2017
Orchard Pest and Disease Management Conference

The 91st Conference is pleased to announce our keynote speaker:

Jim Miller

Professor of Entomology,
Michigan State University

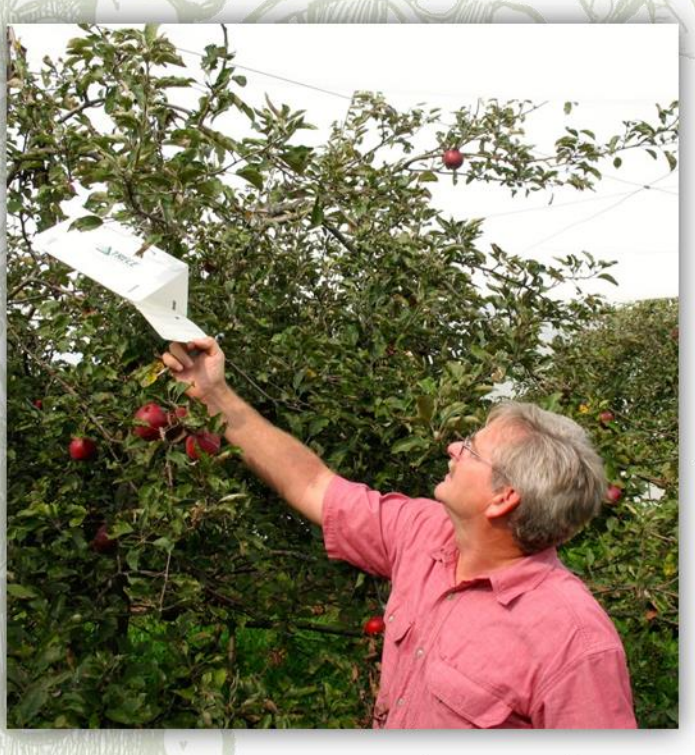
Keynote Address:

Naive Farm Kid Gets Trapped by Pheromones: A Case for Public Education

Hilton Portland, Portland, Oregon
January 11-13

Dr. Jim Miller

After receiving his B.A. in Biology from Millersville University in 1970 and Ph.D. in Entomology from Penn State in 1975, Jim Miller post-doc'd with Wendell Roelofs at Cornell University (Geneva). In 1978 he became an Assistant Professor at Michigan State University and where he has remained for the duration of his career, teaching and conducting research in entomology. Jim's specialty areas are insect physiology, behavior, and chemical ecology. His classic experiments on onion fly behavior are recognized for moving the field away from the idea that only chemical(s) are important in host-plant selection to that based on multiple inputs. His rolling-fulcrum model of insect decision (how both external stimuli and internal physiological factors (e.g., hunger, deprivation of host plants upon which to lay eggs, etc.) affect insect investment behaviors) has advanced the fields of entomology and animal behavior. Jim's contributions in the field of medical entomology include optimization of insecticide-treated bednets for protection of humans, determination of suitable habitat for reproduction of malaria mosquitoes, and the discovery that treating cattle with ivermectins can substantially reduce human malaria epidemics



Jim's contributions to insect pheromones and mating disruption include: popularization of the wind-tunnel as the leading behavioral assay tool, explanation of behavioral modes of action of mating disruptants, and pioneering the mathematics and graphical means for differentiating among mating disruption mechanisms. Jim's recent research on insect-trap interactions resulted in a 2015 book entitled *Trapping of Small Organisms Moving Randomly: Principles and Applications to Pest Monitoring and Management*. In this book, novel methods are presented to measure pheromone plume reach, trapping area, and how to translate catch numbers into estimates of absolute animal density. Jim is author of more than 150 peer-reviewed journal publications. He has many professional awards including Recognition in Pest Management, and ESA Fellow. He is an Outstanding Alumnus from Penn State University and is a Michigan State University Distinguished Professor.

91st Annual Orchard Pest and Disease Management Conference

Orchard Pest and Disease Management Conference
2017 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 11	
8:00 AM	**Registration**
9:00 AM	**Opening Business**—*Janet Caprile, OPDMC Chair*
10:00 AM	Chemical Control/New Products—*Larry Gut, Moderator*
12:00 PM	**Lunch**
1:30 PM	Chemical Control/New Products (cont'd)
3:00 PM	**Coffee Break**
3:30 PM	*Keynote address:* **Naive Farm Kid Gets Trapped by Pheromones: A Case for Public Education** Jim Miller, Michigan State University
5:00 PM	**Mixer (Lobby)**
Thursday, January 12	
8:00 AM	Biology/Phenology—*Emily Symmes, Moderator*
9:00 AM	Mating Disruption/SIR—*Christeen Abbott, Moderator*
10:00 AM	**Coffee Break/Poster Session**
10:30 AM	Mating Disruption/SIR (cont'd)
11:00 AM	Implementation—*Chuck Ingels, Moderator*
11:00 AM	**CAUTION! May Contain Nuts - A Review of Almond, Hazelnut, Pistachio, and Walnuts** (Wiman & Haviland)
12:00 PM	**Lunch**
1:30 PM	Implementation (cont'd)
2:15 PM	Thresholds/Monitoring—*Brad Higbee, Moderator*
3:00 PM	**Coffee break**
3:30 PM	**Insects on Postage Stamps of the World** (Gut)
3:45 PM	Biocontrol—*Jhalendra Rijal, Moderator*
4:00 PM	Invasive Species—*David Haviland, Moderator*
5:00 PM	**Adjourn**
Friday, January 13	
8:00 AM	Invasive Species (cont'd)
11:00 AM	**Closing Business**—*Janet Caprile, OPDMC Chair, Harvey Yoshida, Chair-elect*

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Order of Presentations
FROM THE 91st ANNUAL

ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE

January 11, 12 & 13, 2017

Keynote Presentation: Wednesday, 3:30pm – 5:00pm*
Naive Farm Kid Gets Trapped by Pheromones: A Case for Public Education Jim Miller, Michigan State University

Special Presentation – Thursday, 11:00 AM*	Special Presentation – Thursday, 3:30 PM*
CAUTION! May Contain Nuts - A Review of Almond, Hazelnut, Pistachio, and Walnuts Nik Wiman, OSU & David Haviland, UCDavis	**Insects on Postage Stamps of the World** Larry Gut, MSU

* Times approximate

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Chemical Control/New Products—

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Current Status of Pear IPM in Southern Oregon

Richard J. Hilton
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Keywords: acetamiprid, bifenazate, codling moth, *Cydia pomonella*, diflubenzuron, hexythiazox, spinetoram, *Tetranychus urticae*, twospotted spider mite

Abstract: A new formulation of hexythiazox (Onager) was evaluated for control of twospotted spider mite in Comice pear in a replicated trial. The new formulation performed as well as or better than the previous EC formulation and provided control of spider mites at a level statistically equivalent to bifenazate (Acramite). In a larger scale non-replicated field trial, three materials were compared for control of first generation codling moth: diflubenzuron (Dimilin), acetamiprid (Assail), and spinetoram (Delegate). All three materials resulted in a high level of codling moth control relative to untreated checks but spinetoram consistently resulted in the least amount of codling moth injury. Earwig numbers were lowest in the spinetoram treatment and a marked increase in twospotted spider mites occurred in the acetamiprid treated area in August.

Implementation of IPM programs in three pear orchards in southern Oregon has been followed over the past three years. Two of the orchards use mating disruption for codling moth control and all use pest monitoring, in some cases with assistance from OSU. Results indicate that an IPM program can achieve good control of codling moth while minimizing stimulation of induced pests such as twospotted spider mites, however, true bug injury was observed at varying levels. Comprehensive monitoring remains the key element in implementing a successful IPM program.

Trunk Injection of Insecticides for Pear Psylla Management

John C. Wise and Anthony VanWoerkom
Michigan State University, Department of Entomology, Lansing, MI

Keywords: trunk injection, apple insect management, pear psylla, *Cacopsylla pyricola* (Förster)

Abstract: Trunk injection was used to deliver crop protection materials to pear trees for control of pear psylla *Cacopsylla pyricola* (Förster). 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 a successful “proof of concept” for trunk injection in pear insect management.

Evaluation of a Pesticide Drift Mitigation Technique Using Synchronized Opposing Orchard Speed Sprayers

B. Bisabri[1] and R. A. Van Steenwyk[2]
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Keywords: airblast speed sprayer, insecticides, pesticide drift

Abstract: A study was conducted to evaluate the efficacy of using opposing synchronized orchard sprayers, also known as "Interference Perimeter Spraying," to reduce pesticide drift. The study was conducted using commercial sprayers in a commercial almond orchard near Westley, CA. The four treatments were: 1) a PTO air blast speed sprayer between row one and two directing the air stream and spray material outward (grower standard), 2) two PTO air blast speed sprayers, one on the outer edge of the orchard and the second between rows one and two directing their air stream and spray material against one another, 3) two PTO air blast speed sprayers with the inside sprayer directing the air stream and spray material outward while the outside sprayer directing only an inward air stream and 4) untreated check. Spray drift was measured at 33 ft, 66 ft and 100 ft from the almond orchard edge using water sensitive papers. The study was conducted during both low and moderate wind speed conditions. Spray drift was significantly reduced at 33 ft outside of an orchard using synchronized opposing orchard sprayers when the outside sprayer did not use spray solution and applied only air during both moderate and low wind conditions. Also spray drift was significantly reduced at 33 ft outside of the orchard when using synchronized opposing orchard sprayers when the outside sprayer did use spray solution during moderate wind conditions. Thus the synchronized opposing orchard sprayers technique has the potential of greatly reducing drift Improvements in this technique plus advantages and disadvantages relative to other drift mitigation techniques will be discussed.

Ambrosia Beetle (*Xylosandrus germanus*) Management Trials in High-Pressure Wooded Areas Bordering Apple Orchards

Arthur Agnello, David Combs, Joshua Neal, and Forrest English-Loeb
Department of Entomology, Cornell University, NYS Agric. Expt. Station, Geneva, NY

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

Abstract: Black stem borer (BSB), *Xylosandrus germanus*, has been documented as causing tree death and decline in dozens of NY apple orchards since 2013, mostly in young dwarf apple plantings. Preventive trunk sprays in the orchard using chlorpyrifos or pyrethroids in 2015 did not result in noticeable treatment effects; however, population pressure may have been too low in the trial sites to elicit meaningful results. We tested different trunk insecticide sprays for BSB control in potted apple trees, waterlogged to stress them to produce ethanol, and placed inside wooded areas directly adjacent to orchard sites; additionally, individual ethanol lures were attached to each tree to increase their attractiveness to the beetles. Trees were arranged in circular 5-tree groupings in the wooded areas, which were replicated 10 times at each site. Another identical set of 10 replicate tree groupings was also deployed at each site, with a dispenser of verbenone placed in the center of each of the 5-tree groupings. Verbenone, a component of anti-aggregation pheromone produced by various species of bark beetles, 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; overall, there was some reduction in trunk infestation holes and galleries in the treated tress compared with untreated checks, but in no case did the combination of verbenone repellent plus insecticide sprays appear to improve the control of BSB over the insecticides alone.

A New Diamide Insecticide for Control of Western Cherry Fruit Fly, *Rhagoletis indifferens*

Diane Alston[1], Thor Lindstrom[2], and Andrew Swain[2]
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[2]Utah State University Agricultural Experiment Station, Kaysville, UT

Keywords: western cherry fruit fly, *Rhagoletis indifferens*, tart cherry, cyclaniliprole, Harvanta, cyantraniliprole, Exirel, chlorantraniliprole, Altacor, spinetoram, Delegate, fruit infestation, adult trap capture, mite stimulation

Abstract: A new diamide chemistry (IRAC Class 28), cyclaniliprole (Harvanta, ISK Bioscience Corp.) was compared to two registered diamides, chlorantraniliprole (Altacor, DuPont Crop Protection) and cyantraniliprole (Exirel, DuPont Crop Protection), and a spinosyn, spinetoram (Delegate, Dow AgroSciences; IRAC Class 5), for control of western cherry fruit fly in tart cherry in three trials. Three or four consecutive applications (7-10-day intervals) of Harvanta at 22 oz/acre and Delegate at 6 oz/acre completely prevented fruit infestation. Harvanta at 16.4 oz/acre, Exirel at 14 oz/acre, and Altacor at 4.5 oz/acre kept fruit infestation below 0.5% on peak infestation sample dates. Three applications of Altacor at 3 oz/acre resulted in 4% fruit infestation on several sample dates. Untreated control fruit infestation ranged from 3 to 19% over the three trials. All insecticides exhibited adulticide effects, and none stimulated pest mite or insect densities on tree leaves. A delay in the first application of insecticides following first emergence of western cherry fruit fly was compensated for by the systemic activity of diamide insecticides in killing fruit fly eggs and/or larvae within fruits. In one trial, apple maggot adults were detected on traps late in the trial period. Harvanta was the most effective in lowering apple maggot trap captures; Exirel and Delegate were intermediate in comparison to the untreated control.

Managing the Vectors of Little Cherry Disease

Andrea Bixby-Brosi[1], Elizabeth Beers[1], Holly Ferguson[2], & Dan Villamor[2]
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Keywords: Little cherry disease, Little Cherry Virus, Western X phytoplasma, leafhopper, *Colladonus geminatu, Colladonus reductus,* apple mealybug, *Phenacoccus aceris*, grape mealybug, *Pseudococcus maritime*, insect vector control, cherry

Abstract: Little cherry disease (LCD) is a serious disease of sweet cherry caused by three pathogens, Little Cherry Virus 2 (LChV2), Little Cherry Virus 1 (LChV1), and Western X phytoplasma (WX). Trees with LCD produce cherries of small size and poor flavor making the fruit unmarketable and results in unpicked limbs/trees, tree/orchard removal.

Little Cherry Virus 2 is transmitted via insect vectors, apple mealybug (AMB), *Phenacoccus aceris*, and, grape mealybug (GMB), *Pseudococcus maritimus.* In 2014, 2015 and 2016, a large, naturally occurring AMB population was monitored weekly in a conventional apple orchard, at WSU's Sunrise Orchards, and field experiments were conducted to determine the effects of chemical insecticides on AMB populations. Delayed dormant treatments included Lorsban+oil, Diazinon+oil, and oil targeted overwintering females. Lorsban+oil (2.0 ± 0.4 crawlers/leaf) was the only compound that had a significant lower crawler population compared to the check (15.2 ± 5.2 crawlers/leaf). Two systemic compounds, Ultor+oil (foliar systemic) and Admire Pro (soil drench systemic), were applied 14 days after petal fall; however seasonal crawler averages were similar to the control. Finally, Admire Pro (foliar), Centaur, Diazinon, and Actara were applied to target active crawlers on leaves. Trees treated with Diazinon (2.1 ± 0.5 crawlers/leaf) had significantly lower crawler numbers, while all other treatments targeting crawlers had crawler averages similar to the control. The experiment was repeated in 2015 with a few additional compounds. In 2015, Delayed dormant applications of Lorsban +oil, (1.4 ± 0.1 crawlers/leaf) and Centaur + oil (1.0 ± 0.2 crawlers/leaf) did show some reduction in AMB population compared to the check (2.8 ± 0.75 crawlers/leaf). The addition of Centaur (insect growth regulator) to delayed dormant treatments was aimed to target molting female nymphs emerging during their second instar. Centaur showed promising results especially compared to Lorsban, the most effective treatment in 2014 and 2015. These results suggest that a delayed dormant spray in combination with a spray targeting the crawler stage will provide the best control of AMB. The experiment was repeated in 2016; however, a reduced crawler population resulted from extreme parasitism, by parasitic wasp, *Anagyrus schoenherri,* and can likely be attributed for the lack of significant differences in average crawler numbers.

In 2016, an experiment was conducted on GMB-infested, 1-yr-old, potted 'Bing' trees, in the WSU-TFREC greenhouse, to determine the effects of foliar- and drench-systemic insecticides on GMB. Counts of GMB crawlers (0.1-0.5 mm in length), nymphs (0.6-2 mm in length), and adults (>2 mm in length) were completed 1 day before; and 19, 28, 35, and 56 days after treatments were applied. Average crawler differences were similar for all treatments and all dates. Nymph numbers were reduced to zero on Centaur treated plants at 19 days post-treatment and nearly to zero on trees treated with Admire Pro and Aza-Direct (both soil drench systemic) at 28 days. Admire Pro, Aza-Direct, and Centaur reduced adult numbers to zero 19 days after application. Ultor did not significantly reduce GMB numbers for any life stage.

Western X phytoplasma (WX) is transmitted by leafhopper vectors. Surveys were conducted in 2016 to determine species composition and peak activity periods of leafhopper species within Washington-WX-affected orchards. Leafhoppers were collected from within the orchard and from extra-orchard habitat including alfalfa, sage plants, and herbaceous weeds. Leafhoppers were subjected to DNA extractions and tested for WX using a recently developed detection assay involving PCR that specifically detects WX. Two leafhopper vector species, *Colladonus geminatus* and *C. reductus*, were the most abundant species found on sticky cards in cherry tree foliage and in habitats outside of the orchards. From the molecular diagnostic testing results of 218 *C. geminatus* and 168 *C. reductus*, we confirmed that both species can carry WX. Western X-positive samples for these two species were primarily found in the orchard during two periods of time; early May and late July/early Aug. Data from sticky cards placed in extra-orchard habitats provided new information on alternative habitat/host plants and on seasonal patterns of movement of certain leafhopper vectors.

Season-Long IPM in California Walnuts with Intrepid Edge® Insecticide.

Alistair McKay[1], Melissa Willrich-Siebert[1] and Bob Van Steenwyk[2]
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Keywords: Intrepid Edge, spinetoram, methoxyfenozide, walnuts, *Juglans regia*, codling moth *Cydia pomonella*, walnut husk fly, *Rhagoletis completa*, Navel orangeworm, *Amyelois transitella*, Altacor, chlorantraniliprole, walnut aphid, *Chromaphis juglandicola*, two spotted spider mite, *Tetranychus urtica*e, European red mite, *Panonychus ulmi*

Abstract: Intrepid Edge® insecticide contains two novel active ingredients, spinetoram (IRAC Group 5) and methoxyfenozide (IRAC group 18). A series of field efficacy trials were conducted between 2013 and 2016 in commercial walnut (*Juglans regia*) orchards in California to characterize the efficacy of Intrepid Edge insecticide for season-long insect pest management. Intrepid Edge was evaluated as a foliar spray at a rate ranging from 10.0 – 12.8 fl oz product/acre for codling moth (*Cydia pomonella*), walnut husk fly (*Rhagoletis completa*) and navel orangeworm (*Amyelois transitella*). Intrepid Edge applications were timed according to treatment thresholds established from trap counts and degree days. Applications of Intrepid Edge were made using commercial orchard air-blast sprayers calibrated to deliver between 100 and 200 g/acre. Intrepid Edge at 12 fl oz/acre applied to first generation codling moth (1A, 1B) resulted in fewer dropped nuts and infested nut pairs compared to untreated controls and commercial standards. In 2016, Intrepid Edge applications resulted in 75% to 81% reductions in walnut husk fly populations compared to untreated plots. Insecticide spray programs of the diamide chemistry Altacor® at 3.5 oz/acre followed by Intrepid Edge at 10.0 fl oz/acre timed to 1st and 2nd generation codling moth generations respectively also resulted in an 81% reduction in navel orangeworm infested walnuts at harvest. Following Intrepid Edge applications walnut aphid (*Chromaphis juglandicola*), two spotted spider mite (*Tetranychus urticae*) and European red mite (*Panonychus ulmi*) populations remained low through the season and never reached treatable populations. Results of these studies demonstrate the utility of Intrepid Edge in walnut management programs for key lepidopteran pests and walnut husk fly.

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Control of Walnut Husk Fly in English Walnut

R. A. Van Steenwyk, B.J. Wong and C. S. Cabuslay
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Keywords: walnut husk fly; *Rhagoletis completa*; walnut, Assail 30SG, Acetamiprid, Delegate 25WG, Spinetoram, Exirel 0.83SE, Cyantraniliprole, Venerate XC, heat-killed Burkholderia spp, strain A396, Grandevo WDG, Chromobacterium subtsugae strain PRAA4-I, chemical control, insecticides

Abstract: A field trial was conducted to evaluate the efficacy of Assail 30SG, Exirel 0.83SE, Delegate 25WG, Grandevo WDG, Venerate XC and untreated check for control of walnut husk fly (WHF). The trial was conducted on mature walnut trees near Hollister, CA. Nine treatments were replicated 4 times in an RCB design. Adult WHF population was monitored weekly in two locations in the orchard with Trécé AM traps and ammonia carbonate lures. The traps and lures were replaced weekly. Treatments were applied on 29 June one week after first fly capture and at approximately 3-week intervals on 20 July and 9 August. Insecticides were applied with a handgun orchard sprayer operating at 250 psi with a finished spray volume of 300 gal/acre. All treatments (including the untreated check)

except a high rate of Exirel 0.83SE included Monterey Insect Bait at 1% v/v (8 pt/100 gal) and Latron B-1956 at 0.125% v/v (1 pt/100 gal). Prior to anticipated harvest WHF infestation was evaluated on 9 September by inspecting 250 nuts per replicate (1,000 nuts/treatment). All suspected infested nut were removed from the tree and dissected for WHF stings, larvae and exits. The total nut infestation (a combination of stings, larvae and exits) at harvest showed that there was no significant difference among Venerate XC, Delegate 25WG and Assail 30SG, which is the grower standard. Also, there was a rate reversal with Exirel 0.83SE when combined with Brandt Insect Bait.

Feeding Stimulant Evaluation for Control of Walnut Husk Fly

Christian S. Cabuslay and Robert A. Van Steenwyk
Department of E.S.P.M., University of California, Berkeley, CA

Keywords: *Rhagoletis completa*, walnut husk fly, *Juglans regia*, English walnut, feeding stimulant, bait, GF-120 NF Naturalyte Fruit Fly Bait, Nu-Lure Insect Bait, Brandt Insect Bait, molasses

Abstract: Laboratory and field aging studies were conducted to evaluate the efficacy of NuLure Insect Bait, Brandt Insect Bait, GF-120 (blank) and molasses as attractants and feeding stimulants for walnut husk fly (WHF). Filter papers were dipped into various bait mixtures. The filters paper was exposed to 15 male and 15 female WHF of various feeding status in a test cage and observed for 30 minutes. The number of landing and length of each landing were recorded. There were 6 replicates for all evaluations. Concentration trials compared different concentrations of bait to a water control. In "superbait" trials, baits were mixed with GF-120 to examine how they act together. In starvation trials, flies were starved for 3 days to see how feeding behavior changed. In field-aging trials, filter papers were dipped in molasses at a 4:100 molasses:water mixture and aged in the field for 1, 4, and 7 days. The results show that GF-120 (blank) was a strong feeding stimulant at all concentrations and that molasses at high concentration was particularly exceptional at WHF retention. "Superbait" mixtures of GF-120 (blank) with molasses or NuLure resulted in significantly improved synergistic performance that was better than GF-120 or the respective baits alone. Flies starved for 3 days were more likely to feed on the baits at lower concentrations compared to when they were well fed. In the field trial study, molasses retains its feeding stimulant attributes for at least 7 days.

Control of Navel Orangeworm in Almond

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Department of E.S.P.M., University of California, Berkeley, CA

Keywords: *Amyelois transitella*, navel orangeworm, *Prunas amygdalus*, almond, chemical control, insecticides, Harvanta 50SL, cyclaniliprole, Minecto Pro, cyantraniliprole with abamectin, Altacor 35WDG, chlorantraniliprole, Fujimite 42SC, fenpyroximate, Intrepid 2F, methoxyfenozide

Abstract: A field trial was conducted to evaluate the efficacy of high and low rate of Harvanta 50SL, high and low rate of Minecto Pro followed by Intrepid 2F, Altacor 35WDG combined with Fujimite 42SC followed by Intrepid 2F and Intrepid 2F for control of navel orangeworm (NOW) in almond. The trial was conducted on mature almond trees near Escalon, CA. Seven treatments were replicated four times in an RCB 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 7 July and two weeks later on 21 July. Infestation was determined based on 250 nuts per tree at commercial harvest on 3 August. Intrepid 2F, Altacor 35WDG + Fujimite 42SC, the high and low rate of Minecto Pro, and the high and low rate of Harvanta 50SL had significantly reduced NOW infestation compared to the untreated check and there was no significant difference among the experimental treatments.

Insecticide Evaluations for Control of Peach Twig Borer in Almonds

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Keywords: Anarsia lineatella, peach twig borer, *Prunus dulcis*, almond, chemical control, insecticide, Dimilin 2L, diflubenzuron, Harvanta 50SL, cyclaniliprole, Minecto Pro, cyantraniliprole, abamectin, Altacor, chlorantraniliprole, Assail, acetamiprid, Intrepid 2F, methoxyfenozide, Purespray Green

Abstract: Studies were conducted to evaluate the efficacy of several materials on the overwintering and first generations of the peach twig borer (PTB) in two-year-old almond trees in Oakdale, CA. In the overwintering generation, the experimental materials tested were Assail 30SG, Intrepid 2F, Purespray Green horticultural oil, and an untreated check. Treatments were replicated 8 times. In the first generation study, the experimental materials tested were Dimilin 2L, Harvanta 50SL at low and high rates, Minecto Pro at low and high rates, Assail 30SG, and an untreated check in a 6 replicate study. Delayed dormant treatments were applied for the overwintering generation on 3 February 2016 and were timed just prior to the pink bud stage. First generation males were monitored weekly with pheromone traps, and treatments were applied 250, 350, or 450 degree days after biofix based on anticipated ovicidal or larvicidal activity. Flagged stems indicating PTB infestation were counted and removed from each tree either weekly or biweekly for four weeks. Results indicate that Assail was the most effective in controlling the overwintering generation of PTB, followed by Purespray Green horticultural oil and then Intrepid 2F. During the first generation of PTB, all materials tested significantly reduced PTB strikes compared to the control.

Insecticide Evaluations for Control of Leafhoppers in Grape

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Keywords: Erythroneura elegantula, western grape leafhopper, *Erythroneura ziczac*, Virginia creeper leafhopper, *Vitis vinifera*, grape, Sivanto 1.67SL, flupyradifurone, Beleaf 50SG, flonicamid, Venerate XC, Burkholderia spp. strain A396, Grandevo, Chromobacterium subtsugae strain PRAA4-1, AdmirePro, imidacloprid, PyGanic 5.0EC, pyrethrins

Abstract: A study was conducted on a commercial 'Sauvignon Blanc' grape vineyard in Kelseyville, CA to evaluate efficacy of six materials against two species of leafhopper. Nymphs of western grape leafhopper (WGL) and Virginia creeper leafhopper (VCLH) were sampled, with 1st instars grouped together as their distinguishing characteristics had not yet developed. Initial leafhopper counts were taken on 36 vines on 8 June 2016, then vines were assigned treatments with blocking according to initial counts. Insecticides treatments were Sivanto 1.67SL at two rates, Beleaf 50SG at two rates, Venerate XC, Grandevo, AdmirePro, and Pyganic 5.0EC. Insecticides were applied on 9 June 2016 and populations

were evaluated at 3, 7, and 14 days after application, at which point treatments were no longer significantly different from the control (Fisher's protected LSD at $P \leq 0.1$) and counts were terminated. All treatments provided significant control for VCLH at 3 and 7 DAA though Sivanto and both the conventional and organic growers' standards (AdmirePro and PyGanic) reduced populations to near zero, while Beleaf and the organic materials, Venerate and Grandevo, showed lower leafhopper morality. At 14 DAA the leafhopper population crashed and the study was terminated. Overall, Sivanto 1.67SL proved to be an excellent material for control of both VCLH and WGH, performing as well or better than the grower's standard. Beleaf, Grandevo and Venerate provided control but they had significantly higher populations of both leafhopper species than the conventional and organic grower's standards.

Control of Pest Insects in Apples and Pears with Cormoran® Insecticide

Diane Reynolds and Steve Eskelsen
ADAMA USA, Raleigh, NC

Keywords: Cormoran®, acetamiprid, novaluron, apple, pear, codling moth, *Cydia pomonella*, pear psylla, *Cacopsylla pyricola,* chemical control, insecticide.

Abstract: The efficacy of Cormoran Insecticide was tested against industry standards for the control of codling moth in apples and pear psylla in pears. Replicated plots were treated with equipment to mimic commercial sprayers. Counts for insect pest numbers and signs (e.g., insect entry points on fruit) were made. Cormoran, at labeled rates, performed comparable to current industry standards.

Cormoran® is a registered trademark of ADAMA USA

Control of Nematodes in Tree Fruit and Nuts with NIMITZ® Nematicide

Steve Eskelsen and Issa Qandah
ADAMA USA, Raleigh, NC

Keywords: NIMITZ®, nematodes, fluensulfone, nematicide, tree fruit, tree nuts, chemical control, nematicide.

Abstract: The efficacy of NIMITZ® nematicide was tested in field trials for the control of nematodes in tree fruit and nuts. Replicated plots were treated with equipment to mimic commercial application. Nematodes were counted in soil samples taken from plots, both before and after application. NIMITZ controlled/suppressed nematodes in treated soils. NIMITZ is currently registered on fruiting vegetables. The NIMITZ registration for use in tree fruit and nuts is currently being reviewed by USEPA.

NIMITZ® is a registered trademark of ADAMA USA

Biology/Phenology—

Moderator: Emily Symmes

CRISPR/Cas9 Genome Editing of a Codling Moth Receptor Causes Female Sterility

Steve Garczynski
USDA-ARS, Wapato WA

Keywords: codlemone receptor, codling moth, *Cydia pomonella*, genome editing, future insect control

Abstract: The codling moth, *Cydia pomonella*, is a major pest of apple and pear. The inclusion of semiochemicals, including codlemone and pear ester, in codling moth IPM programs has reduced the amount of chemical insecticides needed to control this orchard pest. Odorant receptors located in the antennae are key sensors in the detection of semiochemicals and trigger downstream signaling events leading to a behavioral response. For codling moth, CpomOR1 is an odorant receptor that is a prime candidate for being a codlemone receptor based on its high expression levels in male antennae. We targeted the *CpomOR1* gene using CRISPR/Cas9 genome editing in attempts to knock down protein production in an effort to determine this protein's function. By injecting early stage eggs, we were able to successfully create mutations, including both deletions and insertions. When attempting to create stable populations of codling moth through mating of males and females containing mutations of the *CpomOR1* gene, we found that both egg production and viability were affected, with edited females producing non-viable eggs. The mechanism of egg activation by CpomOR1 in codling moth is unknown and will be the focus of future studies in an effort to target this protein for future control agents for use in the orchard.

New Opportunities: Adding "the Molecular" to Codling Moth Research

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[2] USDA-ARS, Wapato, WA

Keywords: codling moth, *Cydia pomonella*, apple, chemical ecology, insect olfaction

Abstract: The sense of smell, or olfaction, plays a critically important role in the life history of insects. Vital behaviors, such as food and mate seeking, are strongly guided by olfactory cues detected from an insects' environment. Decades of research on insect olfaction has facilitated novel biorational pest control strategies aimed at reducing the damage of important insect pests, including the codling moth, *Cydia pomonella.*

Within this framework, we study olfactory receptor (OR) proteins, which are expressed in olfactory sensory neurons (OSNs) on the surface of the antennae. ORs interface the insect with its olfactory environment, and relay sensory information to the brain through discrete input channels.

Methods: In order to better understand the chemical ecology of *C. pomonella*, we have studied the nature of the codling moth ORs in the antenna of adult male and female moths and neonate larval head tissue. We are able to extract these ORs from RNA taken from codling moth. We then express individual codling moth ORs in *Drosophila melanogaster* OSNs, where we can study their responses with electrophysiological recordings.

Results: We have identified 58 ORs present in the codling moth antennae. Several ORs are found only in males or only in females. These ORs may be involved in mediating sex-specific behaviors. We have also

identified OR genes only present in larvae that may be relevant to unique aspects of olfactory-guided neonate larval behavior.

Remarkably, we have identified and characterized an OR that is highly specific in its response to the bisexual and larval attractant, pear ester (OR3). Evolutionarily related versions of this receptor have also been identified in other moth species that are attracted by pear ester. Another olfactory receptor (OR19) responds to aromatic compounds and is tuned to a yet unconfirmed odorant of ecological importance, ongoing research points towards a floral compound.

Conclusions: For the first time, we can analyze all codling moth ORs, one by one, after expression in *Drosophila*. This is not possible using conventional electrophysiological recordings from codling moth antennae. Our results confirm the behavioral significance of pear ester as a specific kairomone for codling moth.

Codling moth has 58 odorant receptor types to detect all odorants salient for mate and food finding, and possibly for avoidance of dangerous or toxic organisms. Furthermore, it costs metabolic energy to express ORs in the antennae and we therefore assume that all 58 ORs fulfill a behaviorally important function. The next step is to investigate other ORs. We believe that this may lead to the discovery of other, possibly novel odorants that could be used to supplement olfactory-based pest control strategies.

Current and Future Potential Risk of the Spread of Oriental Fruit Moth in Washington

Lisa G. Neven[1], Wee L. Yee[1] and Sunil Kumar[2]
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[2]USDA-APHIS-PERL, Raleigh, NC

Keywords: Oriental fruit moth, *Grapholita molesta*, ecological niche models, climate change

Abstract: The Oriental fruit moth, *Grapholita molesta* (Busck), is a primary pest of stone fruits in several countries, including the United States. The distribution of this pest is more concentrated in areas receiving higher rainfall than in areas that are more arid. Most areas where stone fruits and apples are cultivated in near proximity, both codling moth, *Cydia pomonella* (L.) and oriental fruit moth are common pests and appear to occupy similar niches. The potential for establishment and spread of codling moth show a close relationship between apple cultivation, day length, and duration of chilling temperatures. However, the biology of Oriental fruit moth differs from codling moth in the requirements for diapause induction and completion, as well as host preference and degree day phenology. The objectives of this study were (1) to identify environmental factors associated with oriental fruit moth distribution, (2) to predict the potential distribution of oriental fruit moth in Washington State using MaxEnt and CLIMEX models, (3) identify those areas within Washington State best suited for establishment of Pest Free Zones, Areas of Low Pest Prevalence, and Pest Free Production Areas, and (4) identify regions most at risk of further expansion of oriental fruit moth populations as a function of climate change. Our models predicted a very small portion of central Washington is suitable to support oriental fruit moth populations, which is consistent with current distribution maps. However, the climate change models predict a large expansion of these suitable areas. These results indicate that action should be taken to greatly reduce current populations of this pest to stem the potential expansion into the major commercial tree fruit production areas in the state.

Implications of No-Chill Duration on Post-Diapause Emergence of the Western Cherry Fruit Fly, *Rhagoletis indifferens*

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Keywords: Western cherry fruit fly, *Rhagoletis indifferens*, diapause, no-chill

Abstract: The Western cherry fruit fly, *Rhagoletis indifferens* (Curran) is a serious pest of sweet cherries in the Pacific Northwest. Previous research by our group demonstrated that WCFF does not pose a threat to commercial cherry production in CA because the climate of that region is insufficient to support a population. A component identified in that study was the predicted lack of appropriate chilling temperatures for a duration sufficient to support diapause completion of this obligate diapausing insect. In this study we performed the longest duration experiment, giving 40 weeks of warm temperature exposure, to examine the impact of no-chill exposure to diapausing pupae of the Western cherry fruit fly. We found that there were three distinct responses, as a function of adult emergence, from pupae receiving no chilling temperature exposure. The first group, which composed approximately 3.2% of the total emergence, were most likely non-diapausing pupae. The second group, which accounted for the remaining 96.8% of the total emergence, were most likely diapausing pupae. However, only 24.2% of all pupae emerged from the non-chilled group as compared to 60.2% of flies emerging from pupae subjected to 20 weeks of cold storage. Of the 75.8% of the un-emerged pupae, 55.9% intact puparia remained following 40 weeks of warm temperature exposure. Of those, 71.9% of the pupae were still viable. This indicates that when WCFF pupae do not receive any chilling period, 0.77% of the population are non-diapausing, 22.2% can emerge within 40 weeks, and 40.2% are most likely 2-year diapausers. These results can be used to assess future impact of climate change as well as pest risk analyses for exported sweet cherries.

Mating Disruption/SIR—

Moderator: Christeen Abbott

Mating Disruption 50 Years On: Pheromones Coming of Age—Finally!

Don Thomson and Jack Jenkins
Pacific Biocontrol Corporation, Vancouver, WA

Keywords: pheromones, mating disruption, pink bollworm, *Pectinophora gossypiella,* codling moth, *Cydia pomonella,* oriental fruit moth, *Grapholita molesta,* European grape vine moth, *Lobesia botrana*

Abstract: The first report of the successful deployment of a sex pheromone to control an insect pest *Trichoplusia ni* was published in 1967. Eleven years passed until the US EPA registered the first mating disruption technology, Gossyplure H.F.®, for control of pink bollworm *Pectinophora gossypiella* in cotton. Over the last 50 years, the commercial deployment of mating disruption has grown substantially with products registered for dozens of insect pests, primarily Lepidopteran species in horticultural crops. Pheromone active ingredients are relatively expensive to produce and commercial success of mating disruption has depended on cost-effective controlled release technologies. Passive-release pheromone dispensers applied by hand or with specialized equipment are the most widely used technologies. However with greater adoption, mating disruption products have evolved to improve efficacy, ease-of-use and economics. Recently, active-release dispensers such as aerosols have been successfully developed and increasingly adopted for several important pests. Mating disruption has been very successful when combined with other management technologies and used in large contiguous areas. Some organized area-wide programs have reduced target insect populations to very low and sustainable levels (*Cydia pomonella, Grapholita molesta*) while others have eradicated the insect from specific geographic areas (*Lobesia botrana*). Currently, mating disruption is used to manage more than 40 species worldwide with an estimated 750,000 hectares treated. Adoption of mating disruption is increasing especially in the European Union and the United States. Issues related to the adoption of mating disruption such as government regulations, health and environmental concerns and pest management and economic considerations will be reviewed. Fifty years on and finally coming of age, future trends in development and adoption of mating disruption technology will be discussed.

History of a Mating Disruption Mega-Dispenser: MSTRS Aerosols and Baggies

T. C. Baker
Penn State University, University Park, PA

Keywords: pheromone mating disruption, Metered Semiochemical Timed Release System, passive-release

Abstract: Dispensers for emitting sex pheromone for pheromone mating disruption have increasingly been engineered to be deployed as high-release-rate, widely spaced dispensers. Such mega-dispensers have been effective at producing satisfactory population control and reducing damage to agricultural crops. Whereas attention with regard to mating disruption success has traditionally been paid to achieving emission rates in terms of amounts emitted per acre or hectare per day, our laboratory has focused on the amounts emitted per dispenser per minute. The key reason for this focus is because we and others learned through long series of behavioral experiments in the 1980s and 1990s that upwind flight responses of moths to pheromone occurs via the moths' upwind surges in response to individual pheromone strands in pheromone plumes. Because upwind flight is due to the intensity of molecular flux of individual strands, we focused on producing dispensers that would create the strongest possible strands downwind. In 1993 we first started researching the efficacy of mating disruption mega-

dispensers that were comprised of pressurized canisters producing metered aerosols of pheromone emitted onto cloth pads on a timed-release basis during certain hours of the day or night. We soon replaced the pressurized canister type of Metered Semiochemical Timed Release System ("MSTRS") with a non-pressurized pump-spray bottle type that emitted the same amounts of aerosols as those emitted by the pressurized canisters. From these two aerosol systems we gained critical knowledge about the pheromone emission rates emanating from the pads that were needed in order to achieve successful mating disruption in the field. By carefully measuring the emission rates from the pads we also realized that the pads receiving the timed aerosol sprays quickly reached a saturation point, after which the sprays did not further increase the pads' emission rates. In other words, within several days, the pads became totally passive dispensers that were very effective at achieving mating disruption. Following these discoveries, working with Cam Oehlschlager of ChemTica Internacional we came up with a new type of MSTRS dispenser that was a totally passive-release system: polyethylene "baggies" whose emission rates mimicked those of the pads. The MSTRS baggies have been shown to be effective mating disruption dispensers against a variety of moth pest species.

Control of Codling Moth by Mass Trapping Using a Kairomone Lure

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[2]Department of Entomology, University of Wisconsin, Madison, WI

Key words: codling moth, *Cydia pomonella*, trap, kairomone, control

Abstract: Control methods for codling moth (CM) are needed that are compatible with pheromonal mating disruption (MD), particularly when local moth populations exceed densities that can be managed with MD. A recently developed bisexual lure for CM was used in delta traps in commercial orchards to remove female as well as male moths, to reduce oviposition and damage to apples. In 4-acre plots, using 50 traps per acre, over 30-day time periods, fruit damage incurred was greatly reduced compared to paired untreated control plots. The results indicate that the lure and trap combination at that density should be sufficient to control CM or reduce population densities to those manageable by MD.

Developing Mass Trapping for Codling Moth: Start with Effective Traps and Lures

Alan Knight[1], Liliana Cichón[2], Esteban Basoalto[3], Wilson Barros-Parada[4],
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Keywords: *Cydia pomonella*, butyl sulfide, pear ester, nonatriene, propylene glycol, adhesives

Abstract: The theory (Dr. Jim Miller) says that removing male moths is better than temporarily disrupting them, and removing female moths is the most effective strategy to dampen the growth of an insect pest population using this approach. Initially, the effectiveness of sex pheromone-based mass trapping programs was inadequate for an injurious, direct pest such as codling moth. Even following the identification of pear ester, ethyl (E,Z)-2,4-decadienoate as a bisexual attractant, the practicality of removing enough moths to attain sufficient level of protection was judged to be insufficient by Light & Knight. Combining acetic acid (AA) co-lures with pear ester provided some new hope because the

numbers of female moths removed could be increased. However, field trials did not provide adequate fruit protection. More recently, identifications of (E)-4,8-dimethyl-1,3,7-nonatriene (DMNT) or n-butyl sulfide when used in combination with pear ester and acetic acid have further improved the opportunity for effective mass trapping strategies. Unfortunately, our expanded studies in North and South America found that these two combinations were only equivalent, though the combination of sex pheromone+DMNT+pear ester in one lure plus AA was the more effective in trapping female codling moth. At the end of the day, however, neither was any better than the combo lure plus AA, which is probably good, since it is commercially available, long-lasting, and does not smell like garbage.

The biggest concern with developing mass trapping besides the efficacy of the lures is the overall cost of materials and labor. Trap density and trap servicing are likely key attributes that can scuttle the further development of this technology. Clearly, the lowest number of non-maintenance traps you need is the way to go with this approach. The best guess would be that it needs to work at < $150 acre or clearly with many fewer than 50 traps per acre. The idea of going to microtraps has come and gone, but it was clever, and maybe with female attractants should be re-evaluated. Standard delta/diamond traps are much larger, but all have a curvilinear response to saturation from the target as well as nontarget organisms. Once their efficacy drops off, the liners need to be replaced and that is a big cost, i.e., to check the traps to see if they need to be serviced and the material costs. However, some improvements were made with these types of traps with the development of tackier hot melt pressure-sensitive adhesives in 2016.

Non-saturating bucket traps could be the answer to minimize in-season servicing costs, though they are much more expensive to purchase, they can be used for many seasons, though the inventory costs of placing, retrieving, and storing traps is likely high. Bucket traps typically use a vapona strip which should last the entire season. The use of retaining powders (kaolin) has been tried with some success though no commercial source is available. To use mass trapping in certified-organic orchards is a problem as all the components need to be deemed safe including the attractants and the retaining material. Propylene glycol seems to work the best but is not allowed in organic orchards despite being a food grade material. However, this can be replaced with certified mineral oil and boric acid can be added to reduce organic decay.

To examine these variables a series of studies were conducted during 2016 in a heavily-infested unsprayed apple orchard treated with mating disruption (MD). Bucket traps with propylene glycol and baited with the combo plus AA lures greatly outperformed similarly baited delta traps with typical liners replaced periodically during the season. However, despite the removal of thousands of codling moth per acre, the entire crop was destroyed by this pest. Several research questions remain to further tweak the optimal trap and lures to use for mass trapping of codling moth. In addition, we are looking at the combined mass trapping of all tortricids with a multi-component lure.

It is important to remember that the initial studies with MD of codling moth did not look very promising as the research was typically conduced in infested orchards. However with MD we get the combined effect of some mating disruption and some delay of mating. With mass trapping the males not trapped get to mate with all the females, and the females not trapped probably get to lay all their eggs. Also, the immigration of mated females that are not disrupted or trapped remain a serious problem with codling moth.

Maybe our initial set of studies showing that mass trapping was not sufficient was seriously flawed by always working with moderate to high populations of pests? We had to have injury to measure a reduction in injury! But, the real question now is whether mass trapping can be used together with careful monitoring and a supplementary insecticide program (IPM) and be as effective as the current use

of MD when the pest populations are low? We propose to further explore this opportunity in 2017. What a great time to have the esteemed Dr. James Miller to chat with!

Aerosol Mating Disruption for Navel Orangeworm: Mode of Action and Relation between Trap Suppression and Crop Protection

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Keywords: navel orangeworm, *Amyelois transitella*, mating disruption

Abstract: Aerosol mating disruption for the navel orangeworm is well established, but optimization of release characteristics based on the mode of action may be useful to increase cost-effectiveness. Since the current formulation uses a single component that does not attract males in the wind tunnel or in the field, the mode of action is presumed to be non-competitive. Increasing frequency of emission above the currently used 15 minute interval had a greater impact than increasing the concentration of material used. This finding is in contrast to finding in the codling moth, in which mating disruption uses an attractive formulation and a competitive mechanism. Comparison of males captured in plots treated with no mating disruption and with dispenser densities of 1 per 10, 6, 3, 1, or 0.5 acres revealed a sharply concave plot instead of the linear response expected for a non-competitive mechanism. Significantly fewer males were captured in plots with 1 dispenser per 0.5 acres than at higher densities, but all but the plots with 1 dispenser per 10 acres had >90% trap suppression compared to the untreated controls. We conclude that plots of male capture as a function of dispenser density should be considered as one line of evidence of mode of action rather than definitive proof; and that, for the navel orangeworm, trap suppression occurs over a much greater range than damage suppression.

Hazelnut IPM: Improving Filbertworm Mating Disruption and Preparing for BMSB Invasion

Vaughn Walton, Betsey Miller, Danny Dalton
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Keywords: Filbertworm, Cydia latiferreana, mating disruption, pheromone, aerosol emitters, flight periodicity, secondary pests, brown marmorated stink bug, Halyomorpha halys, population modeling

Abstract: In the fifth consecutive year of filbertworm (FBW) mating disruption trials in hazelnut orchards in the McKenzie River Valley, Oregon, we compared the efficacy of aerosol emitters to commercially registered ring dispensers as well as the long-term trends of secondary pest pressure between mating disrupted and control orchards. Aerosol emitters were numerically, but not significantly, more effective than ring dispensers at controlling FBW populations, and aphid populations remain significantly lower in mating disrupted orchards. In-field periodicity traps showed an expected night-time peak in FBW flight as well as a significant and unexpected peak in mid-day flight activity.

While FBW has typically been the dominant pest of hazelnuts, the invasion of brown marmorated stink bug (BMSB) has been threatening the industry for the past several years. Pheromone trapping and population modeling of BMSB during 2015 and 2016 indicate that the majority of the BMSB population are adults during spring and fall. Feeding impact studies indicate that the adult life stages cause the

majority of feeding damage. Increased temperature, as found during the latter portion of the growing season, also contributes to damage intensity. For these reasons, we believe that the late summer is the period when the majority of BMSB damage occurs in hazelnut orchards. We will discuss implications of these results for the future of pest management in hazelnuts.

Implementation—

Moderator: Chuck Ingels

Mating Disruption for Navel Orangeworm in Almonds – How We Make it Work

Bradley S. Higbee
Wonderful Orchards, Shafter, CA

Keywords: Amyelois transitella, navel orangeworm, mating disruption, sex pheromone, almonds, puffers, monitoring

Abstract: A commercial product for navel orangeworm (NOW) mating disruption (MD) was introduced in 2005. Since then, its use has grown from 20k acres in 2006 to an estimated 200-300k acres in 2016 (ca. 1.2 million total acres of almonds and pistachios in CA). The cost of the technology was initially an impediment, but as global demand increased, almond and pistachio grower returns also increased. At the same time, damage thresholds for NOW have decreased. Available insecticides are often not able to reduce NOW damage below current damage tolerances. However, when NOW MD is used in combination with insecticides, results have been better than either approach separately. We have developed and adopted a monitoring scheme using traps, preharvest sampling and historical information that has allowed the dreaded "no spray" decision to be made with a reasonable degree of confidence. This approach will be discussed, along with some recent "Big Data" analyses from our Areawide experiments that may lead to more precise management of NOW.

Water is the Connection: Pesticide Use and Salmon Recovery in the Willamette Basin

Sharon Selvaggio
Northwest Center for Alternatives to Pesticides, Eugene, OR

Keywords: pesticide stewardship partnership, salmon, aquatic life benchmarks

Abstract: Recovery of severely depleted runs of salmon and steelhead is a national and state priority, including within the Willamette Basin. Clean, cold, abundant water -- vital to salmonids – is increasingly scarce in the Basin, especially within lower elevation Willamette Valley streams and rivers, which provide spawning and rearing as well as migratory habitat. The 2011 Recovery Plan, required under the Endangered Species Act (ESA), identifies degraded water quality as a significant threat to the Willamette Valley's threatened native salmonid runs. Widespread commitment to improve water quality is critical to recovery.

Oregon's Pesticide Stewardship Partnership program (PSP) tests water samples for dissolved residues of pesticides and works with communities to reduce pesticide residues in waters. Samples are collected biweekly during the growing season in several Oregon sub-basins. Water samples (*n*=872) from streams and rivers collected from 2010-2015 in the Clackamas, Molalla-Pudding, and Greater Yamhill sub-basins were analyzed for detectable concentrations of up to 125 different pesticides and their analytes. Not all pesticides were analyzed in all samples, as the analyte list has expanded over time.

The pesticides (or their degrades) diuron, atrazine or simazine, and glyphosate were each present in 50% or more of the samples (Figure 1). Metolachlor, sulfometuron-methyl, DEET, metribuzin, propiconazole, dimethanamid, and imidacloprid were also frequently detected, with detection frequencies between 15 and 50%.

EPA Aquatic Life Benchmarks (ALBs) are commonly used to assess whether pesticide concentration levels found in water bodies may indicate a potential hazard to aquatic life. Within the designated PSP

areas, many current-use pesticides had occasional detections exceeding the most sensitive ALB. These include chlorpyrifos, bifenthrin, diazinon, atrazine, dimethoate, diuron, simazine, oxyfluorfen, linuron, methomyl, methiocarb, dimethenamid, chlorothalonil, metolachor, 2,4-D, pendimethalin, ethoprop, and sulfometuron-methyl.

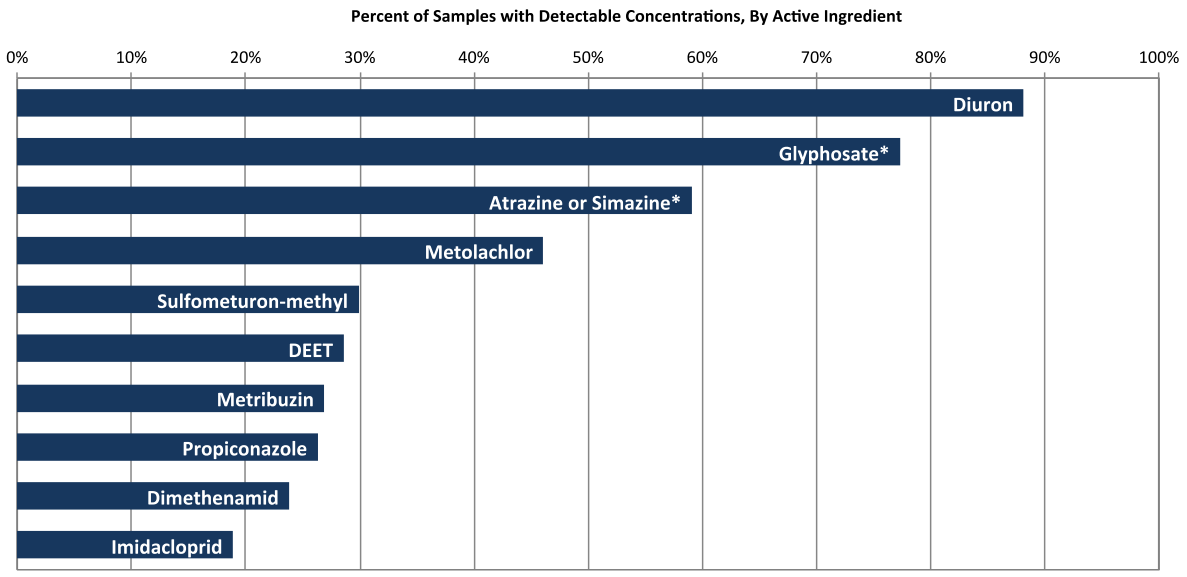
ALBs are based on studies of pesticides in isolation, not in mixture. Mixtures at Willamette Valley sites are the norm, not the exception, with mixtures with four or more pesticides commonly present. Several investigations have demonstrated additive or synergistic effects to salmonids from exposure to mixtures of pesticides at environmentally relevant concentrations. Mixtures remain unregulated, but may pose greater risks to aquatic life that go unaddressed.

Seven of the pesticides detected in the three PSP sub-basins have been determined by National Marine Fisheries Service to pose jeopardy and adverse modification to ESA-listed salmonids present in the Willamette Basin, including spring Chinook, winter steelhead, and/or Lower Columbia Coho; an additional four have been determined by EPA as likely to adversely affect listed salmonids.

In general, the pesticides frequently identified or found above ALBs in the Valley are broad-spectrum chemistries with a wide range of use sites. Strategies to reducing pesticide entry into streams include: reducing the amounts of pesticide applied; substituting less toxic, less persistent, or less mobile pesticides; and reducing the transport of pesticides from field sites to streams. Growers stand to benefit because these measures also promote efficiency (saving money), tend to reduce secondary pest outbreaks, and conserve water. As well, proper use and application of all pesticides delays resistance and preserves the ability to judiciously maintain the chemicals in the toolbox.

A new publication and set of pesticide fact sheets sponsored by the PSP program discusses these topics and provides a variety of best management practice recommendations for Willamette Valley growers.

Figure 1. Ten Most Frequently Detected Pesticides in Streams and Rivers of the Clackamas, Molalla-Pudding, and Yamhill Subbasins, Willamette Valley, Oregon 2010-2015



Heat Kill of Apple Maggot Fly Pupae

Wee L. Yee[1], Peter S. Chapman[1], and Tim O'Neil[2]
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Keywords: Rhagoletis pomonella, organic yard waste, compost, heat treatments

Abstract: The movement of organic yard waste from western to central Washington for recycling and composting could threaten the apple industry in central Washington by introducing apple maggot pupae into apple-growing areas. One solution that will allow waste movement without threatening the apple industry is heating waste to kill fly pupae before waste is moved. In laboratory tests to determine various heating regimes for killing pupae of the fly, it was found that brief exposures of pupae to 51.1, 55.0, or 60 °C prevented adult eclosion. Results suggest these temperature treatments can be used to eliminate the threat of apple maggot in yard waste.

Thresholds/Monitoring—

Moderator: Brad Higbee

Plume Reach and Trapping Area of a Pheromone Baited Codling Moth (*Cydia Pomonella*) Trap in Orchards under Various Mating Disruption Technologies

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Keywords: codling moth, *Cydia pomonella*, mating disruption, plume reach, trapping area.

Abstract: We have previously demonstrated a novel way of interpreting catch data from a single-trap multiple-release experimental design, that elucidates the plum reach and trapping area of a pheromone baited codling moth (*Cydia pomonella*) delta trap in Michigan orchards without mating disruption. Here we use these methods, described in the recent book *Trapping of Small Organisms Moving Randomly*, to measure these distances in orchards under various mating disruption technologies. Field experiments using marked sterilized moths from the Okanagan-Kootenay Sterile Insect Release (OKSIR) facility were released in orchards equipped with hand applied or sprayable pheromone dispensers at full or half rate. Preliminary results suggest that the trapping area is reduced from 18 ha (44 acre) in undisrupted orchards, to 4.5 ha (11 acre) for full rate hand applied conditions.

Combination Phenyl Propionate/Pheromone Traps for Monitoring Navel Orangeworm (Lepidoptera: Pyralidae) in Almonds in the Vicinity of Mating Disruption

Charles Burks
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Keywords: navel orangeworm, *Amyelois transitella*, phenyl propionate, monitoring

Abstract: Aerosol mating disruption is used for management of navel orangeworm, *Amyelois transitella* (Walker) (Lepidoptera: Pyralidae) in an increasing portion of California almonds and pistachios. This formulation suppresses pheromone monitoring trap far beyond the treatment block, potentially complicating monitoring and management of this key pest in such blocks. Phenyl propionate is an attractant that captures adults in the presence of mating disruption which completely suppresses pheromone traps, and lures combining phenyl propionate with a pheromone lure (PPO-combo lure) synergize trap capture in the presence of mating disruption. In this study, data are presented from a trial comparing monitoring of field plots at various distances from fields under commercial mating disruption much of a season with pheromone and PPO-combo lures. While there was some evidence of partial suppression of capture in PPO-combo traps closer to mating disruption compared to lures farther away, there was not a failure of detection as occurred with pheromone lures. The ratio of adults in pheromone and PPO-combo trap varied with proximity from treated fields. These results indicate that, in addition to monitoring in mating disruption plots, phenyl propionate combo lures can be useful for insuring against failure of detection of navel orangeworm pressure in areas where mating disruption is widely used.

Seasonal and Crop Effects on Reliability of Synthetic Navel Orangeworm Lures

Charles Burks[1], Emily Symmes[2], Jhalendra Rijal[3], and Brad Higbee[4]
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Keywords: navel orangeworm, *Amyelois transitella*, phenyl propionate, monitoring

Abstract: Pheromone lures for the navel orangeworm have become available within the last several years, and are now widely used. The navel orangeworm nonetheless has a more complex sex pheromone blend compared to other common orchard moth pests, so ongoing characterization of the use and limitation of this tool is appropriate. Here we compare trapping data sets from walnut blocks in three regions in 2016 to a large data set from almond and pistachio blocks in Kern County in 2015, and a pistachio trail in Fresno County in 2016. In almond blocks, seasonal abundance of males in synthetic lures in the widely used delta traps correlated well with that of males in wing traps baited with unmated females. In pistachio blocks, in contrast, there were periods during which males were detected with female-baited wing traps, while few or none were detected with delta traps baited with pheromone lures. Lack of association between captures in female-baited traps and synthetic lures were not as evident in the walnut blocks. There was, however, greater mid-summer abundance in the southern San Joaquin Valley compared to the northern San Joaquin or Sacramento valleys. There was also greater week-to-week variation in male captured in some brands of lures compared to the others.

Biological Control—

Moderator: Jhalendra Rijal

Exploration of the Role of Sixspotted Thrips in Spider Mite Biocontrol in California Almonds

David R. Haviland
University of California Cooperative Extension, Kern County, CA

Keywords: Sixspotted thrips, *Scolothrips sexmaculatus*, spider mite biological control, *Tetranychus pacificus*, predator, almond

Abstract: Pacific spider mite is a ubiquitous pest of almonds in the Southern San Joaquin Valley of California. Management of spider mites generally consists of biological control in combination with one to three miticide applications per season. In the early 2000s the predominant biological control organisms were predatory mites, such as *Galendromus occidentalis*. However, in recent years there has been a shift whereby phytoseiids are much less common and sixspotted thrips have become more prevalent. Research has shown that sixspotted thrips is a very effective predator of spider mites and can very quickly cause mite populations to crash. The concern with sixspotted thrips is that they can be unpredictable and there is currently no recognized method pest control advisors can use to monitor them. This presentation will report on work during 2016 develop methods for monitoring sixspotted thrips using sticky cards and document the impact they can have on spider mite populations.

Invasive Species—

Moderator: David Haviland

Trissolcus japonicus Arrives in Oregon: Evaluating Biological Control of Brown Marmorated Stink Bug

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Keywords: brown marmorated stink bug, *Halyomorpha halys*, parasitoid, non-target effects

Abstract: Trissolcus japonicus, known by the recently approved common name samurai wasp, offers a solution to management of the Brown Marmorated Stink Bug (BMSB). This parasitoid attacks BMSB egg masses. Samurai wasp was accidentally introduced in the Western USA and recently discovered in Vancouver, WA and Portland, OR. We placed sentinel BMSB egg masses in Portland and found evidence of parasitism by samurai wasp across multiple neighborhoods. The potential of this biocontrol agent to disperse across Oregon may enhance efforts for managing BMSB. While samurai wasp is known to specialize in attacking BMSB egg masses, there is also the possibility of non-target effects on native stink bug species. We investigated samurai wasp movement and behavior in the presence of visual and olfactory cues from BMSB and two common native stink bugs, *Chlorochroa ligata* and *Chinavia hilaris*.

When given a decision between BMSB and a native stink bug, samurai wasp moved towards BMSB more quickly and spent slightly longer amounts of time on filter paper containing BMSB olfactory cues. However, wasps did not restrict movement to BMSB and exhibited egg searching behaviors on surfaces with contact from native stink bugs. *T. japonicus* remains a promising candidate for releases into orchards affected by BMSB, and we discuss the implications of range expansion into the Willamette Valley.

Management Options to Mitigate the Impact of Brown Marmorated Stink Bug in Fruit Orchards

Greg Krawczyk[1], Rob Morrison[2], Tracy Leskey[2], Marcelo Zanelato Nunes[1] and Lauren Shaak[1]
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Keywords: Halyomorpha halys, brown marmorated stink bug, BMSB monitoring, pome fruit, stone fruit

Abstract: Brown marmorated stink bug (BMSB) *Halyomorpha halys* (Stäl) (Heteroptera - Pentatomidae) continues to be the most important driver for the intensity of insecticide based pest management programs in fruit orchards in the eastern United States. But the simple increase in the numbers of insecticide applications is not a sustainable solution to the BMSB problem. The BMSB monitoring studies, 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. And while the precise BMSB treatment threshold levels are still not fully validated, applications of insecticides based on the trapping results were effective in reducing the number of applications and successful BMSB management. During last few seasons we also tested the attract-and-kill strategy in the form of baited trees or insecticidal nets employed in commercial fruit orchards. The project conducted in Pennsylvania and four other Mid-Atlantic states provides very promising indicators suggesting the possibility of significant reduction in the use of insecticides. Combining extensive BMSB monitoring BMSB with judicial use of insecticides allowed some of our growers to practically reduce the

number of insecticide applications by over 70% between the 2013 and 2016 seasons with no differences in the fruit injury levels caused by BMSB.

Monitoring BMSB—Which Trap?

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[2]Oregon State University, Department of Food Science and Technology, Corvallis, OR;
[3]Washington State University, Tree Fruit Research and Extension Center, Wenatchee WA.

Keywords: brown marmorated stink bug, *Halyomorpha halys*, aggregation pheromone, monitoring, plant volatiles

Abstract: A number of commercial traps and lures are available for monitoring brown marmorated stink bug *(Halyomorpha halys)* but many of the current options are unlikely to be widely used by growers. Traps can be unwieldy and expensive, and there is potential that lures could be further enhanced. We report on field trials from western OR and WA examining efficacy of different traps and lab olfactometer trials examining the potential use of host plant volatiles as attractants. We discuss how different traps can work in different situations depending on the goal of the monitoring and whether the traps are informative for treatment thresholds in orchard crops including hazelnuts and pears.

Brown Marmorated Stink Bugs in Sacramento County: Phenology, Distribution, and Trap Comparisons

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Keywords: brown marmorated stink bug, BMSB, *Halyomorpha halys*, monitoring, trapping, phenology

Abstract: In the midtown Sacramento brown marmorated stink bug (BMSB) infestation area, 24 traps were placed and checked weekly to help evaluate BMSB phenology. Half of the traps were standing 4-ft pyramid traps and half were 8-in. tall experimental double cone traps (Trécé) secured to tree of heaven branches. The first traps were placed 9 February, and because February 2016 was unusually warm, the first adults were found in traps only two days later and every week thereafter—far earlier than in past years. The first eggs were found on 12 April, earlier than previous years and the earliest in the country. The first nymphs were trapped on 9 May, 10 days earlier than 2015 and 25 days earlier than 2014. A typical peak of nymphs was seen in traps in June, but a late July heat wave decimated the population for a month and the typical large late summer peak was far lower than in 2014-15. In all 3 years, two generations were found, which agrees with the BMSB model. Traps caught significantly more nymphs than adults, and more females than males. Pyramid traps caught significantly more nymphs than experimental double cone traps. In March, 20 pyramid traps were placed south of Sacramento to Walnut Grove and traps were also placed in agricultural/urban interface areas in Lake and Mendocino counties. From mid-June through mid-July, 3 male adults and 2 nymphs were found in a plum tree near a vineyard by Clarksburg, and in late September and October 2016, 3 male adult BMSBs were found in a trap in Freeport. No BMSB were found in Lake or Mendocino counties.

Pairing of a Lure and a Trap to Improve Trapping and Detection of BMSB

Peter Landolt and Dane Elmquist
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Key words: brown marmorated stink bug, *Halyomorpha halys*, pheromone, trap, detection

Abstract: The brown marmorated stink bug (BMSB) has been rapidly spreading through the state of Washington and increasing in density locally. Commercial pheromone-baited traps comprised of a clear plastic tube housing an internal funnel and set over large green "wings" have been in use for several years, in tandem with active searching using beating sheets, and citizen awareness efforts, to track the presence and spread of the insect in Yakima County. Other studies of ours suggested that an alternate trap design used for paper wasps might provide better capture of BMSB attracted to pheromone lures. Paired tests in urban properties in Yakima showed a strong differential catch of BMSB between the two trap designs. This newer combination of trap and lure was then used in a rapid program to further define the presence of the BMSB in the city of Yakima and environs.

Effects of Net Enclosures and Barriers on Pest and Non-Target Species in Apple Orchards

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Keywords: Cage exclusion, 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: Installations of shade netting have become increasingly popular over Washington orchards with the goal of reducing sun damage to fruit. With some structures enclosing the entire orchard, the netting can become a barrier to certain direct pests including codling moth, *Cydia pomonella*, and the invasive brown marmorated stink bug, *Halyomorpha halys.* Conversely, the enclosures may be disrupting biological control by excluding natural enemies from the orchard. To test the hypothesis that netted enclosures would exclude stink bugs we used the native consperse stink bug, *Euschistus conspersus*. Stink bug damage was lower in the cages than in the conventional (airblast) treatment and the untreated control. Codling moth and leafroller adult densities and fruit damage were significantly lower in the caged plots. Woolly apple aphid densities were significantly higher in the caged plots, along with its parasitoid *Aphelinus mali*. Earwigs, an important aphid predator, were higher in small (3-tree) cages, but no differences among treatment means were found in large (4 row x 12 tree) cages. Lacewings and syrphid flies capture rates on plant volatile baited sticky panels were greatly reduced in the cages compared to uncaged plots. Sunburn was significantly reduced inside the cages.

Detection Survey of Brown Marmorated Stink Bug in Peach Orchards in San Joaquin Valley, California

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[1]University of California Cooperative Extension, Modesto, CA
[2]UC Statewide IPM Program

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

Abstract: Brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål), originated in East Asia and has been spread to over 43 states in the continental United States including California. A significantly large BMSB population was discovered in Midtown Sacramento in 2013 and has been rapidly spreading into nearby areas and neighboring counties. To date, BMSB has been detected in 28 California counties, of which, established populations have been documented in 9 counties. In Stanislaus County for the first time, a reproducing population was detected near Highway-99 in Modesto in mid-July 2015. In 2016, we conducted detection survey in nine peach orchards located within the 10 miles of the Highway-99 in Stanislaus and Merced Counties. The standard black pyramid traps baited with lures containing aggregation pheromone and methyl decatrienoate were used. The first BMSB adult was captured during early July in one of the 9 orchards surveyed. At the same side, more adults were captured during September and October. To our knowledge, this is the first report of consistent BMSB catches in any commercial crops in California.

Status of Brown Marmorated Stink Bug in Utah

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Keywords: brown marmorated stink bug, *Halyomorpha halys*, invasive pest, specialty crops

Abstract: Brown marmorated stink bug (BMSB; *Halyomorpha halys* Stål) (Hemiptera: Pentatomidae) is an invasive insect pest that was accidentally introduced to the U.S. from Asia. It has an expansive host range that includes fruits (tree fruits and berries), vegetables, and woody ornamentals. BMSB can also be a major nuisance pest because it aggregates in and on buildings in the fall through spring where it can impinge on human habitation. Since its first detection in Pennsylvania in the mid-1990s, BMSB has expanded its range to more than 40 states and poses agricultural and nuisance problems in about 20 of these states. BMSB was first detected in Utah in 2012 and is currently found in five counties of northern Utah with highest populations in the greater Salt Lake City area. It is not yet causing economic crop damage in Utah, but is established in the urban-agricultural interface of the Wasatch Front and feeding injury has been detected on numerous ornamental and wild hosts. Research areas of BMSB in Utah include 1) determining host plant and environmental preferences of BMSB in representative urban-agricultural landscapes of northern Utah, 2) determining the phenology of BMSB life stages, 3) assessing the status of biological control of BMSB from native and non-native natural enemies, and 4) comparing efficacy of traps and pheromone lures.

Enhanced Yeast Feeding Following Mating Facilitates Control of *Drosophila suzukii*

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Keywords: semiochemicals, oviposition, *Drosophila suzukii*, yeast, attracticide

Abstract: Spotted wing drosophila, *Drosophila suzukii*, is widely associated with the yeast *Hanseniaspora uvarum*. Yeasts are symbionts of drosophilid flies and communicate with insects through volatile metabolites for spore dispersal. Accordingly, yeasts and behaviour-modifying chemicals produced by yeasts are prospective tools for environmentally sound insect management.

We first bioassayed flight attraction, feeding and oviposition of *D. suzukii* females in response to *H. uvarum* yeast and blueberries, a preferred host fruit. We then investigated the combined effect of yeast and insecticide on adult female oviposition behaviour and mortality towards the development of a yeast-based control method.

Following mating, attraction of female flies to blueberry and yeast odour cues was strongly enhanced. Yeast feeding significantly increased in mated females, while yeast did not increase oviposition on blueberries. This observation suggests that mated flies become attracted to yeast for feeding and to fruit for egg laying. A combined feeding-oviposition assay demonstrated different roles and interference between yeast and fruit stimuli: during the day after mating, females laid fewer eggs when yeast was available.

The post-mating yeast-feeding response is an opportunity for the development of an attract-and-kill technique for population control of *D. suzukii*. Exposing flies to a blend of yeast and insecticide reduced oviposition and greatly enhanced adult fly mortality compared with an insecticide treatment alone.

Synthesis and applications. Mated females are the key life stage for *D. suzukii* population control. Egg-laying females perforate fruit skin and fungal infestations ensue, even when eggs and larvae are killed off by insecticide sprays. Behaviour-modifying chemicals, including yeast metabolites, enable environmentally safe insect management via manipulation of olfactory-mediated reproductive behaviour. Our results highlight that yeast and yeast semiochemicals hold potential for *D. suzukii* management and that response modulation to olfactory stimuli following mating is a vital element for the development of *D. suzukii* control methods. Yeast-feeding is enhanced in mated *D. suzukii* females and this change in post-mating behaviour can be exploited for development of an attract-and-kill strategy, combining a fly-associated yeast with an insecticide. Furthermore, using the *D. suzukii* yeast mutualist, *H. uvarum*, may reduce non-target effects and increase species specificity, which further contributes to the development of an efficient and safe control method.

Influence of the Yeast *Hanseniaspora uvarum* on Courtship Behavior, Mating, and Flight of *Drosophila suzukii* Matsumura (Diptera: Drosophilidae)

Alix B. Whitener[1], Boyd Mori[2], Paul G. Becher[2], Peter Witzgall[2], and Elizabeth H. Beers[1]
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Keywords: chemical ecology, spotted wing drosophila, *Drosophila suzukii*, yeast, *Hanseniaspora uvarum*, copulation behavior, flight behavior

Abstract: Drosophilids are associated with numerous yeast species found on fruit hosts. Recently, *Hanseniaspora uvarum* yeast was found to be closely associated with spotted wing drosophila (SWD), an economically significant pest of cherries and other soft fruit. Better understanding how SWD interacts with this yeast species, including mating and oviposition site-locating behavior, can improve our ability to tailor behavioral control methods, broadening a highly chemical control-dependent pest management program into an integrated approach. We investigated the influence of *H. uvarum* yeast on mating, courtship behavior, and flight response of adult SWD depending on their sex (male/female) and physiological status (fed/starved, mated/unmated). Adult male and female SWD were prepared in different combinations of feeding and mating statuses, then exposed to *H. uvarum*. In the copulation experiments, we measured the occurrence of male pre-mating behavior and mating occurrence in the presence and absence of yeast. We observed flight behavior (contact) of individual adult SWD in a wind tunnel in response to *H. uvarum*. Starved males frequently initiated pre-copulation behavior, but starved females exposed to yeast were significantly less receptive than starved females without yeast. In the wind tunnel, the only significant interactions in response to yeast were with mating status and sex, not with feeding status. Unmated females flew significantly more often than mated females and unmated males in response to *H. uvarum*.

Drosophila suzukii Invasion in Sweden and the Development of Attract-and-Kill Control Measures

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Keywords: Drosophila suzukii, spotted wing drosophila, *Hanseniaspora uvarum*

Abstract: *Drosophila suzukii* (spotted wing drosophila) was first detected in southern Sweden in 2014, and the populations continue to expand and spread northward. With each year the adult trap catches and the proportion of fruit damaged increases. Our research efforts focus on the chemical ecology of the fly. A main goal is to develop behavioral control measures through attract-and-kill technology. *Drosophila suzukii* is associated with the yeast *Hanseniaspora uvarum*, and adults are attracted to this yeast for feeding. We will discuss our work to develop and refine *D. suzukii* attraction to this yeast for pest control in an attract-and-kill formulation.

Sweetening the Deal: Phagostimulants and Insecticide Efficacy for SWD in Cherry

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Keywords: spotted wing drosophila, *Drosophila suzukii*, pesticides, phagostimulant

Abstract: Drosophila suzukii, spotted wing drosophila (SWD), is an invasive fruit fly introduced from Asia and first identified in the United States in 2008. Since that time, it has negatively impacted numerous soft skinned fruits including berries and stone fruit. In order to combat this pest, many growers have been forced to drastically increase their pesticide applications, which in turn has led to an increase in production costs, residue levels, and additional pressure for development of resistance to effective formulations. Efforts to decrease pesticide applications and increase efficacy are important for retaining effective chemistries, as well as protecting non-target species. Many of the pesticides currently used against SWD target the adult stage and are contact materials. Direct contact can be difficult to obtain since SWD prefer to remain deep within plant canopies where coverage can be a limitation. Efficacy of insecticides may be enhanced by addition of phagostimulants. Phagostimulants may increase pest consumption of insecticides and could facilitate reduced application rates without improving coverage. In 2016, three different insecticides including Mustang, Delegate and Exirel were applied to mature 'Bing' cherries to test their efficacy against SWD when applied at label rates and with a 0.1% sugar solution. Leaves and fruit were collected the day before application and then 1, 3, 7, 14, 21 and 28 days following treatment and assessed for efficacy via lab bioassays. Approximately 10 mixed sex adult SWD were added to each bioassay cup, along with a treated cherry and leaf. Mortality was assessed every 24 hr following setup until all flies had died, and cups continued to be observed for emerging larvae and second generation SWD adults. *Rhagoletis indifferens*, cherry fruit fly, larvae and pupal emergence was also noted from some fruit.

Mark-Recapture and Trap Comparison Studies Improve Monitoring Tools for Spotted Wing Drosophila

Danielle Kirkpatrick and Larry Gut
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Keywords: spotted wing drosophila, *Drosophila suzukii*, cherry, trap, trapping area, plume reach, monitoring

Abstract: Methods for trapping spotted wing drosophila (SWD) have not yet been optimized for detecting this devastating pest. No thresholds have been developed as of yet, and catch in a trap often does not relate to infestations. A trap comparison study was conducted to compare novel baited traps with conventional baited traps. Mark-release-recapture experiments were performed to determine 1) the maximum dispersal distance of SWD, 2) plume reach of a red-baited sticky panel trap, and 3) trapping area and population within that trapping area. Results of the trap comparison study show a red-baited sphere trap and a red-baited panel trap catch significantly more SWD than a conventional cup trap when all three were baited with the same commercial lure. Results of the mark-release-recapture experiments show maximum dispersal distance for SWD is 115 m, plume reach for the trap is

less than 5 m, and one trap is sampling 11.2 ac or 4.5 ha. The results of these studies provide valuable insights about movement capabilities of spotted wing drosophila, which can be used to improve monitoring tools, give better management recommendations, and begin to develop a threshold for SWD.

Spotted Wing Drosophila Update

Elizabeth H. Beers, Alix Whitener, Peter Smytheman
Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: spotted wing drosophila, *Drosophila suzukii*, trap, lure

Abstract: SWD pressure was low overall in 2016, and meaningful trap catch did not occur until July; even the early fall levels were lower than in previous years. In the early lure test, Scentry was the most attractive compound, but also had the highest by-catch; and AlphaScents and ACV were the next most attractive, but also had proportionally high levels of by-catch. The other *Drosophila* were <200 flies/trap/week, which is manageable (unlike the 2,000+ in the 2015 trial). All other attractants (Dros'Attract, Suzukii Trap, Trécé High Specificity and Trécé Broad Spectrum) caught too few SWD to be useful at low densities. In the late lure test, all attractants except Trécé High Specificity caught substantial numbers of flies, with the highest captures in the Dros'Attract traps; the latter also had the lowest levels of by-catch, making it a good choice for late season tests. Dros'Attract tended to form a solid mass in the trap at higher temperatures, which may explain its poor mid-summer performance. In the trap test, the PBJ trap caught the most SWD in both early and late deployments. The four liquid traps (PBJ, Scentry, Trécé, and Trapppit Dome) had the highest level of by-catch, which was conspicuously lower in the three AlphaScents sticky traps. While the yellow sticky trap caught about half the numbers of SWD at low densities than PBJ, this may be sufficient for triggering action thresholds. Different sex ratios among the traps were less apparent in the early deployment, presumably because of strong female bias in the population at this time. The late deployment, however, indicated a pronounced male bias in the sticky traps (the underlying sex ratio is unknown, but presumed 50:50). The concept that a trap (versus a lure) could be selective for both species and sex is novel, and merits further exploration.

Poster Session

Chemical Control/New Products

Elicitors of Host Plant Defenses Suppress Pear Psylla Populations under Field Conditions

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

Keywords: pear psylla, *Cacopsylla pyricola*, fire blight, acquired defense, pear, Actigard, Employ, ODC

Abstract: Defense elicitors are products that elicit acquired defense responses in plants, thus rendering the plants less susceptible to attack by a broad range of pests. We previously demonstrated under laboratory conditions that foliar applications of the defense elicitors Actigard (acibenzolar-*S*-methyl), Employ (harpin protein), and ODC (chitosan) on pear (*Pyrus communis* L.) each increase mortality of *Cacopsylla pyricola* (Förster) (Hemiptera: Psyllidae) nymphs, and alter the settling and oviposition behavior of the adults. In a 3-year study, we monitored *C. pyricola* populations on orchard-grown trees treated with water (untreated control), Actigard, Employ, or ODC. In 2014 and 2016, fewer nymphs and adults were observed on trees treated with elicitors compared with untreated trees, but these differences among treatments were not evident in 2015. Observed reductions in psyllid numbers by defense elicitors were modest, and do not warrant the use of these products specifically for control of *C. pyricola*. However, these products are often used for management of fire blight, and knowledge that elicitors may also reduce *C. pyricola* populations may be useful for system-wide integrated pest management approaches.

Thresholds/Monitoring

Development of a Potent Kairomone for Monitoring and Control of Leafrollers in Apple Orchards

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Keywords: kairomone, Tortricidae, benzyl nitrile, 2-phenylethylalcohol, acetic acid, eye-spotted budmoth, oblique banded leafroller, three lined leafroller, pandemis leafroller

Abstract: Binary, ternary and quaternary combinations of volatile organic compounds identified from caterpillar-infested apple foliage were highly attractive to several tortricid leafrollers in trials conducted in apple orchards in USA and Canada. A series of short trapping tests used acetic acid with either benzyl nitrile, benzyl alcohol, and/or 2-phenylalcohol and recorded catches of eye-spotted budmoth *Spilonota ocellana*, oblique banded leafroller *Choristoneura rosaceana* and three lined leafroller, *Pandemis limitata.* Significant numbers of male and female tortricid moths were caught to binary and ternary blends with acetic acid and one or more of benzyl nitrile, 2-phenyl alcohol, and benzyl alcohol. These findings support an optimistic future for new applications in female orchard leafroller surveillance and control based on combinations of kairomone compounds released from conspecific larval-damaged apple trees. The discovery of tortricid adult attractants will provide new tool for monitoring and control of leafrollers in apple orchards.

Minutes of the 90th Annual Meeting

Orchard Pest & Disease Management Conference
Hilton Hotel, Portland, Oregon
January 13-15, 2016

I. Call to Order

The 90th Annual Meeting was called to order by the Chair Steve Ela at 9:00 am on January 13, 2016. Chair Ela welcomed approx. 200 attendees who will present 45 papers and posters, and three featured and two keynote presentations. Chair Ela asked for each attendee to make a brief self-introduction, and then introduced the session moderators. They were:

Invasive Species	Peter McGhee
Chemical Control/New Products	Tim Ksander
Biology/Phenology	Mike Devencenzi
Mating Disruption/SIR	Alan Knight
Implementation	Glenn Thayer
Thresholds/Monitoring	Glenn Thayer
Biological Control	Betsy Beers

II. Old Business

A. Approval of 2015 Minutes: Secretary Alston announced that the 2015 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 2015 minutes.

B. Treasurer's Report: Treasurer Nancy Hays read the 2015 Treasurer's Report. There was a call for questions; there were none. It was moved, seconded, and voted to approve the 2015 treasurer's report.

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

III. New Business

A. Retirements of Officers: Don Thomson has served as Executive Director for 18 years. Nancy Hays has served as Treasurer for many years. Both Don and Nancy are retiring as OPDMC officers. Betsy Beers, John Dunley, and Jay Brunner gave acknowledgements to Don and Nancy, and thanked them for their long-term service. Appreciation gifts were presented to Don and Nancy.

B. Discussion of changing the meeting start and ending times: fewer talks were submitted this year; therefore, we may want to consider shortening the meeting length. Larry Gut gave support for starting on Wed morning and ending on Thursday evening. This would allow East coast attendees to fly out Friday morning. There was a call for a vote. Members voted to meet all day Wednesday and all day Thursday. The timing of the keynote speaker will remain on Wed. pm with the social afterwards.

C. Discussion of allowing commercial displays: commercial displays would have to fit on the same tables as used by the posters. The board doesn't want a trade show. Comments from the members were to keep the poster session as it is (research-based posters) and not allow

commercial displays. Betsy Beers spoke in favor of revitalizing the poster session by adding commercial displays that are no larger than the current poster tables. A vote was taken and the suggestion to add commercial displays was rejected.

D. Those willing to be nominated to the position of Executive Director and Treasurer were announced: Peter McGhee as Executive Director, and Nik Wiman as Treasurer.

E. This year, two featured speaker presentations were invited to the program. A vote of members was in favor of including featured presentations on the program. The number of featured presentations (Entomology for the Fun of It) will be selected based on the number of research papers submitted and available time on the meeting program.

F. Chair Ela announced that there will be an earlier deadline for presentation titles in 2017: November 1. Abstracts will be due December 1. The earlier title deadline will allow the board to invite the appropriate number of keynote and featured speakers to fill out the program.

G. OPDMC website: Chris Sater set up a new website due to the loss of a server at WSU that hosted the old website. The old website content will be migrated to the new site.

H. PCA and OR Pesticide Applicator credits are available. Sign up after each session on sheets kept at the registration table.

I. Committee Assignments:
   a. Audit: Broc Zoller (Chair), Bruce Greenfield, and Chuck Ingles
   b. Nominations: Larry Gut (Chair), Vaughn Walton, and Bob Van Steenwyk
   c. Resolutions**:** Art Agnello (Chair), Rick Hilton, and Betsy Beers

J. Call for the names of any members that passed away during the last year. There were no deceased members this year.

K. Steve provided presentation tips for using the meeting computer and mouse pointer.

L. There will be two keynote addresses: Steve Sheppard on Wed pm and Tom Baker on Thurs pm

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

IV. Closing Business Meeting

Chair Ela called to order the closing business meeting to order on January 15, 2016, at 11:18 am. Chair Ela called for any new business. Peter Shearer asked the board to consider not shortening the meeting length since the 2016 program used the full allotted time. Don Thomson said that an additional keynote and two featured talks were added this year to fill out the program. The meeting could have adjourned by approx. 5:30 pm on Thurs if the additional talks were not added. There was a vote to keep the featured talks and end the conference on Friday morning as per usual.

A. Committee Reports:

   a. Nominations: Chair Gut announced that the nominations committee nominated Harvey Yoshida as Chair-Elect, Diane Alston as Secretary, Nik Wiman as Treasurer, Peter McGhee as Executive Director, and Betsy Beers and John Dunley as Program Co-Chairs. Call for motions and vote to approve the nominations; all officers were voted in.
   b. Audit: Chair Zoller reported that the Audit Committee reviewed and accepted the financial report, and that the OPDMC financial records were in good order. There was a vote to approve the Audit Report.

c. Resolutions: Betsy Beers presented the Resolutions Report in the absence of Chair Agnello who had to depart to catch his flight. The resolutions were accepted by vote.

B. Chair Ela called for nominations for the Rubber Chicken Award.

a. Pete McGhee nominated Don Thomson for retiring from the Executive Director position.
b. Don Thomson nominated Pete McGhee for having the audacity to take over as Exec. Dir.
c. Diane Alston nominated Betsy Beers for the incompatibility of the slideshows presented by herself and her students despite the fact that she keeps the meeting computer. She could have easily tested their talks on the meeting computer. Her group was the only one who had trouble with slide incompatibility.
d. The award nominees were asked to leave the room and Chair Ela called for a vote on the Rubber Chicken Award nominees. The vote was unanimous for Betsy Beers. Betsy gave a rebuttal: "Guilty as charged. I not only screwed up my own presentation, but those of two of my students, thus scoring a rare OPDMC 'Trifecta'. When you have been around this organization as long as I have, there are three things that you need to do: 1) serve as OPDMC Chair, 2) receive the rubber chicken award, and 3) give the keynote address upon your retirement. I am now two for three."

C. Chair Ela announced next year's meeting dates: January 11-13, 2017 at the Hilton, Portland.

D. Chair Ela handed over the gavel to next year's chair Janet Caprile (absent), and called the meeting closed with the pounding of the gavel.

Respectfully submitted,
Diane Alston, Secretary
2016 Orchard Pest and Disease Management Conference

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.

Adult pear psylla

Brown
marmorated stink bug

Woolly apple aphid

Western
cherry fruit fly

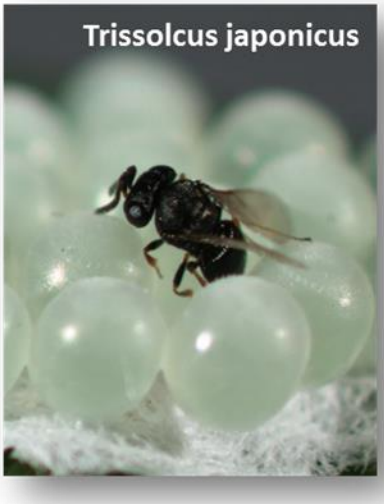
Walnut husk fly

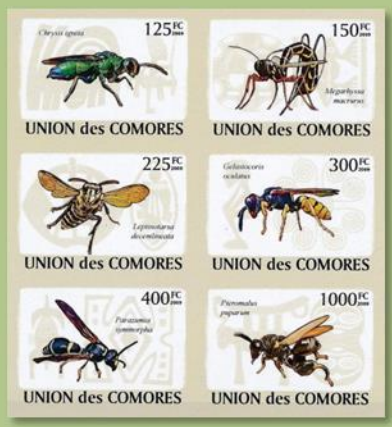
Apple maggot

Navel orangeworm

Spotted wing
drosophila

Codling moth


Trissolcus japonicus



Insect Postage Stamps of the World — images provided by Larry Gut, Michigan State University