyses identified several Orders of organisms, including species from the target list. This eDNA technique was useful in identifying potential invasive species in green yard waste and may prove to be a useful tool in stemming the spread of invasive species.

Development and Testing of a Novel Spotted-Wing Drosophila Deterrent

Gabriella Tait[1] and Vaughn M. Walton[1]
[1]Department of Horticulture, Oregon State University, Corvallis, Oregon, 97331

Keywords: behavioral control, IPM, Spotted Wing Drosophila, new management tool

Abstract: Spotted-wing drosophila (SWD, *Drosophila suzukii*) is an invasive fruit fly species native of Southeast Asia. *D. suzukii* lays eggs in damaged and intact fruit of the most soft-skinned varieties. Oviposition and feeding activities increase the likelihood of vectoring spoilage bacteria, particularly when fruit integrity is negatively impacted due to cracking, diseases, hail injury, and bird damage. The aim of this study was to evaluate the efficacy of a novel *D. suzukii* management tool, a pesticide-free behavioral deterrent. Data were collected from a series of field trials during the 2022 season. Two field trials were conducted during July and September 2022. While in June the experiment was run by testing clusters of berries in small bags, the trial in September was open field. In August a laboratory experiment was conducted to assess the physiological response of the insect towards specific compounds emitted by the deterrent. Numerically lower levels of egg laying were obtained using the deterrent for both field trials. For the first trial, reduced egg laying ranged from 36 to 61%. The open field trial conducted in September indicate a significant reduction in egg-laying at both 6 and 9 days after the application (78.5 and 64.3% respectively). Electroantennography (EAG) analysis resulted in a more pronounced, though not statistically different physiological response of males compared to females. Overall, findings showed a significant reduction in SWD oviposition on susceptible fruit field conditions. These data suggest that the deterrent can be used both in commercial organic and conventional production systems as a non-toxic alternative to this damaging pest.

Banding Together Against Spotted Lanternfly: An Interagency Approach to Preventing Billions in Losses

Jessica La Belle[1], Justin Bush[1], Maria Marlin[1], Joshua M. Milnes[2], Sven-Erik Spichiger[3], Clinton Campbell[4], Fiona Smeaton[5], Marie Hepner[5], Leslie Bliss-Ketchum[5]
[1]Washington Invasive Species Council, Washington Recreation and Conservation Office, Olympia, WA
[2]Washington State Department of Agriculture, Yakima, WA
[3]Washington State Department of Agriculture, Olympia, WA
[4]United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine, Federal Way, WA
[5]Samara Group, Portland, OR

Keywords: Spotted lanternfly, *Lycorma delicatula*, prevention

Abstract: The spotted lanternfly (*Lycorma delicatula*) is an invasive plant hopper native to Asia that was first detected in the US in Pennsylvania in2014.It has since spread to several eastern and midwestern states, causing negative impacts on specialty crops such peaches, hops, and grape vines. An adaptive insect that feeds on the sap of many species of trees and plants, the spotted lanternfly excretes as it feeds, which promotes the growth of sooty mold, weakening the host plant and often resulting in its demise. Washington State is a leading producer of specialty crops, many of which are preferred hosts for spotted lanternfly. The potential economic impact of the spotted lanternfly on Washington's agricultural, nursery, timber, and recreational industries has been estimated in the billions, as well the threat to the unique environmental landscapes of the Pacific Northwest, and cultural impacts on tribal lands and first foods. In light of this threat, Washington is taking a proactive stance and uniting state, federal, tribal, local agencies/governments, and industry stakeholders to develop and implement a statewide action plan to improve the overall knowledge base, response options, and capabilities for both short and long-term preparation and management of spotted lanternfly. The plan will outline specifications pre-and post-spotted lanternfly detection, such as developing and promoting tools and treatments to minimize the time between initial detection and corresponding unified response activities. The plan is notable in that it will be developed prior to the plant pest emergency and identify specific actions, entities, and steps for agencies, industry, academia, and other parties. Beyond spotted lanternfly, this project will also result in a process template for use in Washington State. In the future, when a new high-consequence pest is detected, the template will guide a process that will result in an action plan and inform response actions.

Chemical Control/New Products—

Moderator: Amanda Koppel (Corteva Agriscience)

Evaluation of Hydrogels for Control of Sugar-Feeding Ants in Orchards and Vineyards

David Haviland, Chelsea Gordon, Stephanie Rill and Minerva Gonzalez
UC Cooperative Extension, Kern Co., Bakersfield, CA

Keywords: Sugar-feeding ants, Argentine ant, Pavement ant, Native Gray Ant, citrus grapes

Abstract: Sustainable agricultural production systems rely on efforts to maximize the benefits of biological control. However, in the case of pests that produce honeydew, sugar-feeding ants often impede the ability of natural enemies to parasitize hosts or to engage in host-feeding or predation. Efforts to control sugar-feeding ants are limited in California due to the cancellation of chlorpyrifos and because current liquid baiting systems are not economically viable. Our efforts focused on the use of polyacrylamide gels hydrated with sugar-water and a small amount of pesticide as a way to use application equipment designed for solid baits to apply a liquid bait as a solid. After dispersal, sugar-feeding ants forage by consuming liquids available at the surface of the hydrogel crystals and take those liquids into the nest for communal feeding. Over the past two years we have evaluated hydrogel baiting systems for Argentine ant, native gray ant, pavement ant, and others, in citrus, table grapes, and wine grapes across three different regions of California.

A Sticky Situation: Aphid Phenology and Control Trials in Pacific Northwest Hazelnuts

Heather Andrews, Matthew Pedersen, Nik Wiman
OSU North Willamette Research and Extension Center, Aurora, OR

Keywords: filbert aphid, *Myzocallis coryli,* hazelnut aphid, *Corylobium avellanae,* European hazelnut, *Corylus avellana, Trioxys pallidus*, natural enemies, biological control, action thresholds

Abstract: Two species of aphids (Hemiptera: Aphididae) affect hazelnuts in the Pacific Northwest (PNW), filbert aphid *Myzocallis coryli* (Goetze), and hazelnut aphid *Corylobium avellanae* (Schrank). Both species are found around the world, where European hazelnut (*Corylus avellana* L.) is cultivated. While *M. coryli* has probably been present in the PNW since the industry was established with European stock in the late 1800's, *C. avellanae* is a more recent arrival. Egg hatch of overwintering eggs is synchronized with bud break in spring, and populations can rapidly rise. Heavy infestations result in reduced nut fill and size, and action thresholds for *M. coryli* based on leaf samples were developed prior to the arrival of *C. avellanae*. Experienced growers are relatively tolerant of aphids and rely on delayed classical biological control from the introduced specialist parasitoid *Trioxys pallidus* (Haliday). However, recent heavy infestations of aphids in new hazelnut varieties have called into question relevancy of the old action thresholds, and the excessive use of fertilizer or insecticides targeting other pests such as filbertworm (*Cydia latiferreana*) or brown marmorated stink bug (*Halyomorpha halys*) can exacerbate the problem. These aphid infestations are sometimes leading to late treatments that we suspect are very hard on the natural enemy community. Additionally some growers are applying prophylactic treatments of imidacloprid, clothianidin, or sulfoxaflor. The goal of our research is to gather preliminary data to update action thresholds or IPM guidance to account for *C. avellanae* and new disease-resistant hazelnut varieties that now dominate the industry. We want to gain a better understanding of aphid and natural enemy population dynamics over the whole growing season to examine potential key timings for treating aphids while minimizing nontarget effects. We also conducted a spray trial in 2022 testing early applications of a variety of products to

eliminate early aphid populations including the viviparous fundatrices that cause rapid population increase, while reducing nontarget effects on natural enemies. All treatments reduced aphid populations compared with the UTC, and aphid populations continued to be suppressed 38 days after treatment. Additionally, natural enemies were present and active across all treatment, although there were fewer in the conventionally treated trees likely due to significantly lower aphid populations.

Control of Olive Fruit Fly with Organic and Reduced Risk Insecticides

M. Thayer[1], C. Kron[2] and R. Van Steenwyk[1]
[1]University of California, Dept. of ESPM, Berkeley, CA
[2]University of California, Cooperative Extension, IPM Advisor
Sonoma, Napa, Mendocino, and Lake Counties

Keywords: Olive Fruit Fly, *Bactrocera oleae*, Organic, Reduced Risk Insecticides, chemical control, insecticides

Abstract: A field trial was conducted in an olive orchard to evaluate the efficacy of Danitol, Delegate, Entrust, high and low rates of an experimental compound (MBI-306), Venerate XC and an untreated control. All treatments, including the untreated control, included a mixture of 100 g white sugar, 25 ml Brandt Insect Bait, and 37.5 ml of Nu-Lure Insect Bait. The trial was conducted in a roadside olive orchard near Napa, CA with a moderate olive fruit fly (OLFF) population. Seven treatments were replicated four times in a RCB design. Each plot consisted of three trees. Treatments were applied using a hand-held orchard sprayer operating at 150 PSI with a finished spray volume of 75 gal/acre. Application dates were: 20 July, 25 August, and 22 September, 2022. Adult OLFF were monitored with weekly with ammonia carbonate lures attached to yellow Trécé AM-NB panel traps. The traps were placed in the orchard on 1 July and were monitored weekly from 8 July through 17 October. The traps were replaced weekly and the ammonia carbonate lures were replaced every five weeks. OLFF infestation was determined on 26 October by dissecting 250 olives collected from the center tree of each replicate. The efficacy of the treatments will be reported.

Recent Field Challenges with Management of Codling Moth in Pennsylvania

Greg Krawczyk, Laura Mellott and Josh Gere
The Pennsylvania State University, Department of Entomology, Fruit Research and Extension Center, Biglerville, PA 17307; e-mail: *gxk13@psu.edu*

Keywords: Cydia pomonella, insecticide efficacy, mating disruption, pome fruit

Abstract: 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 and judicious applications of insecticides. Since the initial introduction, insecticides belonging to two IRAC Groups: diamides (IRAC Group 28) and spinosyns (IRAC Group 5) provided excellent supplemental control of both internal fruit feeder species when such additional control was necessary. Unfortunately, during the last three to four years some growers started reporting increased challenges with the management of this pest complex, resulting with the presence of CM and/or OFM injured fruit at harvest. To assess the potential factors affecting the CM and OFM management in apple orchards we evaluated and re-evaluated numerous commercial and experimental mating disruption products as well as the sensitivity of field collected codling moth populations to some diamide and spinosyns insecticides. The field effectiveness of mating disruption was evaluated by comparing seasonal moth captures in traps baited with various pheromone lures and *in-situ* fruit evaluations. Despite utilization of mating disruption programs, the monitoring traps baited with both commercial (*e.g.,* Pherocon CM L2, Pherocon CM DAC-P or Pherocon CM 1X) and experimental (*e.g.,* Pherocon CM Megalure 4K) lures were able to capture CM adults throughout the entire growing season and injured fruit were present at harvest. When possible, codling moth larvae originated at multiple locations were collected and used for insecticide sensitivity bioassays. When compared to a sensitive, field collected CM population, the insecticide bioassays utilized standard diet incorporation method conducted on CM neonates from various populations demonstrated multiple folds reduction in sensitivities to all tested diamide insecticides (e.g., Altacor®, Exirel®, Verdepryn™, Voliam Flexi®, Besiege®, and Minecto®) but no differences in sensitivities to spinosyns (e.g., Delegate™).

New Organic Spray Programs for Codling Moth

Alan L. Knight[1], Esteban V. Basoalto[2], Michele Preti[3]
[1]Instar Biologicals, Yakima, WA; [2]Austral University, Valdivia, Chile; [3]Astra Innovazione, Italy

Keywords: Cydia pomonella, pear ester, horticultural oil, granulosis virus, kaolin clay, diatomaceous earth

Abstract: Two sets of studies were conducted during 2022 to evaluate the addition of horticultural oil and/or DAMEC to seasonal sprays of kaolin (Surround) or diatomaceous earth (Celite).

Diatomaceous Earth Study. Five, 6-10-tree replicates were chosen randomly and flagged within a 2.0 ac block of 6-year-old high density (10 x 3') trellised "Cosmic Crisp" apples situated near Tieton, WA. Six treatments were included in this study: unsprayed, virus + oil, virus + oil + Celite, Celite + oil, Celite + oil + DAMEC, and Celite + spreader. Sprays on eight dates were applied using a pressurized hand-gun attached to a 30 gallon tank at a rate of 100 GPA. Evaluations of fruit injury were conducted mid-season on 29 July and on 9 September.
Levels of fruit injury were low to moderate at mid-season and the only statistical difference was between the untreated control and the combination of Celite, virus, and oil. At mid-season, the addition of the DAMEC appeared to be promising and the use of oil versus a spreader with Celite improved control. Levels of injury in the untreated plots increased 3X from the middle to the end of the season and the virus increased 6X over this period. The 3-way blend of Celite, virus, and oil remained almost clean during the summer. The addition of DAMEC to Celite and oil significantly reduced injuries from the untreated control and was less than half of the Celite plus oil treatment.

Studies were conducted with sleeve cages placed over treated and untreated shoots and fruit in mid-September to examine mode of action of using diatomaceous earth. Pairs of virgin male and female laboratory-reared codling moths were placed in the cages. Shoots after 7 days were cut, sleeves removed, and females were dissected to determine their mating status, and the number of eggs were counted on leaves and fruits inside each sleeve. Among the 8 sleeve cages placed over Celite residues nearly a month after the last spray had been applied only 0 and 1 egg were found on the leaves and fruit, respectively. In comparison, nearly 29 eggs were laid per sleeve on leaves and fruit that were untreated all season.
Interestingly the females placed with males were mated at a high rate regardless of Celite residues.

A laboratory study was conducted with neonate codling moths placed on Celite-treated (30-day-old residues) and untreated apple leaves and larval survivorship was determined after 72 h. Much fewer neonate larvae were able to feed and stay alive on 30-day-old Celite residues than on clean leaves.
The data this year strongly supported the combination of Celite with oil and virus. The data also suggested that the addition of DAMEC to Celite and oil can increase spray efficacy. The mode of action of Celite appears to be as an inhibitor to female oviposition and direct mortality on larvae establishing feeding sites. Celite did not appear to disrupt mating of moths placed in proximity within sleeve cages. No secondary pest issues arose with any treatment including oil. A few fruit in the Celite plus spreader treatment had suspected San Jose Scale markings. We noted that new injuries continued to occur in the untreated control and the previously sprayed blocks with virus and oil in mid to late September. However, no new injuries showed up in the Celite-treated plots. This suggests that sprays can be timed based on visual residues and not on a calendar schedule. Refinement is needed to establish the required minimum effective residue. Coverage is very important to avoid refuges for eggs. More data on the direct effect of

Celite treatments on the adults and neonates of codling moth should be pursued to allow optimal use of this technology.

Kaolin Studies. Studies were conducted in Bartlett pears and Ambrosia and Golden Delicious apples to examine the use of virus and oil versus two rates of kaolin plus oil and oil plus DAMEC. Pears were planted on a 12 x 12' spacing and trees were 3.5 m tall and 2.0 m wide. We established randomized single tree replicates, including 10 replicates of untreated, five replicates of treatments 2 – 6, and 15 replicates of treatments 7 – 12. On the final two spray dates in pear, we randomly grouped 44 trees into two groups with each treated with the low rate of Surround but with either oil or oil + DAMEC added. Sprays were applied in pear using a pressurized handgun attached to a 60-gallon tank at a rate of 400 GPA. A similar but more limited study was conducted in Ambrosia apples planted at 9 x 13',3.5 m tall and 2.0 m wide with seven replicates. A third study was run in Golden Delicious apples (six replicates) were planted at the same spacing but were larger trees, 3.5 m tall and 2.5 m wide. Two different sprayers with a 3- or 25-gallon tank were used to apply sprays at 100 or 200 GPA in Ambrosia and Goldens, respectively. Evaluations of pear and apple fruit injury for the first generation were conducted on 17 and 23 July, respectively; and on several dates up till 9 or 16 September for the second flight in pear and apple, respectively. Samples of pear fruit injury in July consisted of inspecting 50 - 100 fruit per replicate and 100 fruit in September. Mid-season apple samples consisted of 50-100 fruits and all fruits were counted and inspected for injury prior to harvest.
We did not see any difference in the two rates of Surround in pear; however, because we applied the equivalent of 400 GPA trees sprayed with either rate was very well covered with kaolin. Adding oil to the low rate of Surround significantly reduced injury. The addition of DAMEC did not significantly improve the Surround plus oil in pear, but the final injury was 38% lower with DAMEC added to the low rate of Surround in September. For the first generation in pear the use of Surround with oil had much lower levels (64 – 88%) of injury than the use of the virus and oil.

The pear block had all been treated with Surround in the spring for pear psylla as well as the adjoining pears. No pear psylla were found in any leaf samples from the summer-treated kaolin trees which were made periodically during the season as part of my consulting service. The adjoining pear trees outside of our study were treated with Azi-Direct three times during the season and had moderate counts of pear psylla and developed sticky leaves in August.

Levels of injury mid-season in Ambrosia were low across all treatments with no significant differences observed. The three low-rate Surround treatments all seemed to be better than the high rate with the Surround + oil + DAMEC having no injury sampled. In mid-September the two Surround treatments including DAMEC were the only treatments significantly lower than the UTC.

While all three Surround treatments were 60-80% lower in Golden Delicious than the UTC in July; only the Surround + oil + DAMEC was significantly lower than the UTC. However, by September despite 50-55% lower levels of injury in the three Surround treatments from the UTC, no statistical differences were found in the data.
We noted as we did in 2021 that levels of sunburn in apple were much lower on trees treated with Surround despite the use of oil than on untreated trees. No secondary pest issues were noted in any of the Surround treatments. We believe that the use of oil with kaolin helps to minimize the potential for outbreaks of mites, aphids, or leafminers that I reported back in the 1990s with seasonal kaolin spray programs. Finally, we noted that levels of bird injury were much lower on fruit covered with Surround (and Celite) than on untreated fruits.

There were no problems for the grower with diatomaceous earth or kaolin residues at harvest in any of the studies. The pears and Golden Delicious apples were packed for processing and the Ambrosia were packed conventionally. It remains unclear how much kaolin (concentration and spray intervals) is needed to be effective, and how to best achieve that deposit will require more study. The benefits of controlling pear psylla, reducing bird injury, and ameliorating the use of oil on fruit finish and sunburn while enhancing codling moth control are strong benefits of this program.

Final point: DAMEC is a microencapsulated formulation of pear ester which is a strong attractant for codling moth neonates. DAMEC has been shown to enhance nearly all classes of insecticides by increasing larval wandering in search of fruit. The enhanced wandering increases the uptake of insecticides with residual activity. DAMEC can also enhance the use of the granulosis virus through increased oral uptake during the initial larval feeding on the fruit. Surprisingly, DAMEC had never been tested with materials such as kaolin or diatomaceous earth until last year. We now have two years of data that demonstrates that the addition of DAMEC likely improves both materials by increasing the exposure and uptake of the granules on the searching larva and likely its desiccation or displacement from leaves and fruit.

Minutes of the 94th Annual Meeting

Orchard Pest & Disease Management Conference
Hilton Hotel, Portland, Oregon
January 8-10, 2020

The 2021 meeting was canceled due to Covid. The meeting of 2022 was attended by only a handful of people and did not have a quorum, therefore did not have a business meeting. The 2020 meeting was the last time we had a regular business meeting. The attached minutes are from the 2020 meeting.

I. Call to Order

The opening business meeting of the 94th Annual OPDMC Meeting was called to order by Chair Rodney Cooper at 8:56 am (PST) on January 8, 2020. Chair Cooper welcomed approx. 156 attendees to the joint entomology-plant pathology session. The program included 54 papers with 2 cancellations, and no poster session due to low interest. Attendees represented 16 states (AZ, CA, CO, HI, IA, ID, MD, MI, NC, NY, OH, OK, OR, PA, WA) and 4 countries (Japan, Canada, USA, Germany). Chair Cooper pointed out safety exits, the registration desk, where pesticide credit forms were located, and introduced the session moderators. He then asked for each attendee to make a brief self-introduction.

The sessions and moderators:

Mating Disruption/SIR	Chris Adams
Implementation	Karol Krey
Thresholds/Monitoring	Lynn Wunderlich
Biological Control	Kacie Athey (or Rebecca Schmidt-Jeffris in her absence)
Pathology/Diseases	Tobin Northfield
Invasive Species	Greg Krawczyk
Chemical Control	Louie Nottingham
Biology/Phenology	Houston Wilson

II. Old Business

A. Treasurer's Report: Treasurer Nik Wiman presented the 2019 Treasurer's Report (see Treasurer's Report posted at the end of the minutes). Treasurer Wiman reported $8201 in the account going into the 2020 meeting, an improvement from last year. Approval of the Treasurer Report to follow in the closing business meeting.

B. Approval of the 2019 Minutes: Secretary Alix Whitener announced that the 2019 minutes were posted on the OPDMC website and printed in the back of the abstract booklet. She asked for amendments. There were none. A motion to close the minutes was made by Executive Director Peter McGhee, seconded by attendees Epstein and Van Steenwyk, and were approved by the attendees.

C. Chair Cooper announced the industry donors and student winners of the Student OPDMC Scholarship. Industry donations included Corteva, Certis, Pacific Biocontrol, FMC and OK-SIR, who all donated at the 'GOLD' level this year.

a. 2020 student scholarship recipients:
    i. Claire Donahoo, Danielle Evans, Adrian Marshall, Lauri Lutes, and James Hepler. Student scholarships were awarded to qualified students with complete applications, awards totaling $3075, and award amounts varied by financial need.

III. New Business

A. Chair Cooper called for the names of any members that had passed away during the last year.
    a. Peter Landolt
    b. Steve Garczynski
    c. Stan Hoyt
    d. Everett Burts

A moment of silence was given in their recognition.

B. Chair Cooper announced the Keynote Speaker as Gary Judd whose talk was scheduled for 4:00 pm immediately followed by a mixer in the lobby from 5:00 - 7:00 pm

C. Chair Cooper provided speaker instructions and called for any other new business.
    a. Executive Director Peter McGhee had several announcements:
        i. OPDMC was negotiated for the next two years at the Hilton Downtown in Portland for 2021 $139 and 2022 $144. The membership said around the $140 mark they would like to consider alternative hotels due to cost.
        ii. The change in room setup allows for use of two screens due to an event following the OPDMC Meeting. If attendees had any concerns they were to find Peter and let him know.
    b. Chair Cooper brought up the Rubber Chicken Award for our all-in-good-fun blunder award, as well as the Golden Apple Award for the best presenter and asked the attendees to keep in mind who they would like to nominate at the close-of-business meeting

D. Chair Cooper called for Committee Assignments:
    a. Nominations: Rick Hilton (Chair), Alan Knight and Vaugn Walton
    b. Audit: Bob Van Steenwyk (Chair), Dave Epstein and Broc Zoller
    c. Resolutions: Rebecca Schmidt-Jeffris (Chair), Chris Strohm and Amanda Koppel

Chair Cooper called for a motion to close the opening business meeting. It was moved, seconded, and voted to close the opening business meeting at 9:30 am. Chair Cooper introduced the first session moderator, Karol Krey, and the presentations commenced.

IV. Closing Business Meeting

Chair Rodney Cooper called the closing business meeting to order on January 10, 2020, at 10:37 am.

A. Old Business

a. Chair Cooper gave a summary report of discussions and decisions from the 2020 Board of Directors' meeting held on January 8 at noon:
    i. Chair Cooper recognized Peter McGhee for organizing our meeting, as well as the registration desk check in volunteers, the Board, and the Scholarship Committee
    ii. 184 registered members in 2020
b. Treasurer Wiman presented the final treasurer's report
    i. Audit Committee found an error in our opening numbers
        1. 12/31 2019 $8201
        2. Closing 1/10 balance $28112
        3. Total income $21667
        4. Expenses estimated at $25000
        5. Considering increasing our stipend for the executive director

Chair Rodney Cooper called for any other new business.

B. Committee Reports:
    a. Nominations: Rick Hilton, Chair, gave the report. Chris Adams was nominated as Chair-Elect for 2020, Alix Whitener as Secretary, Nik Wiman as Treasurer, Peter McGhee as Executive Director, and Louis Nottingham as Program Chair. Student to serve on the Scholarship Committee – Claire Donahoo volunteered as the new student representative to the Scholarship Committee. Motion made by Scott O'Keef and vote to approve the nominations; all officers were voted in. Second by Don Thomson and accepted by vote of the membership.
    b. Audit: David Epstein, Chair, gave the report. The Audit Committee reviewed and accepted the financial report, and report that the OPDMC financial records are in good order. There was a motion, second and vote to approve the Audit Report. Don Thomson moved and was seconded by Tim Ksander and the membership voted to approve.
    c. Resolutions: Rebecca Schmidt-Jeffris, Chair, gave the report. Claire Donahoo, Joannie Lourimore, Tina Phelps, and Heather Andrews were thanked for their service in covering the registration desk. Peter McGhee was acknowledged for all of his meeting support (proceedings, maintaining OPDMC website, and arranging for pesticide credits). Jim Hepler and Adrian Marshall were acknowledged for their support in transporting computer equipment and setting up meeting displays. Karol Krey, Lynn Wunderlich, Kacie Athey, Greg Krawczyk, Louis Nottingham, Houston Wilson, and Chris Adams were thanked for overseeing the entomology sessions, and Tobin Northfield was thanked for overseeing the Pathology/Disease session of the 2020 meeting. There was a motion to accept by Peter McGhee, second by Ron Britt and accepted by a vote of the membership.
    d. Chair Cooper summarized the Board Meeting's business

i. Item: Update the bylaws to include a program chair as a voting member, as well as a vice program chair to serve as a voting member – the bylaws update would be posted to the website for voting.
    1. Discussion: Program chair and other board member terms to a multi-year term to help prevent rapid turnover and help those responsibilities be transferred to the new board members. 3 or 4 year terms, or the program chair/co-chair to serve 2 years each to rollover
    2. Motion to amend the bylaws made by Melissa Tessche and Rick Hilton
    3. Second by Don Thomson
    4. Vote passed
ii. Item: Create a Code of Conduct to align with modern 501c3 non-profits
    1. Discussion: Highly in favor and suggested to consult ESA for the code of conduct
    2. Motion: Chuck Burks
    3. Second: Rebecca Schmidt-Jeffris and Dave Epstein
    4. Vote passed
iii. Item: Program changes to keep/divide with Pathology, use a poster session to act as talk overflow when talks fill up, or potentially have a speaker panel at the end of each talk session. Panel discussion would remove one talk but possibly
    1. Discussion: International meeting with the discussion panel after each session was fruitful and tied in all the topics in each section together well. Possibly removing questions after each talk to create more time for the panel, or limit questions to one or two before the panel. Strongly recommend to not remove questions after talks in case clarification is necessary after certain talks. Previous experience shared from some highly effective panels but some are not so effective. Another idea was to open the poster session back up and the program chair could decide which submissions are posters and which are talks – could possibly solicit industry support to include mixer drink tickets to encourage people to participate in the poster session. Mixer attendance has declined so this could improve the mixer. Hot topic panels and roundtable discussions can also encourage networking and future collaborations.
    2. Motion: Motion to allow the board to take these ideas and resolve the program to be – Dave Epstein
    3. Second: Wiseman

4. Vote: Passed

C. Chair Cooper called for nominations for the Golden Apple Award.
    a. Nominations: Chris Adams Michigan State/OSU, Karol Krey USDA ARS Wapato
    b. Vote: Karol Krey is our Golden Apple Award winner
D. Chair Cooper for nominations for the Rubber Chicken Award.
    a. Nominations: Bob Vansteenwyk for totally not following the directions slide even though he was the first speaker and had a recent explanation of said directions. Rebecca Schmidt-Jeffris for showing a gel in her presentations AND using rubber chickens to point out her results. Current Rubber Chicken Holder Rick Hilton nominated Greg Krawczyk for showing upside-down videos, the modern version of upside-down slide carousels, and Jay Pscheidt for presenting on a silver bullet solution.
    b. Vote: Greg is our Rubber Chicken Award winner

E. Chair Cooper thanked all of the session leaders, registration desk volunteers, and all of the executive committee members for making the conference run smoothly.
F. Chair Cooper announced next year's meeting dates: January 12-15, 2021 at the Downtown Hilton, Portland.
G. Incoming Chair Allison Walston pounded the gavel at 11:08 am to close the final business meeting

Respectfully submitted,
Alix Whitener, Secretary
Orchard Pest and Disease Management Conference, January 8-10, 2020

Treasurers' Report 2020
Opening Business Meeting:

Total Cash and Paypal Balance (as of 31 December 2018):	*$4401.00*
Total Income from 2019:	*$19,980.00*
Total Expenses of 2019:	*$23,890.00*
Total Cash and Paypal Balance (as of 31 December 2019):	*$8,201.71*

Closing Business Meeting:

Total Cash and Paypal Balance (as of 31 December 2019):	*$8,201.71*
Total number of Registrations (as of 10 January 2020):	*184*
Total Income from 2020:	*$21,667*
Total Cash and Paypal Balance (as of 10 January 2020):	*$28,112.00*
Expenses Estimate for 2020:	*$25,000.00*

Respectfully submitted,
Alix Whitner, Secretary

Orchard Pest and Disease Management Conference, January 8-10, 2020

Minutes of the 94th Annual Meeting
Orchard Pest and Disease Management Conference
Hilton Hotel, Portland, Oregon
January 8th – 10th, 2020

Board Member Signatures

Peter McGhee, Executive Director — Date: 1-10-2020

Rodney Cooper, Chairperson — Date: 1-11-2020

Arthur Agnello, Past Chairperson — Date: unable to attend

Allison Walston, Chairperson Elect — Date: Jan 10, 2020

Elizabeth Beers, Program Chair — Date: unable to attend

Nik Wiman, Treasurer — Date: 01-10-2020

Alix Whitener, Secretary — Date: 10 January 2020

Minutes of Board of Directors' Meeting
Orchard Pest & Disease Management Conference
Downtown Hilton, Portland
January 8, 2020; approx. noon PST

I. Members in attendance
Rodney Cooper, Chairperson
Allison Walston, Chairperson elect
Peter McGhee, Executive Director
Nik Wiman, Treasurer
Alix Whitener, Secretary
Unable to attend: Art Agnello, Past Chair; Betsy Beers, Program Chair

Old Business:

a. 2019 discussions:
    a. Updating the bylaws
        i. Code of conduct
    b. Incorporating a pathology chair if pathology stays in the main program

New Business:

b. 2020 discussions:
    a. Linking the website and the online registration process
        i. Asking for a volunteer from our membership to help in this process or potentially hiring someone to update the website and link the online registration process
            1. Benefit to hiring someone to keep the technology relevant
            2. Asks: search feature for all archived minutes and proceedings
    b. Photos of officers
        i. We decided that members can attend the opening business meeting for the verbal introductions rather than adding an officer website page with photos
    c. Wi-Fi in the meeting room
        i. Decided against paying $500+ daily for Wi-Fi
    d. Bylaws discussion:
        i. Reminding attendees that by attending and registering for the meeting, they are in fact voting members and should attend the opening and closing business meetings
        ii. Items to propose in the bylaws and code of conduct and bring up to the membership at the closing business meeting:
            1. Past chair, current chair, incoming chair, secretary, treasurer, program chair, and a member at large – an odd number of board

members for voting, and having a larger board helps spread the responsibilities among the board
2. Update information throughout the bylaws (e.g. the location's address)
3. Code of conduct

e. Ways to positively impact attendance
   i. Options:
      1. Change the meeting dates (could interfere with the Entomology meeting earlier in the week)
      2. Pathology – combined or separate?
      3. Maintain international participation, formal/informal time limits and abstract submission, maintain field rep attendance, possibly add other specialty crop topics
      4. Fieldperson involvement
         a. Panel discussion, working lunch, sharing applied research asks and providing feedback from what's working or not working in the field
         b. Possibly up to the program chair and executive director to organize

f. We commend the increase in student attendance and participation
   i. Student volunteers should continue to be encouraged to volunteer but not at the expense of them missing any of the meeting talks or business meetings

g. Registration desk
   i. We would like to have someone consistently run the registration desk

h. Abstract books and submitting for pesticide credits
   i. Is this the responsibility of the Program Chair or?
   ii. Stipend? Fee structure? Room comp?

i. Needs:
   i. New computer
   ii. Found a printing source that's more expensive but can be done overnight which allows for last-minute adds/changes to the program
   iii. Projector situation

Respectfully submitted,

Alix Whitener
Secretary
Orchard Pest and Disease Management Conference
January 8-10, 2020

The Rubber Chicken Award

An enduring tradition of informality is the nomination, voting, and awarding of the Rubber Chicken to one of the presenter 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

Travel Scholarships for Students

INDUSTRY SPONSORS

For many years, industry participants in OPDMC have been asking for a way to lend financial support the event. Now there is a way to 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-$500), 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:

- Submit a complete application
- Attend OPDMC and present a talk
- Be available to help with either conference set up or take down.

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/

Thank You

2023 Student Scholarship Sponsors

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Interested in Donating? See https://opdmc.org/home/scholarships/