96th Annual
Orchard Pest & Disease Management Conference

Keynote Address: Art Agnello
"Hits & Flops from a Tree Fruit Entomologist's Playlist"

Hilton Portland, Portland, Oregon
January 12th – 14th, 2022

Keynote Speaker: Art Agnello

Arthur Agnello was Professor and Tree Fruit Extension Entomologist at Cornell University's AgriTech at the New York State Agricultural Experiment Station from 1986-2021. He got his B.S. at Cornell University in 1974, his M.S. at the University of Florida in 1979, and his Ph.D. at North Carolina State University in 1985. His work involved providing recommendations for insect and mite control in tree fruits; survey, diagnosis, biology, and management of fruit arthropods; and development of practical pest management programs in tree fruits, focusing on implementation of sampling and monitoring techniques, pheromone mating disruption, biological control, invasive species, and pesticide application technology. His research and extension programs reflected the primary goal of providing arthropod pest management recommendations to the tree fruit industry, and his main activities were interpreting the results of current research on fruit pests and formulating it into useful information that could be used by different clientele groups

96th Annual Orchard Pest and Disease Management Conference

In Memoriam

Larry J. Gut MSU professor passed away on Sept. 6, 2021, in Wenatchee, Washington, where he recently moved with his wife Kathy, to retire near family and friends. He was 67. He received his B.S. degree from California State University, Chico (1976) and his M.S. (1980) and Ph.D. (1985) from Oregon State University. Larry was a Research Associate at University of Illinois and at Washington State University, and then was an Instructor at Wenatchee Valley College before he accepted the position of Tree Fruit Entomologist at Michigan State University in 1997.

Larry was a global leader in tree fruit research focusing on controlling insect pests using alternative methods to reduce their impact. He traveled extensively to share his research with colleagues and growers around the world and was frequently sought after for his expertise in pheromone mating disruption programs. Larry instituted the first area-wide codling moth mating disruption program in the Michigan.

Larry was a lover of wine, an avid golfer and stamp collector. Larry had a zeal for life and enjoyed spending time with friends and family. He celebrated every birthday on the golf course, often with his son Tommy at his side. Larry was gregarious by nature and hosted the faculty Christmas party at his home for many years.

Larry received a number of awards over the years including MSU's William J. Beal Outstanding Faculty Award, the Entomological Society of America's Excellence in IPM Award, and the Distinguished Service Award from the Michigan State Horticultural Society. Larry was most proud of his service to the Michigan apple industry. He was passionate about using chemical ecology and insect pheromones, rather than pesticides, to control insect pests. Larry was a natural mentor and thought of all of his students as part of his family. A long list of Ph.D., M.S., and undergraduate students found a home in the Gut lab. To honor his commitment to his students the Larry Gut Memorial Endowed Scholarship Fund has been established to support future entomology students.

Orchard Pest and Disease Management Conference
2022 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 12th	
8:00 AM	**Registration/Name Tag Pickup**
8:45 AM	**Opening Business—**Allison Walston, OPDMC Chair
9:30 AM	Mating Disruption / SIR – *Moderator:* Chris Adams (OSU*)*
10:45 AM	Implementation – *Moderator:* Heather Andrews (OSU)
12:00 PM	**Lunch (on your own)**
1:15 PM	Thresholds & Monitoring – *Moderator:* Dani Lightle (OSU)
2:45 PM	Biological Control – *Moderator:* Robert Orpet & Christopher McCullough (WSU)
3:00 PM	**Coffee Break**
3:30 PM	Biological Control *(cont'd)*
4:00 PM	*Keynote Address:* Hits & Flops from a Tree Fruit Entomologist's Playlist Dr. Art Agnello (Cornell University)
5:00 PM	**Adjourn**
5:00 – 7:00 PM	**No Host Mixer (Hilton Lobby)**
Thursday, January 13th	
8:00 AM	Biological Control *(cont'd)*
9:45 AM	Pathology / Diseases – *Moderator:* Maryna Serdani (Marrone Bio)
10:00 AM	**Coffee Break**
10:30 AM	Pathology / Diseases (cont'd)
12:00 PM	**Lunch (on your own)**
1:00 PM	Invasive Species – *Moderator:* Aldo Hanel & Paul Bergeron (WSU)
3:00 PM	**Coffee Break**
3:30 PM	Invasive Species (cont'd)
4:00 PM	Chemical Control / New Products – *Moderator:* Amanda Koppel (Corteva)
5:00 PM	**Adjourn**
Friday, January 14th	
8:00 AM	Chemical Control / New Products (cont'd)
8:45 AM	Biology / Phenology – *Moderator:* Kadie Britt (UC Riverside)
10:15 AM	**Closing Business** — *Allison Walston, OPDMC Chair; Chris Adams, Chair-Elect*

Orchard Pest and Disease Management Conference
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Order of Presentations

FROM THE 96th ANNUAL

ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE

January 12, 13, & 14, 2022

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

Hits & Flops from a Tree Fruit Entomologist's Playlist

Dr. Art Agnello

Cornell University

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Mating Disruption/SIR—

Moderator: Chris Adams
(OSU-MCAREC)

Codling Moth Mating and Oriental Mating Disruption How and Why Do They Differ?

Don Thomson
Pacific Biocontrol Corporation, Vancouver, Washington

Keywords: *Cydia pomonella; Grapholita molesta*; mating disruption; physiology; behaviour

Abstract: Pheromone-mediated mating disruption technologies are well established as important pest management tools for the control of codling moth *Cydia pomonella* and oriental fruit moth *Grapholita molesta*. The sex pheromone of codling moth *(CM)* was identified in 1971. Extensive research and industry support laid the foundation for the successful commercialization of codling moth mating disruption (CM MD) starting in 1991. Initially, adoption was slow with many hurdles to overcome, but CM MD is now an integral part of pest management programs for pome fruit in the USA and worldwide. Despite dispenser improvements and extensive research into CM behavioural responses to its pheromone and the resulting mode of action (MOA) of CM MD, it is still not a stand-alone technology and requires careful monitoring and supplemental controls to ensure acceptable levels of control. The sex pheromone of oriental fruit moth *(OFM)* was identified in 1969. Oriental fruit moth mating disruption (OFM MD) was commercialized in the USA starting in 1987. Grower adoption of OFM MD occurred quickly, hastened by problems with insecticide resistance and a higher level of efficacy often allowing for its use as a stand-alone technology. Why the difference in the level of efficacy between CM MD and OFM MD? What are reasonable expectations for control and how should end-users manage the two systems? The MOA of OFM MD is known to be different than the MOA of CM MD. Despite the differences in MOAs, the physiological responses underlying the MOAs are not known. A better understanding of the physiological responses from first detection of pheromone molecules on the insect sensilla, the processing of pheromone and plant odour signals in the olfactory lobe and the interpretation and release of behaviours in higher brain centers may provide a better understanding of why the MOAs are so different for OFM and CM. CM MD has been successful in large part because of the use of supplemental insecticides to keep populations low. However, the lack of new chemistries and the waning efficacy of older chemistries may present serious problems for the future use of CM MD unless we can improve its efficacy. A fundamental understanding of the physiological differences in how CM and OFM perceive, and process pheromone signals is needed. Understanding the physiological and behavioural responses of OFM to its pheromone may provide a scientific basis for improving CM MD. The loss of so many pheromone research scientists over the last 20 years and the lack of young research scientists interested in the applied use of pheromones along with funding support for such research, will seriously handicap our ability to develop more robust CM MD technologies and practices so desperately needed now and in the future.

San Jose Scale Mating Disruption Mechanism in Apples

Jessika Maas[1], Dr. Julianna Wilson[1],
[1]Michigan State University, East Lansing, Michigan

Keywords: San Jose scale, *Quadraspidiotus perniciosus*, mating disruption, Apples

Abstract: Since its accidental introduction in 1870, San Jose scale (*Quadraspidiotus perniciosus*) (Comstock) has been a sporadic pest in apple orchards across the United States. In recent years *Q. perniciosus* has reemerged as a critical pest in apple orchards. This pest has become harder to control due to increased restrictions in pesticides and the difficulty in timing sprays. Recently, mating disruption has been used to help control other hard to manage pests. Since *Q. perniciosus* males fly short distances to immobile females it would make them a good candidate for mating disruption. ISOMATE dispensers primed with *Q. perniciosus* pheromone were deployed at increasing densities from 0 to 926 per Ha in 0.08 Ha orchard plots. Field trials were conducted during the 2020 and 2021 growing seasons. Results support the hypothesis that *Q. perniciosus* responds to increasing dispenser densities via competitive mating disruption.

Do Sterile Females Contribute to Population Suppression? Lessons from Codling Moth Sterile Insect Release

Megan Andrews[1], Chris Adams[2], Matthew Grieshop[1], Larry Gut[1†]
[1]Michigan State University, Department of Entomology, East Lansing, MI; [2]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR
[†]Deceased as of 6 September 2021

Keywords: Codling moth, *Cydia pomonella,* SIR, Apples

Abstract: Codling moth (*Cydia pomonella*) management has become increasingly difficult as growers lose access to chemical control tactics due to resistance and regulatory changes. Sterile insect release (SIR) has been used as an effective control method for codling moth, which unlike conventional control, is both economically and environmentally sustainable. With small cage studies and modeling, it has been determined that a 40:1 ratio of SIR moths to wild moths is needed to achieve suppression. However, a smaller ratio than this may be successful in an orchard setting when releasing both male and female moths. SIR techniques traditionally release only male insects for population control, however the release of female insects could contribute to population suppression in multiple ways. Like sterile males, sterile females compete with wild females for mating partners, the traditional mechanism for SIR, but they also work as mating disruption much like a pheromone lure. To test this, we used SIR moths to create a ratio of sterile moths to “wild” moths. We tested 5 different ratios to test if the females have an impact on population suppression.

Can Low-rate Twin Tubes Achieve Successful Mating Disruption for Filbert Worm, *Cydia latiferreana* (Lepidoptera: Tortricidae) in Hazelnut Orchard?

Serhan Mermer, Betsey Miller, Peter McGhee, Benjamin J. David, TJ Hafner, Ryan Welty, Vaughn M. Walton

Keywords: mating disruption, filbert worm

Abstract: Hazelnut is an economically important crop to provide great amount of agricultural revenue in Oregon. Filbert worm (FBW), *Cydia latiferreana,* is one of the major pests in hazelnut production result in reduced crop yield and nut quality. Hatched larvae burrow into the husk and feed inside the nut, resulting in unmarketable crop. Insecticides are currently used to suppress the pest populations and resultant damage; however, repeated use increases the risk of FBW developing resistance and may result in contamination of waterways. Pheromone mating disruption is an alternative method to reduce the insecticide use while minimizing the pest damage. In this study, a range of dispenser densities were deployed to evaluate the efficacy of FBW mating disruption in hazelnut orchards. The experiments were conducted within four different hazelnut blocks and each block was approximately 20 ha containing 1.25 ha subplots. ISOMATE HSW Flex dispensers were evenly distributed in the field as 0, 10, 20, 20 (chest height), 30, 50, and 100/ ha. Dispensers were applied to the upper ½ of the canopy 3-4 m above the ground. One treatment was target at a lower height approximately 1.5 meters (approximately chest height) above the ground. Two pheromone-baited delta traps were placed in each subplot for weekly counts of FBW. The mean number of moths caught in the traps were not statistically significant among the pheromone treatments. The results indicate that low-rate dispensers can be useful even in small number of dispensers per hectare e.g., 10. Further research is needed to implement the applicability of the treatments in a large-scale field scenario.

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

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, mating disruption, peaches, pump dispenser

Abstract: A field study was conducted near Yuba City, CA to evaluate a new pheromone pump dispenser for oriental fruit moth (OFM) control. Four treatments were replicated in three orchards. 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 starting on 23 February. OFM infested shoots (strikes) were monitored weekly from 10 center trees in each plot from 5 May through 12 August. Male moths captured in the L2 pheromone traps were suppressed in both the low and high rates of the Corteva OFM experimental pheromone and the grower standard Isomate OFM TT treatment compared to the insecticide treated control. For the combo traps, moths in the high and low pheromone were significantly suppressed compared to the insecticide only treatment, whereas twin tube was lower but not at a significant rate. Although there was no significant difference among the sex ratios for the combo trap, the numerical difference provides an indication of the efficacy of the four treatments. The number of OFM infested shoots (strikes)/10 center trees shows a great deal of variation among the orchards. Both the

high and low rates of Corteva OFM experimental pheromone performed as well or better than the grower standard Isomate OFM TT by Pacific Biocontrol Corp. Corteva OFM experimental pheromone and Isomate OFM TT outperformed the insecticide only treatment.

Implementation—

Moderator: Heather Andrews
(OSU-NWREC)

Codling Moth Task Force Industry Survey Results

Christopher Adams[1], Elizabeth Beers[2], Louis Nottingham[2], David Epstein[3], Michael Doerr[4]
[1]Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR;[2]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA;[3]Northwest Horticultural Council, Yakima, WA;[4]Wilbur Ellis, Wenatchee, WA

Keywords: Codling moth, Industry survey, management practices

Abstract: In September 2020, the Washington Tree Fruit Research Commission (WTRFC) directed the formation of a task force to address the growing concern over codling moth management. The Task Force consists of 29 members including growers, researchers, extension specialists, crop consultants and other industry representatives. It is led by Dr. Christopher Adams, Assistant Professor of Entomology at Oregon State University, along with an executive committee including Dr. Elizabeth Beers (Washington State University), Michael Doerr (Wilbur-Ellis Co.), Dr. David Epstein (Northwest Horticultural Council), and Dr. Louis Nottingham (Washington State University).

Codling moth has been the key pest of pome fruits across the growing regions of Washington and Oregon for over a hundred years. During that time, pest management programs regularly evolved as key pesticides were phased out and new technology was incorporated. Years of successful control and low pest pressure has diminished the focus on this key pest. In recent years, reports of increased codling moth pressure are becoming more frequent. As we continue to adapt new tools and tactics, there is a need to synthesize and evaluate past and current codling moth research and management recommendations, and to communicate that information to stakeholders. The Codling Moth Task Force was created to take the lead in this issue. The Task Force aims to promote education on basic biology, monitoring, and management; identify challenges to control; keep the industry up-to-date on new research findings, both local and worldwide; and, finally, encourage novel research and extension initiatives that will provide new tactics and approaches in the future.

The first critical step in this process is to characterize industry practices for codling moth control, with the aim of better understanding why problems are occurring. To that end, an industry-wide survey was written and circulated. We received 178 responses to this survey. Respondents were split nearly 50/50 between apple and pear. Results of the survey are shared in this talk.

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

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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 this 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 this 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.

Improving Pear Psylla IPM with a New Degree Day Model

Louis Nottingham[1], Robert Orpet[1], and Chris McCullough[1]
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: *Cacopsylla pyricola*, degree days, IGRs, kaolin,

Abstract: Pear psylla has remained a severe and costly pest of Washington pears for decades. Psylla excrete honeydew which marks fruit and stresses trees. To control this pest, conventional pear growers in Central Washington spray, on average, 15 insecticides per season on 14 day intervals, costing approximately $1,500/acre. Many of these sprays poorly align with susceptible psylla life-stages, which worsens psylla and mite problems by disrupting biological control. An integrated pest management (IPM) approach using non-disruptive strategies to suppress pear psylla could save growers money and improve pest management. Unfortunately, IPM has struggled to take hold in pears due to lack of specific recommendations with consistent outcomes. In 2019, a degree day model for pear psylla was completed, and in 2021, we developed management recommendations corresponding to degree days for kaolin clay, insect growth regulators (IGRs), honeydew washing, and summer pruning. In 2022, we will begin testing the degree day program in commercial pear orchards against standard conventional programs. The degree day model, management program, methods to evaluate efficacy, and plans for implementation will be discussed.

FloBeta: An Affordable, Portable, DIY Device for 24-hr Sampling of Plant Volatiles in the Field.

Betsey Miller[1], Caleb Price,[2] Serhan Mermer[1], Vaughn Walton[1]
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[2] Oregon State University, National Geomagnetic Facility, Corvallis, OR

Keywords: In situ headspace sampling, volatile organic compounds, active headspace sampling, field-portable device

Abstract: In our chemical ecology research of the interactions between pest insects and their host plants, we require aqueous solutions of plant volatile compounds suspended in solvent for analysis and assay using electroantennogram detection. To acquire these samples, we needed a field-worthy, portable device that would actively sample the volatile head space of hazelnut clusters on the tree in the orchard for a 24-hour period. Commercial options fitting these criteria were limited, so we built a device, called FloPump, based on an open-source plan outlined by Saryan and Gowda (2020). Once deployed in the field, the FloPump units turned out to be unreliable and difficult to work with. We thus embarked on designing

our own field sampler which improves on the shortcomings of the FloPump. We affectionately named this device FloBeta.

The FloBeta incorporates two 5V diaphragm pumps in each unit, one to pump filtered air into the headspace, and one to draw it out onto an adsorbent cartridge. A microcontroller unit (MCU) runs the two pumps independently using pulse-width modulation outputs to a DC motor driver. Each pump can then be operated independently at variable speeds that correlate to specific flow rates (150 – 650 mL/min) as defined by the user program, which can be selected in the field. The MCU logs data at ten-minute intervals throughout the sampling session to verify the duration of the sampling session and to provide supplemental environmental data. Program start and stop times and session logs are timestamped by a high-precision battery powered real-time clock and the session data is saved to flash memory on the MCU. Data files can be downloaded in the field with a standard USB-C cable and are saved to a microSD card for redundancy. To address to limitations of battery capacity observed in the FloPumps, we developed a self-contained solar power supply comprised of two 12V, 26Ah lead-acid batteries, a small solar charge controller with 5V USB ports, and a 25W solar panel. The solar panel was placed with a kickstand on the ground underneath the hazelnut tree adjacent to the sampling site, oriented to the southern aspect. This power supply was sufficient to power the FloBeta instrument continuously without interruption for several weeks through the end of the field sampling effort.

Here we will discuss the construction of the FloBeta sampling device and compare volatile profiles extracted with FloBeta to those extracted using commercial passive sampling devices.

Augmented Intelligence in Integrated Pest Management

Nathan Moses-Gonzales
M3 Agriculture Technologies
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Keywords: IoT, monitoring, models, machine learning

Abstract: The global population is expected to increase 20% to 9.7 billion over the next 30 years. This growth will require a 40% increase in productivity from agricultural lands domestically and upwards of 70% internationally. To meet this increased demand, improvements to the food production system are required throughout the value chain. Sustainable agricultural intensification will require the development of specialized communications networks, or cyber-physical systems that provide industries with the infrastructure and data necessary to develop and deploy machine learning enabled specialty crop production systems. Such systems capitalize on novel deep learning approaches which may improve surveillance and response to diseases and pests, decrease inputs and increase productivity while supporting sustainable agriculture intensification targets.

A key challenge in developing sustainable specialty crop intensification is the need for resilient production systems that can respond to climate change. To address this challenge, persistent sensing technologies that leverage discrete data focusing on weather variability, resource management, and insect monitoring (to name a few) combined with statistical analysis on landscape scales may provide the decision support framework necessary to ensure cropping systems are resilient and economically viable. Data driven systems may enable growers to adapt sustainably to climate change while also improving the economics of intensified production.

Focusing on weather variability as a key indicator of plant health and pest presence in both managed and unmanaged ecosystems is one of many examples of how landscape scale systems will improve the economics of production. Here, better models lead to improved forecasts which may mitigate the impact of weather variability. Localized forecasting based on data collected by persistent sensors improves farm level coordination, reduces the waste of raw inputs such as water and increases the precision of decision support tools. Beyond field level impacts, aggregation of this data may enable us to map the impact of weather variability regionally, providing deeper insight into the adaptations necessary to mitigate climate related risks to food production.

M3, alongside academic partners in Oregon, Washington State, California, Arizona and Ohio are developing novel, open source approaches that combine machine learning, cloud computing and the Internet of Things (IoT) to support the development of Agriculture IoT tools on large scales. to provide growers and industry with the decision support tools necessary to help specialty crop producers reduce costs and inputs while increasing productivity.

Thresholds & Monitoring—

Moderator: Dani Lightle
(OSU-NWREC)

Observations on the 4K Megalure™ for Codling Moth: A New Hope or the Same Old Hype?

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Keywords: codling moth, *Cydia pomonella*, codlemone, pear ester, acetic acid, kairomone

Abstract: The 4K Megalure for attracting codling moth consists of pear ester and two other plant volatile kairomones in a PVC matrix with a separate acetic acid lure. The lure was deployed in various situations, these evaluations were, with a single exception, conducted in pear orchards. The 4K lure was most often compared to the Combo (codlemone plus pear ester) lure or the Combo lure plus the acetic acid lure. The 4K lure was evaluated in both mating disruption and non-mating disruption orchards. The 4K Megalure consistently caught more female codling moths than the Combo lure with or without acetic acid. In a replicated study conducted in commercial Comice pear orchards using mating disruption, the higher female catch in the 4K lure over the Combo lure (both with and without acetic acid) was statistically significant. Higher catch of male codling moths with the 4K lure was also observed in this replicated study but the difference was statistically significant only with respect to the Combo lure without acetic acid but not the Combo lure plus an acetic acid lure.

A demonstration trial was conducted in 2021 at the SOREC research orchard in a block of Bartlett pears without mating disruption which had seen an increased level of codling moth damage in 2020 despite a spray program that had been effective in prior years. Thirty 4K traps were deployed in this 0.55 ac. block and 1,404 codling moths were trapped over the season with 53% being female moths. Codling moth damage in the block, which received the same spray program as in previous years, was not diminished. Results of the trapping studies and demonstration trial will be discussed.

What We Learn by Quantifying Mating in Codling Moth with the Megalure 4K

Alan L. Knight, Instar Biologicals, Yakima, WA, and Esteban V. Basoalto, Austral University, Valdivia, Chile

Keywords: Cydia pomonella, monitoring, mating disruption, sterile insect release, dispersal, ground cover management

Abstract: The PHEROCON® MEGALURE™ CM DUAL™ 4K™ (4K) is a binary lure with a black PVC matrix loaded with pear ester, linalool oxide, and nonatriene plus acetic acid in a membrane matrix. Traps baited with the 4K lure can catch up to 97X more female codling moth (CM) than those baited with just the standard PHEROCON® CMDA COMBO™ (Combo) lure with pear ester plus sex pheromone. The 4K lure can be used to monitor seasonal phenology of CM more effectively than the Combo lure in orchards treated with mating disruption (MD), even when the Combo lure is paired with an acetic acid co-lure. Female removal using the 4K lure has been shown to be an effective management tool for CM in both apple and pear. New studies in 2021 revealed that the relative performance of the 4K lure was reduced in organic blocks with no weed management in the orchard row. In these sites the 4K lure performed similarly to the PHEROCON® CMDA COMBO™-P + AA lure set. Female removal in organic orchards can be developed using the binary pear ester – acetic acid lure set. Other studies in 2021 focused on using the power of the 4K lure to monitor female CM mating status across 48 orchards under MD. The proportion of unmated female codling moth ranged from 0.21 to 1.00 in the 1st flight and 0.13 to 1.0 in the 2nd/3rd flights. The mean level of mating was nearly twice as high among females in the 2nd – 3rd versus 1st flight in these orchards. The proportion of unmated female CM immigrating from unmanaged sites were typically in the range of 0.2 to 0.3 suggesting that the use of MD would have marginal effect in managing codling moth in these types of orchards. The proportion of unmated wild female CM in orchards receiving sterile insect release were 0.2 to 0.5 in the first flight which was consistent with other non-SIR orchards, suggesting that the releases were not having a significant effect. However, during the 2nd flight the proportion of unmated female CM dropped to 0.1 to 0.3 demonstrating that the releases were impacting the wild population during this warmer period later in the summer. We also noted that conventional orchards treated with two sprays of Altacor in the first generation had levels of mating in the range of 0.6 to 1.0 which was consistent with earlier findings that Altacor can reduce mating by codling moth in the field. Because the performance of the 4K lure is not affected by the use of MD, it can serve as a measure of pest pressure, and the effectiveness of MD can be calculated as the ratio of male catch in traps baited with a sex pheromone (PH) lure versus 4K. Blocks inadvertently treated with both Semios aerosol and Trécé MESO™ dispensers had proportions of unmated females from 0.85 to 0.97 compared with 0.65 in blocks with the aerosols alone. This may suggest that increasing the intensity of MD may be advantageous. Interestingly the proportion of unmated female CM were similar in blocks treated with a new sprayable formulation, despite consistently higher PH/4K male catch ratios in these plots when compared to dispenser-treated blocks. These results suggest that a simple comparison of male catch may not be an accurate tool to judge the effectiveness of different MD approaches (hand-applied, aerosols, and sprayables). A review of the literature using tethered virgin females or virgin female-bated traps will be presented to support the premise that we do not really know how effective MD is as a tool to manage CM if we only use male catch data. Unfortunately, the power of the 4K lure to assess female moth mating was not available to us during the formative 1990's to more easily study the evolving use of sex pheromones and to fairly assess the areawide approach to manage codling moth without the previous reliance on organophosphate insecticides.

Updates to Spider Mite Guidelines for Almonds as Sixspotted Thrips Replace Phytoseiids as Predominant Predator

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Keywords: sixspotted thrips, *Scolothrips sexmaculatus*, Pacific spider mite, *Tetranychus pacificus*, , monitoring, sticky traps, sampling, treatment thresholds

Abstract: Spider mites are a universal pest of almonds in California that are naturally regulated by a variety of biological control organisms. Historically, phytoseiids have served as the predominant predator whereas recent changes in pesticide spray programs have caused a higher-level predator, the sixspotted thrips, to gain importance. Given the changing dynamics, we conducted research to re-evaluate treatment thresholds for spider mites and compare those to previous thresholds established in the 1980s. Efforts were made to develop a sticky card trap system to monitor for sixspotted thrips that was used to generate key information on its biology, phenology, and role in predator-prey relationships. Finally, capture data for sixspotted thrips were used to develop thresholds based on sixspotted thrips sampling that could be used to predict whether mite populations would increase, decrease, or stay the same. Data from all of these trials have been used to develop an integrated pest management program for almond growers that allows treatment decisions to be made according to densities of the pest as well as of its natural enemies.

Challenges and Opportunities for Monitoring Wild Codling Moths Among a Sea of Sterile Moths

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Keywords: Codling moth, *Cydia pomonella*, monitoring, thresholds, sterile insect technique, apple

Abstract: Codling moth is the key pest of apples and an important pest of pears and walnuts in United States and Canada. The sterile insect technique (SIT) is an autocidal pest management strategy that makes up the foundation of an area-wide IPM program against this pest in the main pome fruit growing regions of BC (ca. 8000 ac) and is a supplemental strategy used on a limited scale in WA (ca. 3000 ac). Theoretical and practical challenges for monitoring sterile and wild moths include changes in trap efficiency, increased labor, and absence of spray thresholds. In field trials, kairomone baited traps were better predictors of damage than traps baited with pheromone or combo-lures. More research is needed to develop action thresholds, especially when using SIT and mating disruption (MD) together. Strategies for monitoring orchards under SIT and MD are discussed.

Real Time Automated Pest Monitoring with Pseudo-acoustic Sensors -Will you miss sticky cards?

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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)

Factors Influencing Trechnites spp. Abundance in WA and OR Pear Orchards

Gabriel Zilnik[1], Louis B. Nottingham[2], Rodney Cooper[1], Chris G. Adams[3], David Horton[1], Rick J. Hilton[3], Rebecca Schmidt-Jeffris[1]
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Keywords: Pear psylla, *Trechnites*, pear

Abstract: Pear psylla (*Cacopsylla pyricola*) is the most important pest of pear in the Pacific Northwest. The pest causes fruit russet, defoliation, stunting and, in serious cases, tree death. Large infestations during the season can cause reduced yield due to pickers refusing to harvest sticky, honey-dew covered fruit. Chemical insecticides remain the predominate management tactic, with approximately 10-20 applications made per orchard annually amounting to 46% of the total pest management costs. Biological control is an underutilized alternative to chemical pesticides. As pesticides continue to lose their efficacy due to resistance, growers are increasingly interested in biological control agents. *Trechnites spp.* (most commonly *T. insidiosus*) is the predominant parasitoid of pear psylla in the Pacific Northwest. In orchards practicing softer management programs parasitism rates of pear psylla can approach 80%. Despite its potential utility in pears, little is known about the biology of *Trechnites spp.* including what factors influence *Trechnites spp.* abundance in pear orchards. In this study, we placed 3D-printed tube traps in pear blocks across the Pacific Northwest from Medford, OR up to Tonasket, WA. These traps passively catch pear psylla and *Trechnites spp.* in a vial of antifreeze which allows for later processing and preserves the specimens for molecular analysis. We chose orchards with varying land usage, spray programs, and acreage. We will present a preliminary analysis on the factors that influence *Trechnites spp.* abundance in pear orchards.

Alternative Food Sources for Orchard Predatory Mites and Effects on Predation

Erica Moretti[1], Paul Bergeron[2], Camden Jones[1], Kelly Thomsen-Archer[1], Linda Rehfield-Ray[1], Rebecca Schmidt-Jeffris[1]
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Keywords: *Amblydromella caudiglans*, *Tetranychus ulmi*, twospotted spider mite, apple, pear, cattail, pollen, *Artemia*, brine shrimp cyst

Abstract: The addition of alternative or supplemental food sources for natural enemies is a growing component of conservation and augmentative biocontrol. Supplemental foods can be used to retain natural enemies when prey are scarce and to promote survival, fecundity, longevity, and development of natural enemy populations, especially generalist natural enemies that benefit from a wide diet breadth. In laboratory studies, we evaluated the performance of the generalist phytoseiid mite *Amblydromella caudiglans* (Schuster) on commercially available supplemental food sources, including factitious prey *Ephestia* eggs and *Artemia* brine shrimp cysts, and pollens of apple, pear, and cattail. *Amblydromella caudiglans* is one of the most abundant predatory mites found in commercial apple orchards in Washington and contributes to both twospotted spider mite (*Tetranychus urticae* Koch) and European red mite (*Panonychus ulmi* Koch) control. Evaluations included measuring fecundity of *A. caudiglans* fed exclusively on alternative foods sources alone and in combinations and assessing how the presence of some supplemental foods affects predation on twospotted spider mite nymphs as well as other non-

consumptive effects. We identified that *A. caudiglans* will not consume *Ephestia* eggs and performs best on cattail and pear pollens. Combinations of food sources do not enhance the performance of this predator compared to the best performing single-sources. The presence of alternative food sources does not decrease predation of *A. caudiglans* on twospotted spider mite nymphs, unless that food requires increased handing time by the mite (i.e. *Artemia* brine shrimp cysts). These results lay the groundwork for identifying a way to promote and retain this natural enemy in tree fruit cropping systems.

Establishment of the Samurai Wasp, *Trissolcus japonicus*, a Biological Control Agent of the Invasive Brown Marmorated Stink Bug, *Halyomorpha halys*, in Oregon

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Keywords: egg parasitoids, parasitic wasps, integrated pest management, invasive species, biocontrol

Abstract: The brown marmorated stink bug, *Halyomorpha halys*, is a polyphagous and invasive pest that has caused millions of dollars of economic damage in US specialty crops and is an increasing problem to the specialty crop industry in the Pacific Northwest. An effective control method is the use of broad-spectrum insecticides, but these may be destructive to integrated pest management (IPM) programs already in place. In the home range of *H. halys*, the samurai wasp, *Trissolcus japonicus*, is known to be an efficient egg parasitoid of the pest, with parasitism rates as high as 90%. As of 2021, Oregon State University has redistributed this adventive agent at 39 sites across four ecoregions throughout the state of Oregon. Between 2016 and 2021, we also placed yellow sticky cards and/or sentinel egg masses of *H. halys* at these release sites the year of release and each year following to assess establishment of *T. japonicus* populations in urban, agricultural, and riparian habitats. Including non-release sites for monitoring *T. japonicus*, we have set up sticky cards at 120 sites across five ecoregions in Oregon. Additionally, we collected wild egg masses of *H. halys* at both release and non-release sites and assessed their parasitism by *T. japonicus*. Here, we present our state-wide monitoring efforts and the establishment of this biological control agent in Oregon.

Augmenting Predators for Pest Control in Apples

Authors: Rebecca Schmidt-Jeffris[1], Erica Moretti[1]
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Keywords: mealybug destroyer, lacewing, *Cryptolaemus montrouzieri, Chrysoperla rufilabris, Chrysoperla carnea, Chrysoperla externa*, grape mealybug, woolly apple aphid, green apple aphid, *Eriosoma lanigerum, Pseudococcus maritimus*, release, drone, UAV, organic, apple, insectary

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 2020-2021, we tested two rates, timings, and methods (drone versus ground) of release of mealybug destroyers for control of grape mealybug in organic apple. In 2021, we also tested two species (*Chrysoperla rufilabris* versus *C. carnea*) and life stages (eggs versus larvae) of lacewings for control of aphids. 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. Drone releases were not successful, likely because mealybug destroyers did not land in the plots due to attraction to sunlight. The 2021 attempt of the 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. 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. These results and future work will be used to create scientifically-based recommendations for releasing natural enemies in orchards.

Apple Integrated Mite Management: where can we go next?

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Keywords: *Amblydromella caudiglans*, *Galendromus occidentalis*, *Panonychus ulmi*, twospotted spider mite, brown mite, apple, ground cover, pollen

Abstract: Integrated mite management is one of the most successful biocontrol programs in perennial cropping systems, focusing on the conservation of *Galendromus occidentalis* and the use of pesticides known to be relatively safe to this predator. After 50 years, integrated mite management is still effective, but the ecology of apple orchards has changed as pesticide use shifts from broad spectrum to more selective products. Pest species are also changing and there is a new-to-us predatory mite, *Amblydromella caudiglans*, that is increasing in presence and dominance around Washington state. This predator has a completely different habitat and diet preference, opening the possibilities for integrated mite management. Here, we examine and compare the nontarget effects of orchard pesticides on *Amblydromella caudiglans* and *Galendromus occidentalis*. We also examine the pollen and pest resource use of a predatory mite community. This work found that there are minimal differences in pesticide

nontarget effects between *Amblydromella caudiglans* and *Galendromus occidentalis*. For this reason, slight changes can be made to current integrated mite managements plans that allow for the incorporation of both major apple predatory mites. Also, this work has shown that pollen is an important resource throughout the growing season for predatory mite communities and future work should investigate pollen supplementation programs. This work provides the foundation for the next generation of integrated mite management to shift away from a single species management plan in favor of a multi-species, community level conservation plan.

Earwigs as Biological Control Agents in Temperate Tree Fruit Orchards: What Do We Know and What is the Way Forward

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Keywords: biological control, earwigs, *Forficula auricularia,* pome fruit, stone fruit, trapping

Abstract: The European earwig (*Forficula auricularia*) is considered a pest in stone fruit orchards, sometimes requiring the use of pesticides to control their populations, whereas in pome fruit orchards they are considered predators of important pests, and infrequently damage fruits. Given this dual role in orchards, our goal was to determine if earwig mass-trapping in stone fruit could serve as a source of earwigs for augmentation biological control in pome fruit. As earwig trapping is infrequent in stone fruit, it is not known if this strategy might reduce their abundance and fruit damage. However, earwigs' low dispersal and reproductive output may make this strategy successful. We found that the standard cardboard trap was the most successful in capturing earwigs in stone fruit. Mass-trapping of earwigs did not significantly reduce earwig populations, although we noticed a trend of declining populations throughout the season. We observed a decrease in damage on apricots, but not in cherries. Given the large number of earwigs captured in stone fruit, we believe that this strategy might be useful for reducing damage on stone fruit and using it as a "natural biofactory" of natural enemies for augmentation biological control in pome fruit. Preliminary results on earwig augmentation did not provide enough evidence to demonstrate establishment in pome fruit. Studies will continue in the following season to further evaluate mass-trapping as way to reduce earwig populations where they are considered pests and establish their populations in pome fruit.

Non-Target Effects of Insecticides on Pear Orchard Natural Enemies

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Keywords: Coccinellidae, earwig, *Forficula auricularua*, biological control

Abstract: Natural enemies play a vital role in managing pear orchards pests, particularly the pear psylla, *Cacospylla pyricola*. However, for natural enemies to play an effective role, insecticides used to manage pear pests should not disrupt natural enemies. The effects of several orchard insecticides were tested on a suite of natural enemies with a focus on the European earwig. Mortality and sublethal effects were recorded for natural enemies exposed to insecticides either directly or on residues. Sublethal effects were recorded using Ethovision software to monitor the behavior the insects. The results will be discussed in the context of designing softer spray programs to help conserve natural enemies.

Integrating European Earwig Releases with Spray Programs for Pest Management in Pear

Robert Orpet[1] and Louis Nottingham[1]
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Keywords: augmentation, *Cacopsylla pyricola,* European earwig, *Forficula auricularia,* inoculation, non-target effects, organic, pear, pear psylla

Abstract: In Washington State the key pear pest psylla (*Cacopsylla pyricola*) is typically a problem because excessive pesticide use is ineffective and induces pest population growth by killing predators and parasitoids. In observations in this region from 2017 to 2020, the key pear psylla predator European earwig (*Forficula auricularia*) was absent in 12 out of 14 conventionally managed orchards studied but was absent in only 1 out of 11 organically managed orchards studied. We hypothesized earwigs were extirpated from conventional orchards in the past and could not quickly reestablish because they are non-flying and univoltine. We next released European earwig into two conventional pear orchards and one minimally managed research center orchard to observe effects on pear psylla suppression and to test whether an earwig population would persist in future years. We found that European earwigs did not survive in conventional orchards, which were sprayed excessively and continued to have pear psylla problems. The research center, which was sprayed minimally and had minimal pear psylla, had over 10 times more earwigs than any previous year it was monitored. We suggest that current spray programs in conventional Washington pear orchards violate the original concept of integrated pest management, *i.e.,* combining chemical with biological control. Innovation, extension, and creative collaboration with stakeholders are needed to improve management of this perennially induced pest.

Pathology/Diseases—

Moderator: Maryna Serdani
(Marrone Bio Innovations)

X-disease: a Brief Overview

Tobin Northfield, Abigail Clarke
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Keywords: X-disease, Prunus, cherry, *Candidatus*

Abstract: The Washington stone fruit (cherry, peach, nectarine) industry is experiencing a devastating epidemic of X-disease, colloquially referred to, along with Little cherry viruses 1 and 2, as "little cherry disease" or previously as "buckskin disease." X-disease phytoplasma reduces fruit size and quality in cherries, and once infected trees transmit the phytoplasma for the life of the tree. The causative agent of X-disease, *Candidatus* Phytoplasma pruni is an intracellular, phloem-limited phytoplasma that is transmitted between trees through grafting, including root grafting, and vectored by a small group of leafhoppers. There are no known treatments for the phytoplasma, so growers must rely on reducing spread through vector control and removal of diseased trees. Leafhoppers can spread the phytoplasma to orchard trees and may acquire the phytoplasma from infected other *Prunus* trees or weedy hosts that can host the pathogen without expressing symptoms. Based on its abundance and vector efficacy, the key X-disease vector in Washington is thought to be *Colladonus montanus reductus*. To evaluate the role of groundcover weeds, we evaluated *C. m. reductus* feeding preference on potted peach or cherry trees, and key broadleaf weeds: mallow, alfalfa, clover, and dandelion. Although the leafhoppers readily fed on all plants in the cages, mallow exhibited the highest feeding rates. We have also observed oviposition on mallow, clover, and alfalfa. These findings, along with field observations, suggest that groundcover weeds are a key host for X-disease vectors within Washington stone fruit blocks and may contribute to the X-disease epidemic

Identifying Potential Biocontrol Agents For X-Disease Vectors

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Keywords: X-Disease, Biological Control

Abstract: Cherry production in the Pacific Northwest has been severely affected by Western X 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 multiple leafhopper species. X-disease has no cure, and once a tree is infected, it remains infected until it dies. Therefore, current management options rely on swift identification and removal of infected trees as well as timely pesticide applications to control leafhopper populations. Despite the lack of information on leafhopper natural enemies, we examine the plausibility of two naturally occurring biocontrol agents for the X-disease vectors: a parasitic fly (Pipunculidae) and a parasitic wasp (Dryinidae) found in Central Washington. 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.

Ground Control to Major Tom; Your Hosts are Covered there's Nothing Wrong

Adrian Marshall and Tobin Northfield
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Keywords: X-disease, Prunus, cherry, Candidatus

*Abstract:*A recently re-emerged leafhopper vectored disease, X-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 listed as disease hosts and may serve as leafhopper feeding hosts, suggesting that groundcover weeds may 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.

Cherry Whole Orchard Recycling: Investigating Fruiting Bodies Viability of Cherry Fungal Pathogens and Management of Fungal Canker Diseases of Sweet Cherry in California

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Keywords: Diseases, *Calosphaeria, Cytospora*, spore trapping, fruiting bodies, viability

Abstract: During our recent surveys, we documented the adoption of Whole Orchard Recycling (WOR) in some cherry orchards in San Joaquin County. WOR is the on-site grinding or shredding of whole trees during orchard removal, and incorporation of the ground or chipped biomass into the topsoil prior to replanting. WOR has become more common in recent years, due to the air quality regulations that restrict growers' ability to manage biomass by burning, and because half of the California's many biomass power generation plants have closed, and the ones still open are no longer paying for woodchips. With promising results from almond orchard recycling, and the addition of WOR to CDFA's Healthy Soils Initiative, cherry growers may qualify for funding opportunities, and this practice could provide a sustainable method of tree removal that could enhance both air and soil quality. In-person survey results showed that more growers are interested in adopting this practice, although, the effect of WOR has yet to be investigated in cherry orchard systems. Results indicated also that shredding diseased wood and incorporating them into the soil is a major concern to the growers, raising the question of whether the shredding and soil incorporation of whole trees can lead to an early fungal canker diseases – caused by the plant-pathogenic

fungi *Calosphaeria pulchella*, *Eutypa lata* and *Cytospora sorbicola* – that could affect newly planted orchards. On June of 2021, we initiated an experiment to investigate the survival of *Calosphaeria* and *Cytospora* fungi in fruiting bodies still present in wood chips incorporated during orchard recycling and in shredded prunings between tree rows. After six months, we found that percent germination of *Calosphaeria* ascospores and *Cytospora* pycnidiospores, was significantly reduced after each three months. We are still able to recover viable spores from the cherry woods, thus monthly sampling is still ongoing until there is no further recovery of the pathogens. A four-month spore trap study was undertaken to determine the abundance and spore discharge of the mentioned above fungi. Here we analyzed the correlation between shredding of infected branches between tree rows (following maintenance/cleaning pruning) and the overhead water-based orchard cooling systems – used on very hot days in the southern regions – and Cyt/Colo spore release. Overall, based on colony counts, recovery of spores occurred mainly during or soon after applying the water via the over-tree sprinklers. We also detected high aerial dissemination of spores when shredding of infected branches deposited between tree rows. This information is of great importance as it helps to identify production practices responsible for the spread of these fungal pathogens within cherry orchards.
Acknowledgements: We are thankful to the California Cherry Board for funding this research

Investigating Botryosphaeria/Phomopsis Diseases of Walnut in San Joaquin and Stanislaus Counties, California

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Keywords: Walnut, Diaporthaceae, Botryosphaeriaceae, spore trapping, pathogenicity

Abstract: In the last two years, we have surveyed numerous walnut orchards in San Joaquin County and few others in Stanislaus County to assess the health of walnut trees and investigate the occurrence of Botryosphaeria and Phomopsis blight and canker diseases. Diseased tissue samples have been collected and analyzed from around 50 mature walnut orchards. Isolation work showed Diaporthaceae fungi to be the most prevalent fungal pathogens isolated from diseased walnut samples and Botryosphaeriaceae fungi were only found occasionally. Following a second-year spore trapping study we confirmed the correlation between precipitation events and fungal spore release (Nouri et al. 2020 walnut report). This year spores were mainly captured from end-January to mid- April: Recovery of spores occurred during or soon after a rain event. As in the previous year, the spore trapping study confirmed the results of field surveys, and the captured spores of Diaporthaceae fungi were much higher than those of Botryosphaeriaceae fungi. We also confirmed few spores to be realized during or following the first irrigation of the season in both orchards with sprinkler irrigation, and high spore release when shredding infected branches between tree rows. Molecular identification, based on comparison of DNA sequences of the internal transcribed spacer region (ITS) of the rDNA, revealed the presence of three new species of Diaporthe – found in both spore trapping and diseased tissue isolations. In 2021, we completed pathogenicity studies using the three new species of Diaporthaceae. For the walnut branches inoculation, results of the pathogenicity study showed that all fungal treatments in the experiment produced cankers that were significantly longer than the control, suggesting that all fungi tested are pathogenic when inoculated on Chandler and Howard cultivars. Analysis of cultivar susceptibility/tolerance indicated that the two cultivars tested were equally susceptible to the three Diaporthaceae species showing no

detectable resistance to the pathogens. The results from inoculations of fruit hulls were consistent with those of branch inoculations. All Diaporthe isolates were pathogenic when inoculated on walnut fruits producing a significant wider blighted area than that in the control fruits.

Acknowledgements**:** We are thankful to the California Walnut Board for funding this research

Invasive Species—

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

Oregon Invasive Species Update

Josh Vlach
Oregon Department of Agriculture

Keywords: Gypsy moth, light brown apple moth, granulate ambrosia beetle

Abstract: ODA's Insect Pest Prevention and Management program surveys for over 50 invasive pests not known to be in Oregon every year. In the process, they place over 20,000 traps and survey thousands of sites. The goal is to detect new pests early so they can be eradicated. For many pests, such as gypsy moth, light brown apple moth, granulate ambrosia beetle and others, IPPM is successful. Unfortunately, the volume of trade and movement to Oregon are great and an average of over 10 species new to Oregon are detected every year. These include pests of orchards and other crops. Recent detections will be discussed as which pests we're concerned about next.

Spotted Lanternfly in Pennsylvania – Potential Management Options

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Keywords: Lycorma delicatula, SLF insecticide efficacy, ovicidal efficacy, pome fruit, grapes

Abstract: A new invasive insect pest species, spotted lanternfly (SLF), *Lycorma delicatula* (White), (Hemiptera: Fulgoridae) continues to spread in the eastern United States. First discovered in Pennsylvania, USA in September 2014 now it has established populations in 11 states. During last few years we conducted numerous research projects to understand management and monitoring options for this insect. Various compounds from several IRAC groups such as neonicotinoids, pyrethroids, carbamates and organo-phosphates were very effective in controlling SLF adults and juvenile stages in orchards and vineyards. During early spring ovicidal bioassays were also conducted to evaluate the potential of controlling overwintering eggs with dormant applications of horticultural oils and other products with potential ovicidal properties. Products containing chlorpyrifos were the most effective insecticides against SLF overwintering eggs while partial mortality was observed after treatments with high rates (at or above label rates) of horticultural oils, flupyradifurone and dinotefuran. Addition of oil or insecticidal soap to synthetic insecticides also improved the efficacy against SLF eggs.

When Insect Control Requires Specific Tools: the Long Process Behind the Development of a Suitable Volatile's Release Device for the Control of Spotted-Wing Drosophila

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Keywords: Drosophila suzukii, kairomone

Abstract: Here we describe benefits and disadvantages and efficacy data from 2017-2020 using five delivery devices for organic volatile emission in pest management. These devices are used as substrates

on which a *Drosophila suzukii*-specific food-grade attractant is placed. Results show different levels of efficacy. Data suggest that daily water contact is critical in providing adequate volatile release and substrate consistency. Trails were conducted, illustrating an active range of at least 20 ft. These data suggest dispensers at 50 per acre are needed for most effective *D. suzukii* damage mitigation. Advantages and shortcomings of this technique are discussed within the context of commercial production systems.

Improvement of a Novel Plant-based Deterrent Against *Drosophila suzukii*

Authors: Gabriella Tait[1], Serhan Mermer[1], Ryan Chave[1], Edwin Harris[1], Ben David[1], Maxwell Moeller[1], Kate Oppenheimer[1], Vaughn M. Walton[1]
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Keywords: Spotted-wing drosophila, deterrent

Abstract: Spotted-wing drosophila (SWD, *Drosophila suzukii*) is an invasive fruit fly species native to Southeast Asia. SWD lays its eggs in undamaged and intact fruit of soft-skinned varieties, and larvae feed on flesh result in unmarketable fruit. This study aimed to evaluate the efficacy of a novel and insecticide-alternative SWD management tool, a plant-based deterrent. The primary goal of our project was to test the deterrent under field conditions and characterize the chemical volatile profile of the formulation. The experimental data were collected from a series of laboratory and field trials during the summer of 2019, 2020, and 2021. Results from field trials showed that the improved formula applied at 0.075% v/v rate was able to protect blueberries comparable to conventional insecticides. Reduced egg laying ranged from 38 to 86%. Numerically lower infestations of egg-laying were obtained in most of the collection days. In addition, the electroantennography-gas chromatography analysis (GC-EAD) revealed the presence of multiple compounds towards which there is a clear response from both females and males. Overall, findings showed a significant reduction in SWD oviposition on susceptible fruit under field conditions. To the best of our understanding, this plant-based deterrent can be used under both conventional and organic commercial conditions.

Open-field Observations and Implementation of an Attract-and Kill Strategy Against *Drosophila suzukii*

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Keywords: Spotted-wing drosophila, attract and kill

Abstract: Here we describe benefits, disadvantages, and efficacy data from 2017-2021 for an organic Attract and Kill (A&K) pest management tool. Results are highlighted from eighteen locations and four regions. Data provided describe efficacy with and without the use of toxic insecticides during periods ranging from 10 days to three months. We detail the methodology and use patterns within several commercial production systems. Overall, collaborators report an average of ~45% reduction of *D. suzukii* damage when using the A&K tool alone, or in combination with conventional insecticides. Shortcomings of this technology in its current format include possible incompatibility with other behavioral methods, rodents, and dependency on controlled irrigation systems. Benefits include ease of application, cost, and the fact that weather events such as rain does not impact its efficacy.

Chemical Control/New Products—

Moderator: Amanda Koppel
(Corteva Agriscience)

Timing and Order of Insecticides on Spotted Wing Drosophila (*Drosophila suzukii,* Matsumura) (Diptera: Drosophilidae) Management and Modeling Population Levels

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Keywords: spotted wing drosophila, insecticides.

Abstract: Drosophila suzukii is a detrimental crop pest for soft skinned fruits. Although other control methods have been well-studied, insecticides are still the major control method for *D. suzukii*. Limited data is available regarding timing and order of insecticides and the impact on population levels of *D. suzukii.* The present study investigates the different insecticide application orders and the impact on population levels. Field trials at three locations (Oregon, Georgia, and North Carolina) were performed by applying insecticides at different times classified based on efficacy rates (High, Medium, Low). Trials were conducted using field cages on blueberry and blackberry and challenging treatments with released *D. suzukii*. Treatments consisted of two insecticide applications performed over a three-week period. Treatments included the insecticides and relative efficacy ratings e.g., zeta-cypermethrin (High), cyantraniliprole (Low), and spinetoram (Medium). Infestation was monitored by sampling fruit twice per week from upper and lower canopy zones and recording immature life stages (e.g., egg and larvae). In addition, population model was used to simulate relative efficacy of insecticide regimes on *D. suzukii* population growth. No statistical differences were found between treatments. Model simulations indicated that the High-Low application regime suppressed *D. suzukii* populations similar levels as Low-High regimes. The current study indicates that longer-term season-long application regimes need to be investigated to implement the effect of insecticide timing and order.

Development of a Biofilm for Insect Management in Fruit Crops

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Keywords: Spotted-wing drosophila, biofilm,

Abstract: Plant surface wax and other cellular building blocks are of vital importance in protecting tissue from both environmental stresses and arthropod attack. This importance is reflected in the huge energy expense that plants put into epidermal cuticle formation. A massive flux of metabolized lipids is needed on the plant surface to provide such protection. We know that fruit surface characteristics play an important role as it relates to *Drosophila suzukii* attack. The aim this study was to determine if a novel biofilm containing additional waxes and clay can affect fruit quality including firmness of blueberry, blackberry and cherry to alter *D. suzukii* behavior. Cherry, blueberry and winegrape plants treated with the biofilm showed a significant increase in berry firmness ranging from 4.6 to 11.6%. No quality benefits were observed on blackberry. Laboratory trials resulted in 54% mean oviposition reduction in controlled laboratory trials on blueberry. Short-duration field trials over 72 ± 2 to 96 ± 2 hours on commercial-standard blueberry bushes resulted in 50 to 93.4% reductions of *D. suzukii* damage. Longer-term field trials on cherry and blueberry fruit challenged with egg-laying *D. suzukii* showed reductions of damage ranging from 45-95%, up to 30 days after initial biofilm applications. These results indicate that the biofilm significantly reduces *D. suzukii* damage under commercial production conditions. This reduction may be due to a combination of altered behavior but also fruit quality characteristics. The current work serves to expand integrated pest management options to control *D. suzukii* populations in commercial field settings.

Assembling our Toolbox: Updates on Chemical Control of Cherry Leafhoppers

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Keywords: sweet cherry, *Prunus avium*, leafhopper pests of cherry, *Colladonus* spp., *Euscelidius variegatus*, chemical control, bioassay, thiamethoxam (Actara 25 WG), esfenvalerate (Asana XL), pyrethrins (Pyganic 1.4 EC), mineral oil (IAP 440 Oil), sulfoxaflor (Transform WG), imidacloprid (Admire Pro), fenazaquin (Magister SC), dinotefuran (Scorpion 35SL), diatomaceous earth (Celite 610), kaolin clay (Surround WP)

Abstract: X-disease is a leafhopper-vectored disease that spreads rapidly, has no cure, and renders cherry fruit unmarketable. At present, attempts to prevent disease spread are focused primarily on infected tree removal and control of leafhopper vectors using cultural and chemical methods. During the 2021 growing season, we used direct-spray, leaf-dip, and residue bioassays to determine the efficacy of several insecticide products against mixed species of leafhoppers. We identified one organic and five conventional insecticides that are highly toxic to leafhoppers upon direct spray contact. Additionally, we determined that two particle film products are effective repellents and may have a role in cherry leafhopper management. Finally, we found that residues of two conventional insecticides performed well with and without the addition of mineral oil and over the course of several days to weeks of aging. Results from these bioassays will help inform further research on chemical control of cherry leafhoppers and will add several new tools to our management toolbox.

Vine Mealybug Meets Reduced Risk Programs in Grapes

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

Keywords: Vine Mealybug, *Planococcus ficus*, Marrone, MBI-306, Venerate XC, Assail 30SG, Movento 2SC, Sequioa, Applaud

Abstract: Studies were conducted in 2020 and 2021 in a Chardonnay vineyard near Manteca, CA. The effectiveness of various reduced risk programs was evaluated for vine mealybug control (VMB). Treatments included different combinations of Sequoia, Movento 2SC, Assail 30SG, Venerate XC, MBI-306, and Applaud. Treatment programs were replicated four times in completely randomized designs with each replicate being five to six vines long. Foliar applications were applied with a hand-held sprayer operating with a finished spray volume of 150 gal/acre. Applications were applied based on four grape phenologies (delayed dormant, post-bloom, version, pre-harvest). VMB infestation was monitored with one-minute timed trunk and cordon searches every two-three weeks. Prior to commercial harvests, 25 fruit clusters (2020) and 10 fruit clusters (2021) per center two vines were evaluated for VMB damage. Harvest assessment was categorized as: 0 = no VMB or honeydew, 1 = honeydew but no visible VMB, 2 = honeydew and visible VMB and 3 = honeydew and greater than 10 VMB. Clusters with scores of 2-3 were considered unmarketable. Though there was a numerical difference, there was no significant difference between reduced risk programs and grower's standards in 2020. In 2021, two of the three reduced risk programs suppressed VMB when compared to the untreated control.

Nip it in the Bud: Early Season Insecticide Applications for Selective Control of Aphids in PNW Hazelnuts

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Keywords: *Myzocallis coryli, Trioxys pallidus, Corylobium avellanae , Halyomorpha halys*, hazelnut, aphids

Abstract: Filbert aphid (*Myzocallis coryli* Goetze) was a major problem for hazelnut growers until the European parasitoid *Trioxys pallidus* (Haliday) was introduced in the 1980s. The parasitoid flourished in the PNW climate, and most growers stopped spraying aphids after the classical biological control program was established. Since then, new pest species including the hazelnut aphid (*Corylobium avellanae* Schrank) and brown marmorated stink bug (*Halyomorpha halys* (Stal)) have been introduced, resulting in increased insecticide applications, and therefore complicating biological control of *T. pallidus*. Now there appears to be some resurgence of aphids with populations far exceeding damage thresholds in many orchards, and more growers are treating aphids. Damaging populations of aphids have a cumulative effect on hazelnut trees, leading to reduced photosynthetic activity and reduced ratio of kernel to shell (crackout). We tested new selective and soft chemistries against aphids and we assessed activity of aphid natural enemies in two orchards in the early spring of 2021. All products resulted in significant aphid mortality at 7 and 14 days after treatment, indicating they could help control aphid populations early in the season before natural enemies appear.

From OP's to Neonics: Pesticide Detections in Oregon Streams (1999-2020)

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Keywords: organophosphate, chlorpyrifos, diazinon, malathion, neonicotinoid, imidacloprid, acetamiprid

Abstract: The Pesticide Stewardship Partnership (PSP) program has been collecting data on pesticide detections in Oregon streams since 1999 when high levels of organophosphate insecticides were found in the Hood River watershed. The number of watersheds being sampled has expanded and, currently, nine watersheds have active PSP programs. These include some major fruit growing areas in the Mid-Columbia region (Hood River, The Dalles, and Milton-Freewater), four watersheds in the Willamette Valley, and the middle Rogue Valley. The list of materials being sampled has also expanded and currently consists of 196 analytes. Sampling for imidacloprid was initiated in 2008 and for acetamiprid in 2011. Most of the pesticide detections at present are herbicides, however, most of detections at levels above the current aquatic life thresholds are insecticides due to their potential impact on the aquatic invertebrate fauna. Since testing for imidacloprid began, it has consistently been the pesticide most often detected above the aquatic life threshold. In addition to imidacloprid, the other insecticides that have been detected most frequently above the threshold level are chlorpyrifos, diazinon, and malathion. Trends in the detections of various pesticides and the limitations of the data set will be discussed.

From the Mouths of Growers: Survey Results Assessing Critical Uses of Chlorpyrifos in Oregon

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Keywords: chloryprifos, grower survey, Lorsban

Abstract: We surveyed Oregon specialty crop producers in February 2021 using an online Qualtrics survey to assess grower uses of chlorpyrifos and interest in IPM strategies. There were 106 respondents, of which 64% were growers. While the survey primarily targeted grass seed, clover seed, onion and cherry producers, responses were provided for over 30 specialty crops. Tree crops (No. responses) represented within the survey were hazelnuts (6), cherry (8), apple (5), Christmas trees (5), pears (2) and peach (1). As expected for a broad spectrum insecticide, respondents identified a wide range of pests they currently use chlorpyrifos to control, including piercing/sucking insects (aphids, scale), soil dwelling insects (maggots, symphylans, cutworms), and foliar pests (armyworms, webworms, weevils). The three pests cited most frequently were maggots, symphylans and cutworms. Within tree crops, growers most frequently identified aphids and scale as the pests they are using chlorpyrifos to control. 97% of respondents reported using some type of IPM strategy before applying chlorpyrifos, with 89% of respondents reporting that they monitor or scout for pests for applying chlorpyrifos. 68% of respondents reported waiting until they reached an action threshold before applying chlorpyrifos. Only 12% of respondents reported using non-chemical IPM strategies before applying chlorpyrifos.

Developing New Organic Management Tools for Codling Moth

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Keywords: Cydia pomonella, apple, pear ester, kaolin, diatomaceous earth

Abstract: Several agricultural industry-funded trials conducted in 2021 demonstrated an improved effectiveness with spray programs not relying on the repeated use of the granulosis virus for control of codling moth (CM). These trials were conducted during a summer with historic high June-July temperatures, and our results suggested that the heat wave diminished the effectiveness of the virus and increased the effectiveness of horticultural mineral oil. We found across several trials that the virus (3 oz per 100 GPA) did not improve the use of oil (1%) alone. Similar results were obtained with Virosoft CP4 and Cyd-X HP. Perhaps because of the heat several new spray approaches were developed, and our results demonstrated that the level of CM control achieved with virus plus oil program could be significantly improved with the alternate use of kaolin (Surround, 25 lb per 100 GPA) or diatomaceous earth (Celite, 5 or 10 lbs per 100 GPA). For example, fruit injury in one 9-spray trial was 70% lower with diatomaceous earth plus a spreader than with virus plus oil. In a second trial with 7 sprays, fruit injury from CM was 80% lower with kaolin clay plus oil versus virus plus oil in a block with overhead irrigation. Thinking "outside-the-box" by Dr. Basoalto led us to test whether a microencapsulated formulation of pear ester (CIDETRAK® DA MEC) added to either Celite or Surround could further reduce injury levels. Adding CIDETRAK DA MEC further reduced injury 20-30%. This may have occurred because female CM lay most eggs off the fruit in the first generation and CIDETRAK® DA MEC has been shown to enhance larval wandering prior to attacking fruit and improve the efficacy of many insecticides 40-60%. Our hypothesis is that the enhanced wandering on the plant covered with clay or diatomaceous earth enhances their various physical modes of action, i.e. desiccation, coating mouthparts and legs, or displacement from the plant. The use of kaolin with oil reduced levels of sunburn compared with the virus plus oil program. The kaolin plus oil program also increased median fruit size (100 to 88) and no secondary pest problems occurred. The preliminary 2021 studies examined a limited number of approaches which could be developed with these insecticides. Expanded studies for 2022 will evaluate the importance of spray rates, timing, product rotation, and spray frequency in comparison with standard virus plus oil programs.

Biology/Phenology—

Moderator: Kadie Britt
(UC-Riverside)

Finally! Establishment of a Laboratory Colony of Filbertworm

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Keywords: Rearing, Lepidoptera, *Cydia latiferreana*

Abstract: In 2013, we began the arduous process of establishing a laboratory colony of filbertworm (FBW) to enhance our research efforts. In 2021, we are pleased to report that we have finally established a sustainable colony. Improved rearing protocols, including larger cages, dusk lighting and presence of fresh or frozen maturing hazelnuts, have increased oviposition 14-fold. In 2021, we collected over 57,000 FBW eggs and are currently collecting eggs from the 7th lab-reared generation. Though we feel that we have finally optimized oviposition, challenges remain in the optimization of larval development. Preliminary analysis suggests that no more than 10% of eggs collected develop successfully into adults. Possible explanations for this include suboptimal diet and cannibalism of eggs and/or larvae. Here we discuss the factors affecting ovipositional success and challenges with larval development and survival.

Challenges for Successful Management of Bud Mites in Hazelnut

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Keywords: Bud mites, hazelnuts

Abstract: Filbert bud mite is the common name recognized by the Entomological Society of America for the *Phytoptus avellanae* s.l. (Nalepa) (Acari: Phytoptidae), but it and another species, *Cecidophyopsis vermiformis* (Nalepa) (Acari: Eriophyidae), are colloquially referred to as "big bud mite" as both species cause galls in floral buds, vegetative buds, and catkins of European hazelnut, *Corylus avellana* L. in production regions worldwide. *Phytoptus avellanae* may represent two cryptic species, with one form that has a heteromorphic '*Tegonotus*-like nymph' that is a vagrant and is not associated with the bud galls. Infestations of these mites cause galls in dormant buds, which expand in a popcorn-like fashion, and fall from the tree in many cases. We have observed up to 30% bud infestation in orchards so seems logical to assume a significant effect on yield, yet economic impacts of big bud mite infestations are poorly understood. Our research is indicating that galls on buds can sometimes develop into shoots, and even nut clusters depending on cultivar. Regardless of realized impacts on yield, infestations of bud mites are very apparent on trees coming out of dormancy, and infested orchards are often treated with acaricide. Grower management success is typically very low. Major challenges include rapid re-infestation, interference with biological control, and material selection. However, spray timing is perhaps the biggest limitation. The literature suggests that the optimal timing for treatment with a residue-active acaricide is when 50% of mites have exited the blasted buds to migrate to new axillary buds. However, this target is very difficult for growers, and they often use a "shotgun approach". Early sprays are ineffective because the majority of the mite population is protected in the galls. Our research indicates that the early sprays may be also very harmful to predatory mites (Phytosiidae), which also overwinter in buds and migrate earlier. Late sprays are ineffective because the majority of the mite population has migrated to the new axillary buds. Monitoring the migration of mites is involves regularly counting mites that are caught on double-sided adhesive tape or sticky glue attached on shoots bearing blasted buds under magnification.

Monitoring is difficult, time-intensive, and therefore is not regularly performed by pest managers. Thus, a phenology model that could predict the optimal timing would be highly beneficial to increase efficacy and reduce the number of treatments applied. We have been monitoring mites and conducting trials for six years in Oregon's Willamette Valley, where 99% of the US hazelnut crop is produced. From these data we are developing a rudimentary phenology model and making other compelling observations on the phenology and management of these mites and their predators

Influence of Winter Cover Crops on Navel Orangeworm Populations in California Almond Orchards

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Keywords: ground cover, navel orangeworm, almond,

Abstract: Use of winter cover crops in orchards has typically focused on their ability to increase biological control by supporting beneficial insects or reduce pest densities by acting as a trap crop. In almond orchards, these processes are not likely to be enhanced enough by winter cover crops to increase regulation of navel orangeworm (Pyralidae: *Amyelois transitella*) (NOW) below the requisite 2% damage threshold. Here, we conducted a 2-year study to evaluate the influence of winter cover crops on survival of overwintering NOW larvae in mummy nuts placed into different cover crop treatments (bare soil control, pollinator mix, soil builder mix). We also measured the effect of cover crops on egg deposition by first flight adult NOW in the spring. Each year, cover crop plots were sown in the fall, and each month from November to February multiple cohorts of NOW-infested mummy nuts were placed into each plot. In March, mummy nuts were removed and all NOW reared out to evaluate survival. Egg traps baited with mummy nuts were then placed at ground level to evaluate egg deposition by first flight adults from March to June. Results indicate that mummy nuts residing in either cover crop treatment for at least 2 months tended to have lower survival of overwintering NOW, possibly due to changes in abiotic conditions or increased decomposition of mummies. Egg deposition was also lower in the cover crop plots, likely due to the biomass impeding female NOW from locating and accessing mummy nuts in the cover crops.

Contextualizing data from historic flatheaded borer specimens in contemporary research

Erica Rudolph[1], Nik Wiman[1]
[1]Oregon State University

Key words: Flatheaded borers; Buprestids; *Chrysobothris mali; Chrysobothris femorata*

Abstract: Chrysobothris mali and *Chrysobothris femorata* (Coleoptera : Buprestidae) are economically important wood boring beetles in western North America. Both species are highly polyphagous, feeding on deciduous trees involved in fruit and nut production as well as shade trees grown as nursery stock. *C. femorata* is widely distributed across North America, while *C. mali* is only found in the west. The biology of both species is poorly understood, but there is a notable lack of information in the west, where losses of up to 30% have been recorded in establishing hazelnut orchards. To lay the groundwork for future work with these species, label data was collected from specimens residing in the entomology collections at Oregon State University, Washington State University, and the University of Idaho. The data collected from these institutions was also combined with available databases from the California Academy of Sciences. The data collected from these historic specimens provides insights into flatheaded borer biology across wide geographic and temporal ranges. The results of this historic specimen analysis can be compared with the results of contemporary trails, conducted nearly 100 years later. This allows researchers to obtain a more robust understanding of the biology of these understudied, yet economically impactful, re-emerging pests.

Behavioral Responses of Adult and Nymphal Brown Marmorated Stink Bug, *Halymorpha halys* (Hemiptera: Pentatomidae), to Hazelnut-produced Volatiles

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Keywords: Brown marmorated stink bug, *Corylus avellana*, electroantennography, *Halymorpha halys*, hazelnut, plant volatile compounds, olfactometer bioassays

Abstract: Brown marmorated stinkbug (*Halymorpha halys*) (Hemiptera: Pentatomidae) is a highly polyphagous invasive insect that has feeds on numerous crops and ornamental and wild hosts during all mobile life stages. The attraction of *H. halys* to the male-produced aggregation pheromone has been well-documented, and, since the development of commercial pheromone-baited lures, used in monitoring programs to track and manage *H. halys*. Adding host-plant semiochemicals blends to commercial lures has been found to increase their attractiveness to *H. halys* in some cases. However, the effects of plant-produced volatile organic compounds (VOCs) on *H. halys* behavior can differ based on the semiochemical context in which the VOCs are encountered and the life stage of the insect. Adults and nymphs have exhibited differing or even opposite responses to the same VOCs in some studies.
Identifying host-plant VOCs or combinations thereof that attract, arrest, deter, or repel *H. halys* or that increase the efficacy of commercial lures could provide new strategies for managing this economically important pest. To determine which VOCs may affect *H. halys* foraging behavior in hazelnut orchards, we used electroantennography to compare the physiological responses of *H. halys* adult and nymphal antennae to VOCs extracted from hazelnut trees. Single-choice olfactometer bioassays were conducted to determine whether *H. halys* were attracted by VOCs that elicited antennal responses. We compared behavioral responses young nymphs (2nd and 3rd instar), older nymphs (4th and 5th instar), and adult males

and females to five VOCs. Preliminary results indicate some differences between adult and nymphal responses, with variation in which compounds were most attractive to adults compared to nymphs.

Minutes of the 94th Annual Meeting

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

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	1-10-2020 Date
Rodney Cooper, Chairperson	1-11-2020 Date
Arthur Agnello, Past Chairperson	unable to attend Date
Allison Walston, Chairperson Elect	Jan 10, 2020 Date
Elizabeth Beers, Program Chair	unable to attend Date
Nik Wiman, Treasurer	01-10-2020 Date
Alix Whitener, Secretary	10 January 2020 Date

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

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