Western Orchard Pest and Disease Management Conference

Agenda for 2006 Conference

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. Below is the order in which the sessions will be given and the projected time slot at which that will occur.

Talks within a session will be in the order in which they are listed in the Conference Abstracts, which will be picked up when you pay your registration fee at the beginning of the conference, or can be viewed at http://entomology.tfrec.wsu.edu/wopdmc/index.html.

See the section on "Information for Presenters/Report format" for more information.

Date	**Time**	**Session**	**Leader**
Wed., Jan. 11	10:00 a.m.	Opening Business	Vince Jones
		Mating Disruption/SIR	Lukasz Stelinski
		Implementation	Walt Bentley
Thurs., Jan. 12	8:00 a.m.	Thresholds/Monitoring	Matt Grieshop
		Biological Control	Marshall Johnson
		Resistance Management	Rick Hilton
		Chemical Control	Harvey Yoshida
Fri., Jan. 13	8:00 a.m.	Chemical Control	Harvey Yoshida
		Biology/Phenology	Diane Alston
		Closing Business	Vince Jones/Walt Bentley

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AGENDA
FROM THE 80TH ANNUAL WESTERN ORCHARD
PEST AND DISEASE MANAGEMENT CONFERENCE
January 11, 12 and 13, 2006

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		WEDNESDAY, January 11, 2006
		Convene—10 a.m. **Business Meeting** **Vince Jones, WOPDMC President**
	1.	**Mating Disruption/SIR** **Lukasz Stelinski, Moderator**
1		Codling Moth Mating Disruption: Raising Expectations (Gut, Stelinski, Miller)
2		Improving Codling Moth Mating Disruption Using New Technology (Grieshop, Brunner, Doerr)
3		Insights into Codling Moth Disruption from Lab and Field Behavioral Studies (Stelinski, Gut, Miller)
4		Further Advancements in Mating Disruption Technology (Kahn, Brunner, Granger, Doerr)
5		"Meso-Emitters" for Codling Moth Pheromone: Balancing Performance and Program Costs (Welter and Cave)
		LUNCH—Noon to 1:30 p.m.
5		Disrupt Micro-Flake® Pheromone Mating Disruptants—Summary of 2005 Test Results (Nelson, MacLean, Starner, Heath)
6		"Wombo Combo" Mating Disruption: Three Years of Codling Moth Field Trials in Apples Using Dispensers with Pear Ester Kairomone and Pheromone (Light, Bouyssounouse, Caprile)
6		Formulating Microencapsulated Pheromones with Horticultural Oil Improves Release-Rate Characteristics and Efficacy of Disruption (Judd, Gardiner, Wins-Purdy)
7		Key Results of a 3-Year Project on SIR for Sustainable Codling Moth Management (Thistlewood, Judd, Clodius)
7		Use of Two Species MD and Virus to Manage Internal Lepidoptera on Apple (Hull and Krawczyk)
8		Management of Oriental Fruit Moth in Apples Using Different Pheromone Dispenser Technologies in Combination with In-Season Fruit Damage Inspection (Agnello and Reissig)
8		Navel Orangeworm Mating Disruption Using an Improved Puffer and Different Pheromone Blends—Biological and Damage Effects in Almonds and Pistachios (Higbee, Burks)
		BREAK

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	2.	**Implementation** **Walt Bentley, Moderator**
9		Can Use of Reduced-Drift Venturi Nozzles on Airblast Sprayers Effectively Control Key Prune Orchard Pests? (Niederholzer and Pickel)
10		Shothole Borer Management in Washington Orchards (Doerr, Brunner, Smith)
11		Pesticide Use in Mating Disrupted Pear Orchards 2001-2005 (Zoller)
11		Implementation of Non-Organophosphate Pest Management Programs on Pears in Northern Oregon (Walston, Snelling, Riedl)
12		Areawide Organic Pest Management: The Peshastin Creek Project, Three Years (Dunley and Madsen)
13		Michigan Case Study of Regional CM Management: Can CM Mating Disruption Succeed in Diverse Agricultural Environments and Complex IPM Systems? (McGhee, Epstein, Gut, Noordijk)
13		Aggregation Pheromone of Larval Codling Moth: Identification and Application in IPM Programs (Jumean, Gries, Lafontaine, Wood, Unruh, Judd, Gries)
14		IPM Decision Aids for Washington Tree Fruit (Jones, Grove, Brunner, Tangren, Beers)
14		A Preliminary Look at the Alternative Pollinator, *Osmia cornifrons*, in Michigan Tart Cherry (Rothwell, Taylor, Nugent)
		THURSDAY, January 12, 2006
	3.	**Thresholds/Monitoring** **Matt Grieshop, Moderator**
15		Monitoring Consperse Stink Bug (*Euschistus conspersus*) Using Four Trap and Lure Combinations (Elkins)
15		Testing Codling Moth DA Lures in NY, 2005 (Reissig and Smith)
16		Automated, Remote Identification and Monitoring of Moths in Flight (Kirsch, Czokajlo, McLaughlin, Moore, Haynes and Fadamiro)
	4.	**Biological Control** **Marshall Johnson, Moderator**
17		Impact of a Neonicotinyl Insecticide on the Mirid Predator *Deraeocoris brevis* in the Laboratory and Field (Riedl, Brooks, Kim, Walston)
17		Conservation and Augmentation of the Predatory Mite *T. pyri* in Pennsylvania Apple Orchards (Biddinger, Hull, Krawczyk)
18		Control of Codling Moth in Pears Using Codling Moth Granulosis Virus (Elkins, Ingels, Niederholzer, Wunderlich)
18		Improving Codling Moth Granulovirus (Arthurs, Lacey, Knight, Behle)
19		Evaluating Granulosis Virus (Cyd-X) and Acetamiprid (Assail) for Season-Long Control of Codling Moth in Apples: Results from Two Years of Field Studies (Wunderlich)
19		*Mastrus ridibundus* Parasitoids Eavesdrop on Aggregating Codling Moth Larvae: Kairomonal Attraction and Risk of Parasitism (Jumean, Jones, Unruh, Gries)
		BREAK
20		Rose-Strawberry Gardens to Enhance Parasitism of Leafrollers: A 5th Year Update (Unruh, Peters) **(PRESENTATION AND POSTER)**

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20		Movement of the Leafroller Parasitoid *Colpoclypeus florus* between Rose/Strawberry Gardens and Apple Orchards (Jones, Baker, Unruh)
21		Implementing Biological Control of Oriental Fruit Moth in California Peach Orchards (Bentley)
21		Looking for Biological Control of Pear Psylla (Madsen, Dunley)
22		Entomopathogenic Nematodes for Control of Overwintering Codling Moth in Orchards (Lacey, Headrick, Arthurs, Unruh) **POSTER**
	5.	**Resistance Management** **Rick Hilton, Moderator**
23		Monitoring Tetranychid Mites for Resistance to Etoxazole (Beers, Martinez-Rocha)
23		Evaluating Codling Moth Populations in Northern Oregon Pear Orchards for Organophosphate Resistance and Potential Cross-Resistance (Walston, Snelling, Riedl)
	6.	**Chemical Control** **Harvey Yoshida, Moderator**
24		Dormant Spray Myths: Stretching the Traditional "Dormant Spray" to Improve Surface Water Quality from Orchard Runoff (Pickel and Niederholzer)
24		Impacts of Weathered GF-120 Residues on Olive Fly Mortality in the San Joaquin Valley, California (Johnson, Nadel, Daane, Opp)
25		Chemical Control of Navel Orangeworm in Pistachios (Higbee)
		LUNCH—Noon to 1:30 p.m.
25		Spinosad-Based Control of Walnut Husk Fly (Van Steenwyk and Zolbrod)
26		Walnut Trials Using the Codling Moth Kairomone, Pear Ester—MEC, as an Insecticide Spray Adjuvant (Light and Bouyssounouse)
26		Control of Codling Moth in Walnuts with Reduced Risk Insecticides (Coates, Van Steenwyk, Nomoto)
27		Insecticide Evaluations for Codling Moth Control in Pears (Van Steenwyk)
27		New Materials for Pear Psylla Management—2005 (Greenfield, Madsen, Granger, Dunley)
28		Pear Rust Mites: Alternatives to Carzol—2005 (Greenfield, Madsen, Granger, Dunley)
28		Clutch (clothianidin) for Control of Pear Psylla in Pears (Wade, Schiller, West, Kurtz)
		BREAK
29		Reduced Risk Insecticide Evaluations for Apples in California (Caprile, Van Steenwyk, Nomoto and Zolbrod)
29		Chemical Control of Eyespotted Budmoth in Organic Apple Orchards (Coates)
30		Codling Moth Control Strategies with New Insecticides (Granger, Brunner, Dunley, Doerr)
31		Management of CM and OFM on Apple with Insecticides, Water Volume and Method of Application (Hull, Krawczyk, Biddinger)
31		Clutch (clothianidin) and Battalion (deltamethrin) for Control of Codling Moth in Pome Fruit (Wade, Schiller, West, Kurtz)

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32		Effect of Codling Moth Programs on Integrated Mite Control in Apple (Beers, Martinez-Rocha)
32		Kanemite (acequinocyl) for Control of European Red Mites and Twospotted Spider Mites in Pome Fruit (Wade, Schiller, West, Kurtz)
33		Identifying Multiple Modes of Insecticidal Activity for Control of the Plum Curculio in Apples (Wise)
		FRIDAY, January 13, 2006
33		Behavior of Neonate *Endopiza viteana* (Lepidoptera: Tortricidae) During Entry into Grapes and Its Modification by Reduced-Risk Insecticides (Isaacs and Vander Werp)
34		Timing of Chemical Application for Vine Mealybug Control in Grapes (Bentley and Biscay)
34		Effects of Spinosad Bait and Bait Concentration on Western Cherry Fruit Fly Adult Attraction and Fruit Injury in Sweet and Tart Cherry (Alston)
35		New Methods and Materials for the Control of Western Cherry Fruit Fly (Smith and Gutierrez)
	7.	**Biology/Phenology** **Diane Alston, Moderator**
36		Spatial and Age Distribution of *Prionus* Larvae on Sweet Cherry (Alston, Steffan, Pace)
36		Carpenterworm Found Attacking Cherry in Washington State (Beers, Hannon)
37		Apple Clearwing Moth, *Synanthedon myopaeformis* (Borkhausen): Recent Introduction to Pacific Northwest Pest Complex (Judd, Philip)
37		Where Do Western Flower Thrips Come From? (Cockfield, Beers, Jones, Miliczky, Horton)
38		Phenology of the Eastern Cherry Fruit Fly *Rhagoletis cingulata* in Michigan (Teixeira and Gut)
38		A Search for Molecular Markers to Discriminate *Rhagoletis pomonella* from *R. zephyria* (Barcenas, Unruh, Yee, Lisowski, Archer, Palmandez) **(PRESENTATION AND POSTER)**
39		Cherry Fruit Fly Ecology and Management in the Agricultural-Urban Mix of the B.C. Interior (Thistlewood)
39		Biology and Management of Rosy Apple Aphid and Woolly Apple Aphid (Cockfield, Beers, Pike) **(POSTER)**
40		Spatial and Temporal Distribution of Western Flower Thrips Eggs in Apple Tissues (Miliczky, Horton, Cockfield, Beers) **(POSTER)**
		Business Meeting **Vince Jones, WOPDMC President** **Walt Bentley, WOPDMC President-Elect**
		Adjourn

Mating Disruption/SIR

Codling Moth Mating Disruption: Raising Expectations

Larry J. Gut, Lukasz L. Stelinski and James R. Miller
Michigan State University, East Lansing, MI

Keywords: mating disruption, false-plume following, competitive attraction, camouflage, desensitization, *Cydia pomonella*, release-site density, plant volatiles

Abstract: Mating disruption of codling moth (CM), *Cydia pomonella*, is widely practiced throughout the world. The predominant formulations currently used in the USA are hand-applied reservoir-type dispensers applied at densities of 500 to 1000 per ha. When successful, disruption is typically combined with application of insecticides to knock down CM population densities to "manageable levels." Under high densities and with limited insecticide inputs, inadequate levels of disruption are the norm with currently available technologies. We have been exploring ways of raising the bar to achieve “high-performance mating disruption of CM” that should be consistently effective even under high moth densities with limited insecticide inputs. Our recent studies suggest that disruption of CM under high population densities increases significantly as a function of increasing density of pheromone release sites. Deployment of several thousand female-equivalent dispensers maximizes disruption while using pheromone judiciously. In addition, our preliminary studies suggest that disruption can be enhanced by deploying dispensers that co-release codlemone and the recently discovered kairomone pear ester (ethyl (*E,Z*)-2,4-decadienoate). Our future goals include maximizing CM disruption by developing high-density release devices that can be machine-applied and co-release CM pheromone with attractive kairomones.

Mating Disruption/SIR

Improving Codling Moth Mating Disruption Using New Technology

Matt Grieshop, Jay Brunner and Mike Doerr
Washington State University Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: codling moth, mating disruption, Hercon, Scentry

Abstract: A series of preliminary experiments was performed exploring the active space and optimal spatial arrangement of Hercon and Scentry low dose codling moth (CM) pheromone dispensers. A mark-recapture experiment was carried out to ascertain the active space of a single Hercon CM Micro-flake, a single Scentry No-Mate Fiber, as well as single female codling moth. In addition field behavioral observations were made to further describe the active space of a single No-Mate Fiber versus a blank control. The final experiment explored the effect of different densities of Scentry No-Mate Fibers on male trap catch. Results from the mark-recapture experiment indicated that both a single fiber and flake were capable of attracting male moths from up to 20 m away in a 1-day period and 40 m away over a 4-day period, while a single female CM did not catch any males. Behavioral observations of caged moths suggested that male CM were capable of detecting the pheromone plume of a single No-Mate Fiber at up to 8 m away when wind conditions were between 0.5 and 1 m/s. These preliminary results indicate that under consistent wind conditions, low dosage dispensers have an active space of at least 8 m and a 24 hr attractive range of between 10 and 20 m. Results for the point source experiment indicated that during the first CM flight in a heavily CM infested orchard lacking mating disruption even a very low density of No-Mate fibers (4 within 60 cm of a trap) was capable of significantly reducing trap catch compared to a control. However, during the second flight, when a low rate of Isomate (50 dispensers/acre) was added, only the highest density of No-Mate Fibers (16 within 30 cm) reduced trap capture. This suggests that even a few additional point sources may impede male mate foraging success under low pheromone conditions but that concentrated sources of pheromone may be needed to further reduce male mate foraging success when background pheromone levels are high. Future trials on pheromone active space will focus on refining our understanding of active space for the CM Micro-flake as well as Isomate lures. Additionally, future experiments exploring low dose dispenser arrangement will be carried out in large laboratory wind tunnels and field wind tunnels as well as in orchards under lower CM pressure.

Mating Disruption/SIR

Insights into Codling Moth Disruption from Lab and Field Behavioral Studies

Lukasz L. Stelinski, Larry J. Gut and James R. Miller
Michigan State University, East Lansing, MI

Keywords: Cydia pomonella, mating disruption, flight tunnel, pheromone pre-exposure, habituation, threshold change, EAG

Abstract: Lab and field experiments examined the effects of exposure of male codling moth to pheromone. Seconds- to minutes-long exposures of males to dispensers nearly eliminated subsequent orientations to 0.1 mg codlemone ((*E*,*E*)-8,10-dodecadien-1-ol) and 0.1 mg three-component (codlemone:12OH:14OH, 100:20:5 ratio) lures 15 min later in flight-tunnel studies; however, there was no associated change in EAG responses between pre-exposed and control moths. Behavioral responses of Isomate-C Plus-exposed males were normal 24 h following exposure. The reduced responsiveness following exposure to Isomate dispensers appeared to be associated with an elevation of response threshold. Pre-exposed moths oriented in greater frequency to 1.0 and 10.0 mg lures compared with unexposed moths, while they failed to orient to normally attractive 0.1 mg lures. A field experiment was designed to maximize exposure of codling moth males to Isomate-C Plus dispensers. Ten dispensers were arranged per tree canopy (5,000/ha) such that all possible locations within a tree canopy were at least 1.0 m from an individual dispenser. Disruption in treated plots was 88.3 and 95.9% for the 1.0 and 0.1 mg codlemone lures, respectively, relative to control plots. This work documents that a portion of feral males within a population has the capacity to overcome disruption by high densities of Isomate-C Plus dispensers.

Mating Disruption/SIR

Further Advancements in Mating Disruption Technology

Andrew Kahn, Jay Brunner, Keith Granger and Mike Doerr
Washington State University Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: codling moth, *Cydia pomonella*, Suterra CheckMate CM-F, Scentry NoMate Fiber, Hercon Disrupt CM MicroFlake, Isomate CM/LR Twin Tube, apple, pear, mating disruption, pheromone

Abstract: Scentry NoMate Fiber significantly suppressed trap catch during the first and second generations in 2 of 3 moderate pressure locations when applied at the highest rates. Suppression ranged from 65% to 93% relative to the untreated control. There was no difference between the standard length fiber and a shortened version. The ground applicator for fiber continues to be cumbersome to operate. The Hercon Disrupt CM MicroFlake significantly suppressed trap catch during the first and second generations in 2 high-pressure locations when applied at the highest rates. Suppression was 60% and 78% during the first generation and 73% (both sites) during the second generation relative to the untreated control. Improvements in applicator technology appear very promising. The Suterra CheckMate CM-F (ULV) formulation significantly suppressed second generation trap catch in 2 moderate pressure locations when applied at the highest rates. Trap catch suppression was 72% and 76% relative to the untreated control. Isomate CM/LR Twin Tube demonstrated good efficacy in suppressing CM catch, even under high population pressure. Despite intensive spray programs, damage in conventional blocks was severe (20 and 30%) in 2 of 4 locations, yet was suppressed by 65% and 96% with the addition of CM/LR twin tube, and by 74% and 80% with Isomate C+. Retention studies showed that standard length and short fibers were 75% and 76% retained, respectively, after 22 days with undertree irrigation, but only 43% and 44% retained with overtree irrigation over the same period. Flakes were retained 43% and 34% under the same conditions. A helicopter application of flakes was retained 78% after 42 days. A late season test with a redesigned flake applicator achieved 91% retention after 19 days and nearly an inch of rain and wind.

Mating Disruption/SIR

"Meso-Emitters" for Codling Moth Pheromone: Balancing Performance and Program Costs

Stephen C. Welter and Frances Cave
University of California, Berkeley, CA

Keywords: pheromone mating disruption, paraffin emulsion, passive emitters, codling moth, trap suppression, pears, walnuts

Abstract: The possibility of developing a passive pheromone dispenser that emitted higher doses than traditional hand-applied dispensers, yet lower rates than high dose emitters, e.g., puffers, was explored in walnuts and pears. Experimental emitters consisting of hemi-spherical domes filled with a paraffin emulsion mix containing codlemone (SPLAT technology) were distributed at 12 dispensers per acre with a total load of 10 gm AI of codlemone per acre. Trap suppression was used as the preliminary metric with a 94% reduction in trap capture observed on average across 4 paired plots. Possible advantages might include reduced application costs, lower pheromone application rates, and passive devices using existing technologies which could tune release rate and reservoir.

Mating Disruption/SIR

Disrupt MicroFlake® Pheromone Mating Disruptants—Summary of 2005 Test Results

J. Nelson, P. MacLean, N. Starner and J. Heath
Hercon Environmental, York, PA

Keywords: Hercon, Disrupt MicroFlake, pheromone, flakes, mating disruptant, codling moth, *Cydia pomonella*, oriental fruit moth, *Grapholita molesta*, bark beetle, Scolytid spp., apple, pear, peach, walnut, pine, orchard, forest

Abstract: During 2005, treatment efficacy and application method efficiency of various Disrupt MicroFlake Mating Disruptant formulations were tested against codling moth in apples and walnuts, oriental fruit moth in apples and peach, and Scolytid bark beetles in pine. In general, all treatments showed acceptable to very good efficacy even with the non-optimized application methods used during most of the year. Recent tests of optimized application equipment indicate substantial improvements in treatment efficacy may be possible.

Mating Disruption/SIR

"Wombo Combo" Mating Disruption: Three Years of Codling Moth Field Trials in Apples Using Dispensers with Pear Ester Kairomone and Pheromone

Douglas Light, Paula Bouyssounouse and Janet Caprile
USDA, ARS, Western Regional Research Center, Albany, CA

Keywords: kairomone, pear ester, pheromone, hand-applied dispensers, codling moth, *Cydia pomonella,* apple, mating disruption

Abstract: The effect of the pear ester kairomone (PE) [ethyl (2E, 4Z)-2,4-decadienoate] adjuvant on the efficacy pheromone-based mating disruption has been tested for three years (2003 to 2005) using hand-applied dispensers in trials in 11 Granny Smith apple orchards in California. Pear ester kairomone was formulated in polymeric matrix block-like dispensers, either as PE-alone or PE combined with pheromone in "Combo-dispensers." The dispenser treatments evaluated were a standard pheromone dispenser loop (Isomate CTT, Pacific Biocontrol, Inc.), a polymeric matrix pheromone dispenser (CIDETRAK-CM, Trécé, Inc.), PE-alone dispenser that was co-hung with Isomate CTT loop, and a combo-dispenser with both PE and pheromone (CIDETRAK CM-DA Combo, Trécé, Inc.). Coverage and residual activity of the MD applications were evaluated by the "shut-down" of pheromone-baited and kairomone-baited monitoring traps. Treatment control efficacy was evaluated through fruit injury assessments after the first and second flights and just prior to harvest. Results show that the PE adjuvant combined with the pheromone disruptant reduced fruit damage rates from 40% to 100% below the low damage rates incurred with pheromone-alone dispensers. A key contribution of the kairomone adjuvant was the reduction in percentage of multiple matings by females.

Mating Disruption/SIR

Formulating Microencapsulated Pheromones with Horticultural Oil Improves Release-Rate Characteristics and Efficacy of Disruption

Gary Judd, Mark Gardiner and Andreas Wins-Purdy
Pacific Agri-Food Research Centre, Agriculture and Agri-food Canada, Summerland, BC, Canada

Keywords: leafrollers, *Pandemis limitata*, *Choristoneura rosaceana*, mating disruption, sprayable pheromone, microencapsulation, horticultural oils, release rates, synergism

Abstract: The efficacy of current formulations of microencapsulated (MEC) sprayable sex pheromones as mating disruptants for control of leafrollers and codling moth is limited by, among other things, 1) poor release-rate properties, 2) short-lived activity, 3) poor retention on leaves, and 4) chemical instability of some pheromone components. Our flight-tunnel tests have shown that MEC pheromones effectively disrupt orientation of leafrollers and codling moth for about 7 days, while large amounts of pheromone are being purged by these formulations. However, airborne concentrations of pheromone generated by MEC formulations soon fall below those in a female plume and males are no longer disrupted. In flight-tunnel tests disruption is restored if males remain in contact with pheromone-treated surfaces before contacting a female plume, suggesting that part of the disruption effect seen with MEC pheromones arises through insect contact with pheromone at the air-leaf-surface interface. Formulating MEC pheromones in horticultural oil before application markedly reduced pheromone release rates during the first few days (1-6 days) compared with water-only formulations, but by day 7 oil formulations had significantly higher release rates and more effectively disrupted orientation by male moths for longer periods of time. In addition to providing a more constant release of pheromone, oil formulations may cause greater retention of microcapsules on the leaf surfaces, reduce chemical degradation in the field and potentially provide control of insects by other mechanisms.

Mating Disruption/SIR

Key Results of a 3-Year Project on SIR for Sustainable Codling Moth Management

Howard Thistlewood, Gary Judd and Markus Clodius
Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland, B.C., Canada

Keywords: codling moth, *Cydia pomonella*, sterile insect release, semiochemical suppression, mating disruption, management, chemical alternatives, flight, radiation, reinfestation

Abstract: We are conducting research into a minimal and sustainable areawide management program for codling moth, using semiochemical suppression, sterile insect release, and a precision GIS. Experimental releases of wild and irradiated moths provide insight into movement and activity of sterile moths and are correlated with larger scale studies of results from the existing sterile insect release program. A pilot project was conducted in 131 ha of apple orchards and 12 ha of pears set in 895 contiguous hectares, in 39 properties worked by 25 growers, from May 2001 to July 2003. Results are presented from monitoring of moths by codlemone-baited or pear ester lures (DA kairomone) in traps, using cardboard tree bands, by visual inspection of fruit and surveys when moths or damage were found, and surveys of insecticide use. Movement of diapausing moths in or on bins presented the most serious reinfestation risk to apparently moth-free areas.

Mating Disruption/SIR

Use of Two Species MD and Virus to Manage Internal Lepidoptera on Apple

Larry Hull and Greg Krawczyk
Penn State University, Fruit Research and Extension Center, Biglerville, PA

Keywords: *Cydia pomonella*, codling moth, *Grapholita molesta*, oriental fruit moth, granulovirus, mating disruption, pome orchards

Abstract: Two large block trials were conducted in Pennsylvania commercial apple orchards during 2005 to evaluate the efficacy of mating disruption and the granulovirus Cyd-X® against the codling moth (CM), *Cydia pomonella,* and oriental fruit moth (OFM), *Grapholita molesta*. The following treatments were evaluated in study 1: T1) conventional insecticides; T2) Cyd-X—1st brood CM only, conventional insecticides—2nd brood; T3) conventional insecticides—1st brood CM, Cyd-X—2nd brood CM; T4) Isomate CM/OFM TT and Cyd-X—1st brood CM; and T5) Isomate CM/OFM TT only. The combination of Isomate CM/OFM TT and Cyd-X (T4) was the most effective treatment in reducing CM and OFM fruit injury at harvest (0.2%) followed in order by T5 (0.4%), T3 (1.9%), T1 (2.7%) and T2 (4.4%). The following treatments were evaluated in study 2: T1) Isomate CM TT plus Cyd-X for both CM broods; T2) Isomate CM TT plus insecticides; and T3) conventional insecticides only. The combination of Isomate CM TT plus insecticides was the most effective treatment in reducing CM injury at harvest (0.04%) followed by T1 (0.43%) and T3 (1.52%). A discussion on the use of mating disruption and virus to control this pest complex in Pennsylvania is presented.

Mating Disruption/SIR

Management of Oriental Fruit Moth in Apples Using Different Pheromone Dispenser Technologies in Combination with In-Season Fruit Damage Inspection

Arthur Agnello and Harvey Reissig
Dept. of Entomology, NYS Agricultural Experiment Station, Geneva, NY

Keywords: oriental fruit moth, *Grapholita molesta*, Isomate M-100, polyethylene ties, ropes, MSTRS, low-density, Hercon Disrupt, micro-flake, fruit inspection, mating disruption, pheromone

Abstract: Three different pheromone products (Isomate M-100 ties, MSTRS OFM, and Hercon Disrupt Micro-Flake OFM) plus a sequential fruit sampling procedure were evaluated in oriental fruit moth (OFM) management programs in moderate-risk orchards. All pheromone treatments generally suppressed moth catches to very low levels, although some breakthrough did occur, so trap shutdown was not absolute in all cases. The fruit sampling procedure was convenient to implement and appeared to effectively allow detection of low-level infestations at a very early stage, so that the growers could be notified of any extra needed control measures in a timely fashion. Fruit damage caused by OFM at harvest was very low in all treatments at three of the five sites. At a fourth site, the Isomate plot sustained approximately 10% fruit damage, although its proximity to a nondisrupted organic planting with a high population could have been a contributing factor. The fifth site, which incurred 7 to 17% damage, was in an organic planting that had previously suffered relatively high fruit damage the previous season. At both of these last two sites, codling moth (CM) may have also been present in numbers high enough to cause fruit damage.

Mating Disruption/SIR

Navel Orangeworm Mating Disruption Using an Improved Puffer and Different Pheromone Blends—Biological and Damage Effects in Almonds and Pistachios

Bradley S. Higbee and Charles S. Burks
Paramount Farming Company, Bakersfield, CA

Keywords: Amyelois transitella, navel orangeworm, mating disruption, pheromone, puffer, almond, pistachio

Abstract: Puffers (Suterra) with improved delivery mechanisms containing (*Z*,*Z*)-11,13-hexadecadienal, the major component of the navel orangeworm (NOW) sex pheromone, or one of two newly discovered multiple component pheromone blends and hullsplit insecticide treatments were evaluated for disruption of mating and damage reduction in almonds. Three replicates of 20-acre plots each were used in pistachios to compare the biological effects of mating disruption and 4 replicates of 40-acre plots in almonds to compare biological and damage effects. Intrepid (methoxyfenozide) was applied to areas between treatment plots. Biological comparisons were made in both crops using virgin-baited flight traps at two heights, mating assays and oviposition traps. In almonds, all mating disruption treatments resulted in nearly complete shutdown of male capture in traps baited with unmated females and of mating of females in mating assays. In pistachios, where NOW abundance was higher, the proportion of females mated in both of the multiple component formulations was lower than the single component formulation. All mating disruption treatments reduced damage to both nonpareil and pollinator varieties of almonds.

Implementation

Can Use of Reduced-Drift Venturi Nozzles on Airblast Sprayers Effectively Control Key Prune Orchard Pests?

Franz Niederholzer and Carolyn Pickel
University of California Cooperative Extension, Yuba City, CA

Keywords: orchard spraying, aphid, spider mite, *Brachycaudus helichrysi*, *Hyalopterus pruni*, *Tetranychus urticae,* drift, venturi

Abstract: Off-farm movement of airborne pesticide (drift) is an environmental pollutant and a waste of money. High density plantings and long-established sprayer designs limit low-cost drift control options for growers. Venturi-fitted nozzles mount easily on standard high-pressure airblast sprayers and deliver a larger volume median diameter (VMD) spray pattern than standard hollow cone nozzles. This increase in VMD produces larger spray drops and a potential reduction in drift under proper operating conditions. Venturi nozzles on airblast sprayers have not been tested in California orchards for pest control efficacy. Field studies were done in two different commercial orchards to test control of key, low mobility pests using hollow-cone venturi vs conventional hollow cone nozzles. There was no difference in spider mite control between Acramite® sprayed in July 2004 using standard hollow cone or hollow cone venturi nozzles. In November 2004, a similar comparison was made using Asana® to control prune aphids near the end of leaf drop. Hollow cone venturi nozzles delivered unsatisfactory aphid control in April 2005 compared with standard hollow cone nozzles. These results call to question the simple replacement of standard nozzles with venturi-fitted nozzles on airblast sprayers in prune orchards as an effective drift reduction strategy.

Implementation

Shothole Borer Management in Washington Orchards

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Keywords: *Scolytus rugulosus*, Coleoptera, Scolytidae, cherry, shothole borer, life history, monitoring, management, insecticide, sanitation, host, endosulfan, Thiodan, esfenvalerate, Asana, azinphosmethyl, Guthion, malathion

Abstract: The dominant bark beetle found throughout central Washington was the shothole borer (SHB), *Scolytus rugulosus* Müller (Coleoptera: Scolytidae). It was apparent that two distinct periods of SHB activity occur in Washington. First generation adult emergence began in late April and peaked in late May to mid-June. The second generation began in mid-July and peaked in late July to early August. These data are inconsistent with some reported literature. Traps were useful in identifying peak activity periods but it was not clear whether they would be useful in setting thresholds for treatments. Yellow sticky traps (unbaited apple maggot traps) seemed to be the most appropriate trap to monitor SHB activity but ethanol-baited intercept-style traps also captured significant numbers of SHB adults. Woodpiles of cherry, apple and pear appeared to be the main sources of high beetle densities that caused injury to commercial orchards. However, one population of SHB was found developing on recently cut poplar or cottonwood (*Populus* spp.). Severe injury can result to either stressed or healthy cherry trees adjacent to heavily infested host material. Movement of SHB into live orchards was closely associated with emergence from host material. SHB readily moved distances of 10 to 50 m to attack healthy trees on orchard borders, but did not move more than 2 to 3 rows into a healthy orchard. Many insecticides caused mortality of SHB in field-aged bioassays. The pyrethroid Asana was the most active through 21 days after treatment. Guthion and Malathion provided good suppression through 14 days. Variable results were noted with the chloronicotinyls Actara and Assail, but there is evidence that this class of insecticide has potential to suppress SHB in the field. Thiodan and possibly Avaunt were shown also to be possible options. Orchard sanitation was the most important factor in contributing to a reduction in SHB densities and damage to live cherry trees. Sanitation involved removing potential host material (e.g., weakened limbs, recent prunings) from the orchard and eliminating any host material outside the orchard. Host material can be "eliminated" by burning wood or brush piles or by thoroughly soaking the piles with an effective insecticide delivered by a handgun sprayer. The increased volume of water delivered by handgun applications appeared to be a significant factor in insecticide efficacy.

Implementation

Pesticide Use in Mating Disrupted Pear Orchards 2001-2005

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Keywords: mating disruption, insecticide use, codling moth, *Cydia pomonella,* forktailed bush katydid, *Scudderia furcata*, pear rust mite, *Epitrimerus pyri,* pear leaf blister mite, *Phytoptus pyri,* pear slug, *Caliroa cerasi,* boxelder bug*, Leptocoris trivittatus,* western flower thrips, *Frankliniella occidentalis,* pear psylla, *Cacopsylla pyricola,* western spotted cucumber beetle, *Diabrotica undecimpunctata,* spider mites, tortricid pests, pear

Abstract: In the north coast pear growing region of California during 2001-2005, codling moth was commercially managed by mating disruption supplemented with insecticides on 1200 to 1400 acres in Lake County and 700 to 850 acres in Mendocino County. Although insecticide use to supplement codling moth control did not increase during the period, pesticide use to control other pests has increased. Specific control costs for pear rust mite, pear leaf blister mite, forktailed bush katydid, pear slug, and other tortricid moths besides codling moth have all increased during the period. Foliar insecticide use to control boxelder bug has been significant in some years in some locations. A prebloom, preventive treatment approach for western flower thrips control has been used. Western spotted cucumber beetle has been an occasional minor pest requiring treatment.

Implementation

Implementation of Non-Organophosphate Pest Management Programs on Pears in Northern Oregon

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Keywords: codling moth, pear, organophosphate alternatives, mating disruption, natural enemies, Areawide II

Abstract: Areawide II is a collaborative project to evaluate selective alternatives to organophosphate (OP) insecticides for control of codling moth and to enhance biological control in pear orchards. The study was initiated in 2001 and was limited initially to three commercial orchards in the Hood River Valley. In 2004 and 2005, the demonstration project was expanded to ten commercial pear orchards. Growers had to agree to use organophosphate alternatives for controlling codling moth and other pests. In return, growers were provided with weekly information and advice about the status of major and minor pests, natural enemy activity, timing of sprays and whether pest levels justified control. Growers made their own decisions about what insecticide to apply. Pheromone traps were placed in all orchards to monitor codling moth and obliquebanded leafroller. Pear psylla, mites and natural enemies were monitored weekly by either beating tray or leaf samples. Monitoring information about pest and natural enemy populations was summarized weekly in a report for each grower and distributed electronically. The weekly reports were intended as supplemental information for growers and chemical fieldmen so they could make informed pest management decisions and respond to emerging problems in a timely manner.

Implementation

Areawide Organic Pest Management: The Peshastin Creek Project, Three Years

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Keywords: pear psylla, *Cacopsylla pyricola*, codling moth, *Cydia pomonella*, areawide management, IPM, organic insect control, pear, biological control, sustainable

Abstract: In 2002, an Areawide Organic Management Program was established on 310 acres of contiguous pear in a small valley near Peshastin, WA. Organic pest management practices were implemented for insect and mite control throughout the project. Approximately 50% of the acreage was Certified Organic; however, other organic practices were not required in the remaining acreage (e.g., nutrient, rodent, and weed control were conventional). Comparisons were made over four growing seasons between management programs determined to be the organic (certified), soft (organic IPM, other practices conventional), and conventional comparison blocks nearby. Over the four years, there has been a reduction in pesticide use, and no differences have occurred among the conventional, organic, or soft blocks in insecticide costs, numbers of insecticide applications, and numbers of trips through the orchard to make applications.

Following the first year of implantation, pear psylla densities remained relatively low, and control has been successful. Densities have not been allowed above economic threshold levels, and insecticide interventions were applied in all programs as densities indicated. Spider mite pressure was generally low since project inception. Codling moth pressure was surprisingly high in 2003, but management programs proved very effective at controlling fruit damage, and populations were quite low in 2004 (less than 0.25% damage at all locations) and almost nonexistent in 2005. Low predatory insect densities were found in all programs, with increases in late season correlated with increasing pear psylla. Damage thresholds for pear psylla may simply be too low to sustain higher densities of natural enemies, and replacement of insecticides by biological control appears unlikely at this point. Fruit yield and quality have been maintained, and alternative marketing programs have been successful.

Implementation

Michigan Case Study of Regional CM Management: Can CM Mating Disruption Succeed in Diverse Agricultural Environments and Complex IPM Systems?

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Michigan State University Tree Fruit Entomology Lab, East Lansing, MI

Keywords: codling moth, *Cydia pomonella,* apple, mating disruption, areawide, granulosis virus, pheromone

Abstract: An areawide approach to manage codling moth was implemented on 8 farms over 800 acres in the fruit-growing region north of Grand Rapids, Michigan, in the spring of 2004. Nine additional growers on 1,300 acres joined the project in 2005, bringing the total number of acres of apple utilizing pheromone-based mating disruption, codling moth granulosis virus, and some recently registered insecticides to effectively control codling moth to ca. 2,000 acres. The initial 2 years of this project have been a success. Captures of male codling moth in pheromone-baited traps were significantly reduced from the first to second year in the original 800 acres. The new orchards added in 2005 experienced a similar reduction in the numbers of codling moth captured from first to second generation that the original 8 farms experienced in 2004. Codling moth injury to fruit was 87% lower in areawide orchards at harvest compared to non-disrupted orchards outside the project. Areawide orchards incorporating codling moth virus sustained 4.2% fruit injury compared to 77.9% injury in non-disrupted orchards outside the areawide project. Industry collaborators have expressed strong satisfaction with the program outcomes and indicated their desire to expand the project in 2006.

Implementation

Aggregation Pheromone of Larval Codling Moth: Identification and Application in IPM Programs

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Keywords: codling moth, larval aggregation, pheromone, parasitoid, tree banding, integrated pest management

Abstract: In recent years, we have shown that cocoon-spinning male and female codling moth larvae emit an aggregation pheromone that attracts or arrests other larvae seeking pupation sites. In laboratory bioassays, we determined that the pheromone emanates from freshly spun cocoon silk. Gas chromatographic-electroantennographic detection (GC-EAD) analyses of silk volatiles, using antennae of the parasitoid *Mastrus ridibundus* as the electroantennographic detector, revealed 11 components that elicited antennal responses. Hypothesizing that these components are not only candidate kairomones for *M. ridibundus* but also candidate pheromones of *C. pomonella* larvae, the components were identified by GC-mass spectrometry. In bioassays, we determined that 8 components were critical to attract or arrest *C. pomonella* larvae. In field experiments in commercial apple orchards, pheromone-impregnated corrugated cardboard bands on tree trunks trapped twice as many larvae as control bands. Use of tree bands to capture and reduce populations of overwintering larvae is an effective supplemental tactic within IPM programs for *C. pomonella* and our data suggest that synthetic larval pheromone can be used to enhance the efficacy of this control tactic.

Implementation

IPM Decision Aids for Washington Tree Fruit

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Keywords: IPM, weather, codling moth, pandemis leafroller, obliquebanded leafroller, San Jose scale, western cherry fruit fly, apple maggot

Abstract: WSU has been developing IPM decision aids that will incorporate site-specific weather information from AgWeather Net and PAWS with insect and disease models, management recommendations, and information on the population status of the pests. Currently, we have six insect models (codling moth, pandemis leafroller, obliquebanded leafroller, San Jose scale, western cherry fruit fly, and apple maggot) and the WSU fire blight model (Cougar blight) up on the web. We will be adding several more insect models (Campylomma bug, Lacanobia fruitworm, white apple leafhopper) and disease models (cherry powdery mildew, *Coryneum* blight of stone fruits) this coming year. The system also incorporates the WSU spray guides electronically so that we can present the different pesticide options and their impacts on natural enemies and non-target pests. At present, the system is in a beta testing stage with participants from industry giving us feedback on the pest management warnings, desired features, and tips to improve the functioning of the interface.

Implementation

A Preliminary Look at the Alternative Pollinator, *Osmia cornifrons*, in Michigan Tart Cherry

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Keywords: *Osmia cornifrons*, horn-faced bee, alternative pollinator, pollination, tart cherry, honeybee

Abstract: We investigated the effectiveness of the pollinator *Osmia cornifrons* (horn-faced bee [HFB]) in Balaton® tart cherry, as this variety produces low yields compared with the traditional Montmorency cherry, especially in cool, wet springs. Based on observational experiments, HFB behavior differed from that of honeybees in three primary ways: 1) HFB forage for a significantly longer amount of time per flower than honeybees, 2) HFB visit significantly fewer flowers per tree than honeybees and for fewer flowers per minute, and 3) HFB fly under slightly different conditions (solar radiation, wind speed, and temperature) than honeybees. From our preliminary data, we were unable to determine if one visit from one HFB resulted in the set of one cherry fruit. To quantify HFB's pollinating capability, nesting buckets were placed within the orchards at a density of approximately 250 females/acre, 2 to 3 days before cherry bloom. Each orchard block was divided in half, and one side was stocked with HFB while the other half contained honeybees. Yield data were taken at harvest to determine if HFB increased the pollination rate, hence increasing the average amount of cherries produced. Some orchard blocks had higher Balaton fruit set percentages and yields in areas with HFB, but these results did not hold true for all orchard sites. However, these preliminary data suggest HFB may have the ability to pollinate as well as or better than traditional honeybees. Further research is warranted.

Thresholds/Monitoring

Monitoring Consperse Stink Bug Using Four Trap and Lure Combinations

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Keywords: consperse stink bug, *Euschistus conspersus*, monitoring, pear

Abstract: Consperse stink bug (*Euschistus conspersus*) (CSB) is the most commonly noted stink bug pest of pears in California. Though considered a localized pest, it can cause great damage to fruit if unmanaged and is of major concern in fruit destined for canning. Like other true bug pests, its presence has increased since the advent of mating disruption for codling moth control due to reduced organophosphate use. Management is generally accomplished by visually monitoring the presence of CSB in vegetation outside the orchard in the spring and then CSB presence and damage within the orchard during the summer, followed by treatment with broad-spectrum materials if necessary. Timing applications can be problematic due to the uncertainty of determining the timing of nymphal hatch and development and insect movement from external weed hosts into the orchard. In 2003, research was initiated in one orchard in the northern Sacramento Valley to test a degree day model developed for tomatoes. The model appeared to accurately predict the hatch of the first summer generation in the orchard. In 2005 research continued in four orchards in Lake County. In addition to continued testing of the degree day model, four trap and lure combinations (two traps and two lure types) were compared to determine which best tracked seasonal CSB phenology. The two trap types were the Aldrich trap used in tomato research in California and the cone trap developed by WSU and Applied Plant Technologies. The two lures are commercially available from Trécé, Inc., and APT, respectively. Traps were place within the orchard in the second row from the border, and each trap and lure combination was replicated three times at each of the four sites. Results of the 2005 seasonal findings will be presented.

Thresholds/Monitoring

Testing Codling Moth DA Lures in NY, 2005

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Keywords: codling moth, *Cydia pomonella*, apple, DA lures, DA pheromone combination lures

Abstract: Studies were conducted in 2005 to test DA lures in non-disrupted orchards in western NY apple orchards that had relatively high populations of codling moth, an unsprayed research orchard and an organic orchard. Lures were tested in Delta Pherocon VI traps and replicated ten times in a RCB design. Five replications were tested in an unsprayed research orchard at NYSAES, Geneva, and five replications were tested in an organic orchard in Niagara Co., NY. Traps were checked once/week throughout the season. The following treatments were tested during the first flight of codling moth from June 3 to July 26: 3 mgDA, 15 mgDA, 40 mgDA, 3.0 mg CM pheromone, 3.0 mg DA + 3.0 mg CM pheromone, 0.1 mg CM pheromone + 3.0 mgDA. Another group of treatments was tested during the second flight of codling moth from August 2 to September 1: 3.0 mg DA + 3.0 mg CM pheromone, 0.3 mg DA gray, 0.3 mg DA + 0.3 mg CM pheromone, 0.3 mg CM pheromone gray, 0.3 mgDA + 3.0 mg CM pheromone, 3.0 mg CM pheromone. None of the dosages of DA (0.3 to 40 mg) were attractive to CM males and captured only a few females throughout the season. Combination lures of DA + pheromone were no more attractive to males than pheromone alone. Some treatments of the combinations of DA + pheromone were significantly less attractive to males than pheromone alone. The reasons for the differences in attractiveness of DA lures in different locations are not know. Possible factors could include climate variables, interactions or competition with hosts, or sensory differences in geographic host races.

Thresholds/Monitoring

Automated, Remote Identification and Monitoring of Moths in Flight

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Keywords: Tree Fruit IPM, traps, wireless sensor network, codling moth

Abstract: IPMDC has developed a novel sensing unit that will accurately identify mosquitoes and moths in free flight. The initial "flight signature" system prototype is field proven and a beta device engineering design is complete. This product's value to insect pest management practitioners is real-time automatic and accurate reporting of pest activity to enable rapid targeted intervention at an early stage of pest population increase. Proprietary software is used for signature acquisition and classification and for assembly of a comprehensive reference library of known insect signatures. This technology is complemented by rapid growth and technology breakthroughs in the fields of sensor engineering, wireless networks and signal classification. This technology will advance efficiency and quality in tree fruit IPM, consistent with objectives outlined in The National Tree Fruit Technology Roadmap.

This invention exploits and further refines prototypic technology that successfully distinguishes various genera of insects in free flight. Over fifty years ago, a New Zealand scientist (Richards) found that the wings and bodies of insects reflect and refract ambient light in unique patterns that can be detected by photocells. Based on these findings and subsequent research, our team has developed and is patenting technology that detects, digitizes, records, and labels these patterns with unique identifiers so that, in essence, the photocells can "see" the sound of flying insects. This technology, called Flight Activity Signature Technology for IDentification (FAST-ID™), processes and analyzes these patterns using automatic classification techniques to identify the insects. The system has been researched with mosquitoes and moths, including the fruit pests codling moth, obliquebanded leafroller, oriental fruit moth, redbanded leafroller. The initial prototype (figure at right) combines a photocell, battery, artificial light source and an MP3 recorder. When prototyping of the 2006 beta device is complete, we will be seeking research collaborators for larger scale field testing and implementation trials.

Acknowledgements: We very much appreciate the moths and laboratory support provided by Vince Jones, WSU, and James Miller, MSU. Project partially funded by USDA-CSREES-SBIR program.

Biological Control

Impact of a Neonicotinyl Insecticide on the Mirid Predator *Deraeocoris brevis* in the Laboratory and Field

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Keywords: Assail, acetamiprid, acute toxicity, sublethal effects, reproduction, pesticide impact, natural enemies, biological control, pesticide persistence, apple, pear

Abstract: Deraeocoris brevis Knight is a widely distributed natural enemy in apple and pear orchards. *D. brevis* life stages were reared in the laboratory and treated topically to assess acute toxicity and chronic sublethal effects of pesticides commonly used in tree fruits: the neonicotinyls acetamiprid, clothianidin, imidacloprid, thiacloprid, and thiamethoxam; the IGRs methoxyfenozide, novaluron, and pyriproxyfen; the OP phosmet; the pyrethroid fenpropathrin; abamectin and spinosad. Studies were also carried out to assess the impact of acetamiprid under semi-field and field conditions and to determine if laboratory tests predicted pesticide impact in the field. In the laboratory, topically applied acetamiprid had moderate to high acute toxicity to nymphs and adults at full field rate but moderate toxicity at the 10% rate. Acetamiprid applied to nymphs or adults had no effect on development or reproduction. *D. brevis* nymphs and adults exposed to apple foliage sprayed by airblast with acetamiprid suffered 55-60% mortality at 0 DAT and 15-20% mortality at 16 DAT. Acetamiprid applied by handgun to Anjou pear trees eliminated *D. brevis* for at least four weeks. In summary, laboratory tests accurately predicted the impact of acetamiprid on *D. brevis* in the field. Results suggest that the risk to the mirid predator *D. brevis* from acetamiprid exposure in treated orchards is high.

Biological Control

Conservation and Augmentation of the Predatory Mite, *T. pyri,* in Pennsylvania Apple Orchards

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Keywords: *Typhlodromus pyri*, European red mite, twospotted spider mite, conservation, biological control

Abstract: With the introduction of new classes of insecticides and miticides in Pennsylvania apple orchards since the mid-1990s, biological control of European red mite and twospotted spider mite has shifted from the predatory coccinellid, *Stethorus punctum*, to Phytoseiid predatory mites. At first, the increase in phytoseiid numbers was attributed to a single species, *Neoseilus fallacis*, but the very similar looking *Typhlodromus pyri* was discovered in orchards managed with reduced risk pesticides in 2003. Despite being a key component of mite biocontrol in New York and New England, this was the first time *T. pyri* had been found in Pennsylvania. A much more effective and reliable spider mite predator than *N. fallacis*, *T. pyri* has demonstrated the potential to almost completely eliminate miticide applications. A survey of grower orchards found *T. pyri* to be established at some level in the majority of apple orchards in Adams County. Efforts are now being made to conserve this predator where it already exists by using only selective insecticide/miticides and to introduce it into new orchards. Transfers of shoots and blossoms from "seed" orchards have been shown to be effective and inexpensive ways to establish *T. pyri* into orchards. Another species of phytoseiid predatory mite, *Amblyseius andersoni*, was also found in a reduced risk insecticide managed orchard in central Pennsylvania in 2005 and appears to have prevented the establishment of *T. pyri.* This appears to be the first record of this predator in the eastern U.S.

Biological Control

Control of Codling Moth in Pears Using Codling Moth Granulosis Virus

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Keywords: granulosis virus, Cyd-X, Virosoft, Carpovirusine, codling moth, pears, organic control, mating disruption, puffers, Isomate CM, biological control, microbial control, Surround, kaolin, clay, Entrust, Guthion, oil, spinosad, Intrepid, Confirm, Assail

Abstract: Granulosis virus (GV) products for codling moth *(Cydia [Laspeyresia] pomonella)* control have become available for commercial use in the U.S. though have yet to be registered in California. In 2003, replicated trials under the auspices of IR-4 carried out in four northern California pear districts (Lake, Mendocino, Sacramento and Solano Counties) showed that two formulations of GV, Cyd-X and Carpovirusine, significantly improved control of CM over mating disruption (MD) alone and compared favorably to several reduced risk insecticide programs. In 2005, IR-4-funded trials were carried out in 13 orchards in El Dorado, Lake, Mendocino, Sacramento, and Yuba Counties. Treatments were non-replicated at 12 sites and replicated three times at one site. Eight orchards were conventional and four were organic. Treatments were: 1) GV plus MD and/or other insecticides, with the goal of reducing broad spectrum materials; 2) standard grower program (with or without MD), and 3) MD alone or completely untreated controls (conventional orchards only). CM trap catch (1XL, 1XH, 10XH, and DA) and damage data were collected through September. Secondary and beneficial insect data were collected at some sites (data not presented). Results comparing conventional and organic orchards will be presented.

Biological Control

Improving Codling Moth Granulovirus

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Keywords: codling moth, *Cydia pomonella*, apple, feeding stimulant, pear ester, lignin formulations, UV stability

Abstract: The codling moth granulovirus (CpGV) targets larvae before or during initial entry into fruit and provides growers with an option for CM control that is safe to humans and natural enemies. Limitations of current formulations include relatively short residual activity and the occurrence of shallow entries or "stings" caused by infected larvae penetrating fruit prior to death. In 2005 we evaluated formulation additives comprising (*E,Z*)-2,4-decadienoate (pear ester) and potential feeding stimulants to improve virus uptake and efficacy of a commercial preparation of CpGV (Cyd-X) in laboratory, greenhouse and field tests with apple, *Malus domestica* Borkh. We also tested the potential of several adjuvants, NuFilm, Biolink, Raynox and Trilogy, and freeze-dried lignin formulations of CpGV for UV-stabilization using a methodology developed in the laboratory using specially prepared apples and a solar simulator.

Biological Control

Evaluating Granulosis Virus (Cyd-X) and Acetamiprid (Assail) for Season-Long Control of Codling Moth in Apples: Results from Two Years of Field Studies

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Keywords: Cyd-X, granulosis virus, Assail, acetamiprid, *Cydia pomonella*, codling moth

Abstract: On-farm field trials in two apple orchards in El Dorado County, CA, were conducted to compare season-long codling moth (*Cydia pomonella*) damage from treatments of acetamiprid (Assail), acetamiprid (Assail) plus granulosis virus (Cyd-X) followed one week later by an additional granulosis virus application, and azinphosmethyl (Guthion) for 2 growing seasons. One of the orchards (Red block) had a high codling moth population and the other (Fuji block) had a low codling moth population. Both orchards used mating disruption and orchard airblast sprayers were calibrated to deliver between 225 to 300 gal/acre. In the second year in the Fuji block, Assail + Cyd-X was compared to Cyd-X alone for the first flight. Results from fruit damage assessed after each flight and at harvest will be presented.

Biological Control

Mastrus ridibundus Parasitoids Eavesdrop on Aggregating Codling Moth Larvae: Kairomonal Attraction and Risk of Parasitism

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Keywords: codling moth, *Mastrus ridibundus*, host location semiochemical, larval aggregation pheromone, parasitism, parasitism risk

Abstract: Final instar larvae of the codling moth, *Cydia pomonella*, cocoon in aggregations prior to pupation. The specialist ichneumonid parasitoid, *Mastrus ridibundus*, parasitizes cocooning larvae. In two-choice laboratory olfactometer bioassays, we determined that location of host larvae by *M. ridibundus* is mediated by airborne semiochemicals from fresh cocoon silk and that the attractiveness of silk fades as it ages. Gas chromatographic-electroantennographic detection (GC-EAD) and GC-mass spectrometric (GC-MS) analyses of silk volatiles revealed 11 candidate semiochemicals of which 8 are necessary to attract *M. ridibundus*. Silk volatiles also serve as an aggregation pheromone to pupation-site-seeking larvae. In further laboratory bioassays, we show that large and dense aggregations of larvae have a greater semiochemical apparency than individual larvae and thus are more likely to be located by *M. ridibundus*. However, larvae in aggregations may have a reduced risk of parasitism by egg-limited female *M. ridibundus* and by their micro-location within an aggregation.

Biological Control

Rose-Strawberry Gardens to Enhance Parasitism of Leafrollers: A 5th Year Update

Tom Unruh and Cathy Peters
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Keywords: Colpoclypeus florus, Ancylis comptana, OBLR, habitat modification

Abstract: In 2005, we made 142 collections of leafrollers (LR) at 24 orchards from Oregon to northern Washington adjacent to experimental rose gardens harboring a non-pest LR, *Ancylis comptana*, that *Colpoclypeus florus* uses as an overwintering host. Significant parasitism by *C. florus* occurred in orchards adjacent to gardens established 2 or more years and spring parasitism led to higher summer parasitism ($P_{summer} = (3.4)P_{spring}+27$; $R^2 = 0.6$). Four new gardens were planted, and 2005 and overall results were presented to growers at the Washington Horticultural Convention. *C. florus* accounted for 70% of spring and summer parasitism, compared to almost none prior to gardens.

Biological Control

Movement of the Leafroller Parasitoid *Colpoclypeus florus* Between Rose/Strawberry Gardens and Apple Orchards

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

Keywords: leafroller, *Colpoclypeus florus*, rose, strawberry, apple

Abstract: We present information on new ways to mark the leafroller parasitoid *Colpoclypeus florus* emerging from rose/strawberry gardens and moving to apple orchards. Last year, we tried spraying the rose/strawberry gardens with an orchard handgun, but the complexity of the habitat made this impractical and time consuming. This year, we used netting (tulle) that we draped over a portion of the garden and applied soy flour to netting using a hand-held lawn fertilizer. The netting and the plants have large amounts of soy flour present and when the parasitoid emerges and crawls through the netting, it picks up some of the soy flour. We then use our ELISA assays that are specific for the soy protein to detect whether parasitoids were marked or not. We also developed a new trap to collect *C. florus*. Last year, we tried using yellow and white sticky cards alone, but had few parasitoids captured. This year, we took a small shoot, infested it with 4th instar larvae and inserted the shoot through a hole in the center of a 5 x 5 inch sticky card and into a floral vial filled with water. The sticky card used liquid tangle trap that gives a thin layer that does not wick up on the insect and inhibit the ELISA reaction. Using these methods, we trapped 181 *C. florus* in 3 weeks during late summer and were able to describe the distance/dispersal relationship. Unfortunately, we collected multiple individuals at the furthest trapping locations, suggesting that the scale of trapping was too small.

Biological Control

Implementing Biological Control of Oriental Fruit Moth in California Peaches

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University of California, Kearney Agricultural Research and Extension Center, Parlier, CA

Keywords: biological control, oriental fruit moth, *Macrocentrus ancylivorus,* peach pest management, sunflower moth, peach

Abstract: *Macrocentrus ancylivorus*, a parasitoid of oriental fruit moth (*Grapholita molesta*), was released at intervals in three consecutive plantings of sunflowers at KAC in both 2003 and 2004. Because *Macrocentrus* does not overwinter on OFM, the sunflower moth (*Homeosoma electellum*) functioned as an alternate overwintering host. Sunflowers were planted adjacent to an orchard of Crimson Lady peaches. Laboratory reared *M. ancylivorus* were obtained from the Colorado State Division of Agriculture, Biological Control Unit, in Palisade, CO. Pupae were allowed to hatch in the laboratory at KAC and then collected for release in the sunflower field. Each planting was infested with 1000 *Macrocentrus*. Sunflower heads were caged before and after infestation to monitor emergence of *Macrocentrus*. Emergence of *Macrocentrus* in the sunflowers in 2004 indicated a steady increase in parasitism levels through late season, achieving 100% in our sample populations of sunflower moth. As the plantings were consecutive, so were the *Macrocentrus* releases, resulting in a high degree of parasitism even in our control population. In 2004 *Macrocentrus* wintered on sunflower moth and emerged in the spring of 2005, coinciding with OFM emergence. Oriental fruit moth parasitism reached 95% in the adjacent peach orchard.

Biological Control

Looking for Biological Control of Pear Psylla

Tara M. Madsen and John E. Dunley
Washington State University Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: pear psylla, *Cacopsylla pyricola*, biological control, natural enemies, organic pest management, IPM

Abstract: We monitored the diversities and densities of beneficial insects in pear orchards under Organic, Soft, and Conventional pest management over three years. We also examined the levels of potential predation in the system using direct methods. Predator densities were monitored using beating tray samples over a large area as part of the Peshastin Creek Areawide Organic Project and at a smaller scale on transects that passed from surrounding vegetation into orchard. Using *Ephestia kuehniella* eggs as sentinel prey, we directly measured predation levels on these transects in 2004 (preliminary) and 2005. Large and small scale sampling revealed low predator densities in all programs, but predators appear to be more numerous in orchards under Organic and Soft pest management than in those under Conventional management. Natural enemies were more frequent in the surrounding vegetation samples than in orchards, but we did not find a relationship between distance from surrounding vegetation and predator density within the orchard. Predation of sentinel eggs was higher in surrounding vegetation than in orchards, and levels did not vary with pest management type. Natural enemy densities and predation levels were higher outside Organic and Soft orchards than outside Conventional, but high variation in vegetation types may confound such comparisons.

Biological Control

Entomopathogenic Nematodes for Control of Overwintering Codling Moth in Orchards

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USDA-ARS, Yakima Agricultural Research Laboratory, Wapato, WA

Keywords: codling moth, *Cydia pomonella*, entomopathogenic nematodes

Abstract: Codling moth, *Cydia pomonella*, is the most serious insect pest of apple in the Pacific Northwest. Entomopathogenic nematodes (EPNs) targeted for overwintering stages of the moth and the codling moth granulovirus targeted for neonate larvae offer the potential for a double-pronged strategy for controlling this pest. The overwintering stage of codling moth, cocooned larvae within hibernacula, is a difficult stage to kill using most conventional approaches. In the fall and winter, this stage represents the entire population and is virtually a captive audience if an effective means of control could be harnessed against it. The elimination or reduction of the codling moth at this time would provide significant protection to fruit early in the following growing season. Since 1997 the USDA-ARS-Yakima Agricultural Research Laboratory (YARL) has conducted several trials of EPNs to determine their most effective application strategy to control overwintering codling moth in orchards and fruit bins. We have found *Steinernema carpocapsae* and *S. feltiae* applied at 1-2.5 billion infective juveniles per hectare to be effective in controlling overwintering cocooned larvae of codling moth under a variety of conditions if the habitat is kept moist for 6 to 8 hours and temperatures are 15ºC and above. Maintenance of moisture by using irrigation in orchards after application of the nematodes has been especially successful in trellised apple orchards and older pear orchards. Sustained moisture that was favorable for nematode survival is enhanced in orchards where mulch (shredded paper, hay, wood chips, or clover) is placed beneath trees. In our poster we present the highlights of studies conducted on EPNs for codling moth control from 1999 to 2004.

Resistance Management

Monitoring Tetranychid Mites for Resistance to Etoxazole

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

Keywords: etoxazole, Zeal, European red mite, *Panonychus ulmi*, twospotted spider mite, *Tetranychus urticae*, resistance management

Abstract: Ovicidal leaf-disk type bioassays were conducted on 24-h-old eggs of *P. ulmi* and *T. urticae* and evaluated after 7-10 d. Of nine bioassays (3 ERM, 6 TSM) LC_{50} values ranged from 0.2 to 2.5 mg AI/liter and averaged 1.2 mg AI/liter. TSM appeared to be slightly more sensitive to etoxazole than ERM, based on the distribution of LC_{50}s between the two species. Check mortality ranged from 5 to 21%, with 100% mortality in (at least) the highest rate. After the results of the first 3 bioassays were known, the rate range was reduced from 100 mg AI/liter at the high end to 10 mg AI/liter, providing slightly more resolution in the critical middle part of the probit line. All differences in LC_{50}s at this point appear to be a natural variation in response rather than any indication of increasing tolerance to etoxazole.

Resistance Management

Evaluating Codling Moth Populations in Northern Oregon Pear Orchards for Organophosphate Resistance and Potential Cross-Resistance

Allison Walston, Jane Snelling and Helmut Riedl
Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR

Keywords: codling moth, apple, pear, organophosphates, resistance, azinphosmethyl, acetamiprid, thiacloprid, bioassay

Abstract: Pear and apple orchards in Oregon's Hood River Valley have experienced increasing amounts of codling moth damage in the last few years. Working with concerned growers and fieldmen, experiments were conducted to determine if resistance to organophosphates (OP) was evident in the valley. Topical bioassays were conducted on male moths collected with pheromone traps in problem orchards where resistance was a concern. Three orchards surveyed exhibited an increase in resistance to azinphosmethyl compared to a susceptible laboratory population. Other insecticides such as acetamiprid and thiacloprid were examined for cross-resistance to azinphosmethyl. Eight orchards were evaluated for resistance to acetamiprid with six exhibiting an increase in resistance compared to the susceptible population. One orchard exhibited resistance to all insecticides tested including azinphosmethyl, acetamiprid and thiacloprid. Reactivated diapausing larvae were also treated with acetamiprid to confirm results with the adult bioassays. So far we have no evidence for cross-resistance between azinphosmethyl and the neonicotinyls. Testing will continue in 2006. Growers' spray records and pack-out reports were also collected to determine if increased amounts of codling moth damage were a result of poor management practices, incorrect timing of sprays or ineffective control programs.

Chemical Control/New Products

Dormant Spray Myths: Stretching the Traditional "Dormant Spray" to Improve Surface Water Quality from Prune Orchard Runoff

Carolyn Pickel and Franz Niederholzer
University of California IPM, Yuba City, CA

Keywords: dormant spray, pesticide runoff, organophosphates, pyrethroids, prunes, *Brachycaudus helichrysi, Hyalopterus pruni, Diaspidiotus (Quadraspidiotus) perniciosus, Anarsia lineatella*

Abstract: A dormant spray was once considered the keystone of a good prune pest management program. Beneficial insects and predatory mites are less affected by broad spectrum pesticide applications during the dormant period than by similar insecticides applied during the growing season. Traditional organophosphates and pyrethroids added to the dormant oil spray to control aphid eggs, peach twig borer and improve San Jose scale control have been found in surface water and river sediment at levels above new water quality standards. Aphids are the most damaging pest to prunes and usually require one dormant oil application with either an organophosphate or pyrethroid added for season-long control. From research on how pesticides move into the surface water, researchers and regulators concluded that spreading the dormant spray from November 1 to bloom would decrease the amount of pesticide runoff in surface water. To help growers meet these new regulations, research was conducted to develop monitoring programs, reduced risk alternatives, reduced rates of pesticides, and early and late timing of dormant spray. Results from several years have led to new approaches to dormant sprays.

Chemical Control/New Products

Impacts of Weathered GF-120 Residues on Olive Fly Mortality in the San Joaquin Valley, California

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Keywords: olive fly, *Bactrocera oleae* (Gmelin), olive, GF-120 NF Naturalyte Fruit Fly Bait, Spinosad, bait insecticides, residual activity

Abstract: GF-120 NF Naturalyte Fruit Fly Bait (Dow AgroSciences LLC) is the only approved chemical control for olive fly, *Bactrocera oleae* (Gmelin), in California. Because high summer temperatures may negatively impact GF-120 residue efficacy, field studies were conducted to quantify reductions in toxicity. To determine impacts, two concentrations of GF-120 mixed in water were examined: a 1.5:1 mixture (water to GF-120) and a 4:1 mixture (water to GF-120). These were compared to a 4:1 mixture of water to a "blank" formulation of GF-120 without Spinosad®. October 2003 tests showed that 21 days after treatment (DAT), mean adult mortality in the 1.5:1 solution residue held at 77.9%, but flies exposed to the 4:1 solution exhibited a mortality of only 17.7%. In August 2004 tests, mean mortalities of flies exposed to the 1.5:1 residues from 4 to 21 DAT ranged from 99.2 to 90.6%. During the same time period, mortality at 72 hours post-exposure in the 4:1 ratio residue dropped from 96.5% on Day 4 to 67.5% on Day 21. In September 2004 tests, mean mortalities of flies exposed to the 1.5:1 ratio residues from 4 to 21 DAT ranged from 83.4 to 97.5%. All studies indicate that the dilution of 1.5:1 (water to GF-120) will kill a greater percentage of the test population for 21 days than will the 4:1 dilution, with the latter losing significant impact between 7 to 14 days.

Chemical Control/New Products

Chemical Control of Navel Orangeworm in Pistachios

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Keywords: Amyelois transitella, navel orangeworm, pistachio, Imidan, phosmet, permethrin, Intrepid, methoxyfenozide

Abstract: This trial was conducted in the lower San Joaquin Valley, near Bakersfield, CA, to compare the efficacy of a conventional treatment (Imidan/permethrin) and an IGR (Intrepid) in single and multiple spray approaches to control plots receiving no treatment. Twenty-acre treatment plots were replicated four times in a completely randomized design. Applications were made on May 11 (395 dd), August 28 (2854 dd), and/or Sept 9 (3103 dd). All single application treatments (Imidan or Intrepid on Aug 28, Intrepid on Sept 9) reduced damage from 40 to 55% whereas the multiple spray programs (2 or 3 applications at timings noted above) reduced damage 42 to 73% compared to controls. Greatest damage reductions were observed in treatments that included an application directed at the first generation.

Chemical Control/New Products

Spinosad-Based Control of Walnut Husk Fly

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

Keywords: walnut husk fly, *Rhagoletis completa,* Entrust, GF-120, Success, spinosad, walnut, chemical control, insecticides

Abstract: Field trial evaluations for walnut husk fly (WHF) control were conducted in Hollister and Escalon, CA, to improve the efficacy and reliability of Entrust/Success plus NuLure and GF-120. These studies included rate comparisons of Success/Entrust, dilution effects of GF-120 and increasing the attraction of GF-120 with increased amounts of ammonia acetate. Results from these studies indicate that the amount of Success/Entrust can be dramatically reduced below the recommended field rate of 6.4 oz Success or 2 oz of Entrust per acre plus 3 pt NuLure per acre. Excellent WHF control was achieved with 1.6 oz of Success or 0.5 oz of Entrust per acre plus 3 pt NuLure per acre, provided adequate coverage can be achieved by the speed sprayer. Also under very low populations the rate can be further reduced to 0.8 oz of Success or 0.25 oz of Entrust. There does not appear to be a significant difference in efficacy between a GF-120 dilution rate of 1:1.5 to a dilution rate of 1:9. However, there is some indication that more concentrated GF-120 spray solution (1:1.5) is preferable in a low humidity and low population situation compared to dilute concentrations (1:9). There was no enhancement of the efficacy of GF-120 by increasing the amount of ammonia acetate. A trap height comparison study resulted in a larger number of flies captured in high traps compared to low traps.

Chemical Control/New Products

Walnut Trials Using the Codling Moth Kairomone, Pear Ester-MEC, as an Insecticide Spray Adjuvant

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USDA, ARS, Western Regional Research Center, Albany, CA

Keywords: kairomone, pear ester, micro-encapsulated, insecticide adjuvant, codling moth, *Cydia pomonella*, walnut

Abstract: The pear ester kairomone, in a micro-encapsulated formulation (PE-MEC) (CIDETRAK DA-MEC, Trécé, Inc.), was tested for its efficacy as a spray adjuvant to various insecticides in field trials in a walnut orchard (Chandler variety) in California. To allow the adjuvant activity of the PE-MEC to be resolved, the rates of insecticides used were challenged by reducing them by as much as one-half the label rates. The insecticides tested were two OPs (chlorpyrifos and phosmet), an IGR (methoxyfenozide), and a granulosis virus. PE-MEC adjuvant was tested at rates of 0.2, 0.6, and 1.7 g/acre. Treatments were reduced-rate insecticide vs. reduced-rate insecticide + PE-MEC, and treatments without insecticides were PE-MEC alone and a "blank-MEC." Sprays were applied by handgun to 8 replicate single trees per treatment. Test trees were distributed in a randomized block design throughout a 20-acre walnut orchard that received no grower sprays. Application rate of water was 3.5 gal/tree or 160 gal/acre, and it was applied six times through the season due to CM flight pressure. Treatment control efficacy was evaluated through both canopy-count visual assessments and nut knock-down collections just prior to harvest in late September. Results show that the PE-MEC adjuvant reduced CM and navel orangeworm damage rates from 49% to 88% below the low damage rates incurred with insecticides alone.

Chemical Control/New Products

Control of Codling Moth in Walnuts with Reduced Risk Insecticides

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Keywords: codling moth, *Cydia pomonella*, navel orangeworm, *Amyelois transitella*, walnut aphid, *Chromaphis juglandicola,* walnut, chemical control, insecticide, GF-1640, DPX-E2Y45, Warrior, Lambda-cyhalothrin, Carpovirusine, granulosis virus, Cyd-X, granulovirus, Entrust, spinosad, PureSpray Green, horticultural oil, Assail, acetamiprid, Lorsban, chlorpyrifos, Penncap-M, methyl parathion, chemical control, insecticide

Abstract: A trial was conducted in Hollister, CA, to evaluate reduced risk insecticides for control of codling moth (CM) in English walnuts. Treatments were applied at about 300 degree-days (DD) and 650 DD into the first and second CM flights. Additional sprays were applied one week after each treatment for Carpovirusine (low rate), Cyd-X and PureSpray Green oil. Warrior (high and low rate), GF-1640 (high rate) and DPX-E2Y45 (high rate) provided excellent control. GF-1640 (low rate), DPX-E2Y45 (low rate), Assail, Cyd-X and Lorsban/Penncap-M provided good control. Entrust, Carpovirusine (low and high rates) and PureSpray Green gave only fair control—less than the grower standard. Walnut aphid, navel orangeworm and spider mites were not significant pests in any treatments this year.

Chemical Control/New Products

Insecticide Evaluations for Codling Moth Control in Pears

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Keywords: codling moth, *Cydia pomonella*, pear psylla*, Cacopsylla pyricola,* European red mite, *Panonychus ulmi*, pear rust mite, *Epitrimerus pyri,* MK-936, abamectin, Asana, esfenvalerate, Assail, acetamiprid, Baythroid, cyfluthrin, Brigade, bifenthrin, Danitol, fenpropathrin DPX-E2Y45, GF-1640, Guthion, azinphosmethyl, Imidan, MK-936, abamectin, phosmet, PureSpray Green horticultural oil, Success, spinosad, chemical control, insecticide

Abstract: A single tree crop destruct field trial was conducted to evaluate new experimental insecticides for codling moth (CM) control. This trial showed that GF-1640 and DPX-E2Y45 are two new promising experimental CM insecticides. These products provided significant suppression of CM compared to the untreated check and provided similar or better control compared to the grower standard (Guthion and Imidan). GF-1640 also provided some measure of pear psylla (PP) control. However, GF-1640 caused a significant increase in pear rust mite (PRM) compared to the untreated check and grower standard. DPX-E2Y45 did not induce population flare-ups with any of the secondary pests. In addition to the evaluation of new experimental insecticides for CM control, a single tree crop destruct field trial was conducted to evaluate pyrethroid insecticides (Asana, Baythroid, Brigade, Danitol and Warrior) for CM control. This trial showed that Brigade and Warrior are two new promising pyrethroid products. These products provided similar control compared to the grower standard (Guthion and Imidan). Brigade had elevated populations of PP and PRM but reduced populations of European red mite (ERM), while Warrior had elevated populations of PRM and reduced populations of PP.

Chemical Control/New Products

New Materials for Pear Psylla Management—2005

Bruce M. Greenfield, John E. Dunley, Tara M. Madsen and Keith R. Granger
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Keywords: WLD356, GCL449, CCS548, emamectin, Proclaim, Syngenta, abamectin, Agri-Mek, pear psylla

Abstract: Three new numbered compounds were examined for their potential for pear psylla (PP) management and compared against emamectin (Proclaim, Syngenta) and abamectin (Agri-Mek, Syngenta). The materials were applied three times over the season to mature Bartlett pear trees. Treatments were applied to single trees and replicated four times in a randomized complete block design. A pretreatment count of pear psylla density was performed on all treatments 27 Mar. A Clusterbud (CB) application was made on 31 Mar, at Petal Fall (PF), 27 April, and again in mid-summer on 29 June for all materials used. For the CB and PF applications, all materials showed similar impact on the adult stage of pear psylla and also reduced nymph populations markedly. Impact on the egg stage was variable among the treatments. The summer timing had very much the same results, with no differences among insecticide treatments, although the magnitude of the population reduction was greater. The new numbered compounds all show some potential for the control of pear psylla, as does Proclaim.

Chemical Control/New Products

Pear Rust Mites: Alternatives to Carzol—2005

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

Keywords: pear rust mite, acaricide, *Epitrimerus pyri*, Fenpyroximate, FujiMite, Envidor, spirodiclofen, Acramite, bifenazate, Agri-Mek, abamectin, Proclaim, emamectin benzoate, Nexter, pyridaben, Kanemite, acequinocyl, Pyramite, pyridaben, Abba, abamectin, Gunslinger, Sulfur/[2-*tert*-butyl-5(4-*tert*-butylbenzithio)-4-chloropydrazin-3(2H)-one], Vendex, fenbutatin oxide, Carzol, formetanate hydrochloride, bioassay

Abstract: This trial to test several acaricidal tactics for control of pear rust mite was performed in a young (2-yr-old) commercial pear orchard located near Cashmere, WA, in 2005. The trial was by randomized complete block design, with seven single tree replications per treatment. Applications were made by handgun to drip to simulate 400 gpa. A pre-treatment count was performed early (1 Aug) and then repeated 3 days posttreatment on 4 Aug. Sampling was repeated at weekly intervals for the next three weeks. A single application was made on 1 Aug. All of the treatments provided a rapid and effective response on the pear rust mite population relative to the untreated control. An additional grower application of Envidor was made in a nearby mature pear orchard for comparison, and it quickly knocked down the rust mite population. However, the small untreated control was likely drifted upon, and rust mites also were controlled in the untreated pear.

A laboratory bioassay was developed for determining responses of pear rust mite to acaricides for the purpose of monitoring for resistance. Results of these bioassays will be used as baseline levels for monitoring resistance in the future.

Chemical Control/New Products

Clutch (Clothianidin) for Control of Pear Psylla in Pears

Layne Wade, Chuck Schiller, Jeri West and Alan Kurtz
Arysta LifeScience North America, Roseville, CA

Keywords: Clutch, clothianidin, pear psylla, pear

Abstract: This talk will focus on the compilation and presentation of 2 years of trial data in the Pacific Northwest using clothianidin to control pear psylla in pear orchards. Presentation will include an introduction to the chemistry (including chemical classification) of each material presented.

Chemical Control/New Products

Reduced Risk Insecticide Evaluations for Apples in California

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Keywords: apple, chemical control, insecticide, codling moth, *Cydia pomonella*, San Jose scale, *Quadraspidiotus perniciosus,* rosy apple aphid, *Dysaphis plantaginea,* woolly apple aphid, *Eriosoma lanigerum*, Assail 30SG, acetamiprid, Calypso 4F, thiacloprid, Carpovirusine, granulosis virus, Clutch 50WDG, clothianidin, GF-1640 25WDG, Guthion 50WP, azinphosmethyl, Imidan 70WP, phosmet, Proclaim 5WDG, emamectin benzoate, PureSpray Green oil, Rimon 0.83 EC, novaluron, Success 2SC, spinosad, Warrior 1CS, Lambda-cyhalothrin

Abstract: Nine reduced risk materials were compared to a grower standard (GS) program and an untreated control (UTC) in 20 randomized, replicated treatments in 'Gala' and 'Fuji' apples in the northern San Joaquin Valley of California. Under extreme CM pressure (UTC = 69-87% damage) GF-1640 was the only material that performed as well as the GS (Imidan and Guthion). Treatments with Rimon, Assail, and Warrior performed better than the UTC but not as well as the GS. Success, Calypso, Proclaim and Carpovirusine provided some control early in the season but were similar to the UTC by season's end. Treatments with Assail and Warrior also provided some control for San Jose scale. Treatments with Clutch, Calypso, and Assail suppressed rosy apple aphid.

Chemical Control/New Products

Chemical Control of Eyespotted Budmoth in Organic Apple Orchards

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Keywords: eyespotted budmoth, *Spilonota ocellana*, pandemis leafroller, *Pandemis pyrusana,* brown garden snail, *Helix aspera,* Javelin, *Bacillus thuringiensis,* Entrust, spinosad, apple, chemical control, insecticide, organic

Abstract: Eyespotted budmoth (ESBM) has become a significant leaf-rolling insect pest of organic apples in California's Central Coast. Little is known about ESBM under California conditions. The overwintering generation begins with egg hatch in the fall (not observed), larval damage to buds and shoots in the late winter and spring and adults in May/June. The second generation hatches in late June/July, feeds on leaves and fruit in July/August and is present as adults from August to November. Damage is surface feeding under leaves tied to the fruit. Entrust at 2 oz/acre was applied to Honeycrisp apples 4/1 before bloom, 6/7, 7/6 and 7/14. An additional treatment of Entrust was applied without oil on 4/1 and with oil (1%) on 6/7, 7/6 and 7/14. Javelin at 2 lb/acre was applied 4/1, 4/12 (early bloom), 6/7, 7/6 and 7/14. Damage at harvest was 1.9% ESBM for both Entrust treatments, 3.5% for Javelin and 20.4% for untreated. Very few pandemis or other leafrollers were found. Snails were noted as a significant fruit-feeding problem.

Chemical Control/New Products

Codling Moth Control Strategies with New Chemistries

Keith R. Granger, Jay F. Brunner, John E. Dunley and Michael D. Doerr
Washington State University Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: codling moth, *Cydia pomonella*, apple, chemical control, insecticide, Rimon, novaluron, Calypso, thiacloprid, Assail, acetamiprid, Intrepid, methoxyfenozide, Esteem, pyriproxyfen

Abstract: Codling moth (CM) control with new chemistries is most successful when the foundation is an integrated approach to disrupting the life cycle of the insect at more than one stage. In contrast to the organophosphates that are being replaced in our pest management programs, new chemistries are generally more selective and better suited to target specific susceptible life stages of the insect pest's development cycle. The two stages in the codling moth life cycle most susceptible to chemical input are the eggs, which are laid on the upper surfaces of leaves and fruit, and the larvae, which enter the fruit within a very short period of time after leaving the egg. Traditional insecticide programs target the emerging larvae, beginning at the onset of the egg hatch period and continuing through the conclusion of the generation. New options in chemical control offer the advantage of beginning the pest management process before CM eggs hatch. Ovicides kill CM eggs topically, when the insecticide is applied over the top of eggs that have been deposited in the orchard, or residually, when eggs are deposited on top of insecticide residues that were previously applied to the orchard. Killing CM eggs before they hatch will allow delaying subsequent chemical applications for controlling CM larvae. An ovicide with residual activity, applied before the beginning of the egg lay period, or an ovicide with topical activity, applied just prior to the egg hatch period, will delay significant egg hatch by as much as 10-12 days (100 CM degree days [DD]). Shifting larvicide applications forward 100 DD places the most active insecticide residues into the most active interval of the CM egg hatch period. A more aggressive variation of this strategy is to follow an ovicide application with a delayed application of a tank-mix combination of an insecticide with ovicidal activity and an insecticide with larvicidal activity. This combination kills both eggs and larvae and will protect fruit from CM injury for an entire generation without additional chemical input.

Chemical Control/New Products

Management of CM and OFM on Apple with Insecticides, Water Volume and Method of Application

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Penn State University, Fruit Research and Extension Center, Biglerville, PA

Keywords: *Grapholita molesta*, oriental fruit moth, *Cydia pomonella*, codling moth, insecticides, alternate row middle spraying, apple

Abstract: A large plot study was designed to evaluate three factors—different insecticides (Assail® [acetamiprid], Imidan® [phosmet], and Rimon® [novaluron]); two methods of applications—alternate row middle (ARM) and complete (both row middles) sprays; and two water volumes (50 and 100 gallons per acre [gpa]) for their efficacy to control both the oriental fruit moth (OFM), *Grapholita molesta*, and the codling moth (CM), *Cydia pomonella*. Three complete applications were made at ≈14-day intervals versus six ARM applications at ≈7-day intervals for each treatment during the period of mid-July until early September. Rimon (ARM/100 gpa) was the most effective treatment, followed by Imidan (ARM/100 gpa) and Assail (complete/50 gpa). There was no comparable complete/100 gpa treatment for Rimon. There was no difference in the percentage of apples with injury for method of application (ARM vs complete) when averaged across treatments, but there was a statistical difference for water volume (50 vs 100 gpa) with the higher volume treatments allowing 52% less frass injury for the 100 gpa treatments. In a series of separate efficacy studies, the insecticide E2Y-45 35WG was evaluated as a seasonal program for its efficacy against both CM and OFM. In all studies E2Y-45 was more effective than Guthion® in controlling this pest complex. There was no difference in efficacy of E2Y-45 when applied at 50, 100 and 200 gpa.

Chemical Control/New Products

Clutch (Clothianidin) and Battalion (Deltamethrin) for Control of Codling Moth in Pome Fruit

Layne Wade, Chuck Schiller, Jeri West and Alan Kurtz
Arysta LifeScience North America, Roseville, CA

Keywords: Clutch, clothianidin, Battalion, deltamethrin, codling moth

Abstract: This talk will present 2 years of trial data from the U.S. northeast using the combination treatment of clothianidin and deltamethrin for the control of codling moth. It will also cover additional trials using each of the materials for the control of other secondary pests. Many of these trials have been conducted over the past 10 years in the U.S. as well as internationally. Presentation will include an introduction to the chemistry (including chemical classification) of each material presented.

Chemical Control/New Products

Effect of Codling Moth Programs on Integrated Mite Control in Apple

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Keywords: integrated mite control, European red mite, *Panonychus ulmi*, twospotted spider mite, *Tetranychus urticae*, western predatory mite, *Galendromus occidentalis*, codling moth, *Cydia pomonella*, neonicotinyl insecticides, thiacloprid, Calypso, acetamiprid, Assail, insect growth regulator, novaluron, Rimon, organophosphate insecticide, phosmet, Imidan, azinphosmethyl, Guthion

Abstract: This is the first year of a planned three-year study on the effect of codling moth programs on integrated mite control. Four codling moth programs were tested in five commercials orchards. Plots ranged from 1 to 4 acres in size and were replicated across the five orchards. The key materials (Assail, Calypso, and Rimon) were used in the first generation only (Intrepid in the 2nd generation) and compared to an organophosphate standard (both generations). Mites were counted at 2- to 3-week intervals throughout the season. Only one of the five orchards experienced a significant mite problem, peaking at about 50 mites/leaf; in this orchard, the highest densities were found in the Rimon plot, with Assail and Calypso plots also elevated, but about half that of Rimon. Despite the elevated levels of tetranychid mites, the three non-OP plots had lower levels of predatory mites. In the other four orchards, tetranychid mites never exceeded 2/leaf. No codling moth damage was found.

Chemical Control/New Products

Kanemite (Acequinocyl) for Control of European Red Mites and Twospotted Spider Mites in Pome Fruit

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Arysta LifeScience North America, Roseville, CA

Keywords: Kanemite, acequinocyl, European red mite, twospotted spider mite, codling moth

Abstract: This talk will present 2+ years of data using acequinocyl for the control of European red mites and twospotted spider mites in pome fruit orchards. This includes trials conducted in the Pacific Northwest, the eastern U.S., as well as within California. Other information presented will be additional efficacy trials for control of other mite species. Presentation will include an introduction to the chemistry (including chemical classification) of each material presented.

Chemical Control/New Products

Identifying Multiple Modes of Insecticidal Activity for Control of the Plum Curculio in Apples

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Keywords: apple, PIC Triad, residue profile, lethal activity, oviposition deterrence, plum curculio, *Conotrachelus nenuphar,* Calypso, thiacloprid, Actara, thiamethoxam, Avaunt, indoxacarb, Guthion, azinphosmethyl, neonicotinoid, oxidiazine, chemical control

Abstract: Field-based bioassays and residue profile analysis were used to identify multiple modes of insecticidal activity related to control of the plum curculio (PC) in Michigan apples. The responses of PC adults to insecticides were measured through exposure to field-treated fruit clusters at 4-hr, 7-day and 14-day residual timings after the spray. The modes of insecticidal activity were characterized based on bioassay observations and correlative relationships to residue profiles. Neonicotinoid insecticides demonstrated both lethal and oviposition deterrence modes of activity, whereas oxidiazine and organophosphate insecticides controlled PC primarily through lethal means.

Chemical Control/New Products

Behavior of Neonate *Endopiza viteana* (Lepidoptera: Tortricidae) During Entry into Grapes and Its Modification by Reduced-Risk Insecticides

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Keywords: grape berry moth, *Endopiza viteana*, methoxyfenozide, acetamiprid, spinosad, grape

Abstract: Neonate larvae of grape berry moth, *Endopiza viteana* (Lepidoptera: Tortricidae), were observed for up to 3 h during their selection and excavation of entry sites on grape berries. This revealed a sequence of behaviors, starting with movement and searching behaviors associated with entry site selection in the first 11 minutes, followed by feeding and protective webbing behaviors. Penetration sites were excavated by mandibular cutting of surface tissues and casting of that tissue away from the entry site rather than by ingestion of the tissue. Within 103 minutes of placement on the berry, larvae had removed sufficient berry tissues to establish a feeding site, with their head inside the berry. Larvae engaged in feeding behaviors 50% of the time and spent 60% of their time at the junction of the stem and berry, where the majority of entries occurred. Larval behavior was compared among untreated grapes or those treated with methoxyfenozide, spinosad, or acetamiprid at field-equivalent rates for control of *E. viteana*. Differential disruption of berry penetration behaviors was caused by the three insecticides; methoxyfenozide was the least disruptive, with larvae exhibiting behavior similar to that on untreated grapes. Conversely, acetamiprid caused the greatest disruption in behavior, with larvae spending significantly more time stationary (71%) than on untreated berries (20%) and not progressing beyond feeding on the berry surface. Spinosad had intermediate effects, reducing but not completely preventing internal feeding. The relevance of these findings for protecting fruit from penetration by internal feeding by Lepidopteran pests will be discussed.

Chemical Control/New Products

Timing of Chemical Application for Vine Mealybug Control in Grapes

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Keywords: vine mealybug, Applaud, Lorsban, Admire, grape pest, grape pest control, grape

Abstract: Postharvest and bud swell spray timings were tested for control of vine mealybug in raisin grapes. Both buprofezin (Applaud®) and chlorpyrifos (Lorsban®) were tested. Because of the insidious behavior and the severity of damage by this pest, many grape growers are applying multiple sprays to control it. Five vine replicates were treated either postharvest, at bud swell or both postharvest and bud swell with either chlorpyrifos or buprofezin. Five replications were used. Number of mealybugs per leaf, number of infested clusters, and the severity of infestation measured efficacy. Results show the buprofezin is most effective when applied at bud swell. Chlorpyrifos shows good efficacy as either a postharvest or a bud swell treatment. The double application of chlorpyrifos was consistently more effective than the double application Applaud. Spring applications of the two materials were equally effective.

Chemical Control/New Products

Effects of Spinosad Bait and Bait Concentration on Western Cherry Fruit Fly Adult Attraction and Fruit Injury in Sweet and Tart Cherry

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Keywords: GF-120, spinosad, cherry fruit fly, attract-and-kill technology, fruit injury, organophosphate alternative, cumulative trap catch

Abstract: GF-120 spinosad bait was comparable to the organophosphate insecticide Guthion in protecting sweet and tart cherries from western cherry fruit fly (WCFF) in two research and four commercial orchard trials in 2004 and 2005 in northern Utah. A low level of fruit injury (mean of $\leq$0.6 larvae per 100 fruit) occurred in GF-120 plots in three of the six trials, but Guthion plots also had fruit injury. Orchard sites with fruit injury had nearby sources of migrating mature WCFF adults that caused small failures in fruit protection for GF-120 and Guthion. Two concentrations of WCFF bait, 20% and 40%, were evaluated in one tart cherry trial in 2005 for its effects on adult attraction and retention and fruit protection. In plots sprayed with GF-120 and untreated plots, more cumulative numbers of adults were caught on traps in subplots treated with 40% than 20% bait, however higher trap catch did not translate to a difference in fruit injury. Adjacent non-host trees (pear and peach) treated with 20% and 40% bait attracted a relatively low number of WCFF adults (<12 cumulative adults per trap), and trap catch was not influenced by bait concentration. In conclusion, increasing the bait concentration in GF-120 sprays did not result in greater protection of fruit from WCFF through higher retention and kill of adults, and use of bait sprays in nearby trap crops (e.g., non-host trees) did not show promise.

Chemical Control/New Products

New Materials and Application Timing for Control of Cherry Fruit Fly

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Keywords: cherry fruit fly, *Rhagoletis indifferens*, Assail, Calypso, Provado, dimethoate, postharvest, insect growth regulator, IGR, Entrust, GF-120

Abstract: Various insecticides, rates and spray intervals were tested for efficacy of control of western cherry fruit fly in very highly infested "backyard" trees or small orchards. Assail, Calypso, Entrust, Provado, DPX-E2Y45 and two other numbered products prevented larval infestation of fruit in almost all instances. Control was less certain as rates were reduced and spray intervals were extended beyond 10 days.

An insect growth regulator was tested for effect on a tree that had almost 100% CFF infested fruit in 2004. The IGR had no apparent current season effect on adults, as over 100 adults were captured on one trap in four weeks. However, fruit infestation dropped to 11 larvae in 1000 fruit. Adult emergence will be followed on this site in 2006 to assess possible effect, and the tree will be treated again to determine if failure to completely control CFF was due to the very high infestation level and the overly large tree. The IGR-based control will be much more extensively tested in 2006 with both sprays and baits as treatments.

For the second season, various current or proposed cherry fruit fly control materials were tested for effect on larvae inside of fruit on a very highly infested tree. On fruit that was 135% infested (339 larvae emerged from a 250 fruit check sample), no, or very few larvae emerged from fruit treated with Provado, Assail, Calypso, or the currently recommended dimethoate.

GF-120 bait was evaluated as a CFF control for the fourth season. Eighty-seven well-infested trees on 30 sites have been included in these trials. Two larvae have been found in 21,400 fruit sampled from the treated trees (none in the 13 sites treated in 2005). A second season of treatment eliminated infestation of fruit on the two "failure" sites. During the same period, 2428 larvae have been recovered from 8000 fruit taken from untreated check trees.

Biology/Phenology

Spatial and Age Distribution of *Prionus* Larvae on Sweet Cherry

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Keywords: Cerambycidae, *Prionus californicus*, giant California prionus beetle, root borer, root injury, crown injury, life cycle, subvoltine

Abstract: Heavily infested sweet cherry trees were destructively sampled to determine the distribution of *Prionus californicus* larvae in the root zone and crowns in a commercial orchard in northern Utah (Box Elder County) in 2004. The greatest proportion of young larvae (first to fourth instars) was found in the roots rather than in the crown and soil. The oldest larvae (fifth to sixth instars) were more abundant in the crown than in the roots or soil and were more prevalent in the loose soil near roots than were younger larvae. We speculate that this is due to older larvae seeking pupation sites outside the tree tissue. The age distribution of larvae in the roots was 34% first to second instars, 38% third to fourth instars, and 28% fifth to sixth instars. The age distribution of larvae in the crown was 29% first to second instars, 12% third to fourth instars, and 59% fifth to sixth instars. Based on spiral-shaped larval feeding tunnels on roots and spatial- and age-distribution observations, it appears that as *Prionus* larvae feed they spiral up the root, moving inward toward the tree's crown. Although small and medium larvae were found in the crown, it was rare that a large larva was observed in a smaller diameter root. Root tissue below a feeding larva was often in varying stages of decay and death. We speculate that the severe feeding injury of *Prionus* larvae cause root conductive tissues to decay and die "behind" them as they ascend to the tree's crown. This type of root feeding injury would reduce the uptake and efficacy of a systemic insecticide applied to the root zone of a cherry tree to kill *Prionus* larvae. Our results also suggest that insecticides should be applied early in the population buildup of *Prionus* and at a time of year when a majority of larvae are early instars and before substantial root injury has been incurred.

Biology/Phenology

Carpenterworm Found Attacking Cherry in Washington State

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Keywords: carpenterworm, *Prionoxystus robiniae*, sweet cherry, *Prunus avium*

Abstract: Carpenterworm larvae (*Prionoxystus robiniae* Peck) (Lepidoptera: Cossidae) were found in the main trunk and scaffolds of a sweet cherry tree, *Prunus avium*, in March of 2005 in an orchard on Hwy 28 near Rock Island, WA. The orchard was about 18 years old and consisted of 'Bing' on Mazzard rootstock. Extensive bark damage and holes with sawdust and frass were found on the lower trunk of the tree. Upon dissection of the tree with a chainsaw, extensive tunneling was found in the main trunk and up several of the primary scaffold limbs. Several larvae of various sizes were found during this process, although most were destroyed by the chainsaw. Trunk sections (1-2 ft long) showing damage were placed in a cage in the lab and inspected regularly for larvae, pupae and emerging adults. Four larvae were found, and three adults emerged. Pheromone traps hung in the orchard in early April caught several dozen males in a 4-week period. This is one of the few records of this pest in tree fruits.

Biology/Phenology

Apple Clearwing Moth, *Synanthedon myopaeformis* (Borkhausen): Recent Introduction to Pacific Northwest Pest Complex

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Keywords: apple clearwing moth, *Synanthedon myopaeformis*, Sessidae, invasive species

Abstract: In 2005 a new larval pest, resembling peach tree borer, was found infesting M.9 and Ottawa 3 rootstocks below the graft union, under burls or around cankers above the graft union, in young and mature apple trees in several organic orchards located in the Similkameen Valley, British Columbia, Canada. This insect has been identified as *Synanthedon myopaeformis* and to the best of our knowledge this is the first North American record of this European pest. A brief description of its biology, host range, current distribution and management plans under way in BC will be discussed.

Biology/Phenology

Where Do Western Flower Thrips Come From?

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Keywords: western flower thrips, *Frankliniella occidentalis*, protein marking, dandelion, weeds, apple, sagebrush, steppe, intra-orchard habitat, extra-orchard habitat

Abstract: Many plants in sagebrush-steppe habitat as well as dandelions and other broadleaf weeds in the orchard have been identified as alternate hosts for western flower thrips in apple orchards. A marking technique using proteins was used to determine the origin of thrips in apple flowers. The experiment was conducted in an orchard bordering sagebrush-steppe habitat in 2004 and 2005 (Orondo) and in an additional site (Bridgeport) in 2005. The extra-orchard habitat was sprayed with cow's milk or soy milk solution, and the orchard floor was sprayed with egg white solution. Thrips were collected from apple flowers at full bloom. At the Orondo site in 2004, 14% of thrips in apple flowers were marked with milk protein (extra-orchard), while only 2% were marked with egg white (orchard floor). In 2005, 12% were marked with soy (extra-orchard), and 1% were marked with egg white (orchard floor). Results of tests were not yet complete for the second site. Thus, of the thrips that could be traced to a specific origin, the majority had come from sagebrush-steppe habitat between pink and full bloom. In a second experiment, large blocks with high dandelion populations on one side and low populations on the other were established and maintained over a period of three years in four commercial orchards. By the second year (2004), dandelions had been greatly reduced in the herbicide-treated plots. In these plots, thrips populations in apple flowers and shoots were not significantly reduced in the first two years (2003, 2004). Thrips were significantly reduced in flowers by the third year, when a transient reduction in shoots also occurred. In a third experiment, thrips populations were sampled at different distances from bordering sagebrush-steppe vegetation in 7 to 8 commercial orchards. In both years of sampling higher populations were found next to the native habitat, suggesting such habitats are an important source of thrips in apple flowers during bloom.

Biology/Phenology

Phenology of the Eastern Cherry Fruit Fly *Rhagoletis cingulata* in Michigan

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Keywords: eastern cherry fruit fly, phenology, monitoring

Abstract: The flight period of the eastern cherry fruit fly *Rhagoletis cingulata* was monitored during the summer of 2005 in Michigan, using Pherocon AM and Rebell traps. Trap captures showed that the flight period is longer than previously thought, starting in early June in unmanaged orchards and ending in late September in natural areas where the native host black cherry occurs. Monitoring also revealed large populations living in managed orchards, with a flight period peaking after harvest. These data indicate that in some managed orchards it may be necessary to conduct postharvest insecticide sprays.

Biology/Phenology

A Search for Molecular Markers to Discriminate *Rhagoletis pomonella* from *R. zephyria*

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Keywords: Rhagoletis pomonella, Rhagoletis zephyria, DNA diagnostics, elongation factor alpha intron, mitochondrial CO1, geographic variation

Abstract: The apple maggot, *Rhagoletis pomonella*, is a primary pest of cultivated apples, especially in the northeastern United States and southeastern Canada. However, in the last 25 years it has spread and infested apples in many parts of the Pacific Northwest. To prevent apple maggot from spreading to the main apple producing areas, local authorities rely on early detection and immediate eradication programs. Monitoring is mainly based on captures of adults in sticky traps. Unfortunately, the morphology of *R. pomonella* overlaps with its sister species *R. zephyria*, the snowberry maggot, especially in females. Here we describe a combination of two molecular markers (PCR-RFLP of nuclear intron elongation factor alpha and mitochondrial cytochrome oxidase 1) that lead to 90 to 99% diagnosis, depending on the collection area. This work failed to pinpoint 100% diagnostic markers due to the similarity of the species and possibly due to incomplete reproductive isolation. Further research to find markers with better resolution is ongoing and preliminary data are presented.

Biology/Phenology

Cherry Fruit Fly Ecology and Management in the Agricultural-Urban Mix of the B.C. Interior

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Keywords: western cherry fruit fly, black cherry fruit fly, *Rhagoletis indifferens, Rhagoletis fausta,* trap, lure, phenology, movement, flight, insecticide, non-target

Abstract: Managing the cherry fruit fly (CFF) complex is a serious challenge in B.C., but little Canadian research has occurred since the 1970s. Information is needed to implement any areawide program in the mixed urban-rural landscape of the B.C. interior or to use new reduced risk chemicals and formulations. Surveys occurred in 2002 to 2005 to delineate the flies, their parasitoids, and the plant hosts. Extra-orchard hosts were monitored and fruit sampled from bitter, pin, choke, Schubert choke, Mahaleb, and Nanking cherry trees. Various traps were compared as well as placement at different locations in trees. Estimates of CFF flight and movement were made using passive captures from known sources and mark-recapture experiments. The timing or spatial pattern of emergence of western cherry fruit fly was measured at three locations in 2004 and one location in other years. Tests of compatibility of reduced risk pesticides with western and eastern predatory mites are underway with a collaborator.

Biology/Phenology

Biology and Management of Rosy Apple Aphid and Woolly Apple Aphid

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Keywords: rosy apple aphid, *Dysaphis plantaginea*, woolly apple aphid*, Eriosoma lanigerum*, Admire, imidacloprid, Vydate, oxamyl, NNP-316, Thiodan, endosulfan, diazinon, Safe-T-Side, oil, Raynox, clay, particle film, Aza-Direct, azadirachtin, broadleaf plantain, *Plantago major*, narrowleaf plantain, *Plantago lanceolata*, phenology, summer host

Abstract: A survey of various weed species was conducted to determine the summer host of rosy apple aphid (RAA) in Washington. Nine counties in central Washington and one county in Oregon were included in the survey. Sampling concentrated on plantain, but other species were sampled periodically. RAA was found on both broadleaf, *Plantago major*, and narrowleaf plantain, *P. lanceolata*, in many counties. In a greenhouse experiment, winged RAA landed on *Plantago* spp. in May and June. Winged aphids originating from colonies on *P. lanceolata* and *P. major* returned to apple in the fall, where they produced the yellow, oviparous generation. Sticky bands were used to monitor the movement of first instar woolly apple aphid (WAA) at one site in Bridgeport, WA. In 2005, aphids moved up from root colonies primarily in May through mid-July, with a peak in early June. In a pesticide test on potted apple trees, NNP-316, applied as a foliar spray, and Admire 2F and Vydate 2L, applied as soil drenches, showed activity against both WAA shoot and root colonies. In a commercial orchard field trial, both Thiodan 50W and Diazinon 50W provided excellent control of shoot colonies. Raynox (5% and 10% rate), Aza-Direct, and Safe-T-Side oil did not significantly affect aphid populations in this trial, although Safe-T-Side caused substantial mortality.

Biology/Phenology

Spatial and Temporal Distribution of Western Flower Thrips Eggs in Apple Tissues

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Keywords: western flower thrips, *Frankliniella occidentalis*, Carzol, formetanate hydrochloride, oviposition, phenology, apple, bloom, pansy spot

Abstract: The precise timing of oviposition has been a matter of controversy in the literature for the past 80 years. The first experiment was designed to describe the location of flower thrips eggs in apple blossoms at different blossom stages. Blossom clusters were collected from the field at pink, king bloom, full bloom, petal fall, 15 mm fruit, and 25 mm fruit. At times when adult thrips were not present (pink, king bloom, 15-25 mm fruit), clusters were artificially infested with adult thrips in the laboratory to prompt oviposition. The calyx was highly preferred before petal fall, and no eggs were laid in potentially damaging areas until full bloom or later. Artificial infestation after petal fall led to substantial numbers of eggs in the fruit. However, adults disappeared from clusters at petal fall so, at the time that developing fruit was highly suitable to oviposition, adults were not present in the cluster. In a second experiment, eggs were stained in fruitlets collected at 10 blossom stages, from tight cluster to 21 days after petal fall. In 2004, oviposition in the fruitlet began at full bloom, but the majority were laid when the fruit size was between 5.6 and 10.9 mm. In 2005, oviposition was first detected at petal fall, then greatly increased between 6.0 and 11.6 mm. In a third experiment, thrips were excluded from flower clusters at different times with applications of Carzol and sleeve cages. Sprays reduced pansy spot on fruit until 2 to 3 weeks after full bloom (about 5.6 mm), after which they were not effective.