2008 Orchard Pest
&
Disease Management Conference

The 82nd Conference is pleased to announce two keynote speakers,
Dr. Peter Witzgall (Sweden)
Understanding Codling Moth Chemical Ecology: What Does it Mean for Control
&
Dr. Richard Rice (UC Davis)
35 Years of Watching Chemical Ecology at Work

Hilton Portland, Portland, Oregon
January 9, 10, & 11, 2008

WESTERN ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE
"The Portland Spray Conference"
(1926 - 2008)

Our History: One of the oldest and most appreciated Entomology-Plant Pathology meetings in the Pacific Northwest is the Portland Spray Conference. It dates back to 1926. It was on June 30 of that year at the suggestion of J. R. Parker, Associate Entomologist, Montana Agricultural Experiment Station, that the first meeting was held in Tacoma, Washington. The "Western Cooperative Oil Spray Project" as it was formally named was organized at that meeting. Participants included representatives of Idaho, Montana together with representatives of the U.S.D.A. and the Canada Department of Agriculture. Mr. Parker was named Chairman. Another meeting was held in Spokane, Washington on December 5, 1926 and thereafter, over the past 80 years, this has been an annual gathering. The meeting continues to grow and we now have participants from all fruit growing areas of North America and other countries including Argentina, Chile, and Switzerland.

Our Focus: The meeting has always been one focused on research, without any emphases on the commercial aspects of the applications of the research. Not so long ago (thirty or so years ago), the meeting was small, forty or fifty people, and limited to only research scientists from public institutions. Then extension agents were invited in, then one representative from each chemical company (about twenty years ago), then opened to everyone. Now the meeting participants include researchers, extension personnel, manufacturing reps, fieldmen from agricultural chemical companies, private consultants, and growers. Everyone is invited to give presentations and there is a strong commitment amongst all members to keep presentations scientific not only out of a respect to the origins of the meeting but also to ensure that the meeting is a valuable experience to all participants.

Rubber Chicken Award: In an effort to ensure that presenters and participants maintain the highest standards of conduct and etiquette, WOPDMC members annually award the prestigious but unwelcome "Rubber Chicken Award". Recipients of this high distinction (awarded at the conclusion of the meeting) receive a featherless, rubber chicken appropriately hung by its feet.

Notables who have received the award include:

1. **Clancy Davis**, Berkeley, California for his quiet, sober, professional demeanor on all occasions;
2. **Stan Hoyt**, Wenatchee, Washington for failing to enliven methods of presentation of papers,
3. **Don Berry**, Medford, Oregon for never having made a single comment over 20 years.
4**. Pete Westigard**, Medford, Oregon for returning from a sabbatical with 400 color slides (all failures) and a new child.
5. **Jay Brunner**, Wenatchee, Washington for giving one of the looooongest talks in the history of WOPDMC
6. **Doug Light**, Albany, California for showing incomprehensible data slides again and again and again.
7. **Stephen Welter**, Berkeley, California for inappropriate behavior by leaving the meeting prior to giving his presentation.

Orchard Pest and Disease Management Conference

Agenda for 2008 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 which that will occur.

Talks within a session will be in the order in which they are listed in the agenda found on the following pages.

Time	Session	Moderator
	Wednesday, January 9	
10:00am	Opening Business	Harvey Reissig, WOPDMC President
10:30am	Biocontrol	Lerry Lacey
11:00am	Resistance Management	Alan Knight
11:30am	Chemical Control/New Products	Elizabeth Beers
12:00pm	Lunch	
1:30pm	Chemical Control/New Products (cont.)	Elizabeth Beers
3:00pm	Coffee	
3:30pm	Keynote Addresses	Harvey Reissig
5:00pm	Social Gathering	
	Thursday, January 10	
8:00am	Chemical Control/New Products (cont.)	Elizabeth Beers
10:00am	Poster Session/Coffee	
10:30am	Biology/Phenology	David Epstein
12:00pm	Lunch	
1:30pm	Mating Disruption/SIR	Larry Gut
3:00pm	Break	
3:30pm	Mating Disruption/SIR (cont.)	Larry Gut
	Friday, January 11	
8:00am	Thresholds/Monitoring	Art Agnello
9:00am	Implementation	Loys Hawkins
10:00am	Closing Business	Harvey Reissig, WOPDMC President Thomas Larsen, WOPDMC President Elect
11:00am	Adjourn	

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Western Orchard Pest and Disease Management Conference

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FROM THE 82ST ANNUAL
ORCHARD PEST AND DISEASE MANAGEMENT CONFERENCE
January 9, 10 & 12, 2008

Biocontrol

Lerry Lacey, moderator

Notes

Biological Control

New Website for Tree Fruit Pest Management Information: Orchard Pest Management Online

E. H. Beers, J. F. Brunner, V. P. Jones, J. E. Dunley, and G. Tangren
Washington State University, Tree Fruit Research & Extension Center, Wenatchee, WA

Keywords: tree fruit, integrated pest management

Abstract: The book "*Orchard Pest Management: A Resource Guide for the Pacific Northwest*" was originally published in 1993 and has served as a basic reference for tree fruit pest managers since that time. The book covered biology, description, life history, biological control and management of the major and minor pests of Washington tree fruits, as well as all the important natural enemies. The content of this book is now available online at the WSU-TFREC website at http://jenny.tfrec.wsu.edu/opm/. While the text of the book served as the basis of the website, several enhancements have been made. Many of the articles have been updated to reflect research done since the original publication. Over 600 new pest and damage photos have been added to the original 191 images in the print version. Many of these have been placed in a new section, the "photo gallery" giving readers multiple views of pest stages. Five new articles have been added on pests recently discovered or re-discovered, including brown mite, prionus root borers, weevils, apple leafcurling midge and apple mealybug. Unlike a print version (which is out of date from the moment of publication), the website can be edited online by the authors of the various articles. Lastly, this online resource is in the process of being linked with other WSU and non-WSU web resources.

Observations on the Apple Mealybug and its Parasitoid in Washington

Elizabeth H. Beers
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Keywords: apple mealybug, *Phenacoccus aceris*

Abstract: Apple mealybug is a relatively uncommon pest in Washington State, although it has been reported from the Pacific Northwest (British Columbia) since the 1930s. This mealybug attacks all deciduous tree fruit species, but is best known as the vector of little cherry virus on sweet cherry. The phenology of a population of apple mealybug was followed in an organic orchard in Grant County, Washington during May and June of 2007. When the population was found to be heavily parasitized, the emergence of the parasitoid was also tracked. In the first sample (9 May), about 50% of the females had formed nests, and 10% had laid eggs; nest formation was complete by early June, and egg hatch had commenced. Hatch proceeded slowly through June, with crawlers remaining in the nest for some time after hatch, gradually dispersing to feeding sites on twigs, leaves, and fruit. The latter stages of parasitism caused the formation of mummies; the sample was comprised of about 10% mummies in early May, and close to 80% by early July. Emergence of adult parasitoids (as evidenced by exit holes) was first noted in early June, and leveled off by early July. The parasitoid has been tentatively identified as a species of *Anagyrus* (Hymenoptera: Encyrtidae). The identification of the apple mealybug has been confirmed.

Biological Control

Biological Control of Filbertworm with Entomopathogenic Nematodes

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Keywords: Filbertworm (*Cydia latiferreana*), entomopathogenic nematodes, *Steinernema carpocapsae*, *Heterorhabditis marelatus*, *Steinernema kraussei*, biological control

Abstract: Entomopathogenic nematodes were investigated as an alternative option to control filbertworm in hazelnut orchards in Oregon. First studies focused on the control of filbertworm larvae that over-winter on the orchard floor. The efficacy of three nematode species to infect filbertworm larvae was tested in lab and small-scale field trials. In the lab trials, the nematodes *Steinernema carpocapsae* and *Heterorhabditis marelatus* caused 100% infection in filbertworm larvae, while *S. kraussei* caused 73% infection. Infection rates of filbertworm larvae with and without hibernacula treated with *S. carpocapsae* were 94% when applied at a rate of 75 infective juveniles (IJs)/cm^2, and 89% and 79%, respectively, when applied at a rate of 40 IJs/cm^2. In small-scale field trials, the nematodes *S. carpocapsae* and *H. marelatus* caused 90% and 20% infection, respectively, when applied at a high rate (200 IJs/cm^2). *S. carpocapsae* sprayed in economically useful rates of 40 and 75 IJs/cm^2 was not effective against cocooned filbertworm larvae. Nematode rate, spray volume, and hibernation substrate appeared to have no influence on larval infection rates. Conclusions and implications for future research and possible applications are discussed.

Field Evaluation of Methyl Salicylate for The Attraction of Green Lacewings (Insecta: Neuroptera) in Tree Fruit and Surrounding Native Vegetation

R.T. Curtiss and John E. Dunley
Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: Methyl salicylate, apple, pear, sagebrush, lacewing, biological control

Abstract: A field experiment to determine the attraction of lacewings to methyl salicylate (MeSa) in tree fruit (pear and apple) and surrounding native vegetation was conducted in Orondo, Entiat, and Wenatchee, Washington. Three experimental blocks each included an apple, pear and native vegetation plot within one square mile, to reduce microclimate variations, and allow lacewing migration. The effectiveness of MeSa in the three 'crop' types was variable; MeSa was significantly attractive to *Chrysopa nigricornis* (Burmeister) and *Chrysoperla plorabunda* (Fitch) in pear, significantly attractive to *C. nigricornis* in apple, and significantly attractive to *C. nigricornis* and *Chrysopa coloradensis* (Banks) in native vegetation.

Biological Control

Resistance in *Cydia pomonella* to the Codling Moth Granulovirus in Europe: Could it Happen Here?

Lawrence A. Lacey
USDA-ARS, Yakima Agricultural Research Laboratory, Wapato, WA

Keywords: codling moth, *Cydia pomonella*, granulovirus, resistance, monitoring

Codling moth (CM), *Cydia pomonella*, is a very serious pest of apple and pear in most countries where pome fruit are grown. Of the many insecticides used to control CM in conventional systems, the organophosphate, Guthion® (azinphos-methyl) is still the most widely and extensively used. Development of resistance in CM to this and several other insecticides has been reported in Europe (Sauphanor et al., 1998, Reyes et al., 2007) and North America (Dunley and Welter, 2000). For this and a variety of safety and environmental reasons, softer means of control are being developed. One of the most specific control agents of CM is the granulovirus (CpGV) discovered in Mexico in 1963 (Tanada, 1964). Although first evaluated in North America, its commercial development and widespread use began in Europe. Use of CpGV has increased considerably in North America since 2000, especially in organic orchards (Lacey and Shapiro-Ilan, 2008). The virus provides selective control of CM that is safe to beneficial insects including honeybees and natural enemies of CM and other arthropod orchard pests. It is now estimated that CpGV is applied to over 100,000 hectares annually (Eberle and Jehle 2006). The combination of mating disruption and CpGV has provided complimentary CM control (Charmillot and Pasquier 2003).

Recently, CM resistance to CpGV was reported in Germany and France in organic orchards treated with multiple applications of CpGV over an extended period (Fritsch et al., 2005, Eberle and Jehle, 2006, Sauphanor et al., 2006). Resistance to CpGV has now been found in Switzerland and Italy (Jehle, pers. comm.). Resistance ratios in some CM populations exceed 1000 (Asser-Kaiser et al., 2007). Laboratory studies reveal that rapid development of extreme resistance (100,000 resistance ratio) is possible due to sex-linked inheritance of a dominant resistant gene (Asser-Kaiser et al., 2007).

Studies by German scientists are underway to identify molecular markers that can detect resistance in CM populations more quickly than bioassays using F1 larvae (J. Jehle, pers. comm.). A European project (SustainCpGV) seeks to identify and characterize more virulent CpGV isolates. Currently most CpGV products that are used for CM control are based on the Mexican (M) isolate. At least three other related CpGV strains have been reported from broadly separated countries (England, Russia, Iran). These isolates appear to differ genetically from the Mexican strain (CpGV-M). The SustainCpGV group (www.sustaincpgv.eu) proposes to characterize these different CpGV isolates in order to understand how they can be best used in resistance management programs. The group also proposes to search for and characterize CpGV isolates from Central Asia (the putative center of origin of CM) that can serve as alternatives to the currently used CpGV-M strain and which may assist in the fight against the emerging virus resistance of CM. Also of interest, two of the three commercial producers in Europe have identified isolates of CpGV that overcome CM resistance.

Because CpGV is being increasingly used in North America, the potential for development of resistance should be anticipated. An integrated approach that alternates other soft interventions with CpGV should be considered especially when the virus is used extensively within a region. Determination of CpGV susceptibilities of CM in orchards with treatment success and those with suspected treatment failure in the Pacific Northwest should be undertaken. Baseline data of susceptible populations will provide the necessary foundation for determining future signs of resistance. Management strategies that will maintain the efficacy of CpGV are needed before a decline in CM susceptibility is detected. Various factors could influence the probability that resistance in CM to CpGV would develop in North America. In addition to the frequency of genes responsible for resistance in our CM populations, the number of years that CpGV

has been used against a given population, the number and frequency of applications per season, the size of virus treated populations and their proximity to CM that are not treated with CpGV, could help to determine if and when resistance will develop.

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Acknowledgements. I thank Johannes Jehle, Don Thomson and Tom Unruh for reviews and information and helpful comments used in this manuscript.

Resistance Management

Alan Knight, moderator

Notes

Resistance Management

Codling Moth Insecticide Resistance Coming and Going

Alan Knight
ARS, USDA, Wapato, WA

Keywords: Codling moth, acetamiprid, azinphosmethyl, novaluron

Abstract: The presence of insecticide resistance or tolerance in populations of codling moth appears to be a worldwide problem and six mechanisms have been identified to six classes of insecticides. Studies conducted in 2003 examined field populations of codling moth that expressed a fairly narrow range of responses to azinphosmethyl. Yet, these species had significant differences in several key fitness traits, such as emergence curves, and fecundity. The new phenology model that has been developed predicts a broader emergence curve for the overwintering codling moth than previously found and this is consistent with the expected emergence curve of mixed populations of resistant and susceptible moths. Evidence for cross-resistance between azinphosmethyl and methoxyfenozide and acetameprid was first detected in 2004. Since then additional data has been gathered showing a positive correlation of moths' responses to both acetameprid and azinphosmethyl. Last year I reported a negative correlation between populations' responses to azinphosmethyl or acetamiprid versus novaluron. Similar data were collected during 2007 and, interestingly, the use of acetamiprid significantly reduced this tolerance to novaluron.

Development and Implementation of a Baseline Susceptibility Bioassay for Rynaxypyr™ (Altacor™) on Field-Collected Codling Moth Populations in Washington Orchards

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

Keywords: Rynaxypyr™, Altacor™, anthranilic diamide, ryanodine receptor, codling moth, *Cydia pomonella*, insecticide resistance, diet-incorporated bioassay

Abstract: The effect of incorporating a novel ryanodine receptor modulator belonging to the chemical class anthranilic diamide (Rynaxypyr™, Altacor™, DuPont Crop Protection) into an artificial diet (Heliothis Premix instant soybean – wheat germ diet, #38-06000, Ward's Natural Science, Inc., Rochester, NY) was evaluated against neonate codling moth (CM) larvae from a laboratory colony and several field-collected populations. The purpose of this trial was to establish baseline tolerance levels for a resistance-screening program. Complete dose response curves and select diagnostic dose tests from as many populations as possible will be the foundation for monitoring changes in susceptibility to Altacor™ in future trials. The field-collected populations were from orchards with high CM populations as a result of poor management decisions or otherwise neglected or abandoned orchards. Although these were native populations, they were generally considered organophosphate-susceptible. However, spray histories or background organophosphate susceptibilities were unknown and the potential existed that some of the populations may have elevated tolerances to organophosphates. A statistically significant concentration-based response was noted with the six field-collected populations that produced enough larvae to test a complete dose response curve. Diagnostic dose data were collected from 17 field-collected populations. A significant shift in mortality at the diagnostic dose was noted in several populations. Future tests will focus on those sites, as well as screening populations where observed efficacy was less than expected. Data collected in Washington are part of a worldwide effort to develop a robust method for monitoring changes in susceptibility to Rynaxypyr™.

Chemical Control

New Products

Elizabeth Beers, moderator

Notes

Chemical Control/New Products

New Website for WSU's *Crop Protection Guide for Tree Fruits in Washington*

E. H. Beers, J. F. Brunner, J. E. Dunley, T. J. Smith, M. Bush, G. G. Grove, C. L. Xiao, D. Elfving, F. J. Peryea, R. Parker, T. Maxwell, E. Johansen, S. Foss, C. Daniels, S. Martin, and G. Tangren
WSU Tree Fruit Research and Extension Center, Wenatchee, WA; WSU Pullman, WA; WSU Irrigated Agriculture Research and Extension Center, Prosser, WA; WSU Puyallup Research and Extension Center, Puyallup, WA; WSU Yakima County Extension, Yakima, WA; WSDA, Olympia, WA

Keywords: tree fruit, integrated pest management, chemical control, spray guide

Abstract: WSU has published chemical control recommendations for tree fruits in Washington since 1947. This annually revised publication (currently known as Extension Bulletin 0419, the *Crop Protection Guide for Tree Fruits in Washington*) is the joint effort of WSU research & extension personnel, with help from the experts at the Washington State Department of Agriculture. The bulletin summarizes IPM research by WSU faculty on Washington's deciduous fruit crops, and provides growers with specific guidelines on pest and disease management, foliar nutrients, plant growth regulators, and herbicides. In addition to the crop-specific tables, a wealth of information is included on pesticide use and safety. For the first time in its history, the Crop Protection Guide will be available as a website (http://jenny.tfrec.wsu.edu/eb0419/) for the 2008 growing season. While the format will be similar to the print version (which will continue to be published), the structure has been altered for use on the web. The table portions of the Guide are based on a database of pesticides and their associated label information, thus corrections made to the database will be reflected throughout the tables. This structure should improve the ease and accuracy of error checking. The other operational change is that contributors to the guide will be able to edit the content online with a password-protected account, coordinating with WSU's Pesticide Coordinator. While the majority of changes to the Guide will be made during the fall of each year, the online format allows for changes whenever new information or materials become available. This website will be linked with other WSU resources, especially *OPM online*, where the basic biological information on pests and natural enemies can be found.

Chemical Control/New Products

Chemical Control of Woolly Apple Aphid

Elizabeth H. Beers & Stephen D. Cockfield
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Keywords: woolly apple aphid, *Eriosoma lanigerum*, clothianidin, Clutch™, pyriproxifen, Esteem®, imidacloprid, Admire Pro, Venom™, dinotefuran, spirotetramat, Ultor®, tolfenpyrad, flonicamid, Beleaf, diazinon

Abstract: Field and greenhouse experiments were performed to investigate various materials, timings, and application methods for control of woolly apple aphid. Esteem® and Clutch™ were tested as soil drenches, alone and in combination. Clutch™ appeared to have good activity against root and shoot colonies with this application method. Lorsban® plus oil at delayed dormant provided nearly season-long control of woolly apple aphid shoot colonies, although populations increased in the fall in some plots. Lorsban® applied post-harvest did not affect the mid-summer peak of shoot colonies. Densities in the diazinon treatments, applied post harvest or delayed dormant, did not differ significantly from the checks. Venom™ applied as bark paint or foliarly had some effect on shoot colonies, but the timing may not have been optimal in this experiment. Tolfenpyrad and Beleaf™ appeared to have little activity against the aerial colonies when applied airblast in midsummer, whereas diazinon provided excellent control in all tests. Ultor®, applied twice in the latter half of May, provided season-long control of a population that peaked in mid-summer in the check plots.

The Impact of Pyriproxyfen on Obliquebanded Leafroller, *Choristoneura rosaceana* (Lepidoptera: Tortricidae)

Ashfaq A. Sial, Jay F. Brunner, and Michael D. Doerr
Washington State University Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: Obliquebanded leafroller, pyriproxyfen, sublethal effects, insect growth regulator

Abstract: The obliquebanded leafroller (OBLR), *Choristoneura rosaceana* (Harris), is one of the most destructive pests of tree fruits in Washington. The development of insecticide resistance in OBLR has led us to explore new management strategies. The use of very low doses of insecticides that have strong sublethal effects represents an environmentally friendly option to improve existing integrated pest management strategies. The insect growth regulator pyriproxyfen (Esteem® 0.86EC, Valent U.S.A. Corporation) was tested to determine its lethal and sublethal effects on OBLR. A leaf-disk bioassay was used to test seven doses of pyriproxyfen ranging from 0.0 to 3.0 µg per final instar OBLR. Male and female larvae were assessed separately for mortality as well as other parameters of growth and development. Response to pyriproxyfen was found to be dose-dependent: only 5-6% of the larvae treated with the highest dose emerged as morphologically normal adults, compared to 86% emergence in the controls. Adult emergence was significantly delayed at doses higher than 0.1 µg per larva. The weights of OBLR pupae and adults were significantly increased whereas fecundity and fertility were significantly reduced at a sublethal dose of 0.03 µg per larva. The conclusion was that both lethal and sublethal effects contribute to the observed reductions of OBLR densities in tree fruit orchards treated with pyriproxyfen.

Chemical Control/New Products

New Insecticide Chemistries for Apple – Their Efficacy and Possible Use Patterns Against Internal Feeding Lepidoptera and Leafrollers in Pennsylvania

L. Hull, G. Krawczyk and D. Biddinger
Penn State University, Fruit Research and Extension Center, Biglerville, PA

Keywords: *Cydia pomonella*, codling moth, *Grapholitha molesta*, oriental fruit moth, obliquebanded leafroller, *Choristoneura rosaceana*, tufted apple bud moth, *Platynota idaeusalis*, insecticides, apple

Abstract: A series of experiments in research and commercial orchards of apple were conducted during 2007 to determine the overall efficacy and possible use patterns of three novel insecticide chemistries against the codling moth (CM), *Cydia pomonella*, and the oriental fruit moth (OFM), *Grapholitha molesta*, and two leafrollers - obliquebanded leafroller, *Choristoneura rosaceana*, and tufted apple bud moth, *Platynota idaeusalis*. In addition, the relative toxicity of these compounds against various natural enemy populations was measured. The three novel chemistries were flubendiamide, Rynaxypyr™ and spinetoram. These three compounds were compared to a number of registered insecticides in all studies. For the research orchard trials the treatments were applied to either replicated single tree or 12-15 tree plots using an airblast sprayer calibrated to deliver 100 gal/acre. In the commercial orchard studies, Rynaxypyr™ was evaluated under an Experimental Use Permit and applied at various rates, methods of applications (every row and alternate row middle methods), and within an area-wide mating disruption program. Data on pest and natural enemy populations and fruit injury were collected. All three products were extremely effective, and in most studies more effective, than any standard products for all lepidopteran pests. Rynaxypyr™ provided outstanding control of CM and OFM and the leafroller complex on a 21-day application interval, but control was slightly less effective when applied as alternate row middle versus every middle applications. Spinetoram appeared to be somewhat toxic to the mite predator, *Typhlodromus pyri*. Possible use patterns for these three new chemistries on apple will be presented.

Alternatives to OPs for Control of Codling Moth and Effects on Non-Target Organisms

Richard Hilton
OSU-Southern Oregon Research & Extension Center

Keywords: codling moth, *Cydia pomonella*, European earwig, *Forficula auricularia*, Altacor™, Rynaxypyr™, Delegate™, spinetoram, Entrust®, spinosad, granulosis virus, organophosphates, pear

Abstract: Evaluations of various codling moth control programs indicated that both Altacor™ and Delegate™ were very active on codling moth and provided a high level of codling moth control in Bartlett pear. Extensive testing of Altacor™ showed no indication of phytotoxicity on any of the five main pear cultivars grown in the Pacific Northwest: Anjou, Bartlett, Bosc, Comice, and Red Anjou. In small field tests Altacor™ exhibited little effect on European earwig populations while the effect of Delegate™ was limited and was not as suppressive to earwigs as either neonicotinoid or organophosphate insecticides. A codling moth control program which relied on granulosis virus and a single application of either Altacor™ or Entrust®, timed for control of the summer generation of obliquebanded leafroller, resulted in a high level of control of both codling moth and leafroller relative to an untreated control. The Entrust® treatment also reduced the numbers of earwigs trapped in cardboard domiciles to a significantly greater degree than the Altacor™ treatment. Effects on secondary pests such as pear psylla, spider mites and pear rust mite will be discussed.

Reduced Risk Insecticide Evaluations for Apples in California

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Keywords: apple, chemical control, insecticide, codling moth, *Cydia pomonella*, Assail™ 30SG, acetamiprid, Altacor™ 35WG, Rynaxypyr™, Battalion™ 0.2EC, deltamethrin, Delegate™ 25 WDG, spinetoram, Imidan® 70WP, phosmet, PureSpray Green oil, Warrior® 1CS, lambda-cyhalothrin, A15645, A15365

Abstract: Five reduced risk materials applied at various rates were compared to a grower standard (GS) program and an untreated control (UTC) in 12 randomized, replicated treatments in 'Gala' apples in the North San Joaquin Valley of California. All treatments were applied with a hand-gun to three 10-tree replicates at 250 and 650 degree days (DD) for the first and second flights.

The GS for the first flight consisted of an Imidan®/Warrior®/Agri-Mek® spray at 250 DD followed by an Assail™/Warrior® spray at 650 DD. This was compared with Actara®, two rates of Delegate™, three rates of A15365, and three rates of A15645 applied at the same timing or a Battalion™ spray applied for the 250 DD spray with the GS applied for the 650 DD spray. The GS for the second flight consisted of an Assail™/Warrior® spray at 250 DD and an Imidan® spray at 650 DD. All treatments, except the Delegate™ and Battalion™, used the GS for the second flight. Delegate™ was applied for both sprays in the second flight while Battalion™ was applied for the 250 DD spray with the GS used for the 650 DD spray.

Under high CM pressure (UTC= 43.71% damage), all treatments performed significantly better than the UTC. All other treatments were not significantly different than the GS (5.6% damage) except the low rate (6.4oz/A) of Delegate™ (10.9% damage).

A second, larger trial was applied with a speed sprayer and compared season long treatments of Delegate™ and Altacor™ with the same GS as above. All treatments did significantly better than the UTC and were statistically similar to the GS.

Chemical Control/New Products

Field Performance and Life Stage Activity of New Insecticides for Apple IPM

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Keywords: apple, life-stage activity, codling moth, *Cydia pomonella*, Rynaxypyr™, flubendiamide, spinetoram, thiacloprid, novaluron, azinphos-methyl, chemical control

Abstract: Field efficacy trials and life-stage activity bioassays were used to evaluate the performance and optimal program placement of new insecticides in Michigan apple Integrated Pest Management (IPM). Field efficacy trials were based on two-tree plots sprayed with an airblast sprayer, followed by damage assessments. The life-stage activity bioassays were based on fruit clusters being taken from field-sprayed plots, and then exposed in the laboratory to mated female codling moth adults. Mortality to codling moth adults, survival of eggs, and larval entrees into fruit were assessed afterwards to capture the cumulative life-stage effects of each insecticide. Combining field efficacy results with life-stage activity data provides insights into optimal spray programs for apple IPM.

Comparison of Calypso® with Standard Insecticides for Codling Moth Control

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Keywords: Codling moth, *Cydia pomonella*, pear, Calypso®, thiacloprid, Guthion®, azinphos-methyl, Imidan®, phosmet, Warrior®, lambda-cyhalothrin, chemical control, insecticide

Abstract: The efficacy of the neonicotinoid Calypso® (Bayer CropScience) was evaluated against grower standard (GS) treatments in two orchards in the Sacramento River District of California. Each treatment was replicated four times in Orchard 1 and two times in Orchard 2. Each replicate was a minimum of six rows wide and five to ten acres in size. Treatments were applied with grower-operated air-blast speed sprayer. Isomate-C TT pheromone dispensers were hung in both orchards in early April at a rate of 200/acre. In Orchard 1, Calypso® 4F at 8 oz/acre + Warrior® at 5.1 oz/acre was applied on 16 April, and Calypso® 4F at 8 oz/acre + oil at 0.5% was applied on 29 May. In the GS Assail™ 70WP at 3.4 oz/acre + Warrior® at 5.1 oz/acre was applied on 16 April and Imidan® 70W at 7 lb/acre was applied on 29 May. In Orchard 2, Calypso® 4F at 8 oz/acre was applied on 19 May and 18 June while in the GS Imidan® 70 W at 7 lb/acre was applied on 19 May and Guthion® 50WSP at 3 lb/acre was applied on 18 June. Codling moth (CM) populations were very high in both orchards. CM damage was evaluated at the end of the first generation (2nd week of June) and shortly before harvest (2nd week of July). CM damage evaluations were conducted in the center rows of each replicate by inspecting 50 fruit/tree on 20 trees. After the first generation, CM damage in Orchard 1 averaged 0.15% in the GS and 0.45% in the Calypso® while in Orchard 2 CM damage averaged 1.8% in the GS and 0.7% in the Calypso®. At harvest CM damage in Orchard 1 averaged 3.2% in the GS and 2.4% in the Calypso® while in Orchard 2 CM damage averaged 2.2% in the GS and 2.1% in the Calypso®. From this study Calypso® performed as well or better than the grower standard.

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 mite, *Panonychus ulmi*, twospotted spider mite, *Tetranychus urticae*, pear rust mite (PRM), *Epitrimerus pyri*, Delegate™, spinetoram, Altacor™, Rynaxypyr™, PureSpray Green horticultural oil, Imidan®, phosmet, Agri-Mek®, abamectin, Assail™, acetamiprid, Warrior®, lambda-cyhalothrin, A15894, A15365, pear, chemical control, insecticide

Abstract: A single-tree crop destruct field trial was conducted to evaluate new experimental insecticides for codling moth control. This trial was conducted against a high CM population with over 48% of the fruit infested at harvest in the untreated check. This trial should be considered a rigorous test of the experimental materials. Delegate™ at 6.4 oz/acre and 7.0 oz/acre and Altacor™ at 3.0 oz/acre and 4.0 oz/acre provided excellent control of codling moth. Both insecticides at both rates of application had numerically lower CM infested fruit than the grower standard of Imidan® combined with Warrior® and Agri-Mek® followed by two applications of Assail™ combined with Warrior® and Agri-Mek®. There was little or no rate response with either Delegate™ or Altacor™. Registration of both Delegate™ and Altacor™ is expected for next season. The addition of horticultural oil to both Delegate™ and Altacor™ appears to marginally increase their efficacy. A15894 at 7.6 oz/acre, 11.4 oz/acre and 15.2 oz/acre and A15365 at 2.7 oz/acre, 3.1 oz/acre and 5.5 oz/acre also provided excellent codling moth control that was similar to Altacor™ and Delegate™ and there was no rate response with either A15894 or A15365. However, A15894 and A15365 were applied only against the overwintering generation and Assail™ and Warrior® combined were applied against the first peak of the first generation. Delegate™ and A15894 provided pear psylla control and Delegate™ at the high rate of application caused some population increase of pear rust mite. Thus, it appears that we have a number of excellent experimental materials that can compete favorably with the grower standard. No phytotoxicity was observed with any of the experimental treatments.

Chemical Control/New Products

Materials and Methods for Control of Cherry Fruit Fly, Testing Limitations

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Keywords: Cherry fruit fly, western cherry fruit fly, *Rhagoletis indifferens*, imidacloprid, Provado®, acetamiprid, Assail™, Entrust®, GF-120

Abstract: Products in this project during the 2007 trials included acetamiprid (Assail™), imidacloprid (Provado® Pro 192 SC), Entrust®, and GF-120 NF Bait. All products, rates and timings were tested under pest pressure conditions far in excess of what would be expected in commercial orchards. Emphasis of these trials was testing the efficacy of lower rates applied at 10-day intervals. GF-120 Bait was applied at lower rates on sites that had relatively lower pest pressure, or at full rates in difficult situations, in the attempt to demonstrate avoidable control problems.

- As in similar trials the past two seasons, chloronicotinyl class insecticides continued to control larvae of all instars inside of infested fruit. Imidacloprid (Provado® Pro 132 SC) provided post-infestation control to a degree similar to that of full dimethoate rates. This "kick-back" effect may demonstrate advantages chloronicotinyl class insecticides offer as part of a pre-harvest control program.

- Entrust® was 100% effective at the full 1.9 oz/acre rate, but showed signs of inconsistency at 1.0 oz/acre applied at 10-day intervals.

- Imidacloprid (Provado® Pro 132 SC) and acetamiprid (Assail™ 70 WP) resulted in excellent control when applied at 10-day intervals even at relatively modest rates.

- Reducing GF-120 rate to 10 fl. oz/acre, 1/2 the recommended rate, resulted in a consistent failure of control in lightly infested test trees.

- Full 20 fl. oz/acre GF-120 rates greatly reduced, but did not completely control cherry fruit fly (CFF) infestation on sites with very high numbers of adults emerging during the first season of treatment. A second season of treatment has been required to achieve 100% control on extreme populations.

- Full 20 fl. oz/acre GF–120 rates greatly reduced, but did not completely control CFF infestations on sites where an untreated infested tree was nearby. This demonstrated the importance of area sanitation in IPM.

Chemical Control/New Products

Spider Mite Control in Almond for 2007

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Keywords: Desperado™, Envidor®, FujiMite®, Kanemite®, Vendex®, Zeal™, miticide, acaricide, chemical control, spider mite, almond

Abstract: The efficacy of various miticides for control of spider mite in almond including Desperado™, Envidor®, FujiMite®, Kanemite®, Vendex® and Zeal™ were tested. The trial was developed as a randomized complete block design with six replications of single tree plots. Treatments were applied with an airblast backpack sprayer delivering 100 gallons of spray solution through a No. 2 nozzle. Up to 16 days after treatment (DAT) all treatments exhibited excellent control. By 21 DAT all treatments except Kanemite® still exhibited excellent control. At 28 DAT, only Envidor® continued to exhibit excellent control.

Navel Orangeworm Control at Hull Split in Almond, 2006

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University of California Cooperative Extension, Madera, CA

Keywords: Imidan®, Delegate™, Warrior®, GWN-1976, Baythroid® XL, Intrepid®, Proclaim®, Altacor™, Lorsban®, novaluron, Alverde®, Assail™, Omite®, Dimilin®, navel orangeworm, *Amyelois transitella*, almond

Abstract: Insecticides were tested for efficacy on navel orangeworm. A Carmel orchard was divided into five replications of 27 treatments in a randomized complete block design. Materials were applied at hull split to single tree plots using a handgun delivering 150 gallons of spray solution through a 90 disc tip at 200 psi. Sequential treatments were applied 13 days later. Two hundred nut samples were collected and examined for worm damage. Imidan® mixed with GWN-1971 and Latron B1956® showed the least infestation. This was not significantly different from Imidan® at 5.33 lb mixed with Latron B1956®, XDE-175, Warrior® mixed with Induce™, GWN-1976 mixed with Latron B1956®, Baythroid® XL mixed with Induce™, XDE-175 followed by Intrepid® mixed with Latron B1956®, Intrepid® mixed with Latron B1956®, Proclaim® mixed with Warrior® and Induce™, two applications of novaluron mixed with Silwet®, DPX-E2Y45 at 3 or 4 oz mixed with Induce™, Imidan® at 2.07 lb mixed with Latron B1956® or Alverde® mixed with Silwet®.

Chemical Control/New Products

Efficacy and Use of Delegate™ WG (Spinetoram) in Tree Fruits and Tree Nuts

Barat Bisabri[1], Harvey Yoshida[2], Brian Olson[3], Fikru Haile[4], and James Dripps[5]

Dow AgroSciences LLC
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Keywords: Delegate™, spinetoram, peach twig borer, *Anarsia lineatella*, navel orangeworm, *Amyelois transitella*, oriental fruit moth, *Grapholitha molesta*, codling moth, *Cydia pomonella*, pear psylla, *Cacopsylla pyricola*, western flower thrips, *Frankliniella occidentalis* citrus thrips, *Scirtothrips citri*, pome fruit, stone fruit, tree nuts, citrus, chemical control, insecticide

Abstract: Delegate™ WG is a new broad-spectrum spinosyn insecticide developed for use in tree fruits and tree nuts by Dow AgroSciences, LLC. Delegate™ WG received USEPA registration on September 28, 2007 and is now registered in most states. Field studies in tree fruits and tree nuts conducted during the 2005, 2006, and 2007 growing seasons in California, Washington, and Oregon demonstrated effective control of key pests such as peach twig borer, *Anarsia lineatella* (L.), navel orangeworm, *Amyelois transitella* (Walker), oriental fruit moth, *Grapholitha molesta* (Busck), codling moth, *Cydia pomonella* (L.), pear psylla, *Cacopsylla pyricola* (Foerster), western flower thrips, *Frankliniella occidentalis* (Pergande) and citrus thrips, *Scirtothrips citri* (Moulton). Effective use rates range from 1.5 to 3 oz/acre (26-53 gai/ha) for peach twig borer control to 7 oz/acre (123 gai/ha) for navel orangeworm control. In large-scale grower trials conducted in 2007, Delegate™ WG provided excellent control of codling moth in apples and oriental fruit moth on peaches. Studies conducted in 2006 and 2007 demonstrate that Delegate™ WG remains effective under natural rainfall and overhead irrigation. Spinetoram, the active ingredient in Delegate™ WG, offers a novel mode of action for the use against key tree fruit and tree nut pests. Delegate™ WG is an effective chemical control option for use in tree crop integrated management programs.

Ultor® 150SC for Control of New York Apple Pests, 2007

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Cornell University/New York State Agriculture Experiment Station, Geneva, NY

Keywords: San Jose scale, green apple aphid, Ultor®, spirotetramat, systemic insecticide, Guthion®, azinphos-methyl, Esteem®, Pyriproxyfen, chemical control, insecticide, apple

Abstract: Airblast applications at 100 gallons per acre were used to test the efficacy of Ultor® 150SC against biting and sucking pests found in NY. Standard materials of Guthion® and Esteem® were used as comparisons. These treatments as well as an untreated check were replicated 3 times in a RCB design. Samples taken after each generation of San Jose scale had emerged showed that one or two applications of Ultor® at petal fall or at petal fall and first cover were effective in controlling this pest through out the growing season. In contrast, the Esteem® with a single application did not have similar effects and the level of control exhibited by Guthion® took a season long program to obtain. Green apple aphid samples were also taken and it was apparent that the same timings were effective in subduing these populations as well. All treatments that contained Ultor® were effective in reducing aphid colonies from that found in the other insecticide treatments as well as the untreated check plot. The systemic activity of the product was extremely apparent in the two-application program probably due to the increase in foliage exposed to the material.

Chemical Control/New Products

Woolly and Green Apple Aphid Suppression on Apple Trees with Spirotetramat

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Keywords: Apple, woolly apple aphid, *Eriosoma lanigerum*, green apple aphid, *Aphis pomi*, chemical control, insecticide, shoot infestation, limb populations, parasitism, root galls, gall ratings, systemic activity, adjuvants, spirotetramat, Ultor®, azinphosmethyl, Guthion®, horticultural mineral oil

Abstract: Two rates and timings of the systemic insecticide Ultor® 150SC (spirotetramat) were compared to Guthion®, horticultural mineral oil, and an untreated control for suppression of woolly and green apple aphids on apple tree limbs, and woolly apple aphids on roots. Ultor® belongs to a new chemical class, tetramic acids. It is highly mobile within plant vascular tissues and inhibits lipid synthesis. All of the Ultor® treatments (8 and 12 oz/acre; all applied at petal fall and some applied again 33 days later; mixed with three different adjuvants) prevented green and woolly apple aphid densities from increasing on limbs for up to six and eight weeks, respectively, as compared to untreated trees. Horticultural mineral oil and Guthion® provided moderate suppression of woolly, but not green apple, aphids on limbs. Parasitized aphid mummies were low in all treatments except the untreated where abundant aphid densities supported parasitism. In evaluations of apple roots, Ultor® applications made at 12 oz/acre either once or twice were more effective in suppressing galls formed by woolly apple aphid than Ultor® applied twice at 8 oz/acre or the untreated control. More galls were present on the fine and mid-diameter roots in the 8 than 12 oz rate treatments. Ultor® applications made in the spring and summer significantly reduced new root gall formation, but did not affect galls formed in previous years on the larger-diameter roots.

Movento® Evaluation for Wooly Apple Aphid Control in California

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Keywords: apple, chemical control, insecticide, woolly apple aphid, *Eriosoma lanigerum*, Movento® 2SC, spirotetramat

Abstract: Movento® 2SC, a new xylem and phloem mobile insecticide, was applied at three different timings to evaluate effectiveness in controlling woolly apple aphid (WAA) on 'Gala' apples in the North San Joaquin Valley of California. All treatments were applied with a backpack mist blower to four three-tree replicates in fall 2006, in spring 2007 or both fall 2006 and spring 2007. Collecting soil/root samples and extracting aphids from the samples in the lab evaluated control.

There was a significant reduction in WAA a month after the fall 2006 treatments compared to an untreated control (UTC). After applications in the spring of 2007, a second evaluation of WAA populations in the fall of 2007 showed a substantial (75-90%) reduction throughout all treatments including the UTC compared to populations before or after treatment the previous fall. This could indicate material movement across plots with irrigation water, soil or root grafting. All treatments were a slightly lower than the UTC but only the fall 2006 treatment was statistically different.

Chemical Control/New Products

Efficacy of Ultor® on San Jose Scale in Apples

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Keywords: San Jose scale, *Quadraspidiotus perniciosus,* Ultor®, spirotetramat, chemical control, apple, insecticide, new product, Bayer CropScience, efficacy

Abstract: The efficacy of Ultor®, spirotetramat, was tested for San Jose scale control on apples. This trial was conducted by Vernon Fischer, Columbia Ag Research, Inc. Hood River, Oregon. Applications were made with a hand-gun sprayer calibrated to deliver the solution in 200 gal/acre. Depending on the treatment, applications were made delayed dormant, at petal fall and 30 days later. Two applications of Ultor® were applied at 10, 12 and 14 oz/acre. Evaluation for San Jose scale crawlers was conducted by placing ½" wide double side adhesive tape to three scaffold limbs per plot. After collection of tape from plots, tape was observed using dissecting microscope to count crawlers adhered to tape. Data is recorded as total crawler per three limbs. All treatments significantly reduced the incidence of crawler damage to fruit. However, no significant differences were observed comparing treatments. Generally, Ultor® at 10 oz/acre resulted in slightly less efficacy toward crawler control compared to the 12 and 14 oz/acre rates. As well, Induce™ plus Ultor® typically provided lower scale crawler numbers and less fruit damage compared to oil when used in the third application timing, but this was not significant.

Control of Pear Psylla with Ultor®

Vernon Fischer
Columbia Ag Research, Inc. Hood River, Oregon

Keywords: Pear psylla, *Cacopsylla pyricola*, Ultor®, BYI08330, spirotetramat, Actara®, thiamethoxam, Agri-Mek®, abamectin, chemical control, pear, insecticide, new product, efficacy, Bayer CropScience

Abstract: The efficacy of Ultor® was tested against pear psylla on d'Anjou pear trees during 2005, 2006 and 2007. All treatments were applied with an airblast sprayer calibrated to deliver spray solution in 100 gal/acre. Ultor® is very effective for residual control of pear psylla when applied during early egg hatch. Ultor® may be slower acting compared to conventional pear psylla insecticides, but is very mobile with in the plant tissue. Two applications of Ultor®, made at petal fall plus 30 days later, provide excellent pear psylla control. Best psylla control by Ultor® is when used with an adjuvant. Horticultural mineral oil and mentholated seed oil has showed most consistent results. Ultor® applied with nonionic and organosilicone surfactants have resulted in more varying results.

Chemical Control/New Products

Effectiveness of Spirotetramat in Controlling Pear Psylla Nymphs

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Keywords: Pear psylla, *Cacopsylla pyricola*, spirotetramat, surfactant, timing, multiple application, chemical control, insecticide

Abstract: Data are presented on five years of research on a new active ingredient from Bayer CropScience for control of pear psylla. All of the research trials were conducted at a site located in Yakima, WA. Tests were conducted on various formulations, rates, volumes and surfactants. In general, spirotetramat was very effective in controlling psylla nymphs in all tests. There was an indication that multiple applications were more effective than single applications. Rates in the range of 110 to 150 grams active per hectare were most effective. Spray additives such as nonionic surfactant, Silwet®, MSO, and Induce™ improved the performance of spirotetramat compared to spirotetramat applied alone.

Scale Control with Spirotetramat on Peach: Field and Greenhouse Studies

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Keywords: San Jose scale, *Quadraspidiotus perniciosus*, white peach scale, *Pseudaulacapsis pentagona*, Damoil, diazinon, Assail™, acetamiprid, Centaur™, buprofezin, Esteem®, pyriproxyfen, Movento®, Ultor®, spirotetramat, peach, chemical control, insecticide, greenhouse

Abstract: The efficacy of various formulations of spirotetramat was tested against scale insects on peach. Single-tree replicates were treated with an airblast sprayer calibrated to deliver 100 gal/acre. Some spirotetramat treatments provided control that was equivalent to standard materials and control was only obtained when applications were made post-bloom when foliage was present. A potted-plant greenhouse study demonstrated spirotetramat moves both acropetally and basipetally within the plant and prevents crawler development within the San Jose scale females.

Chemical Control/New Products

Efficacy Studies of Movento® on Grape Mealybug and Grape Phylloxera

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University of California Cooperative Extension, Santa Rosa, CA

Keywords: grape mealybug, *Pseudococcus maritimus*, grape phylloxera, *Daktulosphaira vitifoliae*, chemical control, insecticide, spirotetramat, Movento®

Abstract: Two experiments were conducted to test the efficacy of Movento® (spirotetramat), for the control of grape mealybug and grape phylloxera. In the grape mealybug experiment five treatments (EcoTrol oil, Applaud™, Movento® at 5 oz/acre, Movento® at 8 oz/acre and untreated control) were replicated five times. Foliar sprays were applied with a backpack pump sprayer. Grape mealybug populations in both Movento® treatments (5 and 8 oz) and the Applaud™ treatment were significantly lower than the untreated control and the EcoTrol treatments. In the grape phylloxera experiment four treatments (one 8 oz/acre application of Movento® in the fall, the spring, two applications of 8 oz/acre of Movento® in fall and spring and untreated control) were replicated four times. Foliar sprays were applied with an air-blast mist blower with a finish spray volume of 75 gal/acre. Movento® had little effect on the grape phylloxera population. These finding could be the result of low rate of surfactant and Movento® or both.

Evaluation of New Insecticide for Control of San Jose Scale

Ron Britt
Ron Britt and Associates, Inc.

Keywords: SPT, Ultor® 150SC, chlorpyrifos, Lorsban® 4EC, Supreme Spray Oil, Omni Supreme, Induce™, surfactant, San Jose scale, *Quadraspidiotus perniciosus*, apple, *Malus domestica*, chemical control, insecticide

Abstract: The objective was to determine if Ultor® plus different surfactants could achieve commercial San Jose scale control when applied to apple trees heavily encrusted with over wintering San Jose scale. The Ultor® treatments were also compared to two control standards, Lorsban® plus oil and Confidor™ 708SC applied once at delayed dormant time.

The fifty-year-old Red Delicious orchard used for this trial had an established resident San Jose scale population with a history of heavy pest pressure. The trial was laid out in a complete randomized block design. The San Jose scale were evaluated twice to determine efficacy of the various treatments.

Ultor® 150SC combined with oil, applied at petal fall, followed by Ultor® 150SC combined with oil or Induce™ 20 days later was very effective for controlling San Jose scale. All treatments of Ultor® 150SC regardless of the rates in this study, resulted in better San Jose scale control than the commercial standard controls applied at delayed dormant timing.

Chemical Control/New Products

Ultor®: A new Product from Bayer CropScience with a Novel Mode of Action for Broad-spectrum Sucking Insect Control

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Bayer CropScience, Research Triangle Park, NC

Key words: Spirotetramat, tetramic acid, systemic, new mode of action, sucking pests, perennial and annual crops

Abstract: Ultor® contains a novel active ingredient, spirotetramat, from the new chemical class of tetramic acids. When applied to the foliage, this highly systemic insecticide is translocated within vascular tissues, resulting in effective pest control on shoots, leaves and roots. Ultor® is active via ingestion and provides excellent initial and long-lasting residual control of a broad range of economically important sucking pests infesting perennial and annual crops, including aphids, whiteflies, scales, mealybugs, psylla, and *Phylloxera*.

As a new mode of action, spirotetramat exhibits no cross-resistance to currently available chemical classes. In addition, Ultor® has minimal impact on beneficial organisms. This new product from Bayer CropScience provides outstanding pest control and will serve as a powerful tool in Resistance and Integrated Pest Management programs.

Efficacy of Flubendiamide (Belt®, Bayer CropScience) on Codling Moth and Leafroller

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Keywords: flubendiamide, Belt®, phthalic acid diamide, ryanodine receptor, codling moth, *Cydia pomonella*, obliquebanded leafroller, *Choristoneura rosaceana*, pandemis leafroller, *Pandemis pyrusana*, chemical control, bioassay

Abstract: A novel ryanodine receptor modulator belonging to the chemical class phthalic acid diamide (Belt®, flubendiamide, Bayer CropScience) was evaluated against codling moth and leafroller in a series of laboratory bioassays, field-aged residue bioassays, and field control trials. Only low-moderate toxicity was noted with Belt® on codling moth in a laboratory bioassay using an apple dip technique. It was not clear if our standard screening method for new insecticides was appropriate for Belt®. The results were only slightly better when tested at field-use rates in residue bioassays and field control trials. Belt® appeared to be highly toxic to both obliquebanded and pandemis leafrollers in leaf dip and field residue bioassays. However, mixed results were noted in field control trials. A summer trial against obliquebanded leafroller was promising, but a petal fall trial against overwintering pandemis leafroller was confounding.

Chemical Control/New Products

Efficacy of Belt® on Codling Moth in Apples

Vernon Fischer
Columbia Ag Research, Inc. Hood River, Oregon

Keywords: Codling moth, *Cydia pomonella*, Belt®, flubendiamide, Calypso®, thiacloprid, chemical control, apple, insecticide, new product, Bayer CropScience, efficacy

Abstract: The efficacy of Belt® with various adjuvants was tested for codling moth control on apples near Hood River, OR. Applications were made with a handgun sprayer calibrated to deliver the solution in 200 gallons per acre. First application was made at 241 degree days and continued on a 14-day application interval to harvest. Calypso® was applied at 4.0 oz/acre. Belt® was applied either alone; with Omni Supreme Oil; Latron B56; or Silwet®. All Belt® treatments were applied at 5.0 oz/acre. Belt® provided poor codling moth control at harvest when applied without surfactant. The addition of Latron B 56 or Silwet® greatly improved the efficacy of codling moth control. Belt® applied with Omni Supreme Oil provided best codling moth control that would be considered commercially viable. Calypso® provided poor codling moth control at 4.0 oz/acre.

Efficacy of Belt® on 1st and 2nd Generation Obliquebanded Leafroller in Apples

Vernon Fischer
Columbia Ag Research, Inc. Hood River, Oregon

Keywords: Obliquebanded leafroller, *Choristoneura rosaceana,* OBLR, Belt®, flubendiamide, Success, Spinosad, Intrepid®, methoxyfenozide, chemical control, apple, insecticide, new product, Bayer CropScience, efficacy

Abstract: The efficacy of Belt ®was tested with and with out an NIS for control of 1st and 2nd generation OBLR on Granny Smith apples. Applications were made with an airblast sprayer calibrated to deliver the solution in 125 gallons per acre. Treatments for 1st generation OBLR were applied during the "pink" growth stage at a time when over-wintering OBLR larva were emerging. The addition of NIS resulted in decreased efficacy at 7 DAT but no difference was observed at 11 DAT and 18 DAT. Belt®, applied alone, provided 71 percent control of first generation OBLR. Belt® provided 75 percent control of first generation OBLR with NIS. Intrepid® lacked the performance that was expected at all evaluations.

Treatments for 2nd generation OBLR were applied during emergence of summer generation. Larvae were second to third instar at time of application. Evaluation for OBLR control was completed 4 and 9 days after treatment. Most OBLR larvae were confirmed dead in all treatments of Belt® and Success 4 DAT; however some OBLR larvae were noted to be moribund. At 9 DAT, these earlier moribund larvae were confirmed dead. Belt® with an NIS provided increased control 4 DAT compared to Belt® without NIS. All treatments provided 100 percent OBLR control 9 DAT.

Chemical Control/New Products

Belt® and Synapse®: New Products from Bayer CropScience with a Novel Mode of Action for Lepidopteran Insect Control

D. Christie, S. Krueger and R. Steffens
Bayer CropScience, Research Triangle Park, NC

Key words: Flubendiamide, broad spectrum, Lepidoptera, novel mode of action, perennial and annual crops

Abstract: Belt® and Synapse® are two new products containing the active ingredient, flubendiamide, for broad-spectrum Lepidoptera control on perennial and annual crops. Flubendiamide is the first member of a new chemical class, the phthalic acid diamides with a novel mode of action; disruption of cellular Ca^{2+} balance. Upon ingestion, flubendiamide produces rapid cessation of feeding resulting in excellent pest control and superior plant protection.

As a new mode of action, flubendiamide exhibits no cross-resistance to currently available chemical classes. In addition, Belt® and Synapse® have minimal impact on beneficial organisms. These new product offerings from Bayer CropScience provide outstanding pest control and will serve as powerful tools in Resistance and Integrated Pest Management programs.

Control of the Apple Clearwing Moth (*Synanthedon myopaeformis*) Using Trunk Sprays of Entrust® and Sevin®

Amanda Brown
University of British Columbia, BC (MSc - Integrated Pest Management)

Keywords: apple clearwing moth, *Synanthedon myopaeformis,* apple, organic agriculture, Entrust®, spinosad, Sevin®, carbaryl

Abstract: Apple growers in the Similkameen Valley of British Columbia are experiencing high levels of a recently introduced European pest, *Synanthedon myopaeformis,* apple clearwing moth, which weakens and can eventually kill apple trees by boring into the trunk and feeding on the cambium layer. Mating disruption using Isomate P has been employed for the past few years; however apple clearwing moth populations continue to increase and the level of grower concern is rising. The average number of larvae per tree trunk prior to any treatments was 2.87 and of nearly 500 trees sampled, 91.75% had at least one larva.

The efficacy of two insecticides, Entrust® (spinosad) and Sevin® (carbaryl), was tested against the apple clearwing moth during the summer of 2007. Both were applied as trunk sprays using weed and backpack sprayers during emergence, flight and oviposition of the moth. The non-target impact of these applications on earwig populations was also monitored. The results of both treatments were statistically significant; however, the organic Entrust® spray achieved a much higher level of control. A difference was also observed in the type of applicator used, as backpack/gun sprayers were more effective than weed sprayers.

Biology

Phenology

David Epstein, moderator

Notes

Biology/Phenology

Is Biofix for the Codling Moth PETE Model Necessary in Washington?

Vincent P. Jones, Jay F. Brunner, Michael Doerr, Tawnee D. Wilburn
Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: Codling moth, *Cydia pomonella*, phenology

Abstract: The importance of biofix to the accuracy of the PETE model for codling moth was examined using historic weather data from WSU orchards (34 orchard years data) and comparing it to a large data set (80 orchard years of data) from commercial orchards scattered throughout the state from 1997-2005. The WSU data was taken at 1-2 day intervals around biofix (average = 13 DD, max 33 DD), while the data from commercial orchards was typically taken at weekly intervals (average 40 DD, max 83 DD). The WSU orchard data showed the average biofix occurred at 173 DD (SD=26), but data from the commercial orchards were considerably delayed. Some of the problems were clearly because of the use of weather data that was inappropriate for the site, or because populations were low and hard to detect. The data was filtered to remove any site where first moth was considered to happen at >236 DD, which corresponded to the 99% CI for the WSU data. Adjustments were also needed to correct for the difference in trap checking interval by assuming that at the commercial sites first capture occurred at the average DD accumulation between the first date moths were captured and the previous date the trap was checked. When these corrections were made to the commercial sites, the average first moth catch occurred at 174 DD (SD=26), virtually identical to the WSU locations. When the accuracy of the PETE model was evaluated with indifference band validation using biofix versus assuming biofix happened at 173 DD, we found no significant differences in accuracy for either adult flight or egg hatch.

Biology/Phenology

Investigations of Kairomone-based Lures for Monitoring the Navel Orangeworm in Tree Nuts

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USDA-ARS, Western Regional Research Center, Plant Mycotoxin Research Unit, Albany, CA

Keywords: navel orangeworm, *Amyelois transitella,* kairomones, monitoring, GC-MS, GC-EAD

Abstract: The navel orangeworm (NOW), *Amyelois transitella*, is the chief moth pest that has historically been associated with the introduction of *Aspergillus* mold species and the occurrence of aflatoxin in all tree nuts, almonds, pistachios and walnuts, and also figs. Currently, a season-long dependable monitoring lure is lacking for NOW. Presently, no pheromone-based lure is available due to its unstable nature and the lure for "egg traps" is typically based on "almond presscake," that is only seasonally effective from winter through spring but is ineffective/unreliable at the crucial summer "hull-split" pre-harvest period of highest vulnerability of nuts to NOW attack. Critical life-cycle vulnerabilities of NOW are: 1) feeds only on kernels, can't feed or penetrate hulls and shells, thus must seek prior openings (hull-shell splits) or prior damage incurred by other attacking, 2) does not diapause, must find and overwinter in residual orchard nuts present on the ground or "mummies" that remain on the tree, and 3) multiple eggs are selectively laid on specific nuts. Female moths discriminate and lay eggs selectively on susceptible nuts, including mummies, prior-damaged nuts, and hull – shell split nuts. We are headspace-collecting (by SPME and Tenax) and GC-MS analyzing the odors emanating from these specific, vulnerable host resources and performing both laboratory (GC-EAD, flight tunnel) and field bioassays to define and identify the specific attractant volatiles present and formulate an optimal lure. Laboratory experiments have clarified the association of NOW nut damage and "vectoring" with *Aspergillus* infection and levels of aflatoxin contamination. Neonate larvae carry on their body setae *A. flavus* spores and readily transport spores to almond kernels, and the number of worm feeding holes is correlated with the amount of aflatoxin accumulated. Thus, NOW larvae were found to vector *A. flavus* and their nut-penetrating damage does facilitate aflatoxin accumulation. Further, pursuit of a kairomone-based monitoring lure will improve control and management of NOW and *Aspergillus.*

Reproductive Maturity and Larval Development of Cherry Fruit Fly *Rhagoletis cingulata* (Loew) (Diptera: Tephritidae) in Nature

Luis A. Teixeira, Rufus Isaacs and Larry J. Gut
Department of Entomology, Michigan State University, East Lansing, MI

Keywords: cherry fruit fly, *Rhagoletis cingulata*, reproductive maturity, phenology

*Abstract: R*eproductive maturity of cherry fruit flies captured in different habitats was determined. Flies in cherry orchards became reproductively mature faster and earlier than those on the native host. Captures suggest a complex dynamic where flies may move from orchards to native host early and from native host to the orchard late in the season. Reproductive maturity on the native host preceded fruit infestation and drop. Peak fruit infestation coincided with peak fruit drop. A large proportion of larvae dropped from the tree while still in the fruit and continued development while fruit was on the ground.

Biology/Phenology

Oviposition Preferences of Oriental Fruit Moth for Different Apple Cultivars

Neelendra K. Joshi[1], Larry A. Hull[2], Clayton T. Myers[3], Greg Krawczyk[2], and Edwin G. Rajotte[1]
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Keywords: Oviposition preferences, oriental fruit moth, apple cultivars

Abstract: Oviposition preference of the oriental fruit moth (*Grapholitha molesta* [Busck], Lepidoptera: Tortricidae) for different apple cultivars was determined in a series using a series of multiple-choice tests and no-choice tests in laboratory experiments. Ten apple cultivars, viz., Stayman, York Imperial, Golden Delicious, Fuji, Delicious, Gala, Pristine, Honeycrisp, Arlet and Sunrise were evaluated in vitro. Each treatment was replicated eight and ten times in multiple-choice and no-choice tests, respectively. In no-choice tests, 16 ounce transparent plastic cups each containing a single apple were used, while in multiple choice tests, cylindrical chambers made of transparent optical-fiber glass each containing multiple apple cultivars were used. Pupae were sexed and released into test chambers. Observations were recorded after 15 days (multiple-choice) and 8 days (no-choice test). Total numbers of eggs oviposited on the fruit surface were counted. Oriental fruit moth strongly preferred Golden Delicious and Fuji and least preferred Sunrise for oviposition. In addition, a higher number of eggs was recorded on Stayman than the cultivars Pristine, Honeycrisp and Arlet.

Oviposition Preferences of Codling Moth for Different Apple Cultivars in the Laboratory

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Keywords: Oviposition preferences, codling moth, apple cultivars

Abstract: Laboratory bioassays were conducted to study the oviposition preferences of the codling moth, *Cydia pomonella* (L.) for different apple cultivars using a series of multiple-choice tests and no choice tests. In each test, ten apple cultivars (treatments), viz., Arlet, Fuji, Gala, Golden Delicious, Honeycrisp, Pristine, Delicious, Stayman, Sunrise, and York Imperial were presented to the moths in vitro. Each treatment was replicated ten times in no-choice tests, and eight times in multiple-choice tests. Cylindrical oviposition chambers were used in multiple-choice tests, while 16 ounce transparent plastic cups (internally covered with plastic charcoal screen) each holding a single apple were used in no-choice tests. In both sets of no choice experiments, one pair of sexed pupae was used, and the deposited eggs were counted after eight days. In multiple choice tests, seven pairs and six pairs of pupae were utilized in the first set (second week of July) and second set of experiments (first week of August), respectively. Total numbers of eggs were counted after 15 days (first set of experiments), and 10 days (second set of experiments). Codling moth strongly preferred to oviposit on the apple cultivars Golden Delicious, Fuji, and Stayman to other cultivars like Arlet, Honeycrisp, and Sunrise.

Mating Disruption

SIR

Larry Gut, moderator

Notes

Mating Disruption/SIR

Commercial Use of Codling Moth Mating Disruption: A Success Story Despite the Limitations

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Keywords: Codling moth, *Cydia pomonella,* mating disruption, pome fruit

Abstract: Forty years have past since the first publication demonstrating the potential of deploying sex pheromones for insect pest control. Following that landmark paper, extensive research has focused on the development of control tactics that employ synthetic copies of insect sex pheromones to control a wide variety of pests in agriculture and forestry. These tactics include attract-and-kill, mass trapping, and mating disruption. Sex pheromone-mediated mating disruption is the tactic that has emerged as a commercial success, most notably for the control of lepidopteran pests in pome and stone fruit, grapes, tomatoes and cotton.

Cardé and Minks (1995) identified constraints to the successful use of mating disruption in moth pest control including: the inherent population dynamics of the pest, the complexities of the mating system and the limitations imposed by management systems. They went on to argue that these limitations were the main reason why mating disruption could not be successfully implemented for all species. Pink bollworm, oriental fruit moth and tomato pinworm were held up as very amenable targets for the approach, with levels of control similar or better than that achieved with insecticides. Codling moth control using mating disruption was considered more problematic. For codling moth, Cardé and Minks (1995) stated that the technical reliability of the mating disruption technique had not been fully achieved and therefore, the routine large use of the mating disruption technique was not yet possible. They specifically identified three limiting factors including the need for: (1) low populations, (2) a high degree of isolation from adjacent non-pheromone treated orchards and (3) a limited number of generations per year (one or two).

Despite the concern that these limitations might preclude wide-scale adoption of mating disruption for codling moth, substantial progress had been made. In 1991, the first mating disruption product was registered for the control of codling moth in the USA. Codling moth mating disruption is now deployed to a lesser or greater degree in many countries around the world including Australia, parts of the European Union, South Africa, Argentina, Chile, Mexico and the United States. It is now estimated that codling moth mating disruption is used on approximately 166,000 hectares. It is deployed most widely in the western states of the USA, parts of Europe and areas of South America. In states such as Washington and California and the South Tyrol region of Italy, codling moth mating disruption is now deployed on well over 50% of the pome fruit hectares and is considered an integral part of pest management practices for this pest. It is important to understand why it has been so successful and adopted so widely in many highly prolific fruit growing areas. In this presentation, we will not only address the technical progress that has been made vis a vis formulation development and progress towards a better understanding of the mechanisms of disruption, but we will also discuss the other possible driving factors in different regions of the world that have expanded or curtailed adoption of codling moth mating disruption. Finally, we will discuss how this information might be used to develop more cost effective formulations and what impact this will have on wider adoption.

Mating Disruption/SIR

Relative Effects of Mating Disruption on Oriental Fruit Moth and Codling Moth

Larry Gut, Lukasz Stelinski, David Epstein and James Miller

Keywords: Grapholitha molesta, *Cydia pomonella*, mating disruption, puffer, sprayable, wax

Abstract: Conducting research in eastern tree fruits has provided us the opportunity to evaluate mating disruption as a viable control for six moth pests. Some species have proven to be more amenable to disruption than others. For example, Oriental fruit moth is easier to disrupt than codling moth. This holds true whether the pheromone is delivered via a reservoir, sprayable or aerosol formulation. Over the past eight years we have been studying the factors that may allow the more resilient species to operate in environments permeated with synthetic pheromone. We have found that there are fundamental differences in the sensitivity of species to pheromone and in their capacities to become adapted and/or habituated when exposed to high doses of synthetic pheromone. In addition, we know that species differ in their dispersal and reproductive capabilities. Finally, we have provided evidence that pheromones vary considerably with respect to rates of evaporation, dispersion in air, and adsorption onto solid surfaces. Collectively, differences in these physico-chemical properties can have profound effects on the longevity and movement of pheromones in the environment. These basic differences in the properties of moths and their pheromone contribute to making some species highly susceptible to mating disruption, while others are capable of averting the effects of this control technique.

Mating Disruption/SIR

False-plume Following and Desensitization as Combined Mechanisms of Codling Moth Disruption

Lukasz L. Stelinski, Larry J. Gut, and James R. Miller

Keywords: Cydia pomonella, mating disruption, pheromone pre-exposure, competitive attraction, habituation, threshold change

Abstract: Over the past several years we have been investigating the behavioral and physiological mechanisms underlying codling moth disruption by synthetic pheromones. Studies have focused on detailed observations of moth behavior directly in the field and in laboratory wind tunnels and have been supplemented by electrophysiological quantifications of antennal sensitivity following various regimes of pheromone exposure. Collectively, the results support competitive attraction or false-plume-following as an essential component of communicational disruption of codling moth. Furthermore, habituation of central nervous system (CNS) response appears to be an important additional mechanism for males having oriented along plumes of high-dosage dispensers. Several lines of evidence support these conclusions. Field observations have revealed that male codling moths orient to and approach polyethylene tube reservoir dispensers of pheromone characterized by release rates > 1,000 times higher than female moths as well as "female equivalent" dispensers which release pheromone at rates approximating calling females. Furthermore, codling moth disruption is superior via higher rather than lower densities of pheromone release sites at common overall release rates of pheromone per hectare. However, male codling moths are capable of orienting to and finding traps baited with 0.1 mg pheromone lures as well as mate tethered virgin females surrounded by eight Scentry fibers 30 cm away or 16 fibers 45 cm away in otherwise untreated plots and plots treated with a background of 50 Isomate C Plus dispensers per hectare. This is also true in plots treated with up to 5,000 Isomate C Plus dispensers/hectare. Although the average airborne concentration of pheromone achieved in orchards treated with these pheromone dispensers is unlikely to desensitize males flying or resting meters away from the source of emanating pheromone, anemotactic orientation of attracted male moths to within close proximity of dispensers likely does induce habituation. Flight tunnel studies have proven that seconds-long exposures while orienting along plumes of reservoir dispensers habituates males without associated antennal adaptation. Moths may be capable of making close (within 1 m) approaches to high-dosage dispensers by orienting along the edge of the pheromone plume, modulating their exposure dosage. Thus, the combination of initial orientation by codling moth males along plumes of synthetic pheromone compounded by habituation of subsequent response due to over-exposure is a highly plausible explanation for mating disruption by polyethylene-tube reservoir dispensers and related technologies. Behavioral observations of pink bollworm implicated the combination of false-plume following and habituation as important contributing mechanisms of disruption almost a decade ago (Cardé et al., 1998) and current evidence with codling moth is consistent with those conclusions.

R. T. Cardé, R. T. Staten, and A. Mafra-Neto 1998. Behavior of pink bollworm males near high-dose, point sources of pheromone in field wind tunnels: insights into mechanisms of mating disruption. Entomol. Exp. et App. 89: 35-46.

Mating Disruption/SIR

A Long-Lasting, High Density, Hand-Applied Mating Disruption Formulation for Control of Tortricid Moths

Michael D. Reinke, Larry, J. Gut and James R. Miller
Michigan State University, East Lansing, MI

Keywords: codling moth, obliquebanded leafroller, mating disruption, pheromone, high point source, apple, grape

Abstract: Field studies were conducted in small orchard plots of 25 freestanding trees ranging between eight and 15 feet tall. Formulations were made to test control of codling moth and obliquebanded leafroller. These formulations were applied at a rate of 6,000 point sources per acre. Isomate products were applied at recommended rates. All codling moth formulations had a significant reduction in moth captures over the control, and one formulation reduced moth capture (92% versus control) significantly more than Isomate C+ (69% versus control). The obliquebanded leafroller formulation significantly reduced moth capture versus the control, but showed no difference compared to Isomate OBLR/PLR +. Another study was conducted in a 50-year-old Concord grape vineyard with plots 64 vines in size for control of grape berry moth, *Endopiza viteana*. Labeled treatments were applied at recommended rates. Our formulation was applied at 3,000 point sources per acre. With complete trap shutdown, our formulation was significantly different from the control, but not from Isomate GBM + or ISCA's GBM SPLAT formulation.

Mating Disruption/SIR

Codling Moth, *Cydia pomonella* (L.), Canopy Distribution and Implications for Mating Disruption Applications

Epstein, D.L.[1], L.J. Gut[1], J.R. Miller[1], and L. Stelinski[2]
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Keywords: *Cydia pomonella*, canopy distribution, mating disruption, dispenser height, diel behavior

Abstract: Studies aimed at determining the location of searching codling moth (*Cydia pomonella* [L.]) (Lepidoptera, Tortricidae) males and calling females in mating disrupted and non-disrupted plots and the effects of varying mating disruption dispenser height in the tree canopy were conducted in Michigan, USA in 2005 through 2007. Moths were sampled four times during the hours of 09:00-18:00 from May 25, 2005 through June 15, 2005 and a second series of four collections were completed during the hours of 18:00-22:00 from July 20, 2005 to August 22, 2005. Only eight codling moth adults were collected during the four daylight samples. Twilight vacuum samples resulted in significantly higher moth captures ($p < 0.001$) then daylight samples. Ninety-four moths were collected during four evening samples, with equal numbers sampled in disrupted and non-disrupted plots. In mating disruption plots, 42% of females were found in the top third of the tree canopy, 46% were found in the middle third, and 12% were recovered in the lower third. There was no significant difference between females captured from the top third as compared to the middle third of the canopy in disrupted plots ($p < 0.827$), but there were significantly more females in the top third compared with the lower third ($p < 0.052$) and significantly more females in the middle third compared with the lower third ($p < 0.033$). No significant differences in canopy height distribution of 22 females sampled from non-disrupted plots were found, with 36.4% in the top third, 36.4% in the middle third, and 27.2% in the lower third of the tree canopy. Releases of marked moths were conducted in 2006 and 2007 in screened tents to identify daytime habitats for adult moths within the orchard. Of moths recaptured, 21% of females and 34% of males were recaptured from the ground (herbicide strip and drive-row grass) after 16 hours, 40% of females and 8% of males from the ground after 40 hours, and 52% of females and 24% of males from the ground after 64 hours. In the dispenser height study, traps placed high in the tree canopy captured greater numbers of male moths at all dispenser heights (2m, 4m and a combination of 2m and 4m), with the fewest moths captured where both traps and dispensers were placed high in the tree. Mating of virgin female moths was highest when moths were tethered at 2m high in the tree of a 4m high dispenser placement treatment and when moths were tethered 4m high in the tree of a 2m high dispenser placement treatment. Overall, mating of females was lowest where dispensers were placed at a combination of heights, 2m and 4m.

Mating Disruption/SIR

Twelve-Tree Field Cages for Quantitative Studies of Moth Mating Disruption in Orchards

Peter McGhee, James Miller, Larry Gut
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Keywords: cage, pheromone, apple, *Cydia pomonella*

Abstract: Past field studies on the behavioral mechanisms of mating disruption have been conducted in a setting where the densities of male and female moths are unregulated and unknown. Flight tunnels where individuals may be directly observed are best suited for identifying and optimizing pheromone mixtures. Conducting studies in large field cages using released moths offers advantages similar to knowing the concentration of enzyme and substrate in enzyme kinetics studies.

We will describe and document a system for constructing replicated 3.5m high x 21 x 21 meter field cages over plots of 12 apple trees. The support system is 10 cm diameter poles and high-tension trellis wire. The netting is white 40% shade cloth. All codling moth, *Cydia pomonella*, males released into these cages flew immediately to the top half of tree canopies. Approximately 50% of the released moths per cage were recovered within three days in a Delta style trap baited with a 0.1mg codlemone lure.

Codling Moth Males in Twelve-Tree Field-Cages Obey the Predictions of Competitive-Attraction

James Miller, Peter McGhee, and Larry Gut
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Keywords: cage, pheromone, apple, *Cydia pomonella*, mating disruption, competitive-attraction

Abstract: Miller et al. (2006; J. Chem. Ecol. 32:2089) predicted that catch of male moths (M) in a monitoring trap (T) in the vicinity of females moths (F) and pheromone dispensers (D) would conform to the relationship: $C = T_D*M_D/(T_D+F_D+D_D)$, where the subscript $_D$ refers to density of the respective competing point source, all of which are equally attractive. This prediction was tested using at total of 96 lab-reared codling moth males released into each field-cages containing a standard monitoring trap baited with 0.1 mg codlemone on a red-rubber septum. Competing pheromone "dispenser" treatments were: 0, 1, 2, 4, 8, and 17 identical baited traps lacking sticky liners per cage. No females were included in this test. The profile of cumulative catch per monitoring trap vs. density of dispensers exactly followed the predictions of the above competitive-attraction equation, adjusted for the finding that only 50% of the released moths were caught in the control cage lacking any competing pheromone sources. This finding offers validation for the use of large field-cages in studies of the mechanisms of mating disruption, as well as for the core relationships captured in the competitive-attraction equation.

Mating Disruption/SIR

Improving Mating Disruption for the Codling Moth and Other Fruit Crop Tortricids with Pheromone Plus Host-Plant Semiochemical Formulations

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Keywords: Cydia pomonella, codling moth, *Eupoecilia ambiguella*, grape berry moth, *Lobesia botrana*, grapevine moth, behavior, sensory physiology, pheromone, host plant odor, apple, pear, grape, mating disruption formulations

Abstract: Given the limitations of mating disruption at high pest population densities, we set out to increase the effectiveness of currently used pheromone formulations for three tortricid pests of fruit crops through the addition of host pant semiochemicals. The three moth species we have studied are the codling moth, *Cydia pomonella*, and the tortricid pests of the vine *Eupoecilia ambiguella* and *Lobesia botrana*. There is ample evidence to suggest host plant derived semiochemicals play a fundamental role in the sensory ecology of these insects. We have found that the antennal receptor cells of the tortricids are finely tuned to the perception of secondary plant products that are common to the range of host plants these insects exploit. More particularly, the behavioral responses of males of the three species to their sex pheromones can be improved through the inclusion of host plant products in formulations. Real time recordings show that the reaction time of males is shorter, their upwind flight to the stimulus source is quicker, and the proportions contacting the pheromone source are higher when host plant products are added to formulations. These moth pests evidently use plant derived semiochemicals to rendezvous on their host plants, so this constitutes an aspect of tortricid sensory ecology that can be exploited to improve mating disruption.

Using Pear Ester All Season-long

Alan Knight
ARS, USDA, Wapato, WA

Keywords: Codling moth, mating disruption, kairomone, insecticides, pest management

Abstract: Pear ester is now well established as a kairomone attractant and is widely used in a combo lure to monitor codling moth in pheromone-treated orchards. The use of a microencapsulated formulation (Cidetrak™ DA-MEC) to improve larval control by insecticides has been evaluated for four years and good results prior to this year have been reported in California walnuts with several classes of insecticides and with reduced rates of organophosphates in both Argentina and the U.S. During 2007, I found that the MEC material improved the performance of a number of insecticide types applied at full rates and in particular, reduced the incidence of live larvae in the fruit. This MEC formulation had previously been shown to improve the use of sex pheromone for mating disruption in walnuts and apple in California by Dr. Light. Similarly, the addition of pear ester in hand-applied sex pheromone dispensers has improved the disruption of female-baited traps over the past two years. Interestingly, data collected in 2007 has suggested that the repeated use of Cidetrak™ CM-DA MEC with insecticide sprays during the season was particularly effective in an orchard also sprayed with sex pheromone (Checkmate® CM-F). Studies are planned to assess whether the current integrated control programs used in orchards would benefit from using pear ester to both monitor and to manage larval and adult populations.

Mating Disruption/SIR

Development of Meso-emitters for Pheromone Mating Disruption of Codling Moth

Stephen Welter and Frances Cave
University of California, Dept. of Environmental Science, Policy, and Management, Berkeley, CA

Keywords: codling moth, *Cydia pomonella*, walnuts, pears, mating disruption, pheromones

Abstract: The most common pheromone mating disruption programs for management of codling moth rely on hand-applied dispensers applied at 100-400 dispensers per acre. Implementation of pheromone mating disruption has been limited in some cases by logistic difficulties with large tree canopies found in many walnut orchards, labor costs associated with hand-applied dispensers, or the perception of low labor availability at specific times of the year. "Meso-emitters" are defined as dispensers targeting intermediate pheromone emission rates between traditional hand-applied units and aerosol puffer emitters. The goal is to use dispensers with higher emission rates, which are applied at fewer units per acre. Based on research over the past two years and winter-laboratory studies, a series of trials was conducted using five-acre plots to evaluate both trap and damage suppression in pear and apple orchards. Two pear orchards with extreme levels of codling moth pressure were challenged with the meso-emitter applied at 24 point sources per acre. In one orchard with 284-1551 moths per trap for the season, control was not different for either the meso-treatment or a CheckMate® treatment at 200 dispensers per acre. In the second orchard, damage in the meso-treated plots was reduced from 28.2% on average in the controls to 11.7% in the meso-treated plots, but these differences were not significant ($P>0.05$). However, in walnuts with more moderate populations, significant differences were found between the meso-emitter treated plots and the appropriate control, at 0.6 and 2.9% damage, respectively. In a larger, replicated trial, six meso-emitter treatments were compared to the grower standard treatment and a CheckMate® treatment. Each treatment was replicated twice in five-acre plots. The number of dispensers was adjusted based on their expected release rates to try and have a fixed level of pheromone per acre across the meso-emitter treatments. All plots were treated with the standard grower insecticide regime. The meso-treated plots experienced less than 0.5% damage for all treatments with 18-60 point sources per acre, whereas the plots with 12 points per acre experienced less than 1% damage compared to the control plots at 2.5%. All meso treatments were statistically equivalent to the plots treated with CheckMate®, but statistically different from the control plots ($P<0.01$). No trend towards increased control from 18-60 point sources was observed.

CheckMate® CM-F Formulation Improvements

Matt Hamman and Kristin Ketner
Suterra LLC, Bend, OR

Keywords: Codling moth, codlemone, oxidation, sunlight, CheckMate®, stabilizer, degradation

Abstract: Current antioxidants and light stabilizers used in CheckMate® CM-F were tested against new candidates. Sample formulations were exposed to elevated temperatures, high airflow, UVB radiation, and full sunlight to compare rates of degradation. Both technical grade codlemone pheromone and flowable formulations were tested. Improved antioxidants and UV stabilizers were identified. Field testing of best flowable formulations will begin in 2008.

Mating Disruption/SIR

Mechanization of SPLAT Cydia and SPLAT OFM Applications: Applying Once for Season-long Protection

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Keywords: Sex pheromone, OFM, mating disruption, high population density, population suppression, economic threshold, Brazilian apple moth, long lasting emission, *Cydia pomonella, Grapholitha molesta*

Abstract: SPLAT (Specialized Pheromone Lure & Application Technology) is a proprietary base matrix formulation of biologically inert materials used to control the release of semiochemicals and/or odors with or without pesticides. Extensive research on SPLAT using a variety of pheromones and inert ingredients, dollop sizes and application techniques demonstrates that this matrix emits semiochemicals at effective pest suppression levels ranging from 4 up to over 60 weeks. Having a wide range of viscosities research and develop teams adapted SPLAT Cydia and SPLAT OFM to a variety of application methods with the intent of substantially reducing application labor costs, but maintaining the cost effectiveness of a long lasting formulation. Point source or dollop density, architecture and volume have strong influence in the field longevity of the SPLAT formulation. In order to achieve a single application of SPLAT with dollops that last the entire fruit cycle, the application method evolved from the manual use of spatulas, to precise multi-dosing guns and metered backpack sprayers, and culminated with the use of tractors using the Spinner arm and air blasting sprayers easily applying 30 acres per hour. Requiring a single application per cycle, the savings in labor cost provided by mechanization of SPLAT are substantial. Although SPLAT application is feasible using aircraft such as planes and helicopters, the resulting point source volume is significantly smaller than that of a ground application, thus providing longevities of only 60 to 90 days in the field: two or three applications would be needed to protect an entire apple growing cycle. SPLAT is compatible with adaptation and habituation coupled with competition mechanisms of mating disruption: mechanization provides a tool for the deployment of variable point source densities of the disruptant, allowing the user to match the dollop density of the formulation with the existing pest population density levels in the field to be protected. SPLAT increases productivity by mechanizing the application of pheromone dispensing points. The amorphous and flowable quality of this highly adaptable product allows for an easy transition from small-scale manual applications to large-scale mechanical applications.

Mating Disruption/SIR

Commercial-scale Trials of New Mating Disruption Products, 2007

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

Keywords: Codling moth, Trécé Cidetrak CM, Hercon Disrupt CM MicroFlake, Pacific Biocontrol Isomate CTT and C-plus, apple, pear, mating disruption, pheromone

Abstract: Hercon Disrupt-CM MicroFlake treatments had significantly higher average trap catch and fruit injury than Isomate C-plus in both first and second codling moth (CM) generations. Interception of flakes by the tree canopy was 6% on 27 April (biofix), 56% on 15 May, and 78% on 23 July. A separate rate study indicated the potential of the technology if adequate numbers (3 to 10 times current rates) of flakes could be placed in the tree. Trécé Cidetrak CM (pheromone-only) treatment and CM/PE (pheromone + pear ester) had lower average moth capture in 1X traps in the first generation compared to the Isomate C-plus treatment but moth captures in all treatments were similar in the second generation. There was no difference in the average fruit injury between any of the pheromone treatments in either CM generation. Isomate CTT showed a reduction in moth catch as pheromone dispenser point sources increased in the first CM generation but this difference was not statistically significant (Prob > F = 0.19). In the second generation, when CM populations were lower, there was no relationship between moth catch and pheromone dispenser density. First generation fruit injury in the CTT treatments was low and not different from the Isomate C-plus treatment. Three supplemental insecticide applications likely masked injury differences between dispenser density treatments. At harvest, the 50 dispensers per acre Isomate CTT treatment (d/a) had a10-fold higher injury level than the C-plus treatment (400 d/a). There was a negative relationship between fruit injury in the second generation and pheromone point source density.

Impact of Mating Disruption Across Multiple Crops: Peach/Apple Interface Study

Peter W. Shearer and Ann Rucker
Rutgers University, Agricultural Research & Extension Center, Bridgeton, NJ

Keywords: Oriental fruit moth, *Grapholitha molesta*, Codling Moth, *Cydia pomonella*, peach, apple, mating disruption, CheckMate®, chemical control, insecticide

Abstract: The hypothesis for this experiment is that deploying mating disruption against oriental fruit moth across adjacent peach and apple blocks provides better control than if applied to either one or the other crop. CheckMate® OFM dispensers were applied in mating disrupted peach blocks and CheckMate® CM/OFM Duel dispensers were used in mating disrupted apple blocks. Where used, mating disruption was in addition to insecticide programs. First year results confirm that it is easier to disrupt oriental fruit moth in peach than codling moth in apple.

Mating Disruption/SIR

Mating Disruption for Navel Orangeworm – From Small Plots to Areawide Projects

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

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

Abstract: Over the past five years, we have examined various aspects of using the principal sex pheromone component of the navel orangeworm (NOW) on sexual communication and control in almonds. Based on this work, we have focused on the use of timed aerosol release devices (puffers) and have been able to demonstrate damage reductions that are similar to conventional insecticide programs over a wide range of pest pressure in 40 and 160 acre replicated plots, and most recently in large (1000+ acre) areawide projects that used a combination of sanitation, insecticides and mating disruption. Trap suppression of males in pheromone traps has consistently been in the 98-100% range and suppression of eggs and females have ranged from 50-85%.

Protein marking and harvest samples were used to examine female movement and activity in three 320-acre sites comprising adjacent 160-acre blocks under conventional and mating disruption treatments for control of navel orangeworm. The pattern of NOW harvest damage to Nonpareil was examined at 200-foot intervals along 1000-foot transects. Previous protein marking and mark-release-recapture experiments have demonstrated that individual NOW of both sexes can travel great distances, however our most recent studies indicate that most oviposition and damage occurs closer to where NOW females emerge from pupae.

Genetic Technologies to Enhance the Sterile Insect Technique (SIT)

Andy McKemey
Oxitec Ltd., Abingdon, Oxford, United Kingdom

Keywords: Codling moth, *Cydia pomonella*, Sterile Insect Technique, SIT, Oxitec

Abstract: The Sterile Insect Technique (SIT) is an effective, species-specific and environmentally friendly method for controlling pest populations. Modern genetic methods hold out the prospect of significant operational and cost-effectiveness improvements to the SIT, and could make it applicable to a far broader range of insect pests. Oxitec Ltd. is developing techniques including (i) improved identification of released individuals by incorporating a genetic marker; (ii) built in sex separation (genetic sexing); (iii) reduction of the hazard posed by non-irradiated accidental releases from mass-rearing facility (fail-safe); (iv) elimination of the need for sterilization by irradiation (genetic sterilization). These are incorporated into genetic systems trademarked RIDL®. The RIDL® system can be adapted to a wide range of species and thus far has been transferred to the following agricultural and public heath pests; Mediterranean fruit fly (*Ceratitis capitata*), Mexican fruit fly (*Anastrepha ludens*), Pink Bollworm (*Pectinophora gossypiella*) and the dengue mosquito vector (*Aedes aegypti*). In addition Oxitec is currently applying its RIDL® technology to codling moths (*Cydia pomonella*). The most advanced program is for pink bollworm where a second year of open field testing was completed in the USA in 2007. Over one million moths with a heritable fluorescent marker were released in 100 hectare of cotton over five weeks. For *A. aegypti* and *C. capitata* confined field trials are in progress in Malaysia in Guatemala respectively, with open field evaluations expected to take place in the near future.

Mating Disruption/SIR

Mating Disruption of Codling Moth Using Two Strategies with High Densities of Sex Pheromone Dispensers

Gino Angeli, Mario Baldessari, Gianfranco Anfora, Federica Trona
IASMA Research Center, Plant Protection Department, San Michele all'Adige (TN), Italy

Keywords: Cydia pomonella, E8,E 10-dodecadien-1-ol, Ecodian®, EcoTape®, false-trail following, field trial

Abstract: Two mating disruption strategies with high-density point sources of pheromone dispensers have been recently proposed for mating disruption of codling moth (CM), *Cydia pomonella* (L.); hook-shaped Ecodian® CP dispensers, biodegradable and formulated with 10 mg of codlemone, and EcoTape® device made of a continuous adhesive tape integrated with dispensers at 0.6 m distances, each loaded with 2.0 mg codlemone. Thus, in comparison with standard mating disruption, the content of a point source in both strategies is strongly reduced, with the aim to emphasize the competition between natural and synthetic sources. In addition, their density is increased (Ecodian® CP 1,400-2,000/ha; EcoTape® 2,000-4,000/ha). The release rate of field-aged dispensers decreased over time with a good linearity; both devices released a significant amount of synthetic sex pheromones over the entire season. Traps lured with both aged Ecodian® CP and EcoTape® dispensers were able to catch CM males in the field throughout the season, in a number comparable to that of traps loaded with standard monitoring lures. Field trials (2003-2007) confirmed the efficacy of both systems for the control of codling moth, even in small and isolated orchards. However, despite satisfactory results obtained with different point-source densities, the number of dispensers required for an effective pest control should be adapted to the CM population density. The efficacy of the two techniques was comparable with that of a conventional management (2 chitin inhibitors + 1 organophosphate). To ensure negligible CM damage in most cases no supplemental insecticides were applied.

Thresholds

Monitoring

Art Agnello, moderator

Notes

Thresholds/Monitoring

Obliquebanded Leafroller Summer Infestation Trends on a Whole-Farm Scale

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

Keywords: obliquebanded leafroller, *Choristoneura rosaceana*, pheromone trap monitoring, larval infestation, apple

Abstract: There has been an incomplete understanding of the role that habitat, alternate hosts, and adult movement plays in New York fruit infestations by obliquebanded leafroller (OBLR). Our intention was to get a temporal and spatial picture of summer larval re-infestation patterns. The study was set up on three commercial farms (18-33 acres, total size) with a history of OBLR injury. To eradicate the overwintered larvae, an unrealistically aggressive early season spray program was used. Summer generation adults were monitored using a network of pheromone traps located at different orchard strata: edge, mid-interior and center on all four ordinal sides (N,S,E,W). Weekly terminal- and fruit-infestation samples were taken at each station. Although large numbers of adults were caught in all the orchards, subsequent larval terminal infestations and fruit damage remained low during the season in all blocks. There were no substantial differences in adult catches, larval infestations or fruit damage in the different orchard strata. Results suggest that large-scale or whole-farm OBLR management might reduce damage from summer generation OBLR more effectively than treating individual blocks or small plots; sampling of fruit might better determine initial timing and treatment need than the traditional practice of timing preventive sprays for 1st egg hatch and then sampling terminals for larvae.

Performance of an Electronic Trap for Obliquebanded Leafroller and Codling Moth

Mike Omeg, Steve Castagnoli, Lynn Long, and Helmut Riedl
Omeg Orchards, The Dalles, OR

Keywords: electronic trap, monitoring, obliquebanded leafroller, *Choristoneura rosaceana*, codling moth, *Cydia pomonella*

Abstract: The performance of the DataLynx® Bug Count Electronic Insect Counter (Automata, Inc., Nevada City, CA) was compared to that of conventional traps for obliquebanded leafroller (*Choristoneura rosaceana*) in cherry during the 2004 growing season, and for codling moth (*Cydia pomonella*) in pear during the 2006 and 2007 growing seasons in the mid-Columbia region of Oregon. During the peak obliquebanded leafroller (OBLR) flight, actual moths trapped in the electronic trap were 66% of the conventional trap. However, the electronic trap caught 8.7 times more moths than the conventional trap during the off-peak flight. False positives were a minor problem with the electronic OBLR trap, providing a reading of 140% of the actual trap count during the peak flight and 125% of the actual during the off-peak flight. For codling moth, actual moths caught in the electronic traps were about 25% in 2006, and about 8% in 2007 of the conventional traps, despite modifications in 2007 to increase the attractiveness of the electronic traps. In pear, the electronic traps recorded in excess of 100 times more moths than were actually caught in the traps in both seasons. Many of the false readings were likely due to wind activation of the electronic trap sensor.

Thresholds/Monitoring

Association of Pheromone and Egg Trap Counts with Subsequent Navel Orangeworm Damage in Almonds

Charles Burks, Bradley S. Higbee, Mark S. Sisterson, and David G. Brandl
USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Parlier, CA

Keywords: navel orangeworm, *Amyelois transitella*, Lepidoptera, Pyralidae, almond, Nonpareil, Monterey, pheromone trap, egg trap, crude almond oil, damage, prediction, Kern County, San Joaquin Valley, California, USA

Abstract: We examined the association of navel orangeworm damage with the number of males captured in wing traps baited with unmated females and eggs on egg traps. In 2006, a pheromone trap and two egg traps were placed in the center of 41 16-hectare blocks of almonds located throughout a 201,500 hectare area. Harvest samples were collected and evaluated for navel orangeworm damage. In 2007, a similar design was used, but one egg trap was treated with 10% crude almond oil (CAO). In 2007 there was a decrease of ≥74% in navel orangeworm damage compared to 2006. Significantly more males captured in pheromone traps in Flight 1 in 2007 v. 2006 and the same number of males in both years Flight 2, but there were significantly fewer eggs on egg traps in 2007 compared to 2006 in Flights 1, 2, and 3. In 2007, the egg traps with 10% CAO had significantly more eggs per trap than those without CAO, whereas there was proportion of traps with eggs was not significantly different with or without CAO. Bootstrap analysis of the 2006 egg trap data indicated that, for a ≥90% chance of detecting Flight 2, traps from ≤16 plots were needed. We conclude that egg traps were more closely associated than pheromone traps with year-to-year fluctuation of navel orangeworm damage, but the number of egg traps used for prediction is at least as important as the use of crude almond to increase their attractiveness.

Implementation

Loys Hawkins, moderator

Notes

Implementation

Pest Management Transition Project – A New Effort to Help the Apple Industry Adopt New Insecticide Technology

Jay F. Brunner
Washington State University, Tree Fruit Research and Extension Center, Wenatchee, WA

Keywords: Pest management, transition, organophosphate, new insecticides, education, documentation

Abstract: The Environmental Protection Agency (EPA) announced the phase out AZM by 2012. This regulatory action marks a new era for the apple industry, which must control codling moth while transitioning from AZM to new IPM-based strategies. Recognizing an opportunity to move proactively and transition to new technologies that would not only meet but surpass EPA regulations, apple industry leadership sought and received funding ($550,000 for 07-09 biennium) through the State Legislature for the Pest Management Transition Project (PMTP). The objective of PMTP is to change practices, attitudes and perceptions of IPM while maintaining acceptable crop protection, sustaining grower profitability, reducing pesticide exposure risks of farm labor, and enhancing environmental health. A broad-based Advisory Committee has been formed to provide input on PMTP programs and evaluate progress towards stated objectives. The primary vehicle for change for the apple industry will be the Implementation Unit (IU). Patterned after the model used in the Codling Moth Areawide Project, the IUs will be comprised of growers/managers in an area who will work together to implement new pest control technologies. Educational and planning efforts will primarily take place with the IU. Outreach to non-ag stakeholder groups will be a part of the PMTP.

Implementation

Creating a New Market Niche for Eastern Apples Treated With Reduced-Risk Pesticides

H. Reissig[1], A. Agnello[1], D. Cooley[2], J. Clements[3], M. Rozyne[4], and T. Green[5]
[1]Department of Entomology, NYSAES, Cornell University
[2]Microbiology Department, University of Massachusetts
[3]Extension, University of Massachusetts
[4]Red Tomato
[5]IPM Institute of North America

Keywords: IPM, reduced risk pesticides, marketing apples, Red Tomato™, Eco-Apple™

Abstract: In 2007, Cornell University, University of Massachusetts, Red Tomato (a nonprofit produce marketing corporation), and the IPM Institute of North America, Inc received a two-year grant to develop a protocol for producing and marketing "eco apples™" in the Northeast. Red Tomato's mission is connecting farmers and consumers through marketing, trade and education and a belief in family-farms, and a locally based, ecological, fair trade food system. The goal is to create a market niche for "eco apples™" that will resulting in premium prices and access to high quality, markets such as Whole Foods, and Trader Joe's. Red Tomato's apple sales grew from $130,000 in 2004 to $600,000 in 2006. The program grew from six New England growers with 441 acres in 2006 to 771 acres and 12 growers in 2007. Participating growers complete a self-assessment, pay an annual certification fee and submit scouting and pesticide application records. Red Tomato employees, participating growers, and university personnel adjust the protocol annually. Pesticides are classified into three categories: green, use with justification; yellow, use when green materials are not available or effective; and red, do not use. In 2007, pest control in "eco apple™" orchards was generally as effective as that in growers' standard blocks. Economic costs and returns to participating growers have not yet been calculated.

Implementation

Second Year Results of an Area-Wide Mating Disruption Program in Pennsylvania for the Management of CM and OFM in Various Tree Fruit Crops

L. Hull, G. Krawczyk, E. Bohnenblust
Penn State University, Fruit Research and Extension Center, Biglerville, PA

Keywords: Area-wide, mating disruption, *Grapholitha molesta*, oriental fruit moth, *Cydia pomonella*, codling moth, pheromone dispensers

Abstract: In 2007, the area-wide mating disruption (AWMD) program to manage both the codling moth (CM), *Cydia pomonella*, and oriental fruit moth (OFM), *Grapholitha molesta* was expanded by 40% to over 1300 acres of various deciduous fruit crops in Adams County, PA. The original AWMD program in 2006 was organized into four large and fairly contiguous sites. During 2007, more acreage was added to each site and a new fifth site was initiated. In apples, the growers again predominantly used Isomate CM/OFM TT at dispenser densities of 100-200/acre depending on pest populations. At the fifth site, various mating disruption technologies (e.g., Isomate CM/OFM TT, Hercon Flakes and Trécé CM DA and OFM) were evaluated in replicated studies. In peaches, the majority of growers used Isomate M-100 dispensers at a density of 100 per acre with applications initially targeted for second-generation flight. CM and OFM populations were monitored at weekly intervals from mid-April to mid-September using various types of monitoring lures (1X, 10X and CM-DA Combo) in sex pheromone traps. Fruit was assessed *in situ* for the presence of frass during mid-July and again in September on apples and in August on peaches. Capture of adult CM in all monitoring traps in AWMD blocks during the second year was reduced by over 60 percent from 2006 levels. OFM adult captures were again reduced to zero in most blocks throughout the season. Fruit injury from CM and OFM across all AWMD apple blocks in 2007 was reduced by 70% from 2006 levels, while fruit injury in all conventionally treated blocks increased during the second year. The proportion of live worms collected from all injured apples across all four original sites and management programs at harvest was 75% CM and 25% OFM; whereas, only OFM larvae were collected from peaches. In addition, substantially less insecticide was used in the AWMD blocks in 2007 with a number of the growers integrating the CM granulosis virus into their overall control program. At the new fifth site, both the Trécé and Isomate treatments reduced CM adult capture and fruit injury to very low levels, while adult capture and fruit injury in the Hercon treatment was intermediate but significantly lower than the conventional block.

Implementation

Commercial Trials and Implementation of Codling Moth Mating Disruption Puffer Program

Loys Hawkins[1] and Rick Hilton[2]
[1]Bear Creek Orchards, Inc.
[2]OSU-Southern Oregon Research & Ext. Center

Keywords: codling moth, *Cydia pomonella*, CheckMate® Puffer, CheckMate® CM XL-1000, Disrupt CM, GIS/GPS, labor, mating disruption, pear

Abstract: Suterra CheckMate® CM Puffers at a density of 0.9 per acre were implemented in 2006 in two orchards on 268 acres of Comice pears as an alternative to standard hand-applied mating disruption dispensers to investigate efficacy and reduction in labor requirements. The number of acres treated with puffers was expanded to 903 acres in 2007. Maps were generated of the puffer locations using PDAs with HGIS and ArcView GIS programs. Codling moth activity was monitored using Trécé Combo and Suterra Biolure (10X) baited traps. Damage was evaluated with fruit checks of 1000 fruit per block every other week during late growing season, and with packinghouse cull analysis. Data from puffer plots were compared to data from 1640 acres of grower standard mating disruption blocks using hand-applied pheromone dispensers at 200/acre (CheckMate CM XL-1000 or Disrupt CM). Results indicate that puffers were as effective as hand-applied dispensers in preventing trap catch and damage, and labor costs to implement puffer program were approximately two-thirds less than the grower standard mating disruption program. Puffer densities can be adjusted to address areas of high and low pressure, allowing for customization and material/labor savings. Puffers are a viable alternative in appropriate locations to help this grower limit supplemental pesticide treatments, and address impending labor shortages.

A New Areawide Approach: Implementing IPM from the Outside to the Borders of Pome Orchards

Alan Knight and Rick Hilton
USDA, ARS, Wapato, WA and OSU, Medford, OR

Keywords: Codling moth, pest management, phenology, dispersal, host range

Abstract: The areawide program for codling moth in the 1990's demonstrated the importance of cleaning up the 'hot spots' that surround nearly all orchards. Until growers can share information and work effectively to reduce these problem areas the transition of management programs within orchards will be a bumpy ride. Acquisition of knowledge on the threat of moth immigration, efforts to reduce the level of immigration, enhanced ability to detect immigration, and new tools to improve management of immigrant moths will be developed to improve the economics of crop production by reducing the incidence of pest populations and the use of unnecessary insecticide applications. GIS mapping tools, mobile data acquisition, electronic data management, and the application of precision agriculture techniques have become accessible to growers and will also dramatically impact orchard management. The use of these tools to manage codling moth from the outside to the borders of orchards will be discussed.

Implementation

Altacor™ Experimental Use Project and Small-Plot Research Trial Results

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

Keywords: Codling moth, *Cydia pomonella*, apple, Rynaxypyr™, Altacor™, chlorantraniliprole

Abstract: Several small-plot trials were conducted with DuPont Altacor™ insecticide to evaluate rate, frequency, and timing of applications for control of codling moth (CM) on apple. The low rate that was tested (2 oz/acre) resulted in a lower level of CM control than the middle (3 oz/acre) and high (4 oz/acre) rates. When an ovicide was used early (100DD) followed by two applications of the middle rate (350DD, +17d) CM control was significantly improved in comparison to the middle rate applied three times at traditional application timing (250DD, +17d, +34d) and slightly better than the high rate applied twice (250DD, +21d). Specific results from small-plot trials comparing application strategies will be discussed.

Six commercial orchards were established as test sites by Washington State University in agreement with the Washington State Experimental Use Permit (WSEUP) 07015 for the experimental use of DuPont Altacor™ insecticide on apples in Washington State. Each test site consisted of a four-acre plot that was treated with Altacor™ timed to target first generation CM and an area of similar size and close proximity that was treated with a standard insecticide program. Second and third CM generations, in both the Altacor™ and comparison plots, were treated with the same standard insecticide program. Altacor™ provided good control of first generation CM in each of the six test sites. Application strategies and site-specific results will be discussed.

Areawide Navel Orangeworm Management Project in Almonds, Walnuts and Pistachios

Joel P. Siegel and Bradley S. Higbee
USDA-ARS, San Joaquin Valley Agricultural Sciences Center, Parlier, CA

Keywords: navel orangeworm, *Amyelois transitella*, areawide, sanitation, almond, pistachio, walnut, mating disruption

Abstract: The USDA-ARS has funded an areawide project for the management and control of navel orangeworm, *Amyelois transitella* (Walker), in almonds, pistachios and walnuts. The project is a cooperative federal, state and industry venture that will be funded for five years and integrate sanitation, mating disruption and insecticides in an areawide approach.

Tree Fruit Diseases

Comparison of Capture of Ascospores of *Venturia pirina* with Accumulated Degree Days ($0^{O}C$), Temperature of Rain and Dry Periods in Mendocino County, California 2007

Broc G. Zoller
The Pear Doctor, Inc., Kelseyville, CA

Keywords: *Venturia pirina*, pear scab, ascospores, temperature, wetness, dryness

Abstract: Ascospores of *Venturia pirina* were trapped during rain periods using rotor rod samplers as part of a disease management program in Mendocino County pear orchards. Data of spores trapped for the season vs. degree days above 0°C were compared. It was possible to judge the effect of degree days, wetness temperature and dryness on apparent pseudothecial productivity as measured by ascospore capture. There were captures with rain periods of 6 hour wetness at least 7.2°C. Capture often rose with increasing temperature. Rains beginning at night or early AM were judged to have spore discharge started at 7AM the next morning for the beginning of the 6 hours unless a warmer 6 hour period occurred later. Rains occurring before 5% and after 95% of the seasonal spore total had been captured were ignored, since a shortage of ascospores in the pseudothecia would lower productivity as measured by spore capture data. Regression analyses of accumulated degree days vs. accumulated total spores yielded R square value of 0.87, (P= 0.001). Apparent lags in captures predicted by degree days followed dry periods (<30% minimum daily RH for three days) or coincided with cooler 6-hour rain periods ($<8.6^{O}C$).

Appendix

Minutes of the 81st Annual Meeting
Orchard Pest and Disease Management Conference
Hilton Hotel, Portland, Oregon
January 10 -12, 2007

I. Call to Order

The **President Walt Bentley called the 81st Annual Meeting to order** at 10:00 AM. President Bentley extended an official welcome to everyone. President Bentley then called for the participants to introduce themselves. President Bentley introduced section leaders. They were:

Thresholds/monitoring	- Lucia Varela
Biological Control	- Vince Jones
Resistance Management	- Bob Van Steenwyk
Chemical Control/New Products	- Joe Grant
Biology/Phenology	- Pat Weddle
Tree Fruit Diseases	- Gary Grove
Mating Disruption/SIR	- Carolyn Pickle
Implementation	- Walt Bentley

II. Old Business

A. Issues Arising from the Meeting of the Board of Directors

President Bentley announced that the Board of Directors held their annual meeting at 6:30 am on Wednesday, January 10. The Board consisted of Past President Vince Jones, President Walt Bentley, President Elect Harvey Reissig, Program Chair John Dunley and Secretary/Treasurer Nancy Hays.

B. Reading of 2006 Minutes

It was moved and seconded that the reading of the minutes be dispensed with and that the minutes be approved as written. Secretary Hays indicated that the minutes would be posted at the registration desk and that members could also review them in the appendix to the abstracts, which are available on the organization's web site.

C. Miscellaneous

Posters will be put on display today. Thursday at 10:00 am a poster session will be held for one hour. The presenters were asked to be available for questions.

President Bentley called for a report of the officers. There were no reports.

President Bentley called for any other old business. There was none.

III. New Business

A. Committee Assignments

The following committee assignments were made:

Nominations: Mike Willett, Joan Fisher, and Harvey Yoshida
Audit: Broc Zoller, Dave Epstein and Lucia Varela
Resolutions: Carolyn Pickle, Rick Hilton and Bob Van Steenwyk

B. PCA Sign Up Sheets

Sign up sheets will be available at the registration desk by afternoon coffee.

C. Call for Further New Business

There was no further new business. The business meeting was then adjourned until 11:00 am, Friday, January 12.

IV. Closing Business Meeting
President Bentley called the closing business meeting to order at 10:30 am on January 12.

President Bentley asked if there were any additions to the minutes. It was moved, seconded and approved to accept the minutes.

President Bentley called for further new business.

Joan Fischer asked that we do not reduce the size of the room next year from Wednesday to Thursday. Executive Director Thomson stated that we had been in this room for five or six years. He said because of attendance the room is too small now. Executive Director Thomson will talk with the Hilton.

Another member asked about the program schedule. Executive Director Thomson stated it rotates every year so if Thresholds was first this year then next year it will be last.

Executive Director Thomson talked about how Helmut Riedl and Pierre Charmillot were invited to talk as guest speakers. He suggested we invite a speaker every year and pay for the speaker's travel expenses. He suggested a candidate might be Camille Parneson to talk about global warming. Betsy Beers like the idea of a keynote speaker in general. Broc Zoller suggested that the keynote speaker should pay his or her own way. Agenor Mafra asked for free beer at the wine & cheese reception instead. Peter Shearer made a motion that the Board of Directors should decide on the topic and keynote speaker each year. The motion was seconded and approved.

Agenor asked about continuing to have the poster session. It was discussed that the Board will talk about how to improve the poster session.

Pat Weddle mentioned that he heard complaints about not having enough abstracts this year. Program Director, John Dunley said it was more flexible to have the abstracts on the internet so members could peruse beforehand. Chris Nobbs suggested we print the list of speakers, (program agenda) if we did not print the abstracts. Helmut Riedl and Betsy Beers also liked the idea of a program. Tom Larson asked to have a link by the Hotel Icon to print the abstract. John Dunley said the website would be more smooth next year. Executive Director Thomson suggested we stick with the electronic abstracts.

Pat Weddle asked if everyone who participated in the meeting actually registered. Executive Director Thomson said it was not a big issue. An idea was presented to have a locked box so when people come late they could still register.

President Bentley then called for the committee reports.

A. Committee Reports:
1. Nominations:
The nominating committee nominated Tom Larsen, Suterra LLC, 213 SW Columbia, Bend, OR 97702 as President Elect; Nancy Hays, Pacific Biocontrol Corporation, 14615 NE 13th Court, Suite A, Vancouver, WA 98685 as Secretary/Treasurer; Don Thomson, DJS Consulting Services, LLC, 3015 SW 109 Street, Seattle, WA 98146 as Executive Director; and John Dunley, Washington State University, Wenatchee, WA as Program Chair for the 2008 meeting. A motion was made and seconded to accept the recommendations of the nominations committee. The motion passed unanimously. Walt Bentley, University of California, Parlier, CA will be the Past-President for the 2008 meeting and Harvey Reissig, Cornell University, Geneva, New York will be the President for the 2008 meeting.

2. Audit
The Audit Committee reported that the committee had met with Treasurer Nancy Hays and Executive Director Don Thomson. The committee reported that they have examined the Report of the Treasurer and recommended that the membership accept the report of the Treasurer. It was moved, seconded and approved.

Nancy Hays gave the Treasurer's report. She reported that the balance forward from December 31, 2005 was$3,750.14. The 2006 meeting took in $4,600.00. Expenses in 2006 were $6,136.13. The balance as of December 31, 2006 was $2,214.00. For the 2007 meeting we have taken in dues of approximately $8,600.

3. Resolutions

a. Be it resolved that this conference extend written appreciation to the management and staff of the Hilton Hotel for the courteous service and the fine accommodations provided.
b. Be it resolved that the members of the conference express their appreciation to Past President Vince Jones, President Walt Bentley, Secretary/Treasurer Nancy Hays, Executive Director Don Thomson and Program Chair John Dunley for their leadership and dedication in organizing the 2007 meeting.
c. Be it resolved that the members of the conference extend their appreciation to the Tree Fruit Research and Extension Center, Washington State University and in particular Bette Brattain and Christina Mayer for applying for pesticide applicator credits from the various states.
d. Be it resolved that the members of the conference extend their appreciation to the Tree Fruit Research and Extension Center, Washington State University, Wenatchee, and in particular Bette Brattain, Christina Mayer and John Dunley, for preparing the abstracts.
e. Be it resolved that the members of the conference extend their appreciation to the Tree Fruit Research and Extension Center, Washington State University, Wenatchee and in particular, Jerry Tangren, Better Brattain, Christina Mayer and John Dunley, for organizing and maintaining the WOPDMC web site.
f. Be it resolved that the members of the conference extend their appreciation to the section leaders: Lucia Varela, Vince Jones, Bob Van Steenwyk, Joe Grant, Pat Weddle, Gary Grove, Carolyn Pickle and Walt Bentley.
g. Be it resolved that the Secretary write letters of condolences to Kelly Denton and the family of other members who passed away the past year.
h. Be it resolved that the members of the conference express their appreciation to our guests of honor, Pierre-Joseph Charmillot and Helmut Riedl, for sharing their life's work and memories at the 2007 conference.

It was moved, seconded and approved to accept the resolutions.

Andy Kahn was awarded the Rubber chicken award.

It was announced that the meeting for the 2008 meeting will take place the 2nd full week of January.
President Bentley thanked those who had attended and helped in various capacities to make the 81st Orchard Pest and Disease Management Conference a success. President Bentley turned over the proceedings to President Elect Harvey Reissig. He adjourned the meeting.

Respectfully Submitted,
Nancy J. Hays
Secretary/Treasurer
Orchard Pest and Disease Management Conference