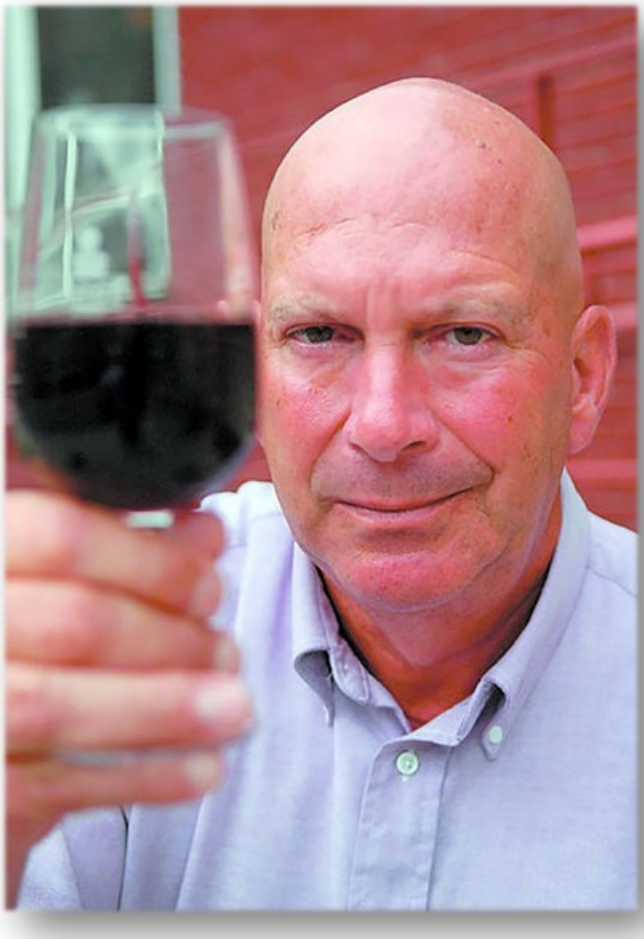
# 2018

# Orchard Pest and Disease Management Conference

The 92nd Conference is pleased to announce our keynote speaker:



## Harvey Reissig

Professor Emeritus, Cornell University

*Keynote Address:*

**What I Learned About Tree-fruit IPM Working 40 Years for Cornell, or: Reflections from a retired "Nozzlehead"**

Hilton Portland, Portland, Oregon
January 10-12

# Dr. Harvey Reissig

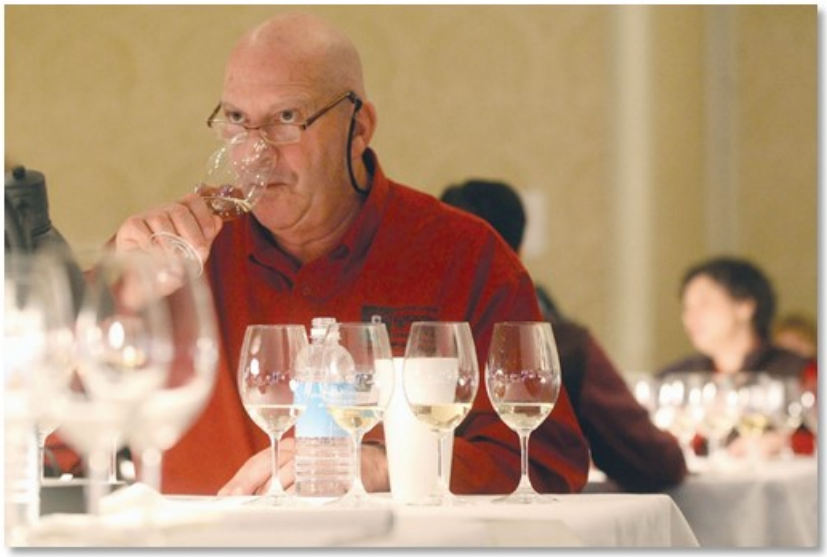
Dr. Harvey Reissig is a Cornell University professor of entomology and stationed at the New York State Agricultural Experiment Station in Geneva.

He has helped to guide the statewide IPM program in tree fruits for over 30 years focusing much of his research on pests of apple with significant contributions to our understanding the biology and management of leafrollers and apple maggot.

His research into understanding and managing pesticide resistance in orchards is extensive. Most recently he has served as the director of Pesticide Management Education Program at Cornell.

Reissig received B.S. and M.S. degrees in entomology from Kansas State University in 1969 and 1970, respectively. He received his Ph.D. in entomology in 1973 from Oregon State University (Go Beavers!). Harvey was named assistant professor in the Department of Entomology at Geneva in 1973, associate professor in 1978 and full professor in 1986. He has authored or co-authored more than 100 papers in refereed journals, many others in non-refereed research publications, and given numerous presentations at local, national and international levels.

Reissig is a member of the Entomological Society of America, the New York State Horticultural Society, the New York State Agri-Business Society and the American Wine Society. Everyone that knows Harvey Reissig will attest that he is a wine enthusiast! He has visited wineries in the Napa and Sonoma regions in California and extensively toured Finger Lakes vineyards for 30 years. He also regularly serves on tasting panels and as a judge for wine competitions and has published regularly in The Fingerlakes Times under "The Grape Guru".



# 92nd Annual Orchard Pest and Disease Management Conference

# Orchard Pest and Disease Management Conference
# 2018 Agenda

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

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

| Wednesday, January 10th | |
|---|---|
| 8:00 AM | **Registration/Name Tag Pickup** |
| 9:00 AM | **Opening Business**—*Harvey Yoshida, OPDMC Chair* |
| 10:00 AM | Biology/Phenology—*Moderator: Louis Nottingham (WSU)* |
| 11:30 AM | **Codling Moth Control in the Canadian Okanagan: 25 years of SIT. Now What?** (Tesche) |
| 12:00 PM | **Lunch (on your own)** |
| 1:30 PM | Mating Disruption/SIR—*Moderator: Chris Adams (MSU)* |
| 2:15 PM | **Food Narrative Project: An Empirical Approach to Increasing Public Understanding of Farming Practices** (Gut) |
| 2:30 PM | Implementation—*Moderator: Larry Gut (MSU)* |
| 3:00 PM | **Coffee Break** |
| 3:30 PM | *Keynote Address:*<br>**What I Learned About Tree-fruit IPM Working 40 Years for Cornell, or: Reflections from a retired "Nozzlehead"**<br>Harvey Reissig, Professor Emeritus, Cornell University |
| 5:00 PM | **Adjourn** |
| 5:00 – 7:00 PM | **No Host Mixer (Hilton)** |
| **Thursday, January 11th** | |
| 8:00AM | Implementation (cont'd) |
| 8:45 AM | Thresholds/Monitoring—*Moderator: Chuck Burkes (USDA-ARS)* |
| 9:45 AM | **Coffee Break/Poster Session** |
| 10:15 AM | Biological Control—*Moderator: Peter Shearer (WSU)* |
| 11:30 AM | Entomology for Fun |
| 12:00 PM | **Lunch (on your own)** |
| 1:30 PM | Invasive Species—*Moderator: Alix Whitener (WSU)* |
| 3:15 PM | **Coffee Break** |
| 3:45 PM | Invasive Species (cont'd) |
| 5:00 PM | **Adjourn** |
| **Friday, January 12th** | |
| 8:00 AM | Chemical Control/New Products—*Moderator: Barat Bisabri (Bisabri Ag Research & Consulting)* |
| 10:15 AM | **Closing Business**—*Harvey Yoshida, OPDMC Chair; Arthur Agnello, Chair-Elect* |

**Orchard Pest and Disease Management Conference**
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**For information, see:** http://opdmc.org/

## Order of Presentations
## FROM THE 92nd ANNUAL

# ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE

### January 10, 11 & 12, 2018

| Keynote Presentation: Wednesday, 3:30pm – 5:00pm* |
|---|
| **What I Learned About Tree-fruit IPM Working 40 Years for Cornell, or: Reflections from a retired "Nozzlehead"**<br>Harvey Reissig, Professor Emeritus, Cornell University |

| Special Presentation: Wednesday, 11:30 AM* | Special Presentation: Wednesday, 2:15 PM* |
|---|---|
| **Codling Moth Control in the Canadian Okanagan: 25 years of SIT. Now What?**<br>Melissa Tesche, Okanagan-Kootenay Sterile Insect Release Program | **Food Narrative Project: An Empirical Approach to Increasing Public Understanding of Farming Practices**<br>Larry Gut, MSU |

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# Biology/Phenology—

**Moderator:** Louis Nottingham (WSU)

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Biology/Phenology

## Molecular Gut Content Analysis to Pinpoint Where Pear Psylla Overwinter

W. Rodney Cooper and David R. Horton
USDA-ARS, Wapato, WA

*Keywords*: pear psylla, *Cacopsylla pyricola*, winterform, dispersal

*Abstract*: A factor complicating the management of pear psylla is the tendency of winterform psylla to disperse from pear orchards in autumn and overwinter on non-pear shelter plants, including on other dormant fruit trees, in windbreaks, and on evergreen trees and shrubs. It is not known whether certain shelter plants are more suitable than others for the overwintering survival of pear psylla. Better understanding of the landscape-level migrations of winterform pear psylla will substantially improve our ability to predict whether a given orchard is likely to receive a large post-winter influx of psylla (i.e., those orchards near favorable overwintering habitat) versus a small influx (i.e., those orchards surrounded by less-favorable habitat). We developed a PCR-based method to detect and identify plant DNA in the guts of psyllids, and are using the technology to identify what plant species are commonly fed upon by wintering psylla. Using this technique, we have found that winterform psylla feed upon numerous taxonomically diverse plants prior to the onset of winter, regardless of whether the psylla are collected from pear or from non-pear shelter plants. We are currently using this technique to identify what shelter plants winterform pear psylla had previously visited before immigrating into pear orchards in early spring.

## Updating the DeGrandi-Hoffman Apple Bloom Phenology and Honeybee Foraging Models: Implications for Orchard Management

Peter W. Shearer[1], Vincent P. Jones[1], Gloria DeGrandi-Hoffman[2], Henry Graham[2], Tory Schmidt[3], and Julian Andres Valencia Arbelaez[4]
[1]Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA;
[2]Carl Hayden Bee Research Center, USDA-ARS, Tucson, AZ;
[3]Washington Tree Fruit Research Commission, Wenatchee, WA,
[4] Plant Breeding Department, University of Caldas, Manizales, Caldas, Colombia

*Keywords:* honey bee, *Apis mellifera*, apple bloom phenology, foraging model

*Abstract:* Data were collected for bloom phenology of five cultivars and preliminary analysis showed that the majority of cultivars have similar bloom timing, with Cripps Pink being the earliest and Cosmic Crisp being the latest. Predictions of the daily honey bee foraging population generated from weather and bloom data accurately estimated the number of bees foraging on each apple cultivar. Additionally, predictions of honey bee foraging activity from the WSU Decision Aid System (DAS)-Honey Bee Foraging Model were highly correlated with actual foraging activity during apple bloom. This information will allow orchard managers to determine if adequate pollination has occurred and whether bee hives can be removed from the orchard for various reasons including pest management.

## Screening Honey Bees for Fungicide Exposure During Orchard Bloom - Implications for Honey Bee Health and Disease Management

Julianna Wilson and Jacquelyn Albert
Michigan State University, Department of Entomology, East Lansing, MI

*Keywords*: apple, tart cherry, fungicides, honey bees, pollination

*Abstract*: Honey bee hives are commonly rented for pollination during orchard bloom in Michigan. Blossoms and new shoots are vulnerable to diseases such cherry leaf spot and apple scab if not protected during bloom. While not likely to directly kill bees, fungicides are now thought to have sub-lethal effects on honey bees based on newer toxicology studies. The purpose of this project was to 1) quantify field-level exposure to fungicide residues during orchard bloom in Michigan, 2) determine what floral resources are important for honey bees during orchard bloom, and 3) begin to refine best management practices to balance the need for disease prevention in the crop with the need for strong honey bee hives providing pollination services.

## Movement of Navel Orangeworm Males and Females Between Adjacent Walnut and Almond Orchards

Emily Symmes[1], Jhalendra Rijal[2], and Chuck Burks[3]
[1]UC Cooperative Extension, Oroville, CA; [2]UC Cooperative Extension, Modesto, CA;
[3]USDA-ARS, Parlier, CA

*Keywords*: navel orangeworm, *Amyelois transitella*, dispersal, almond, walnut, California

*Abstract*: The navel orangeworm is sometimes an important pest of walnut, but it is not always clear whether damage is predominantly from resident populations, or moths entering from other fields and other crops. This distinction is important in determining the necessity of husk-split insecticide treatments, and relative importance of in-season and husk-split treatments. A recent study in indicates that monitoring navel orangeworm eggs or gravid females can provide better prediction of damage in almond compared to pheromone traps, but these female traps also have low detection levels compared to pheromone traps. We therefore used an analysis of fatty acid composition of navel orangeworm males and females, respectively trapped in pheromone and pistachio meal traps, to compare the number of residents and immigrants in the two trap types in adjacent almond and walnut orchards in the Sacramento Valley and the northern and southern San Joaquin Valley. Equal numbers of males from both crops were captured in pheromone traps in this study, whereas the proportion of females developed in walnuts was significantly greater in walnuts and less in almonds. The converse was true for females developed in almonds. These data indicate that female traps in walnuts provide more local information compared to pheromone traps. This information is being used to explore methods of comparing trap counts to reveal situations in which a resident navel orangeworm population is more important in almonds.

## Back to the Basics: Biology and Behavior of Filbertworm

Betsey Miller and Vaughn Walton
Oregon State University, Horticulture Department, Corvallis, OR

*Keywords*: filbertworm, *Cydia latiferreana*, hazelnuts, overwintering, pupation, emergence, oviposition, flight periodicity

*Abstract:* Filbertworm (FBW) is a key pest of hazelnuts in the Pacific Northwest. Recent efforts to develop a mating disruption program highlighted a need for a better understanding of basic biology and behavior of FBW. Controlled experiments with field-collected larvae demonstrated that disturbance of overwintering larvae may be an important control strategy. After 100 days of overwintering, percent survival of larvae with disturbed or intact hibernacula was 21.8 and 83.5, respectively. In a population of individuals reared under a controlled temperature regime, models indicated that 60% or greater of the population was in the larval stage up to 600 degree days (DD). The first adult emerged at 653 DD and after 1,000 DD, 80% or greater of the population had emerged. Two females were successfully mated. Each laid 5 eggs in the first week after mating and an average 10 eggs over three weeks. Mean percent egg hatch of 50, 75 and 85% occurred at 137.5, 212 and 300 DD after oviposition, respectively. Periodicity trapping data from two seasons demonstrated that FBW flight is not restricted to dawn and dusk. The only period where no flight occurred was from 1500 to 1700 hours. The most significant flight activity occurred from 1730 to 2330 hours and approximately two-thirds of all flight occurred between 1730 and 0500 hours. The majority of flights occurred when the temperature was 65 °F and light intensity was below 20,000 lux.

## Biology and Management of the Pacific Flatheaded Borer in Hazelnuts

Anthony Mugica, Heather Andrews, Aaron Heinrich, Kody Transue, and Nik Wiman
Oregon State University, Department of Horticulture,
North Willamette Research and Extension Center, Aurora, OR

*Keywords:* Pacific flatheaded borer*, Chrysobothris mali*, hazelnuts, damage, phenology, insecticides

*Abstract:* Oregon accounts for 99% of the hazelnuts produced in the United States, and with thousands of new acres being planted each year, a new pest problem has emerged. There has been substantial damage caused by Pacific flatheaded borer (PFB, *Chrysobothris mali*, Coleptera: Buprestidae) in new orchard plantings. The adult female PFB are attracted to young stressed or establishing trees; eggs are then laid on imperfections or wounds in the bark where larvae hatch and enter the cambium. Feeding can cause extensive girdling, which may result in flagging branches or even death of the entire tree once transpiration is disrupted. Even if the girdling process does not cause dieback, it compromises the tree's architecture, which can result in breakage years down the road if the tree bears a heavy crop load, or succumbs to strong wind. While cultural practices that reduce tree stress are preventative, roughly half of new plantings are treated with insecticides against PFB. Timing applications to coincide with the flight period of this pest are essential to optimize efficacy, but very little is known about the phenology of PFB. Current stop-gap management strategies include spraying of trunks with contact insecticides, applying soil drenches of imidacloprid, and applying cover sprays; all strategies that require knowledge of PFB phenology to be successful. There are no pheromones or traps for PFB, and buprestids in general are notoriously difficult to trap. In 2016 we surveyed several orchards in the Willamette Valley to determine

the damage rate at some of the most severely affected sites. In 2017 we followed PFB phenology and generated an emergence curve, and carried out chemical trials to test the efficacy of several treatments that could potentially be used against PFB. Two natural enemies of PFB were found in our samples. We also conducted a grower survey that generated data about crop loss, management strategies, and grower attitudes about PFB.

# Mating Disruption/SIR—

**Moderator:** Chris Adams (MSU)

Mating Disruption/SIR

## Codling Moth Control in the Canadian Okanagan: 25 years of SIT. Now What?

Melissa Tesche
Okanagan-Kootenay Sterile Insect Release Program, Kelowna, BC, Canada

*Keywords*: codling moth, *Cydia pomonella*, sterile insect release, area-wide IPM

*Abstract*: The Okanagan-Kootenay Sterile Insect Release Program (SIR) has been providing area-wide codling moth (CM) control in the Canadian Okanagan since the early 1990s. Release of sterile moths is the program's primary control tactic, supplemented by grower-applied sprays, cultural controls, and/or mating disruption when necessary. Collaborations between SIR, fruit growers, homeowners, and various governments have reduced codling moth populations in the Okanagan by over 90%. Codling moth damage at harvest is <0.2% in over 90% of the orchards serviced. Perhaps most importantly, reliance on chemicals for control has been greatly reduced—local sales data estimate a 96% reduction in pesticides used against the codling moth since 1991. The SIR program has evolved into a successful CM suppression program, but pome acreage is a fraction of what it was when the program started and the pest complex is constantly changing. The program is under pressure to provide support for other crops and pests, but is grappling with the technical, political, and financial realities of providing area-wide services. The million dollar ($3.2M annually, actually) question is, "What now?"

## Potential of SIT for Codling Moth Management in Michigan

Christopher Adams, John Pote, and Larry Gut
Michigan State University, Department of Entomology, East Lansing, MI

*Keywords:* SIR, sterile insect release, SIT, sterile insect technique, codling moth, *Cydia pomonella,* over-flooding ratio, suppression, IPM, bio-pesticide

*Abstract:* Codling moth (CM) is the principal internal fruit feeding pest of apple that growers must control to produce marketable crops. Managing this key pest is very challenging for Michigan fruit growers due to the loss of compounds through restrictions or resistance. The sterile insect technique (SIT) approach entails sterilization of mass reared insects that are subsequently released in large numbers to compete with the wild males for mating with wild females. The mass rearing facility in Okanagan, British Colombia, where these insects are reared and released, has demonstrated the effectiveness of this technique over the last 25 years of operation. Over the past four years Michigan State University has worked in collaboration with the Canadian SIT program to import these insects and investigate fundamental questions about movement and trapping. We now turn our attention towards the applied side to investigate their potential use as part of an IPM program in Michigan orchards. The Canadian program was originally designed for eradication of the wild population and thus applied moths at an unspecified over-flooding ratio in every other row of all treated orchards. Knowledge gained from our fundamental research suggests that there are opportunities for optimization. We investigated the pattern of release needed for uniform distribution of the released population and the sterile to wild ratio required for suppression. We found that moths released at discrete locations quickly distributed themselves across a wide area. Additionally, SIT moths provided complete suppression of marked "wild" moths at a sterile to wild ratio of 40:1 in orchards under mating disruption.

## Effect of Time of Treatment on Suppression of Sexual Communication in the Navel Orangeworm, and Implication for Mechanism of Mating Disruption

Chuck Burks[1], Don Thomson[2], and Christeen Abbott-Hearn[3]
[1] USDA-ARS, Parlier, CA; [2]Pacific Biocontrol, Vancouver, WA; [3]Pacific Biocontrol, Kingsburg, CA

*Keywords*: navel orangeworm, *Amyelois transitella,* mating disruption, pistachio, almond, California

*Abstract*: The navel orangeworm, *Amyelois transitella* Walker (Lepidoptera: Pyralidae), is an important pest of California nut crops which is frequently controlled with timed aerosol mating disruption. The pheromone is expensive to produce, so there is interest in reducing the amount used. Experiments therefore examined the period and number of hours of emission per night needed to suppress male location of pheromone sources. In late April and May, suppression of males in pheromone traps was not different between aerosol emitters dispensing 12 hours per night compared to emitters dispensing 8 hours per night. From late May through August, emitters that began dispensing 6 hours before sunup suppressed males in pheromone traps equally well whether treatment ended at sunup, or one or two hours earlier. During cooler periods in October, emitters that dispensed starting either 6 hours or 12 hours after sundown suppressed males captured in pheromone traps, whereas dispensers starting 6 hours before sunup provided little or no suppression of males in pheromone traps. When aerosol dispensers were turned off, the number of males captured in pheromone traps were not different between untreated control plots and plot that had previously been treated with mating disruption. The effect of emission from aerosol dispenser on location of pheromone sources therefore seems to last a couple of hours, but less than 24 and probably less than 12 hours. These results indicate that camouflage is not the sole or primary mechanism of navel orangeworm mating disruption with the current formulations. The findings suggest that it is more important to treat from the start of the period of sexual activity than to treat until the end of that period.

## Comparison of Suppression of Sexual Communication by Non-Attractive and Attractive Passive Mating Disruption Formulations for the Navel Orangeworm

Chuck Burks[1], Bill Lingren[2], and Lino Salinas[1], and Matt Hicks[1]
[1]USDA-ARS, Parlier, CA; [2]Trécé Inc., Adair, OK

*Keywords*: navel orangeworm, *Amyelois transitella,* mating disruption, pistachio, almond, California

*Abstract*: Mating disruption has been used for management of navel orangeworm, *Amyeolis transitella* Walker (Lepidoptera: Pyralidae) in an increasing proportion of California almond and pistachio acreage, but more options and greater cost-effectiveness could nonetheless further increase adoption of this environmentally friendly management technique. Previous studies have suggested a non-competitive mechanism for current mating disruption formulations, and suggested that an aerosol formulation with a more complete blend disrupted sexual communication more effectively. Data from the current study demonstrate that hand-applied dispensers containing the major aldehyde pheromone component by itself are not attractive, whereas the aldehyde in combination with minor polyunsaturated long-chain hydrocarbon is attractive. Hand-applied dispensers with the attractive formulation disrupted sexual communication more effective than dispensers with the non-attractive formulation. These data suggest that mating disruption for navel orangeworm with hand-applied dispenser can be improved by use of the attractive two-compound formulation.

# Implementation—

**Moderator:** Larry Gut (MSU)

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Implementation

## Food Narrative Project: An Empirical Approach to Increasing Public Understanding of Farming Practices

Larry Gut
Michigan State University

Keywords: IPM, integrated pest management, communication

*Abstract*: The Farming and Food Narrative Project traces its origins back to the desires, frustrations, and obstacles faced by agricultural scientists trying to communicate IPM to policymakers and the public. As the project has evolved, its ambitions have grown – from the desire to simply elevate awareness of IPM to a broader goal of breaking through the polarized simplicity that characterizes much of current discourse on food and farming (e.g., conventional vs. organic, GMO vs. non- GMO). Understanding that more information, better science, better writing, or clever slogans will not turn this around, the project is pursuing a methodical, empirical inquiry into effective ways to (1) increase knowledge and understanding of farming practices and (2) influence the public' s opinion's, behavior, and policy preferences around farming. This project is a unique collaboration among the social scientists at FrameWorks Institute, IPM scientists and NGOs, such as IPM Voice and Red Tomato. The Farming and Food Narrative Project relies on Strategic Frame Analysis®, an approach to reframing social issues pioneered by FrameWorks. This "two-science" approach to science translation involves close collaboration between scientists and communications researchers. The methodology can be summarized as follows: (1) Map the terrain: use expert interviews to clarify the scientific concepts that would guide informed decisions; use cultural model's analysis to develop a systematic understanding of public thinking on the topic; conduct a gap analysis comparing the two. (2) Develop a strategy that can navigate to new terrain; develop and test a set of communication approaches and outcomes and develop recommendations based on the findings. (3) Make the reframing strategy transparent; make the new framing content useful to the field. Translate the recommendations into formats that allow advocates for good farming practices to appreciate and adopt them. Through the use of this evidence-based framing strategy, the Project will create a re-framed farming and food narrative, which incorporates IPM as an important element that can be utilized by a diverse group of people and organizations. Changing the narrative is a necessary part of, and often precedes, the change of a system, a policy, or practices. Leaders of food and farm organizations who understand framing and the science behind effective communications can be more strategic and collaborative in their efforts to engage the public and help people see the connections between how we farm, how we eat, and how this impacts our communities, our health, and our environment.

## Developing Integrated Approaches for Pear Psylla Management

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*Keywords:* pear psylla, *Cacopsylla pyricola* (Förster), IPM, reflective film

*Abstract:* Successful management of pear psylla in the Wenatchee Valley, WA is challenged by insecticide resistance, lack of effective products and difficulty gaining adequate spray coverage. These issues have forced many growers to increase the number and frequency of pesticides used per growing season,

decimating potential contributions from predators and parasitoids. Psylla sprays occurring from late winter to bloom rely on broad-spectrum organophosphates and pyrethroids. Despite the potency of these sprays, control efficacy is usually mediocre due to the winterforms' high mobility and gradual migration out of overwintering sites. Without the advent of a more effective adulticide, developing an alternative(s) approach to managing overwintered adults is necessary. One such method is repelling insects with reflective polyethylene films, which has demonstrated success against numerous insects including the closely related Asian citrus psyllid. In early March of 2017, small field plots were established in a pear orchard at the WSU-TFREC with reflective film, black film and no film. Reflective film plots exhibited significant reductions in psylla adults, eggs and nymphs compared with black film and no film plots through early May. Numbers of psylla eventually leveled and were sometimes higher in reflective plots in mid to late summer. These results suggest that reflective films have potential for psylla management in the early season, but further research is necessary to determine specific protocols for commercial implementation.

## Spray Drift Mitigation Using Opposing Air-Blast Sprayers

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*Keywords*: Drift, mitigation, coverage, mortality

*Abstract*: The objective of this study was to determine the spray deposition on off-site areas from a PTO sprayer, comparing several methods of application: 1) the grower standard application, where a single sprayer sprays between rows one and two, then returns along the outside of the orchard to spray the outside of the row; 2) two sprayers driving and spraying parallel to each other on the outside row; and 3) similar to method 2, but the outside sprayer applies only air into the orchard, followed by the inside sprayer returning along the outside of the orchard to spray the outside of the row. A spray volume of 125 gallons water/acre + 1% horticultural oil was applied at 2.0 miles per hour using air-blast PTO speed sprayers. Drift was measured using water-sensitive papers placed 25 ft, 37.5 ft, 50 ft, 100 ft, and 150 ft from the dripline and downwind from the orchard, in an open field. Canopy coverage was estimated in separate trials using aluminum cans wrapped in glossy paper, with dyed spray solution. Navel orangeworm mortality tests with Intrepid 2F were conducted with the coverage trials to confirm results with the coverage data. Treatment 3 resulted in significantly reduced drift coverage of the canopy compared to the grower standard. Treatment 2 resulted in significantly higher drift, but also significantly improved coverage in the canopy compared to the grower standard. Navel orangeworm mortality results support the coverage data.

# Area-Wide Program to Eradicate the European Grapevine Moth, *Lobesia botrana* in California, USA.

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*Keywords*: mating disruption, invasive species detection, European grapevine moth, EGVM, eradication, grape pests, regulatory program, quarantine pest.

*Abstract:* In the fall of 2009, the first confirmed North American detection of the European grapevine moth (EGVM), *Lobesia botrana*, was made in Napa County, California. Based on its status as a significant grape pest in other parts of the world, the establishment of EGVM in California presented significant production and export issues for grapes, as well as for other fresh market agricultural commodities. Over the past seven years, an intensive California statewide survey and area-wide eradication campaign was undertaken in partnership in cooperation with agricultural officials at local, state, and Federal levels; university scientists; and the wine, table grape, and raisin industries. These efforts resulted in a dramatic decline in moth captures from over 100,000 moths in 2010, to one in all of 2014, and none in 2015. In August of 2016, eradication was declared from all previously infested areas in California, USA.

The eradication campaign employed a coordinated logistical, regulatory, and technical effort that included: 1) a statewide monitoring effort using a network of moth pheromone traps and in field monitoring; these results were placed into a geographic information mapping system and was used to regularly communicate survey results to program officials; 2) an area-wide application of hand-applied mating disruption dispensers to all infested grapes including use in urban environments within infested zones; 3) treatment coordinators implemented area-wide applications of insecticides with application timing determined by degree day modelling for each infested region; 4) a robust regulatory program that initiated and maintained a quarantine of infested areas that regulated movement of fruit, farming equipment and winery processing wastes; 5) an extensive outreach program to grape growers, wineries, pest control specialists, and the public; 6) a technical advisory group was formed along with a robust methods development and research effort to provide guidance to the operational program and to develop and test tools needed to support the program.

An extensive methods development effort supported the program and included developing enhanced detection methods for vineyards under mating disruption, testing efficacy and residual control of insecticides, testing mating disruption formulations, evaluating the impacts of winery processing methods on EGVM mortality, developing methods to determine EGVM biofix to improve degree day models in California, developing EGVM rearing methods, testing the quality of pheromone lures and trap monitoring; and a spatial analysis of trapping data to determine program effectiveness and to analyze invasion pathways.

# Prospects for Development of an Area-Wide Control Program of Navel Orangeworm Affecting Tree Nuts in California

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*Keywords*: mating disruption, area-wide integrated pest management, sterile insect technology, SIT, navel orangeworm, *Amyelois transitella*

*Abstract:* The navel orangeworm (NOW), is a key pest of California tree nuts. These crops are planted on more than 1.9M acres and valued >$6.2B per year. For almonds and pistachios, tolerance to pest damage by NOW is extremely low given the relationship between NOW damage and aflatoxin and the low tolerance for insect damage in export markets.

There is extensive IPM information developed by industry, University of California, and USDA research including from a previous area-wide demonstration project conducted on several thousands of acres of almonds and pistachios. Available tools include orchard sanitation to destroy remnant nuts that harbor overwintering populations, improved pheromone and food bait trapping systems, degree day predictive models for treatment decision making, new more effective mating disruption blends, several effective pesticides, and an area-wide release program to inoculate orchards with a benign *Aspergillus flavus* strain that reduces aflatoxin producing toxigenic strains.

However, there are many concerns that these measures will not be sustainable for the long-term management of NOW. Significant factors causing changes in NOW pest status include the dramatic increase in acreage of almonds, pistachios and walnuts; the wide-host range and high dispersal capability of NOW, making field-by-field IPM control difficult; an increase in resistance to the most effective pyrethroids and reduced availability of previously effective pesticides; warmer winters and longer growing seasons which increase winter survival and provide longer favorable periods for NOW population growth; and difficulties in obtaining good coverage with pesticides in the dense canopies of mature orchards. Recent costs for all NOW control measures in almonds and pistachios may range higher than $400 per acre, yet this can still result in unacceptable levels of damage, with industry reports of record economic losses in 2016.

Recent interest in developing SIT for NOW led to a project to develop mass rearing and to evaluate effective sterilizing radiation doses at the APHIS-PPQ sterile pink bollworm production facility in Phoenix. SIT is complementary with other area-wide control measures and could function effectively with sanitation, mating disruption, and coordinated applications of pesticides; its addition could help the long-term sustainability of NOW management. Given the importance of sanitation for control of the critical overwintering population, using SIT on an area-wide basis at this stage could be particularly effective to guard against incomplete or late sanitation efforts or to reduce the impact of moths coming from surrounding host crops or vegetation. Targeting NOW at this stage would help limit the build-up of NOW populations in subsequent generations and may result in smaller numbers of moths being needed for release, which would allow the strategic use of sterile moths while production capacity is being developed.

Current NOW management tools are reviewed and an assessment is given as to what improvements and new tools are needed for an operational area-wide program, including how SIT could be integrated into an area-wide program. Prospects for implementation of regional, area-wide management are included in this discussion as well as comparisons to other established area-wide programs for moths that include SIT as a component. The dynamic nature of NOW pest management and its importance as a key pest argues for ongoing investments in multiple strategies to keep pace with the control of this pest.

## Evaluation of Four Mating Disruption Systems for Navel Orangeworm in California Almonds

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*Keywords*: mating disruption, navel orangeworm, *Amyelois transitiella*, Puffer NOW, Semios NOW, Isomate NOW, Cidetrak NOW

*Abstract*: Navel orangeworm, *Amyelois transitella* (Walker), is the most significant insect pest of California almonds. Damage includes direct feeding on the almond kernel that can also predispose almonds to infection by *Aspergillus* sp. Fungi, which produce aflatoxins. Typical management programs include dormant sanitation of mummy nuts coupled with one or two in-season insecticide applications. Within the past decade, significant advances in the understanding of navel orangeworm pheromones have led to the development of mating disruption systems. During 2017 we conducted trials on 300 acres of almonds to evaluate four different mating disruption systems for their impact on navel orangeworm populations and yields. This included two static-release dispenser systems using aerosol-based canisters from Suterra and Pacific Biocontrol, one variable-rate system using aerosol-based canisters where dispensers can be turned on and off remotely from Semios, and a static-release system using passive dispensers from Trécé. All four mating disruption products reduced male moth captures in pheromone traps by greater than 90%. This resulted in a 46% reduction in kernel damage (range 41 to 50%). Economic analysis across all products showed that average grower returns in mating disruption orchards were increased by $106 to $125 per acre. These results were consistent with the results of six larger side-by-side demonstration plots utilizing approximately 1,000 acres that showed that mating disruption increased crop value by an average of $143 per acre.

# Thresholds/Monitoring—

**Moderator:** Chuck Burkes (USDA-ARS)

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Thresholds/Monitoring

## How Can Tortricid Fruit Injury Still be a Thing? Recent Studies Developing Improved Monitoring Tools for Tortricid Pests

Alan Knight[1], Michele Preti[2], Valentino Giacomuzzi[2], Liliana Cichón[3], Esteban Basoalto[4], Wilson Barros-Parada[5], Valentina Mujica [6], Eduardo Fuentes-Contreras[7], Marcos Tasin[8], Júlia Jósvai[9], G. Krawczyk[10], Jim Walgenbach[11], Randy Hansen[12], and Gary Judd[13]

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*Keywords:* apple, peach, codling moth, *Cydia pomonella*, oriental fruit moth, *Grapholita molesta*, leafrollers, kairomones, host plant volatiles

*Abstract:* Effective, low-cost monitoring of key tortricid pests has been the backbone in the development of integrated management programs in deciduous tree fruits. With the adoption of sex pheromones for mating disruption (MD) the importance of monitoring has only increased. Despite nearly 45 years of success in utilizing just sex pheromones for monitoring, further improvement is possible for all of these species. Two major factors currently limit pest managers' monitoring of tortricid pests. First, in orchards treated with MD the use of lures with the same modality can be problematic for most tortricids. Second, tracking female moths through the season can provide a better indication of pest pressure and timing than available with the collections of only male moths, and can minimize the difficulty in assessing differential immigration of the two sexes into orchards. Probably no one here disagrees with these ideas; yet at present, monitoring of female tortricids in orchards is fairly uncommon. We feel that pest managers are likely stretched too thin and continue to believe they can be effective utilizing their current sex pheromone lure programs. As always, if the pest density is very low it is more than likely that current programs can avoid unexpected disasters. However, the economic driver in tree fruits around the world is to make money and develop sustainable, organic or conventional programs that have minimal worker health, consumer safety, and environmental degradation issues. Every year, including 2017, managers experience fruit losses from tortricids that were not expected or remain unexplained. We feel that the wise adage from George Santayana that those "who ignore history are doomed to repeat it" is pertinent to the management of tortricid pests. Thus, our work remains focused to provide new tools for managers to easily gather reliable and time-dependent data to manage tortricid pests. In that vein, our talk today will summarize recent collaborative results in the development of bisexual lures for codling moth, oriental fruit moth, and a large suite of leafrollers across much of the globe.

## Comparison of Monitoring Techniques in and Near Almonds and Pistachios Under Mating Disruption for Navel Orangeworm

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*Keywords*: almond, pistachio, navel orangeworm, *Amyelois transitiella*, monitoring, kairomone, phenyl propionate

*Abstract*: As use of mating disruption for control of the navel orangeworm *Amyelois transitella* Walker (Lepidoptera: Pyraliade) in California increases, it becomes more important to find non-pheromonal attractants that perform well for monitoring, both in the presence and absence of mating disruption. Accordingly, in a study running from June to mid-September we compared the performance of navel orangeworm traps baited with either phenyl propionate (PPO) or an attractive synthetic five-component kairomone blend (kairomone blend). The attractants were evaluated alone and combined with a pheromone lure in both almond and pistachio orchards that were either under navel orangeworm mating disruption treatments or in the vicinity of mating disruption. Under all tested conditions, traps baited with PPO alone and in combination with the pheromone lure (PPO-combo) captured more navel orangeworm adults than the kairomone blend alone, or, in three of the four sites, the kairomone blend with a pheromone lure (blend-combo). Traps baited with PPO alone capture more moths than traps baited with the kairomone blend alone and, under the conditions of this study, the attractiveness of both PPO and the kairomone blend were enhanced when presented with pheromone. These findings indicate that both the kairomone blend and PPO can serve for monitoring navel orangeworm in orchards under mating disruption treatments and in regions where mating disruption is common; but the more robust detection ability of PPO gives it an advantage for this application.

## Development of Sampling Methods for Pre-Season Mite Detection in Almonds

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*Keywords:* brown mite, *Bryobia rubrioculus* (Scheuten), clover mite, *Bryobia praetiosa* Koch*,* pre-season sampling, spider mite, almonds

*Abstract:* Several mite species that include brown almond mites, European red mites, and web-spinning spider mites are known to feed on almond leaves. Among them, the web-spinning spider mites are an economically important pest in almond production in California. The spider mites overwinter in orchard floor during the winter and move back to the tree canopy during the season. In practice, we only know the mite infestation after we see the damage on leaves (leaf stippling) in the Spring or later. If there are ways to quantify overwintering mite population in the soil and/or during their movement to the tree canopy from the ground, we can potentially use that knowledge for pre-season mite detection. The objectives of the study were 1) to develop pre-season sampling method(s) to detect and estimate overwintering mite population (using soil samples) and 2) to assess the mite population and timing using tree-band traps when they begin to move to the tree canopy. In our study, no spider mites were recovered from the soil or tree-band sampling. A substantial number of 'brown mites' were captured in tree-band

traps; however, based on its known biology, no brown almond mites were captured in tree trunks. Preliminary identification showed that the new species is a clover mite, *Bryobia praetiosa* which has wider ecological adaptation than the *B. rubrioculus*. Further study is needed to confirm this finding, and to develop a simple sampling protocol for potentially new 'brown mite.'

## Evaluating *Rhagoletis cerasi* Traps with Ammonium Acetate and Carbonate Lures Against Western Cherry Fruit Fly

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*Keywords:* European cherry fruit fly, *Rhagoletis indifferens*, yellow sticky strip, Rebell trap, CSALOMON® PALz trap

*Abstract*: European cherry fruit fly is a serious pest of cherries in Europe that was recently detected for the first time in eastern North America. It presence there emphasizes the need to conduct trapping surveys for it in cherry-growing regions in western North America. However, traps and lures targeting *R. cerasi* in most of those regions may also capture western cherry fruit fly (WCFF), cluttering traps and reducing survey efficiency. Here we compared the yellow sticky strip (YSS), the best trap for WCFF, with Rebell and PALz traps developed for *R. cerasi* and baited with ammonia compounds for catching WCFF in central Washington. The Rebell trap caught as many WCFF as the YSS, whereas the PALz trap caught fewer than both in two of three tests. Ammonium carbonate (AC) lures attracted more WCFF than ammonium acetate (AA) lures using YSS, Rebell, and PALz traps, whereas a 1:1 mix of AA:AC was no more attractive than AC alone. The sexes were equally responsive to AC, but females were more responsive to AA than males. Since the Rebell trap captures more WCFF than the PALz trap, the PALz trap would be preferred in *R. cerasi* surveys, assuming the traps are equally efficacious against *R. cerasi*. However, if the goal is to detect both fly species, then the Rebell trap should be used, taking into account that AC is more attractive than AA to WCFF.

# Biological Control—

**Moderator:** Peter Shearer (WSU)

Biological Control

## New York Survey of *Trissolcus japonicus* Populations in BMSB Trapping Sites

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*Keywords:* BMSB, brown marmorated stink bug, *Halyomorpha halys*, samurai wasp, sentinel egg masses, samurai wasp, *Trissolcus japonicus,*

Abstract: The samurai wasp, *Trissolcus japonicus,* was recently discovered in the Mid-Atlantic States, the Northwest coastal states of Oregon and Washington, and in the Hudson Valley of New York, captured by using flash-frozen sentinel eggs of brown marmorated stink bug (BMSB) in late August 2016. In August 2017, after weeks of placing freeze-killed sentinel BMSB egg clusters in the field, we began seeing emergence of samurai wasp. The eggs they parasitized were redistributed onto farms throughout the state. To date, we have placed over 2,300 *T. japonicus*-infested eggs in 28 release sites on NY farms in Monroe, Orleans, Columbia, Dutchess, Ulster, and Orange counties. In the Monroe Co. (Rochester area) orchard site, we have been able to successfully recapture the wasp using sentinel eggs. In the spring of 2018, we plan to re-visit the release sites and place freeze-killed BMSB sentinel egg clusters in the field to attract samurai wasps into visiting and parasitizing these eggs. Upon re-collecting the sentinel eggs and rearing them to adult emergence, we could confirm its establishment in these sites, in an effort to promote its future success at biological control of invasive BMSB around the state.

## Slaying Brown Marmorated Stink Bug by Samurai: Monitoring the Release and Dispersal of a Parasitic Wasp

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*Keywords:* brown marmorated stink bug, *Halyomorpha halys*, samurai wasp, *Trissolcus japonicus,* hazelnut, caneberry

*Abstract:* Samurai wasp (*Trissolcus japonicus*) is an adventive parasitoid wasp that attacks brown marmorated stink bug eggs (BMSB). Since its initial detection in the Portland metropolitan area, we initiated efforts to monitor its spread. In 2017, we began redistribution efforts by releasing adult wasps in 28 sites across Oregon. We investigated samurai wasp's ability to locate BMSB egg masses near release sites and its ability to disperse in caneberry fields and hazelnut orchards. Wasps located and parasitized egg masses at nearly 50% of release sites. Detection efforts were most successful in caneberry, and there was evidence that samurai wasps can locate egg masses as far as 160 feet beyond the point of release. Biological control using the samurai wasp is expected to increase in the coming years, and we discuss strategies that will enhance the success of release and detection efforts.

## Update on the Brown Marmorated Stink Bug and Biological Control Options in Washington State

Joshua Milnes and Elizabeth Beers
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Keywords: *Halyomorpha halys*, brown marmorated stink bug, *Trissolcus japonicus*, egg parasitoid, biocontrol, non-target effects, integrated pest management, IPM

*Abstract:* Invasive species can lead to negative effects on non-native ecosystems and agricultural production. One emerging pest of concern is the brown marmorated stink (BMSB, *Halyomorpha halys*). This invasive pest has caused catastrophic losses in the Mid-Atlantic States and insecticides have not proven to be very effective. In 2015, we detected an exotic egg parasitoid of BMSB, *Trissolcus japonicus* (samurai wasp) in Vancouver, WA. In 2017, we detected the samurai wasp for the first time in Walla Walla, Washington. This wasp is considered a key natural enemy of BMSB in its native range, and dispersal of this biological control agent across the Pacific Northwest may suppress BMSB to manageable levels. In the Pacific Northwest, BMSB threaten high-value specialty crops (e.g., apples, cherries, pears, hazelnuts) and the need for integrated pest management strategies to contain this pest is urgent. Our survey's goal is to determine the spread of the samurai wasp in eastern Washington, and to determine if its presence has non-target effects on native stink bugs. Further, we have made releases in areas where it is not known to occur (viz., Yakima, WA).

## Earwigs Control Aphids and do not Damage Apples: Experimental Evidence from Four Orchards

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*Keywords*: woolly apple aphid, *Eriosoma lanigerum*, earwig, *Forficula auricularia*, apple, predator

*Abstract*: European earwigs, *Forficula auricularia*, are very common in Washington State apple orchards. Interviews with 18 apple industry professionals indicate that there is high uncertainty about the potential positive and negative roles of these generalist omnivores in apple orchards. To address this uncertainty, in 2017 we added earwigs, removed earwigs, or did nothing within 8 tree by 2 row sections of apple orchards (3 treatments X 4 replications X 3 Fuji orchards) and monitored for woolly apple aphid colonies, earwigs, and fruit damage. At a fourth site, earwigs were added or removed from sections of a Gala orchard (2 treatments X 5 replications) in 2016 and monitored in 2016 and 2017. In earwig augmentation areas, woolly apple aphid colony densities never went above 1 colony per tree. In earwig removal areas, woolly apple aphid colonies were prevalent across the season and maximum woolly aphid densities reached 6 colonies per tree at the most infested section. A total of 11,950 apples were inspected within 5 days of harvest and scored for all types of damage. There was no evidence of greater damage in earwig-abundant vs. earwig-impoverished areas.

# Two Ways to Kill a Pest: Parasitism and Host-Feeding of *Pachycrepoideus vindemmiae* on Spotted-Wing Drosophila

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*Keywords:* spotted win drosophila*, Drosophila suzukii*, Parasitism capacity, Parasitism behavior, Longevity

*Abstract: Pachycrepoideus vindemmiae* is parasitoid with the potential to control the spotted-wing drosophila (SWD), *Drosophila suzukii*. Here we investigated how nutrition affects the biology and behavior of this parasitic species. Adults were offered (T1) honey, (T2) water, (T3) honey and water, and (T4) no honey and no water, in presence or absence of hosts (SWD pupae). Parasitism consistently declined as females aged, independently of treatment. Total parasitism varied from 301 to 438 SWD pupae, being highest in honey-fed females (T1 and T3). In host absence, T3 caused adults to live up to 6x longer than T4. In host presence, treatments did not affect longevity. However in T3, host presence caused longevity to be 0.6x that of host absence, i.e., parasitism activity reduced longevity of female parasitoids. In T4, host presence caused longevity to be 2.5x that of host absence, i.e., parasitoids practiced host-feeding on SWD. This behavior, as well as parasitism itself, were enhanced when females were dehydrated (T1 and T4), resulting in a higher fly mortality in comparison to water-offered treatments (T2 and T3). Females were found attacking SWD pupae exclusively to host-feed (not to perform parasitism) and such behavior could kill the pupae. Host-feeding did not affect the survival of *P. vindemmiae*'s offspring. Footage of individual parasitoid females foraging in arenas containing SWD pupae confirmed that both honey-fed and fasted females practice host-feeding. However, the time spent host-feeding was higher in fasted than in honey-fed females. Moreover, females that were fasted for 5 days host-fed for longer than females that were fasted for 1 day only. Future research will investigate the impact of nutrition on the parasitism of *P. vindemmiae* on SWD in blueberry fields.

# Entomology for Fun

Entomology for Fun

## State Insects and Fruits: Tales of Pests, Pollinators and Politics

Rick Hilton
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*Keywords:* California dogface butterfly, *Zerene eurydice*, Oregon swallowtail butterfly, *Papilio oregonius*, rain beetles, *Pleocoma* spp., honey bee, *Apis mellifera*, apple, pear

*Abstract:* Currently 47 states have given at least one insect official status as a state symbol. A number of states have designated multiple insects, usually a state butterfly in addition to a state insect. Twenty states have the honey bee as their official state insect. The stories of how these insects came to be recognized are often heartwarming tales of schoolchildren lobbying their legislators such as in the case of the California dogface butterfly. However, the story of the rain beetle's rise and fall as a proposed state insect for Oregon is a tale of petty politicians and pest versus pollinator.

Thirty-one states have adopted an official state fruit along with various other state nuts and state berries. The first official state fruit was the apple, which was recognized in West Virginia in 1972, and then amended in 1995 to specify the Golden Delicious apple. New York followed suit in 1976 also declaring the apple as state fruit. At this time, seven states, including Washington, have the apple or an apple variety as their official state fruit. Competing grower interests can make the declaration of a state fruit problematic as demonstrated by the story concerning the adoption of the pear as the official state fruit of Oregon.

# Invasive Species—

**Moderator:** Alix Whitener (WSU)

Invasive Species

## Phenology and Relation of Pheromone Trap Captures to BMSB Damage to Apples in North Carolina

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*Keywords:* brown marmorated stink bug, *Halyomorpha halys*, apple, pheromone trapping, damage

*Abstract:* The brown marmorated stink bug (BMSB) abruptly developed into the most important arthropod pest of apples in North Carolina in 2015. Initial pheromone trap monitoring programs showed that BMSB populations and damage to apples were highest during August and July. In view of the need for IPM incompatible pyrethroid insecticides to manage BMSB, studies were conducted to predict when BMSB damage is first inflicted so that applications of pyrethroid insecticides can be targeted to coincide with damaging bug populations. Studies were conducted in 14 different orchards over a two-year period to correlate the appearance of damage to a) captures in pheromone traps, b) calendar day, and 3) degree-day (DD) accumulations. Location of traps on the exterior or interior did not differ, and there was no significant relationship between trap captures and damage. The best predictor of BMSB damage was degree-day accumulation from 12 April (13-hr day length). Separate field cage experiments showed a minimum of 7 to 10 days was necessary for BMSB damage symptoms to be expressed on apples following exposure to adults. Initiation of insecticide sprays for BMSB is hence recommended to begin approximately one week before an accumulation of about 700 DD.

## Management of the Invasive Brown Marmorated Stink Bug in Apple Orchards Using Attract-and-Kill Technology

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*Keywords*: brown marmorated stink bug, *Halyomorpha halys*, pheromone, attract-and-kill, IPM

*Abstract*: The introduction of *Halyomorpha halys*, the brown marmorated stink bug (BMSB), in the USA has disrupted many established IPM programs for apple throughout the mid-Atlantic region. Following the identification of *the H. halys* pheromone and pheromone synergist as well as effective monitoring trap designs, we explored the potential for attract-and-kill (AK) implementation in commercial apple orchards to effectively manage the threat posed by this invasive species. Over two years at farms in New Jersey, Pennsylvania, Virginia, West Virginia, and Maryland, we found that the use of AK (perimeter row apple trees baited with pheromonal stimuli and treated with insecticides weekly) effectively controlled BMSB

compared with standard grower practices. At select AK-baited trees, over 10,000 BMSB individuals were killed in two growing seasons, while use of AK reduced the crop area treated with insecticide against BMSB by up to 97%. Using AK had no impact on the natural enemy or secondary pest community over the same period. Further optimization of AK including defining the 'trapping area' of pheromone lures as well as long-lasting insecticide treated nets has the potential to improve the overall adoptability of this approach by commercial growers.

## Field Evaluation of a Pheromone-Baited, Light Emitting Commercial Solar Powered Insect Trap for Brown Marmorated Stink Bug and Other Orchard Pests

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Keywords: phototaxis, brown marmorated stink bug, *Halyomorpha halys*, filbertworm, *Cydia latiferreana*, leafrollers, *Choristoneura rosaceana*

*Abstract:* We evaluated a commercial light trap that is designed to attract insects with phototactic behavior in commercial hazelnut orchards in the northern Willamette Valley, Oregon. Previous research has established that some of the key pests of hazelnuts such as brown marmorated stink bug (BMSB), filbertworm (FBW), and leafrollers such as obliquebanded leafroller (OBLR) are attracted to light. The combination of light and pheromone can be particularly attractive to BMSB. A typical limitation for light traps is wiring needed to power the light source at remote field locations. The trap we evaluated is very low maintenance as it is solar powered, and it is dark and temperature-activated so that the light is only illuminated when the ambient temperature is above a threshold in the absence of precipitation. The trap also has a self-cleaning cycle that prevents debris from dead insects from blocking the electrified grid. We tested the idea that such a trap could be utilized as a low-maintenance, multi-species pest kill station in an orchard, or at least as a multi-species monitoring trap. To test whether pheromones might further enhance light trap captures, we baited half of the light traps with pheromone lures for BMSB, FBW, and OBLR. Baited traps were also provided with ethanol lures that are attractive to wood boring beetles. Standard traps, including pyramid traps for BMSB, and baited delta traps for FBW, were also placed in the orchards to provide a basis for comparison with the light trap. Traps were checked weekly for target pests during the 2017 growing season. For the light traps, the catch was broken down into pest and beneficial insect groups.

## Brown Marmorated Stink Bug Trapping as a Potential Management Option

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*Keywords:* brown marmorated stink bug, *Halyomorpha halys,* insecticide treated nets, BMSB monitoring, pome fruit, stone fruit

*Abstract:* As the insecticide treatments remain the most effective tools to manage the brown marmorated stink bug (BMSB) *Halyomorpha halys* (Stäl) (Heteroptera - Pentatomidae) in Pennsylvania fruit orchards,

we also attempt to develop alternative methods to manage this pest in a more sustainable, environmentally responsible way. The BMSB monitoring studies from previous seasons, which included lure and trap design comparisons, documented the viability of BMSB field monitoring practices for accurate assessment of the actual BMSB pest pressure at least from mid-July until October. During the 2017 season we tested deltamethrin insecticide treated nets (D-Terrence net, Vestergaard Group, Lausanne, Switzerland) baited with BMSB monitoring lures (3x or 5x) either from Trécé Inc. (Adair, OK) or AgBio Inc. (Westminster, CO) to monitor BMSB populations around commercial apple orchards. Starting from late July, the treated nets were placed on 2.4 m high shepherd hooks and distributed outside of the apple blocks, at about 50 m distance between each net; however higher numbers of nets were placed in the direction of potential influx of BMSB from outside vegetation such as woods. To assess the number of BMSB adults and nymphs killed by nets, plastic tarps 1.8 m in diameter were positioned under some net stations. The standard BMSB monitoring sticky traps (Trécé Inc.) or container based Rescue traps (Sterling Int.) were used to assess the pest population in the orchards surrounded by the net traps and control blocks. At the peak BMSB activity periods high numbers of BMSB adults and nymphs, as well as native stink bugs were collected from tarps under the BMSB net traps. The numbers of BMSB captured by standard monitoring traps located inside the orchards surrounded by net traps were always lower than in the control apple blocks. Although the practical implications of our experiment with insecticide nets still remains to be determined, the results from the 2017 season are very promising and potentially can be used for the development of alternative BMSB trapping method(s).

## Development of Brown Marmorated Stink Bug Trap Catch Thresholds in Hazelnuts, Pears, and Cherries in the Pacific Northwest

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*Keywords:* threshold, brown marmorated stink bug, *Halyomorpha halys,* pears, cherries, hazelnuts, damage

*Abstract:* Brown marmorated stink bug (BMSB) is a serious economic pest in a variety of orchard crops grown in the Pacific Northwest. Action thresholds for BMSB caught in pyramid traps have been developed for apples in the Mid-Atlantic, but it is unclear how well these thresholds apply to orchard crops in the Pacific Northwest where production of tree fruits is more intense, climates and environments are different, and there is more genetic diversity in BMSB populations. Commercial lures for BMSB, consisting of a two-component blend of methyl decatrienoate (MDT) and murganiol, tend to be less attractive early in the season, which is when detection and trap-based decision support is critical, particularly for early crops such as sweet and tart cherries. Thus, it is important to determine how useful BMSB traps can be in these crops. Pyramid traps also have limited prospects for adoption by growers because they are very cumbersome, and so we investigated the possibility of using sticky cards as a decision-support trap. In the 2016 growing season we initiated trap threshold studies by deploying BMSB pyramid traps baited with three different lures on the edge and in the middle of hazelnut and pear orchards in the Willamette Valley. We expanded our trap trial in 2017 to include cherries, and added replicates of sticky cards affixed to poles at all sites. Traps were checked weekly throughout the spring/summer, and fruit/nut samples were collected biweekly and checked for BMSB feeding damage to develop a correlation between trap catch and crop damage, and begin examining action thresholds in these crops.

## Netting Applications for Direct Apple Pest Control

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*Keywords*: cage exclusion, shade cloth, biological control, brown marmorated stink bug, *Halyomorpha halys,* consperse stink bug*, Euchistus conspersus,* codling moth, *Cydia pomonella*, woolly apple aphid, *Eriosoma lanigerum, Aphelinus mali,* parasitoid, lacewings, syrphid flies, spider mites, Tetranychidae, predatory mites, Phytoseiidae

*Abstract:* Over the past 10 years, Washington apple growers have increased their use of shade netting to protect fruit from sunburn. Top cover only netting is typical, however, some structures enclose the entire orchard, thus the netting can become a barrier to certain direct pests including codling moth, *Cydia pomonella*, and stink bugs, *Euschistus conspersus.* Full enclosures could also exclude natural enemies from orchards resulting in a disruption of biological control. We conducted a two-year test on shade net exclusion of pests and natural enemies at a WSU research orchard using 4 large (4 rows x 12 trees) and 12 small (3 trees) netted cages, compared to conventional codling moth treated and untreated plots. Results from 2016-2017 indicate that direct pest densities and damage were lower in the cages than in the conventional (airblast) treatment and the untreated control. Woolly apple aphid densities were significantly higher in the caged plots, along with its parasitoid *Aphelinus mali*. No significant differences were found between treatment means for earwigs. Lacewings and syrphid flies capture rates on plant volatile baited sticky panels were greatly reduced in the cages compared to uncaged plots. Sunburn was also significantly reduced inside the cages. These outcomes show that netting can reduce direct pest densities and damage, but can also exclude important natural enemies and lead to secondary pest outbreaks.

## Brown Marmorated Stink Bug, *Halyomorpha halys,* in Southern Interior British Columbia, Canada

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*Keywords*: brown marmorated stink bug, *Halyomorpha halys*, survey, ornamental hosts, parasitoid, red velvet mite

*Abstract*: Brown marmorated stink bug, *Halyomorpha halys*, a serious invasive pest in the United States and Europe was first detected in Canada in Ontario in 2011 and in Quebec in 2014. First detections of *H. halys* in British Columbia were in Chilliwack in the Lower Mainland in 2015 and Penticton in the Okanagan Valley in 2016. Surveys with pheromone baited sticky, pyramid and panel traps in interior valleys of B.C. in 2017 indicate *H. halys* is present in urban landscapes in the Okanagan Valley from Salmon Arm to Osoyoos, with the highest numbers captured in central Kelowna. Ornamental hosts recorded to date in Interior B.C. are chokecherry (*Prunus virginiana*), tree of heaven (*Ailanthus altissima)*, maple (*Acer* sp.), honey locust (*Gleditsia* sp.), catalpa (*Catalpa speciosa*), mountain ash (*Sorbus* sp.), lilac (*Syringa* sp.), magnolia (*Magnolia grandiflora*), cotoneaster (*Cotoneaster* sp.) and snowberry (*Symphoricarpos* sp.). Three native stink bug parasitoid species *Trissolcus euschisti, Telenomus podisi*, and *Ooencyrtus* sp. were

reared from sentinel spined soldier bug (*Podisus maculiventris*) egg masses at detection sites in Kelowna and Penticton in 2017. A red velvet mite (*Balaustium* sp.) was found feeding on sentinel eggs in the field and attacked *H. halys* eggs in the laboratory. The principal natural enemy of *H. halys* in Asia that has recently been found in the Pacific Northwest U.S.A., *Trissolcus japonicus*, was not reared from sentinel eggs. High numbers of *H. halys* found in central Kelowna are a concern due to their proximity to orchards. Surveillance of urban sites and commercial farms, as well as surveys for biological control agents will continue in 2018.

## An Update on Brown Marmorated Stink Bug Spread to the Agricultural Crops in the Northern San Joaquin Valley, California

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*Keywords:* brown marmorated stink bug, *Halyomorpha halys*, phenology, almonds

*Abstract:* Brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål), (Hemiptera: Pentatomidae) is an invasive insect that has become the most important pest in tree fruit and other crops in much of the United States. In California, since the discovery of a large BMSB population in Midtown area of Sacramento in 2013, BMSB has been detected in >30 counties with an established population reported in 9 counties. In Stanislaus County (Modesto area), a reproducing population of BMSB was first reported in summer 2015, since then, BMSB has spread to several locations within the Modesto Metropolitan area and nearby smaller towns. Given the clear indication of BMSB established in the area, and the potential risks of BMSB to tree crops, trap-based and visual BMSB monitoring and fruit damage evaluation were conducted in peach, almond and walnut orchards in 2016 and 2017. Standard black pyramid traps captured a considerable number of BMSB in 2016 in a peach orchard, which became the first report of consistent BMSB finding in any agricultural areas in California. In 2017, BMSB nymphs and adults were captured in pyramid and sticky panel traps from peach and almond orchards. BMSB adult activities were observed in April-May, July, September-October in the northern San Joaquin Valley area. In almonds, for the first time, reproducing population of BMSB with feeding injuries on developing nuts was reported. Harvest sample manifested the BMSB injury on the hull, shell, and ultimately to the kernel of the almond nut.

## Tracking the Brown Marmorated Stink Bug in Michigan - From Residential Nuisance to Crop Pest

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*Keywords:* apple, peach, BMSB, brown marmorated stink bug, *Halyomorpha halys*, trapping, citizen science

*Abstract:* We know that the brown marmorated stink bug is well-established as a nuisance pest in Michigan residences largely because of a call-to-action in the fall of 2015 asking people to report sightings to the Midwest Invasive Species Network (www.misin.msu.edu). Since 2013, we have also been tracking

the pest in fruit production areas with baited traps, but the majority of sites still report low numbers. Some growers in 2016 started to find damaged fruit in orchard margins, and in 2017, damaged fruit has started to come across some packing lines. The 2017 season was the first time some Michigan apple and peach growers started to actively manage for the pest in orchard margins if they found damaged fruit the previous season. In June 2017 we organized a BMSB Clinic to help growers recognize stink bug damage, to talk about monitoring techniques, and management programs. This presentation will also include a brief overview of some of the work being done in Michigan on trapping efficacy.

## Attract-and-Kill: Is There a Future for Spotted Wing Drosophila Management?

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*Keywords:* attract-and-kill, spotted wing drosophila, *Drosophila suzukii*, deltamethrin, cherry

*Abstract:* The effects of three attract-and-kill (AK) prototypes: MSU attract and kill pouch, prototype A, and SinoGreen B, on trap captures of spotted wing drosophila were assessed in cherry orchards. All three prototypes consisted of a device treated with deltamethrin and a food based bait. The MSU AK pouch was deployed at 500/acre in 0.5 acre plots, along with two controls: one plot with no pouch and the other plot containing 500 control pouches with the bait only. Interestingly, the plot with control pouches caught at least 2 times more males and females SWD than the plot with no pouch and the plot with AK pouch, indicating that the baits might draw flies into the testing plot. The prototype A was deployed at 0, 20, or 40 per plot (approximately 0.7 acre each). Similar SWD capture was recorded between control and AK treated plots. SinoGreen B was deployed at 0, 70, and 210/acre in one-acre plots. Plots containing 210 SinoGreen B received the least amount of SWD among treatments. Therefore, MSU prototype and prototype A failed to provide SWD control, but SinoGreen B may have a potential to suppress SWD population.

## A Food-Grade Gum as a Management Tool for *Drosophila suzukii*

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*Keywords:* Gum, insecticide-free lure, behavior manipulation, Integrated Pest Management

*Abstract:* Spotted wing drosophila, *Drosophila suzukii*, is a worldwide pest of soft-skinned and small-fruit. This species is able to utilize different habitats and substrates for both nutrition and reproduction. This capacity can be attributed to multiple olfactory cues, a topic of multiple investigations. The current study first aimed to identify volatiles that facilitate altered orientation and oviposition behavior. The identified volatiles resulted in significant levels of both response and attraction of *D. suzukii* in controlled orientation and electrophysiology studies. We secondly aimed to incorporate these volatiles into a matrix in order to be in direct competition to susceptible fruits. Subsequent incorporation of these volatiles into a gum matrix resulted in mean reductions of 50% of egg laying in controlled in laboratory trials on blackberry, blueberry, cherry, raspberry and strawberry.

Small and large-scale field trials were hereafter conducted over periods of 2.5 to 4 days. Blueberry fruit on bushes were exposed to predetermined *D. suzukii* populations in commercial-standard blueberry field settings. Both small and large-scale field trials using the gum matrix resulted in 50% to 76% reduction in fruit infestation and eggs laid respectively. Up to 40% and less than 20% of untreated and treated fruit were respectively targeted by *D. suzukii*. These results indicate that the insecticide-free gum matrix significantly alters *D. suzukii* behavior to ultimately result in reduced damaged fruit. This reduction may be due to a combination of altered behavior and the division of reproductive resources. The reproductive resources lost on the gum ultimately results in less egg laying in susceptible fruit, as well as lowered fertility of adults. We believe that our work will help expand the toolbox for spotted wing drosophila control in commercial field settings.

## Winter Morph Spotted Wing Drosophila: Biology, Phenology, and Response to Visual and Olfactory Cues

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*Keywords*: spotted wing drosophila, SWD, *Drosophila suzukii*, winter morph, biology, phenology, color, trap

*Abstract*: Spotted wing drosophila, *Drosophila suzukii* (Matsmura) (Diptera: Drosophilidae) has rapidly become a devastating global pest of soft-skinned and stone fruits. Much has been learned about the spotted wing drosophila summer morph, the morph trapped during spring and summer months, but little is known about the spotted wing drosophila winter morph, the morph trapped in fall and winter months as temperatures begin to decrease. Compared to summer morphs, winter morphs have longer wings, darker bodies, and upregulated genes that enable them to withstand colder temperatures and successfully overwinter. Here we report outcomes of choice and no-choice laboratory bioassays quantifying alightment on sticky disks of various colors, but no odors. Red, purple, and black disks captured the most spotted wing drosophila summer and winter morphs. The electroantennogram (EAG) method was used to compare and record the responses of antennal olfactory receptors to six volatile compounds for summer and winter morphs. Significant differences in antennal responses between spotted wing drosophila summer and winter morphs were observed for three of the volatiles tested. Behavioral laboratory bioassays comparing responses of summer and winter morphs were performed combining optimal visual and olfactory cues based on the results of the laboratory color bioassays and electroantennogram studies. The combined results of these behavioral bioassays will optimize traps for the different spotted wing drosophila morphs based on their behavioral responses to visual and olfactory cues, enabling growers to trap spotted wing drosophila earlier in spring months and delay or reduce the population buildup throughout summer.

# Chemical Control/New Products—

**Moderator:** Barat Bisabri
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Chemical Control/New Products

## Trunk Injection of Insecticides for Pear Psylla Management

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*Keywords:* trunk injection, apple insect management, pear psylla

*Abstract:* Trunk injection was used to deliver crop protection materials to pear trees for control of pear psylla *Cacopsylla pyricola* (Forster). Seasonal field observations were made of the incidence of psylla nymphs and eggs. Treatment comparisons of several compounds and application methods were included in the study. The results of this study provide performance comparisons of foliar spray and trunk injection for pear insect pest management.

## Optimizing Trunk Injection to Match Seasonal Physiology of Apple Trees

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*Keywords:* trunk injection, neonicotinoid, nectar, pollen, *Choristoneura rosaceana*, *Empoasca fabae*

*Abstract:* Trunk injections were performed at different timings to assess effects of season on pesticide uptake. Apple trees were injected with emamectin benzoate and imidacloprid in the fall and spring following petal fall. Nectar and pollen were sampled in the spring and analyzed with HPLC. Bioassays of *Choristoneura rosaceana* and field observations of *Empoasca fabae* were also conducted. This study adds to our understanding of how injection timing contributes to insecticide mobility in woody plants, and possible ways to reduce pollinator risk by using seasons to mitigate insecticide movement into nectar and pollen.

## Effects of Verbenone Repellent on *Xylosandrus germanus* Ambrosia Beetle Infestations in Apple Trees

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*Keywords:* black stem borer, *Xylosandrus germanus*, apples, trunk sprays, verbenone

*Abstract:* The ambrosia beetle *Xylosandrus germanus* has been documented as causing tree death and decline in dozens of New York apple orchards since 2013, mostly in young dwarf apple plantings. Preventive trunk sprays in the orchard using chlorpyrifos or pyrethroids in 2015-16 has not resulted in noticeable treatment effects. In 2017, we tested different trunk sprays for *X. germanus* control in potted apple trees, waterlogged to stress them to produce ethanol, and placed alongside of wooded areas directly adjacent to orchard sites; additionally, individual ethanol lures were attached to each tree to increase their attractiveness to the beetles. The preventive treatments included different topical formulations of verbenone, a component of anti-aggregation pheromone produced by various species of bark beetles, which has been found to repel this and related species of scolytines from traps and attractive

host trees. Trunk and tree damage was assessed among the different treatments, to determine what effect the verbenone, either alone or in combination with chlorpyrifos, had in preventing attacks by this ambrosia beetle. At two of the trial sites there was negligible infestation damage across all treatments, including the untreated checks; however, at the third site, infestations were significantly lower, showing no damage, in treatments of a modified verbenone formulation of SPLAT, a wax-based matrix applied with a caulking gun.

## Choices, Choices: a New Look at Pesticide Selectivity

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*Keywords:* twospotted spider mite, *Tetranychus urticae*, western predatory mite, *Galendromus occidentalis*, pesticide selectivity, selectivity ratio, non-target effect.

*Abstract*: Selectivity of pesticides toward natural enemies has typically been defined on the basis of the ratio of $LC_{50}$s derived from probit bioassasys of both species. While providing some measure of intrinsic toxicity, these indices suffered from several drawbacks. First, they were based on acute mortality, which does not account for potentially important sublethal effects of some materials. They also failed to provide insight about differential effects at field-relevant doses. We investigated the lethal and sublethal effects of pesticides on a predator-prey system (western predatory mite and twospotted spider mite) in a series of abridged life table studies at the label rate. Our metric was the production of live larvae from treated females, standardized as the percentage reduction from the check. This metric incorporated all preceding effects of mortality, fecundity, egg hatch, and larval survival on residues. This metric, the Life Table Selectivity Index (LTSI), is the difference between the percent reduction of the predator minus the percent reduction of the prey larvae. Negative values indicate that there is a greater detrimental effect on predator than on prey, and positive values the reverse; those near zero have a similar effect on both. Of the 23 compounds studied, 19 had negative values, and only 4 had positive values. Of the latter group, only two acaricides (Acramite and Nealta) had highly positive values, and could be termed selective.

## Efficacy of Rimon and Dimilin for Control of Spotted-Wing Drosophila (*Drosophila suzukii* (Diptera: Drosophilidae)) via Three Routes of Exposure

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*Keywords:* insect growth regulator, Rimon, novaluron, Dimilin, diflubenzuron, spotted-wing drosophila, *Drosophila suzukii,* route of exposure

*Abstract:* While most insecticides currently used against spotted-wing drosophila (SWD) target adult females before oviposition occurs, there is utility in preventing eggs that are laid from reaching maturity. Rimon and Dimilin are insect growth regulators (IGRs) that prevent chitin biosynthesis (IRAC group 15). We tested Rimon and Dimilin insecticides by three routes of exposure (direct contact, residue contact, and *per os*) to mature mated female SWD and recently eclosed females in laboratory bioassays. None of the treatments caused high enough mortality levels to be considered useful for adult control. When

mature female flies were exposed to Dimilin residues, none of the eggs successfully produced adults despite high numbers of oviposition punctures. However, when flies were exposed immediately after eclosion, both Rimon and Dimilin in the residual and *per os* treatments suppressed oviposition and completely shut down adult emergence. These results are consistent with the known IGR effect of disruption of oogenesis.

## Control of Olive Fruit Fly in Olive

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*Keywords*: olive fruit fly, *Bactrocera oleae,* Assail 30SG, Danitol 2.4EC, Sivanto 200SL, Venerate XC, olive, chemical control, insecticides

*Abstract*: A field trial was conducted to evaluate the efficacy of Assail 30SG, Danitol 2.4EC, Sivanto 200SL, Venerate XC, and molasses for control of olive fruit fly (OLFF) in olives. The efficacy of Assail 30SG plus molasses, Sivanto 200SL plus molasses, and Venerate XC plus molasses were compared to Danitol 2.4EC (grower standard) plus molasses and molasses alone. The trial was conducted on a mature Sevillano olive grove near Corning, CA. Five treatments were replicated four times in a randomized complete block (RCB) design. Each replicate was a nine tree (3X3) plot. The center tree of each replicate was the sample tree and the surrounding trees were treated buffer. Treatments were applied using a hand-held orchard sprayer operating at 200 psi with a finished spray volume of 150 gal/acre at pit hardening on 28-29 June and in late summer/fall as adult OLFF activity increased on 23-24 August. Adult OLFF were monitored by placing one McPhail trap baited with Torula bait in the center tree of each replicate on 5 June. The traps were monitored weekly and bait was changed weekly. At commercial harvest on 12-18 Oct. ca. 1500 fruit were inspected for OLFF damage and larval present by block. Olive fruit fly adult captures in the McPhail traps were much lower this year than in previous years. The suppression of flight was probably due to the excess temperatures this season with 31 days over 100 °F, and one day of 113 °F. Although the infestation was low this year, Venerate XC plus molasses, Sivanto 200SL plus molasses, and Danitol 2.4EC plus molasses had significantly lower OLFF infestation as compared to molasses alone while Assail 30SG plus molasses was not significantly different as compared to molasses alone. Also, there was no significant difference among Danitol 2.4EC plus molasses and Sivanto 200SL plus molasses as compared to Assail 30SG plus molasses. Based on this research it appears Venerate XC plus molasses may be a viable alternative for organic growers that can be used in rotation with GF-120 to slow the development of resistance to spinosad.

## Control of Codling Moth in Walnuts

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*Keywords: Cydia pomonella* L., Codling moth, *Juglans regia* L., walnut, *Amyelois transitella*, navel orangeworm, *Chromaphis juglanicola,* walnut aphid, *Tetranychus urticae,* twospotted spider mite, chemical control, insecticides, Besiege ZC, Chlorantraniliprole with Lambda-cyhalothrin, Minecto Pro, Abamectin with Cyantraniliprole, Proclaim, Emamectin benzoate, Assail 30SG, Acetamiprid, Brigade 2EC, Bifenthrin, Altacor 35WG, Chlorantraniliprole, Agri-Mek 0.70SC, Abamectin, Delegate 25WG, Spinetoram, Onager 1EC, Hexythiazox, Intrepid 2F, Methoxyfenozide.

*Abstract:* The efficacy of various treatments in the control of codling moth (CM) in walnuts was evaluated. Treatments included Besiege ZC, Minecto Pro, Proclaim, Assail 30SG + Brigade 2EC, Altacor 35WG, Agri-Mek 0.70SC + Delegate 25WG, Delegate 25WG, Altacor 35WG + Onager 1EC, Encounter, and Intrepid 2F. The trial was conducted on walnut trees near Tracy, CA. Nine treatments were replicated four times in a randomized complete block design. Each replicate was an individual tree. Treatments were applied using a hand-held orchard sprayer at 250 psi and a spray volume of 250 gal/acre. Treatment were based on the degree-days (DD) timings. CM flight activity was measured using pheromone traps and the first biofix set to 26 March and the second biofix set for 3 June. CM infested dropped nuts were monitored weekly from mid-May through late June. CM and navel orangeworm (NOW), infestations were determined on 125 nuts per replication (500 nuts per treatment) at commercial harvest on 26 September. The treatment program of Besiege ZC at 1A timing followed by Minecto Pro at 1B timing followed by Proclaim at the 2A timing followed by Assail30SG combined with Brigade 2EC and Minecto Pro at husk split provide superior CM and NOW control as compared to the grower standard and untreated check. Twospotted spider mite were monitored by sampling 10 leaves per tree weekly for 3 weeks after treatment application. There was no statistically significant difference between the treatments.

## Control of Navel Orangeworm in Almond

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*Keywords*: *Amyelois transitella*, navel orangeworm, *Prunas amygdalus*, almond, chemical control, insecticides, Harvanta 50SL, cyclaniliprole, Minecto Pro, cyantraniliprole with abamectin, Altacor 35WDG, chlorantraniliprole, Intrepid 2F, methoxyfenozide, Besiege 1.25ZC, lambda-cyhalothrin with chlorantraniliprole, Entrust 2SC, spinosad, Exirel 0.83SE, Cyantraniliprole, Zylo, methoxyfenozide

*Abstract*: A field trial was conducted to evaluate the efficacy various rates of Harvanta 50SL, Exirel 0.83SE, Minecto Pro + Intrepid 2F, Besiege 1.25ZC + Intrepid 2F, Altacor 35WDG + Intrepid 2F, Entrust 2SC, Intrepid Edge, Altacor 25WDG, Zylo, and Intrepid 2F for control of navel orangeworm (NOW) in almond. The trial was conducted on mature almond trees near Escalon, CA. Fourteen treatments were replicated four times in a randomized complete block design, each treatment being an individual tree. Foliar sprays were applied with a hand-held orchard sprayer operating at 200 psi with a finished spray volume of approximately 150 gal/acre. Treatments were applied on 10 July and 24 July or on 28 July and 1 August. Infestation was determined based on 250 nuts per tree at commercial harvest on 22 August. Intrepid 2F, Intrepid Edge, the high rate of Harvanta 50SL, and the high rate of Minecto Pro + Intrepid 2F all significantly

reduced NOW infestation compared to the untreated check. The high rate of Exirel 0.83SE resulted in significantly higher infestation than all experimental treatments, and also resulted in an increase in spider mite infestation.

## Control of Frosted Scale on Walnut

Emily Symmes[1], Robert Van Steenwyk[2], and Christian Cabuslay[2]
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*Keywords*: Frosted scale, *Parthenolecanium pruinosum,* Centaur 70WDG, PureSpray Green, Venerate XC, Movento 2SC, Sivanto 1.67SL, Lorsban Advanced, Assail 70WP, walnut, chemical control, insecticides

*Abstract*: A field trial was conducted to evaluate the efficacy of materials and treatments timings targeting frosted scale, *Parthenolecanium pruinosum* (Comstock) in a mature, commercial 'Chandler' walnut orchard in Butte County, CA. Treatments were replicated seven times in a randomized complete block design. Each replicate was an individual tree with a buffer tree between each treated tree. The following treatments were applied 9 March 2017 (delayed dormant): Centaur 70WDG, PureSpray Green, Centaur 70WDG + PureSpray Green, and Venerate XC. The following treatments were applied 22 May 2017 (following crawler emergence): Movento 2SC, Movento 2SC + Sivanto 1.67SL, Sivanto 1.67SL, Lorsban Advanced, Assail 70WP (two rates), and Venerate XC (two crawler applications, second applied 1 June 2017). Treatments were applied with a hand-held orchard sprayer operating at 200 psi with a finished spray volume of 150 gal/acre. Frosted scale crawlers were monitored weekly from 24 May 2017 through 28 June 2017 using double-sided sticky tape (2/tree on separate scaffolds). The number of frosted scale crawlers was counted on a 1-cm section of each tape in the laboratory under magnification (20x), and crawler density was compared among treatments. Results indicate that Centaur 70WDG alone or in combination with PureSpray Green horticultural oil applied at the delayed dormant timing provided suppression of frosted scale crawlers in the same season. No other treatments effectively reduced crawler numbers. Due to the nature of the insect life cycle and the varying modes of action of the materials tested, additional data collection to evaluate the longer-range impacts of treatments on the overwintering population will be collected and analyzed in January 2018.

# Poster Session

POSTER
Biology/Phenology

## Introducing a New Codling Moth Biofix Option to Utah Producers

Marion Murray and Diane Alston
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*Keywords*: apple, pear, codling moth, *Cydia pomonella*, degree days, biofix, phenology

*Abstract*: In Utah, setting a codling moth biofix from traps has become problematic due to aberrant spring weather conditions, higher use of mating disruption, and lack of time and resources to place traps in the 91 locations represented on Utah's online degree-day tool. Research from Washington State University (Vince Jones et al. 2013) found that site-specific codling moth emergence (in degree days) is predictable using a formula based on latitude and elevation. We are introducing the "formula biofix" to Utah apple growers by demonstrating the similarity in codling moth phenology between the formula- and trap catch-based methods in six key locations. Through season-long trapping and by determining dates of first fruit larval entry for generations 1 and 2 in 2016 and 2017, we have seen that key predictions using the two biofix options (such as start of egg hatch, peak egg hatch, and subsequent moth flights) only varied by 1 to 6 days. Our target was a variance of no greater than 5 days, so the formula-based model (with a March 1 start date) meets our goal for most locations in most years, and performs as well as the trap-catch-based model. The final phase of the project will be grower outreach, and gauging grower confidence in switching to the formula biofix option.

Jones, V. P., R. Hilton, J. F. Brunner, W. J. Bentley, D. G. Alston, B. Barrett, R. A. Van Steenwyk, L. A. Hull, J. F. Walgenbach, W. W. Coates, and T. J. Smith. 2013. Predicting the emergence of the codling moth, *Cydia pomonella* (Lepidoptera: Tortricidae), on a degree-day scale in North America. Pest Management Science DOI 10.1002/ps.3519.

POSTER
Biological Control

## Does Proximity to Cherry Orchards Disrupt IPM in Pear? Preliminary Results from the Oregon Hood River Valley

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*Keywords:* pear orchards, pear psylla, *Cacopsylla pyricola,* cherry orchards, pesticides, beneficial arthropods

*Abstract:* In the Hood River valley, it is common to have orchards of neighboring pear and cherry blocks, but the benefits and drawbacks of such mixed agroecosystem are not understood. Specifically, it is hypothesized that chemical control against the newly introduced spotted-wing drosophila in cherry orchards is negatively affecting integrated pest management of pear orchards in neighboring blocks. It is possible that frequent applications of broad-spectrum insecticides for the control of spotted wing drosophila are also eliminating populations of beneficial arthropods that migrate to nearby pear orchards and prey on pear psylla. We monitored 11 pear blocks in the Hood River valley (five blocks adjacent to

cherries) for pests (pear psylla *Cacopsylla pyricola,* and mites), parasitoids (*Trechnites insidiosus* and others), and predators (*Campylomma verbasci, Daereocoris brevis,* and other generalistic predators). Specifically, we assessed whether pear blocks adjacent to cherry blocks had higher or lower abundance of psylla, total pests, total beneficial arthropods, and pest: beneficial insect ratios, compared to isolated pear blocks. We found that pear blocks that were adjacent to cherry blocks received on average more conventional insecticide applications than isolated pear blocks. However, additional conventional insecticide applications in cherry-adjacent pear blocks did not reduce the total number of pests, psylla (eggs, nymphs and adults), or beneficial arthropods (predators plus parasitoids). We also found that pear blocks with more conventional insecticide applications (and next to cherry orchards) had a non-significant trend to have a higher pest: beneficial ratio, that is, a higher abundance of pests relative to beneficials. All these results raise the question: Are pear blocks next to cherries receiving unnecessary insecticide applications and pest pressure does not decline past a certain level, or are these additional sprays needed to maintain pest pressure at a level similar to isolated pear blocks? These questions will be addressed in future trials including more pear blocks.

POSTER
Biological Control

## Early Releases of the Cosmopolitan Parasitoid *Trichopria drosophilae* to Control the Invasive *Drosophila suzukii*

Marco Valerio Rossi Stacconi[1,2], Claudio Ioriatti[2], Alberto Grassi[2], Gianfranco Anfora[2,3]
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*Keywords*: spotted wing drosophila, *Drosophila suzukii*, parasitism, augmentation, field trials, biological control, Diapriidae

*Abstract*: Biological control remains unutilized as yet in the framework of spotted wing drosophila (SWD) management. Although several parasitoid species attack the pest under laboratory conditions, information is lacking on their host-finding and dispersal capabilities in natural environments. We tested the effect of repeated parasitoid releases on SWD populations in infested orchards and the effect of the *Augmentorium* technique for enhancing the parasitoid activity. The pupal parasitoid *Trichopria drosophilae* (Perkins) was released on different crops and in different environments throughout Italy. Collected data showed a significant reduction of *D. suzukii* emergence from ground-sampled fruit, and augmentation enhanced parasitism, increasing the numbers of parasitoids emerging from host pupae. Although further field studies are required, these results suggest that *T. drosophilae* may be considered a potential biocontrol agent for *D. suzukii*. Control strategies using this parasitoid should be aimed to low the SWD population at the very beginning of the season, thus regulating the pest population dynamic before the fruit ripening in the orchards and successively throughout the entire season.

POSTER
Invasive Species

## Invasion History of Brown Marmorated Stink Bug in Utah

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*Keywords*: brown marmorated stink bug, *Halyomorpha halys*, ornamental hosts, specialty crops, monitoring, natural enemies

*Abstract*: Brown marmorated stink bug (BMSB) was first detected in Utah (Salt Lake City) in 2012 by the general public; by 2015, it caused nuisance problems in some urban-suburban areas of northern Utah. To date, BMSB has been found on 49 host plants from 20 families in Utah, with high numbers on catalpa, chokecherry, apple, Siberian pea shrub, and common lilac. In 2016, BMSB was detected in pheromone traps in a few commercial peach orchards and growers found BMSB at their urban fruit stands. In 2017, BMSB was detected in traps in commercial fruit and vegetable crops in five counties, but populations were still low. However, crop damage was confirmed for the first time and growers reported BMSB in their freshly picked fruit bins. Crops impacted to-date include peach, apple, popcorn, and squash. Interestingly, pheromone trapping studies indicate that trap effectiveness varies by habitat: pyramid traps perform best in urban-suburban landscapes while sticky panel traps caught more BMSB in agricultural sites. To-date, at least four species of native egg parasitoids have been documented to kill BMSB in Utah: *Anastatus mirabilis*, *Psix tunetanus*, *Trissolcus euschisti*, and *T. utahensis*.

POSTER
Chemical Control/New Products

## Post-Harvest Methyl Bromide Fumigation Control of Blueberry Maggot (*Rhagoletis mendax* (Diptera: Tephritidae) (Curran, 1932))

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*Keywords*: blueberry maggot, *Rhagoletis mendax*, post-harvest, methyl bromide, blueberry, quarantine

*Abstract:* United States blueberry production is valued at >800 million USD. Of these blueberries 55% are under quarantine due to the presence of blueberry maggot. Blueberry maggot (BBM) is a major pest of blueberries in the north-east and east coast regions of the US and prevents the shipment of fresh blueberries internationally. This research focuses on the development of a post-harvest fumigation that would open the international market to these growers.

Blueberries were collected from a site in Bangor, MI and fumigated with methyl bromide. Treated life stages were predicted using a previously developed life table. Mortality in the controls was high, so while control with methyl bromide was achieved, the mortality may have been influenced by co-infestation of spotted wing drosophila (*Drosophila suzukii*) or other factors. Control mortalities were lowest for 3rd instars and highest for eggs at 69% and 98% respectively.

# Minutes of the 91st Annual Meeting

**Orchard Pest & Disease Management Conference**
**Hilton Hotel, Portland, Oregon**
**January 11-13, 2017**

## I. Call to Order

The 91st Annual Meeting was called to order by Chair Janet Caprile at 9:11 am on January 11, 2017. Chair Caprile welcomed approx. 200 attendees who will present 48 papers and posters, and one keynote and two featured presentations. Chair Caprile asked for each attendee to make a brief self-introduction, and then introduced the session moderators. They were:

| | |
|---|---|
| Chemical Control/New Products | Larry Gut |
| Biology/Phenology | Emily Symmes |
| Mating Disruption/SIR | Christeen Abbott |
| Implementation | Chuck Ingels |
| Thresholds/Monitoring | Brad Higbee |
| Biological Control | Jhalendra Rijal |
| Invasive Species | David Haviland |

## II. Old Business

A. Approval of 2016 Minutes: Secretary Alston announced that the 2016 minutes were posted on the OPDMC website and printed in the back of the abstract booklet. She asked for amendments. There were none. It was moved, seconded, and voted to approve the 2016 minutes.
B. Treasurer's Report: Treasurer Nik Wiman presented the 2016 Treasurer's Report. The OPDMC current account balance (carry-forward) is $5,320. Last year's registration income was $9,950. This year's registration income is projected to be $11,518. With the 2017 registration income, the new balance will be $16,838. Outstanding expenses include 2016 Executive Director pay of $1,000; WSU (Chris Sater) costs for website update and maintenance, and preparation of conference proceedings ($3,569 for 2016); and keynote speaker travel costs for 2017 of about $700. There was a call for questions; there were none. It was moved, seconded, and voted to approve the 2016 treasurer's report.

Chair Caprile called for other old business. There was none.

## III. New Business

A. Executive Director Peter McGhee provided an update on the impact of the current weather conditions on the conference. Portland was currently shut down due to snowfall and cold temperatures; many restaurants were closed. The hotel will provide a buffet lunch. Conference attendance is down, in part due to the bad weather.
B. ED McGhee asked all members to update their contact information by clicking on the link in the Mail Chimp-generated OPDMC email messages.
C. Committee Assignments:
    a. Nominations: Larry Gut (Chair), Betsy Beers, and Chuck Ingles
    b. Audit: Bob Van Steenwyk (Chair), Mike Devencenzi, and Rick Hilton

c. Resolutions: Art Agnello (Chair), Peter Shearer, and Alan Knight

D. Chair Caprile called for the names of any members that had passed away during the last year.
   a. Bill (William) Coates with University of California Cooperative Extension is a member that recently passed away. A moment of silence was given in recognition of Bill Coates.

E. Chair Caprile gave the new conference announcements:
   a. Caprile introduced the keynote speaker, Jim Miller, Michigan State University. Jim will speak at 3:30 pm today, followed by a mixer at 5:00 pm.
   b. The poster session will be held during the coffee break on Thursday at 10:00 am.
   c. The featured presentations will be on nut orchards by Nik Wiman and David Haviland at 11:00 am on Thursday, and on insect postage stamps by Larry Gut at 3:30 pm on Thursday.
   d. The disease conference session will be held in the Broadway I room. Today's topics will be vegetables, ornamentals and turf. Tomorrow's topic will be tree fruit.

F. Chair Caprile provided presentation instructions to speakers.

Chair Caprile called for a motion to close the opening business meeting. It was moved, seconded, and voted to close the opening business meeting. Chair Caprile introduced the first session moderator.

**IV. Closing Business Meeting**

Chair Caprile called the closing business meeting to order on January 13, 2017, at 11:59 am.

A. Old Business
   a. Secretary Alston gave a summary report of discussions and decisions from the 2017 Board of Directors' meeting held on Jan 11 at noon:
      i. The contract with Hilton hotel runs through our 2018 meeting. ED McGhee will lead an inquiry into potential hotel sites in Portland.
      ii. The OPDMC website was re-designed in 2016-17; movement of the archived materials is still in progress.
   b. Treasurer Wiman presented the final treasurer's report (see II. Old Business).

B. New Business
   a. ED McGhee discussed the concern for shortening the meeting that would coincide with loss of hotel room nights that must be met with the current contract. Peter recommended that we maintain the 2.5 day meeting length through 2018. There was an open discussion of pros and cons for the current meeting length. McGhee decided to poll the entire membership with an online survey sent out in an email message. He will ask if members want to keep the length as it is, start Wednesday at 1:00 pm (delayed from current start of 9:00 am), or end Thursday evening (the last two options will shorten the meeting by 0.5 day).
   b. ED McGhee asked if email communication with the members was going well. The unequivocal answer was 'yes'.
   c. ED McGhee relayed that the OPDMC Board of Directors want to raise registration fees to $90 pre-registration + $10 abstract = $100 to better cover conference costs. Students will still be free.

d. ED McGhee proposed that the Plant Pathology group should formally join the Entomology group in paying registration fees (fees cover coffee, the social open bar, and meeting room costs). If they agree, one member representing plant pathologists will be added to the Board of Directors.

Chair Caprile called for any other new business. There was none.

C. Committee Reports:
   a. Nominations: Betsy Beers gave the report for Chair Gut. Arthur Agnello was nominated as Chair-Elect, Diane Alston as Secretary, Nik Wiman as Treasurer, Peter McGhee as Executive Director, and Betsy Beers as Program Chairs. Call for motions and vote to approve the nominations; all officers were voted in.
   b. Audit: Rick Hilton gave the report for Chair Van Steenwyk. The Audit Committee reviewed and accepted the financial report, and report that the OPDMC financial records are in good order. There was a vote to approve the Audit Report.
   c. Resolutions: Peter Shearer gave the report for Chair Agnello. The resolutions were accepted by vote. (*Note to Secretary Alston – revise next year to acknowledge Chris Sater for IT support).

D. Chair Caprile called for nominations for the Rubber Chicken Award.
   a. Broc Zoller nominated all speakers for using too small of text in their slides.
   b. Rick Hilton nominated David Haviland for attacking the microphone several times during his talk.
   c. Peter McGhee nominated Lisa Neven for submitting her talk late, two times, and including incorrect information on Okanagan Co. in her presentation.
   d. David Haviland nominated Tom Baker for believing in immunity from the rubber chicken award, and then going over his allotted presentation time.
   e. All MSU speakers were nominated by numerous members for shamelessly promoting the 'Miller Book' in their talks.

   Chair Caprile asked the award nominees to leave the room and called for a vote on the Rubber Chicken Award. The vote was strongly in favor of Lisa Neven. When informed of her selection, Neven defended herself by saying that she was given incorrect information for Okanagan Co.

It was suggested that OPDMC could add a Golden Apple Award to recognize a top quality presentation each year.

E. Chair Caprile thanked all of the section leaders and executive director for making the conference run smoothly. Caprile thanked Betsy, Chris and the WSU team for developing the new website and conducting the meeting preparation.
F. Chair Caprile announced next year's meeting dates: January 10-12, 2018 at the Hilton, Portland.
G. Chair Caprile passed the gavel to the in-coming Chair Harvey Yoshida, who closed the meeting with the pounding of the gavel.

Respectfully submitted,
Diane Alston, Secretary
*Orchard Pest and Disease Management Conference, January 11-13, 2017*

# 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):

- **Rachel Elkins (2001)**, University of Calif., Clear Lake, for using an overhead projector in a digital age.
- **Jay Brunner (2002)**, Washington State University, Wenatchee, for giving one of the looooongest talks in the history of the WOPDMC (Seriously. His 10-minute talk was an hour).
- **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. Bob graciously accepted the award.
- **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. He also assumed that at least one of the many well-educated members of the Conference (ahem, Broc Zoller), most of whom were lugging their own laptops, would be able to find the correct button to turn on the conference laptop, and that labels on the two (!) cords would make the connections between the laptop and projector clear. He was proven to be incorrect.
- **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. Also, Don temporarily lost the rubber chicken in the foyer, but he did later recover it.
- **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.

Adult pear psylla

Brown
marmorated stink bug

Woolly apple aphid

Western
cherry fruit fly

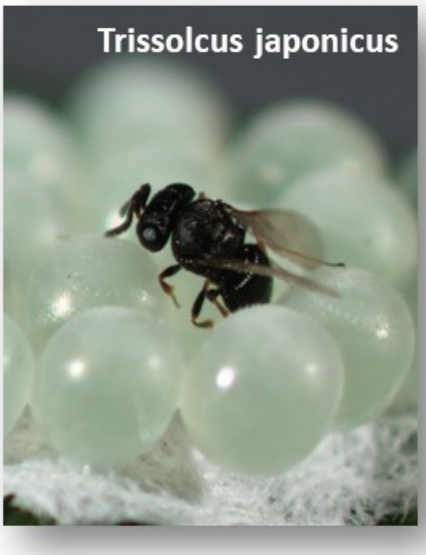
Walnut husk fly

Apple maggot

Navel orangeworm

Spotted wing
drosophila

Codling moth


Trissolcus japonicus