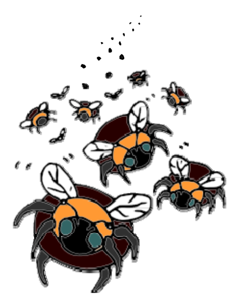
RESEARCH REPORTS
72nd ANNUAL PACIFIC NORTHWEST INSECT MANAGEMENT CONFERENCE

HILTON HOTEL, PORTLAND OREGON
JANUARY 7TH AND 8TH, 2013



****These are research reports only, NOT management recommendations.**

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JANUARY 7TH AND 8TH, 2013

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AGENDA

72nd ANNUAL PACIFIC NORTHWEST INSECT MANAGEMENT CONFERENCE
HILTON HOTEL, PORTLAND, OR
JANUARY 7th and 8th, 2013

MONDAY, JANUARY 7th

Registration	9:30am
Call to Order + Business Meeting	10:00am
Section I	10:15am
Lunch (on your own)	12:00pm
Section I (cont'd)	1:00pm
Break	2:45pm
Section I (cont'd) & begin Section II	3:15pm
Adjourn	4:30pm

TUESDAY, JANUARY 8th

Registration	8:00am
Call to Order	8:25am
Section III	8:30am
Break	10:00am
Section III (cont'd) & begin Section IV	10:30am
Lunch (on your own)	11:45am
Section V & Section VIII (no reports for Section VI & VII)	1:00pm
Break	2:45pm
Section IX	3:15pm
Business Meeting and Awards	4:00pm
Adjourn	4:30pm

SECTION I
INVASIVE & EMERGING PESTS

Moderator: Jim Todd

ADULTICIDAL EFFECTS OF NEONICOTINOIDS ON *DROSOPHILA SUZUKII* AND OVICIDAL EFFECTS THROUGH TRANSLAMINAR UPTAKE INTO BLUEBERRIES

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Neonicotinoid pesticides were tested as a contact adulticide and translaminar ovicide for SWD control. Neonicotinoid residuals have low efficacy against adults; however dip trials have shown that they may suppress egg deposition and hatching through translaminar absorption into fruit.

Adulticidal effects were tested by submitting lab-reared flies to probit analysis. Four labeled formulations of neonicotinoids were used: Actara 25WG, Assail 30SG, Provado 1.6F, and Scorpion 35SL, and arranged in a complete randomized design, indoors at 21°C, $\pm$1°C. Concentrations of the pesticides were based on 0.5, 1, 2, 3, and 4 times the high field rates. Ten adult SWD flies per treatment were anesthetized and put into Petri dishes. They were immediately sprayed in a Potter Sray Tower and then transferred to clean Petri dishes. Each dish included a piece of growth media and a piece of dental cotton wetted with DI water, which provided food and water necessary for keeping adults alive four days or more. Adults were evaluated each day until 5DAT – however flies were not able to be kept alive in the controls at 5DAT so data at 4DAT was evaluated.

Dip trials to evaluate the translaminar effect of neonicotinoid pesticides on SWD were performed on storebought organic blueberries. Four labeled formulations of neonicotinoids were used: Actara 25WG, Assail 30SG, Provado 1.6F, and Scorpion 35SL. In the second trial, the adjuvant R-56 was added to each treatment and included as an additional control, for a total of six treatments. Berries were dipped for 5 seconds, dried, and held at 20°C. Berries were pinned to dense cotton plugs attached to the inside of 2 oz. condiment cups. To keep flies alive long-term, 2 mL of 10% sucrose solution innoculated with yeast was added to each cotton plug. A single gravid adult female was added to each cup. Ten experimental units per treatment were prepared each day, for a total of six days after treatment (DAT), for 0DAT – 5DAT. Each set was checked for morbidity at 24 hour intervals.

Results of the probit analysis showed that even at 4x concentrations of pesticides, mortality did not reach 50% at 4DAT for any treatment. Percent mortality for each treatment at the 3-4x high rates were: Actara (a.i. 299.6 ppm) 8% $\pm$ 5.83 SEM, Assail (a.i. 357.2 ppm) 14% $\pm$ 6.78, Provado (a.i. 435 ppm) 34% $\pm$ 5.92, and Scorpion (a.i. 410.2 ppm) 18% $\pm$ 11.14. These data were normalized on a log concentration scale to determine the LC_{50} for each pesticide. Provado had the highest mortality for its concentration at all levels. In another trial which allowed exposure to pesticides on a large surface area (i.e. applied to one side of a petri dish) mortalities did reach higher percentages. Residues on large surface areas better simulate a natural environment where blueberry bushes have been sprayed, so higher mortality might be expected for a field application if treated leaves were used for bioassays.

At the end of 5 days, adults were removed and eggs in each fruit were counted. Blueberries were destructively sampled two weeks after females were initially added, to determine percent of infested fruit. Virtually no adult mortality was observed in treated and control samples. Overall, fewer fruit were infested in Assail and Scorpion treated berries than other treatments. Scorpion suppressed infestation more, but Assail had a longer residual effect. Dead eggs were found under blueberry epidermises during destructive sampling, suggesting an ovicidal effect. The number of eggs laid and the infestation rate were lower for the second trial and the cause of this is unclear; however the inclusion of R-56 does not appear to have had an effect when the two controls are considered. During the winter, more translaminar trials will be performed to further investigate the ovicidal effects of neonicotinoids on SWD.

SYSTEMIC CONTROL OF DROSOPHILA SUZUKII THROUGH NEONICOTINOID CHEMIGATION IN HIGHBUSH BLUEBERRY

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Neonicotinoid pesticides were tested as a systemic ovicide for SWD control. Chemigation trials were performed on blueberry bushes in the WSU NWREC experimental field. Neonicotinoids were shown to exhibit systemic entry into the blueberry leaf tissue, but no insecticides were found in the fruit tissue based on bioassays or laboratory residual tests.


Fig. 1. Drip line irrigation connected through PVC manifold.

A system of ½” drip lines was installed to deliver neonicotinoids to experimental plots in the field (Fig. 1). Two rows of mid-season ‘Bluecrop’ and two rows of late-season ‘Elliot’ were used. Each row contained four randomized plots of four bushes each. Separate lines were installed for each of the three treatments and the control. The nozzles were self-pressure regulating and dripped at a rate of ½ gph. A Y-filter, backflow inhibitor, and flow regulator were installed at the head of a four-arm ¾” PVC manifold. Insecticides were applied through a six-tank sprayer calibrated to run at 40 PSI. Multiple applications were made to ‘Bluecrop’ throughout the season, and a single high rate application was applied to ‘Elliot’ bushes. Insecticides used were Assail 30SG® (5.3 oz/A and 26.5 oz/A), Admire Pro® (imidacloprid, 7 fl oz/A and 14 fl oz/A), and Scorpion 35SL® (5 fl oz/A and 10.5 fl oz/A).

Ripe berries were collected from 1 DAT to 7 DAT, and 8 DAT to 28 DAT (the pre-harvest interval for Scorpion), twelve berries per plot. Single berries were then placed in arenas with mature lab-reared female SWD, which were allowed to oviposit for 48 hours. Eggs were counted and compared to number of emerged offspring after a two-week period to obtain the percent emergence data. Samples of blueberries and leaves for residual chemical analysis were taken at 27 DAT for Scorpion-treated plots from the ‘Bluecrop’ trials, and 26 DAT for all treatments from the ‘Elliot’ trials. These samples were sent to Cascade Analytical, Inc. (Wenatchee, WA).

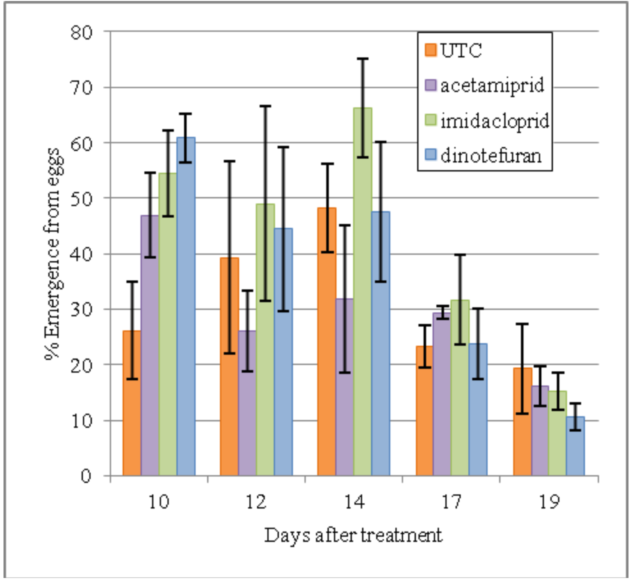

Fig. 2: SWD % emergence from eggs laid in chemigated 'Bluecrop' blueberries.

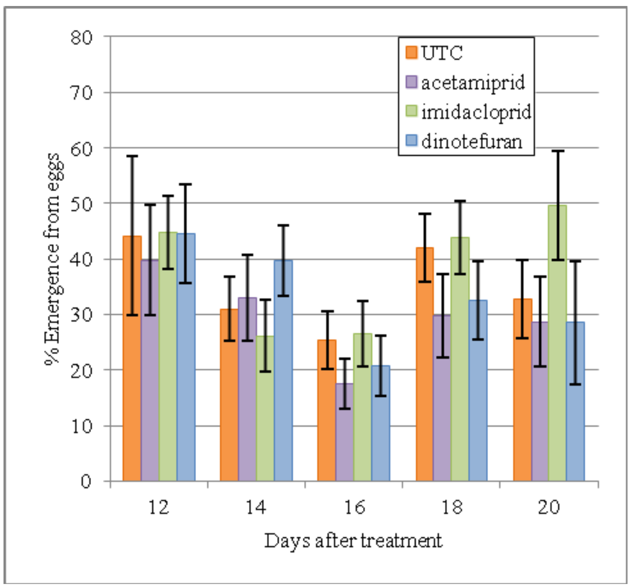

Fig. 3: SWD % emergence from eggs laid in chemigated 'Elliot' blueberries.

Oviposition in the Bluecrop variety was relatively low, and death of adults was frequent – however this occurred in controls as well as treatments and was likely due to the test arena, which was large, layered with sand, and allowed for desiccation. In light of this, 'Elliot' blueberries were placed in smaller arenas with more available water, and adults rarely died. The percent emergence of offspring from 'Bluecrop' samples was not found to be significant except in some cases where the control was lower than treatments (Fig. 2). There was no signficant differences in emergence found between treatments in the 'Elliot' fruit (Fig. 3). These results do not indicate any activity for neonicotinoids acting as ovicides. Residual data for the samples of Scorpion-treated bushes from the Bluecrop variety had 0.32 ppm (AI) of Scorpion found in sample of leaves, and not detected in the sample of berries. From samples of Elliot variety, the concentrations of Admire Pro and Scorpion (AI) were found at 0.12 ppm and 0.86 ppm in leaves respectively, and not detected in fruit samples. Assail was not detected in "Elliot' fruit or leaf samples (Table 1).

These data indicate that neonicotinoids are systemic within plants, but the insecticides do not appear to enter the fruit tissue. This may be caused by a specific barrier to entry, or be due to timing of application. At the end of ripening, xylem does not contribute as much to fruit mass increase, and pesticides entering from the roots during this period would not reach the fruit. Applying earlier could prove successful. However there could still be a barrier to entry, since that hypothesis does not account for the presence of neonicotinoids (specifically imidacloprid and dinotefuran) found in the leaves (Table 1). When blueberries are ripening, uptake from xylem is reduced, but uptake from phloem is increased, and pesticides could enter the fruit from that direction. Another chemigation trial will be needed to address these questions.

Table 1. Results of HPLC analysis for neonicotinoid residues in treated plots.

“Bluecrop”	Amount Detected	Limit of Quantitation
Dinotefuran fruit	*Not detected*	0.010 ppm
Dinotefuran leaves	0.32 ppm	0.020 ppm
“Elliot”	Amount Detected	Limit of Quantitation
Acetamiprid fruit	*Not detected*	0.010 ppm
Imidacloprid fruit	*Not detected*	0.010 ppm
Dinotefuran fruit	*Not detected*	0.010 ppm
Acetamiprid leaves	*Not detected*	0.029 ppm
Imidacloprid leaves	0.12 ppm	0.030 ppm
Dinotefuran leaves	0.86 ppm	0.030 ppm

PREVENTION: FROM CRISIS MANAGEMENT TO IPM PROGRAMMING

LESSONS AND CHALLENGES

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Introduction

The invasive pest, *Drosophila suzukii* (SWD), arrived in Oregon in 2009, and now has established a stronghold in the Western and Eastern United States (>30 states); and is widespread in many of the European countries. SWD came out in force in 2012. Fruit quality was reduced along with increased economic losses (measured by increased sprays, reduction in grade, added labor for monitoring, etc).

The lack of adequate knowledge about SWD has triggered numerous applications of insecticide treatments; and chemical use became the lead management practice.

Why is this pest difficult to manage?

1) Fly infestation occurs inside the fruit, which makes control challenging and enhances accidental dissemination of flies; and the difficulty of treating SWD, hidden in plant canopies.

2) SWD has a very short generation time, and many generations (3-7 are predicted in Oregon), which could mean at least 2 generations in a single fruit-cropping period.

3) SWD has a wide host range including managed and unmanaged fruits, including ornamental/garden plants and non-commercial uncultivated berries; and within a single season SWD can move from one fruit type to the next as well as between wildland habitat and agroecosystems. (The preferred suitability of each host is being investigated.

4) *Drosophila* flies can randomly acquire genetic mutations that can manifest as morphological and physical changes, so the rate of fly adaptation and the associated competitive ability, reproductive fitness, and potential for pesticide resistance is of great concern.

Research addressing decision support tools and prevention-oriented IPM practices (e.g., timely harvesting, sanitation, cold storage) will increase opportunities for growers to widen their options for managing SWD. Seasonal variations and activity-density changes are most likely influenced by varying environmental conditions, behavioral needs, and other factors.

SWD prevention is key. This requires a thorough understanding of SWD biology, behavior and movement not only in cultivated crops but in adjacent landscape.

The following report will address some findings that could help minimize SWD populations:

1) Monitoring (trapping adults, degree-day modeling, larvae extraction)
2) Sanitation (e.g., fallen fruit)
3) Cold Storage (post-harvest treatment)
4) Use of Landscape Knowledge

Monitoring. *Trapping Adults*. Color (Fig. 1), entry area (Fig. 2), headspace (volume) (Fig. 3,4), new design and bait types (Fig. 5) were tested in 2012. All studies were replicated 3 times over a time period of 11 to 13 weeks. Traps were rotated into new positions each week. Trap catch was compared using apple cider vinegar (ACV) and a yeast solution baits over a 3-year period in no-spray blueberry field.

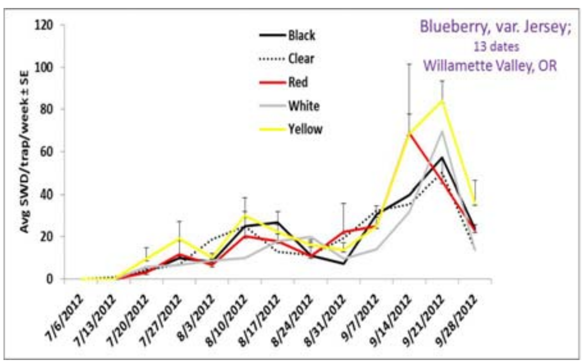


Fig. 1. SWD attractiveness to trap color varied.

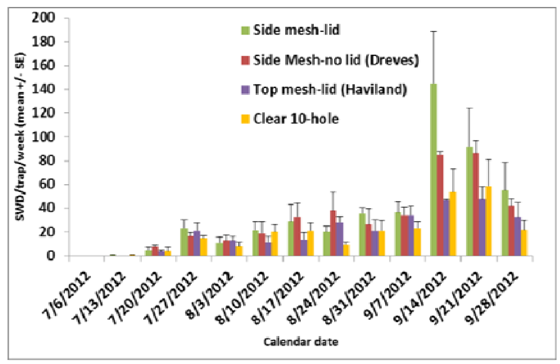


Fig. 2. Increased entry area caught more flies.

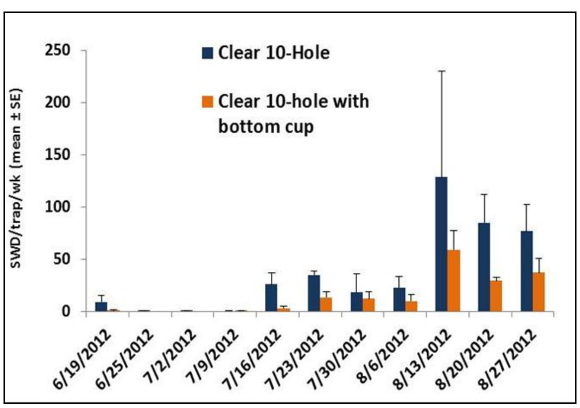


Fig. 3. Less headspace in trap more SWD catch.

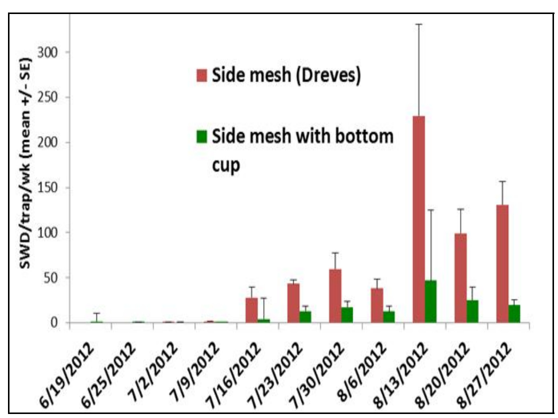


Fig. 4. Less headspace more trap catch.

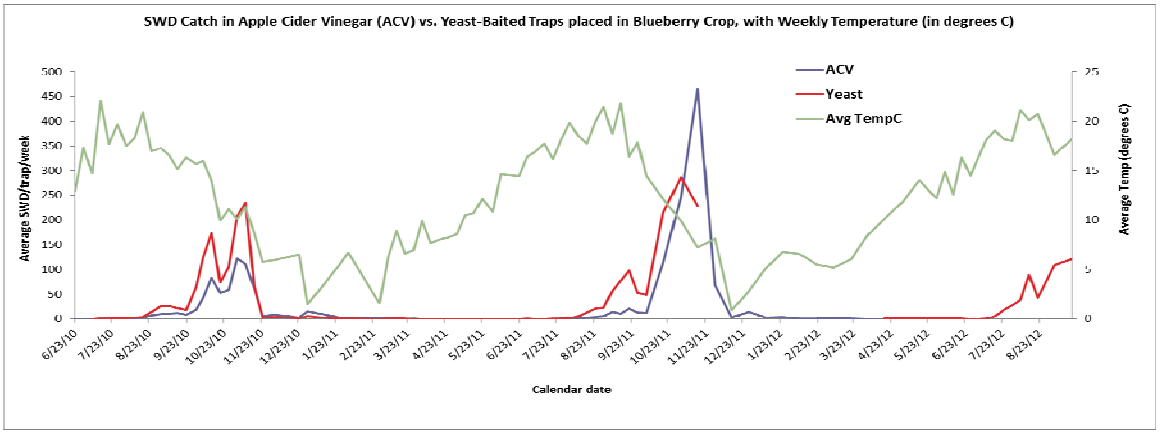


Fig. 5. Yeast baits caught significantly more SWD than vinegar baits during harvest periods.

***Degree-Day Modeling*.** Predictive models are being tested and validated to help answer questions, including: Can trap catch found in late fall traps correlate with counts collected after winter mortality predict the risk of spring populations? Can DD models predict 1st generation activity and egg-laying events to help time treatments and reduce unnecessary treatments?

***Larval Extraction*.** Crushing fruit, rather than leaving whole, will increases larval exit from fruit (>50% more) to determine SWD infestation. Solution types salt (15 Brix; 1 cup), brown sugar (16 Brix; 2 ½ c), or white sugar (15 Brix; 3 ¼ c) did not yield significant different numbers of larvae in total (p = .45), but relative performances of methods based on efficiency (the fraction of total larvae that are harvested after 15 minutes) were significantly different (p-value < 10-7) when adding a solution of. Boiling fruit was not as effective in extracting small larvae.

Sanitation. SWD can survive in fallen infested fruit under blueberry plants (Fig. 6); and SWD will oviposit in clean fruit on the ground, when fruit is not available on the plant (Fig 7).

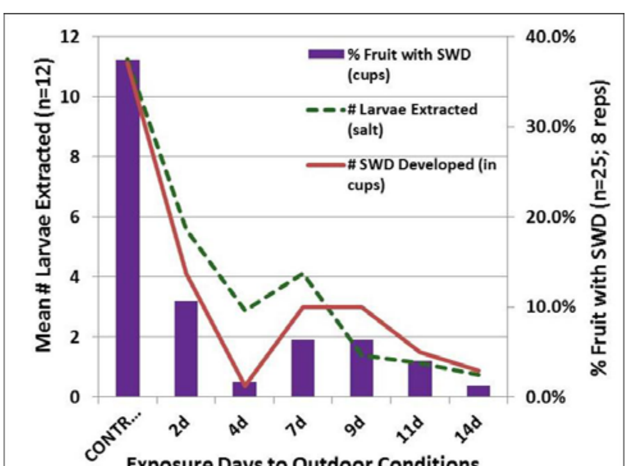


Fig. 6. A percentage of SWD are able to survive in fruit that falls to the ground.

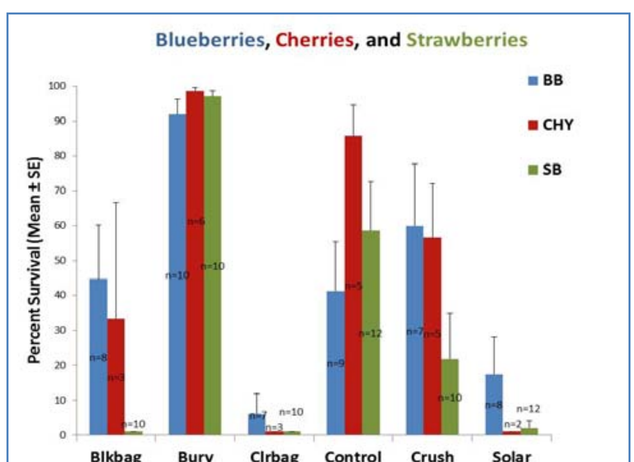
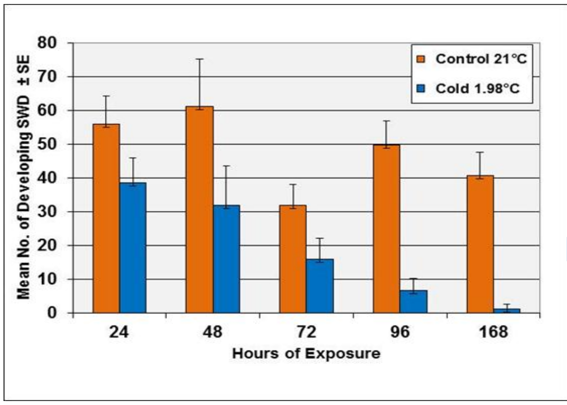


Fig. 7. Solarizing and bagging (clear) infested fruit were effective when environmental conditions were sunny with minimal rain.



Cold Storage. SWD eggs and both young and old larvae were reduced in post-harvest fruit when exposed to cold periods compared to the control (21°C), however older larvae and pupae were less susceptible to cold than eggs and 1st instar larvae (Fig. 8). When fruit exposed to longer periods of cold, less larvae survived.

Fig. 8. Cold treatment reduced SWD survival and development in post-harvest fruit.

FURTHER INVESTIGATION INTO SPOTTED WING DROSOPHILA MONITORING TRAP DESIGN EFFICIENCY

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Previous efforts to discover optimal trapping techniques to adequately monitor spotted wing drosophila (SWD) (*Drosophila suzukii* Diptera: Drosophilidae) during periods of low abundance led to intriguing directions considered worth investigating further. Bait, color, trap height, and trap entrance were variables that could be tweaked to economically and effectively improve detection of the pest of several food crops. Adults can be caught year-round in significant numbers indicating either improved design or a disturbing trend of establishment that may require post-harvest treatments instead of relying on seasonal knockdowns related to weather events.

Traps were placed in or near wild Himalayan blackberry in mid-winter (late-January) and were changed and randomly positioned every week to ten days. Four replicates of red cups with three kinds of entrances and three kinds of baits (nine total per replicate) were initially used among the vines with some additions later involving height and color modifications. Collections of the catches were screened, rinsed and placed in plastic bags to be frozen until counted and sexed under microscope at a later date. Baits included (in approximately 100 mL aliquots): two kinds of apple cider vinegar (Heinz® and either Walmart or Safeway brand), until a consistent advantage was determined; and a diluted (1:1 with water) soy sauce (Kikkoman®) solution, . The trap entrances included: two sizes of hardware cloth rectangles glued with hot glue gun, with either quarter-inch or eighth-inch spaced grids, two of same size on opposite sides of 8 ounce Kirkland Chinet® cups (Costco); and ten 3/16^{th--}inch diameter holes poked one inch apart with soldering iron around the same type cup. Entrances were approximately one to two inches below the lid. Black party cups (slightly smaller than the red cups) with similar entrances and baits were eventually added in April, as well as placement of the traps with partial sets of treatments over 10 feet above ground in a Bartlett pear tree and a Douglas-fir tree.

The more expensive Heinz® apple cider vinegar (not the flavored option) was consistently a preferred attractant for the fly over the other brands of vinegar in a three month period, so the latter treatment was discontinued at the end of April (Figure 1). Soy sauce baits were competitive during the same period and were continued throughout the study, although a summer drop-off was observed in the field before a deterministic count was made. The larger quarter-inch entrance trap, conjectured to be more efficient in terms of SWD numbers, was not consistently observed to be definitively any better while collecting, and also allowed for more houseflies and other larger species to get trapped. The larger openings allowed the bait solutions to evaporate faster and often dried out in warmer periods, as observed in earlier years.

Comparisons in the spring among the various locations showed that the higher placed traps generally had more SWD than in the blackberries (Figure 2) . The preference for one color over another was not determinate and varied among areas. As observed previously, the black color is often more preferred among blackberries, but there was much variability, and the black traps were not fully replicated. There was a late winter snow that affected catch totals for the ensuing weeks (Figure 3) , and a significant surge did not occur until late September as noted in the two previous years.

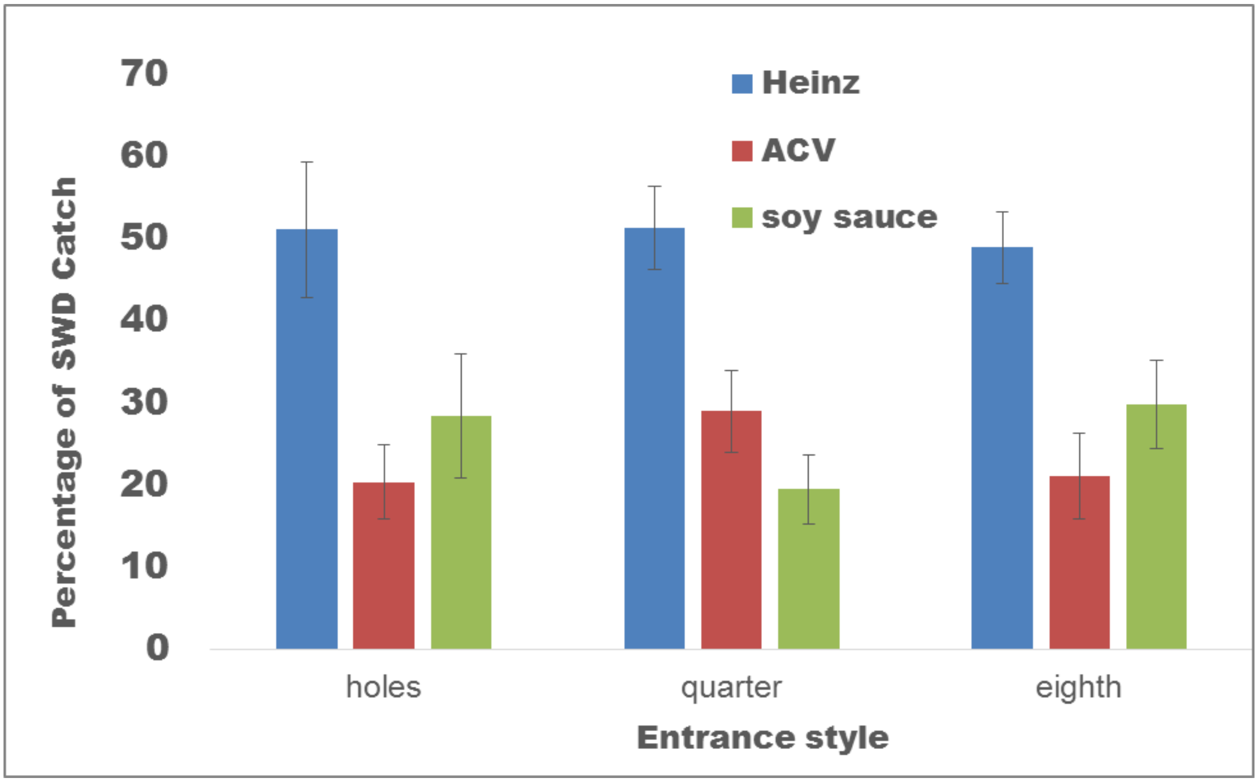

Figure 1. Proportion of SWD catch comparing baits according to entrance (red cups in blackberry).

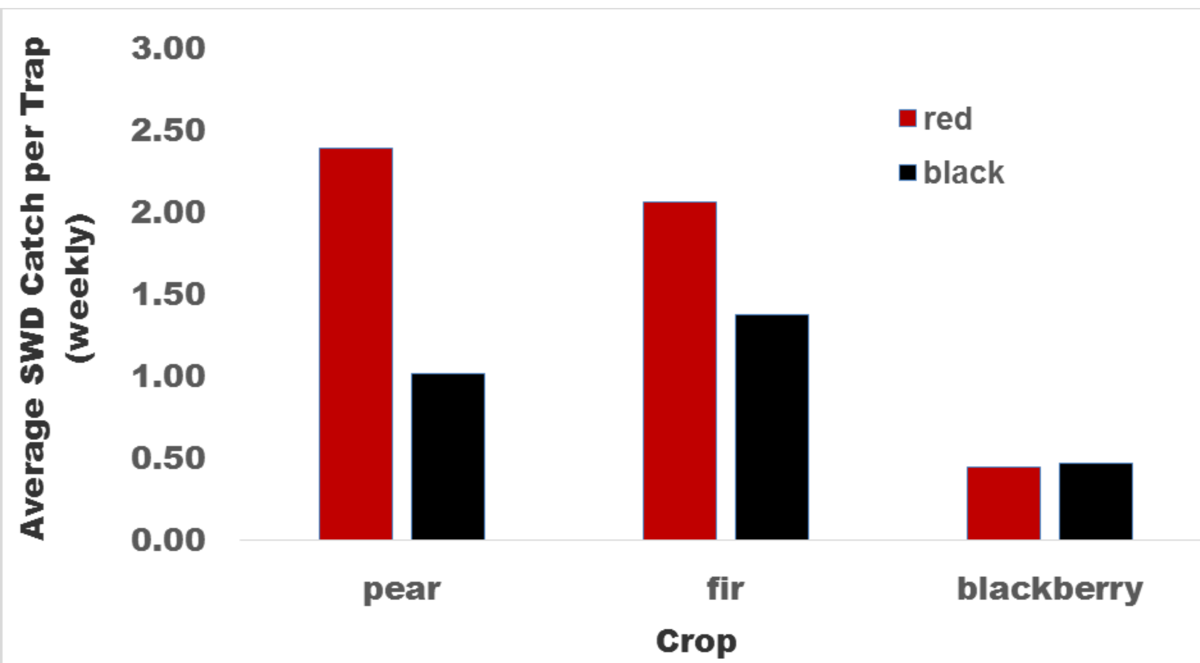

Figure 2. Average catch of SWD among trap locations spring 2012 by trap color.

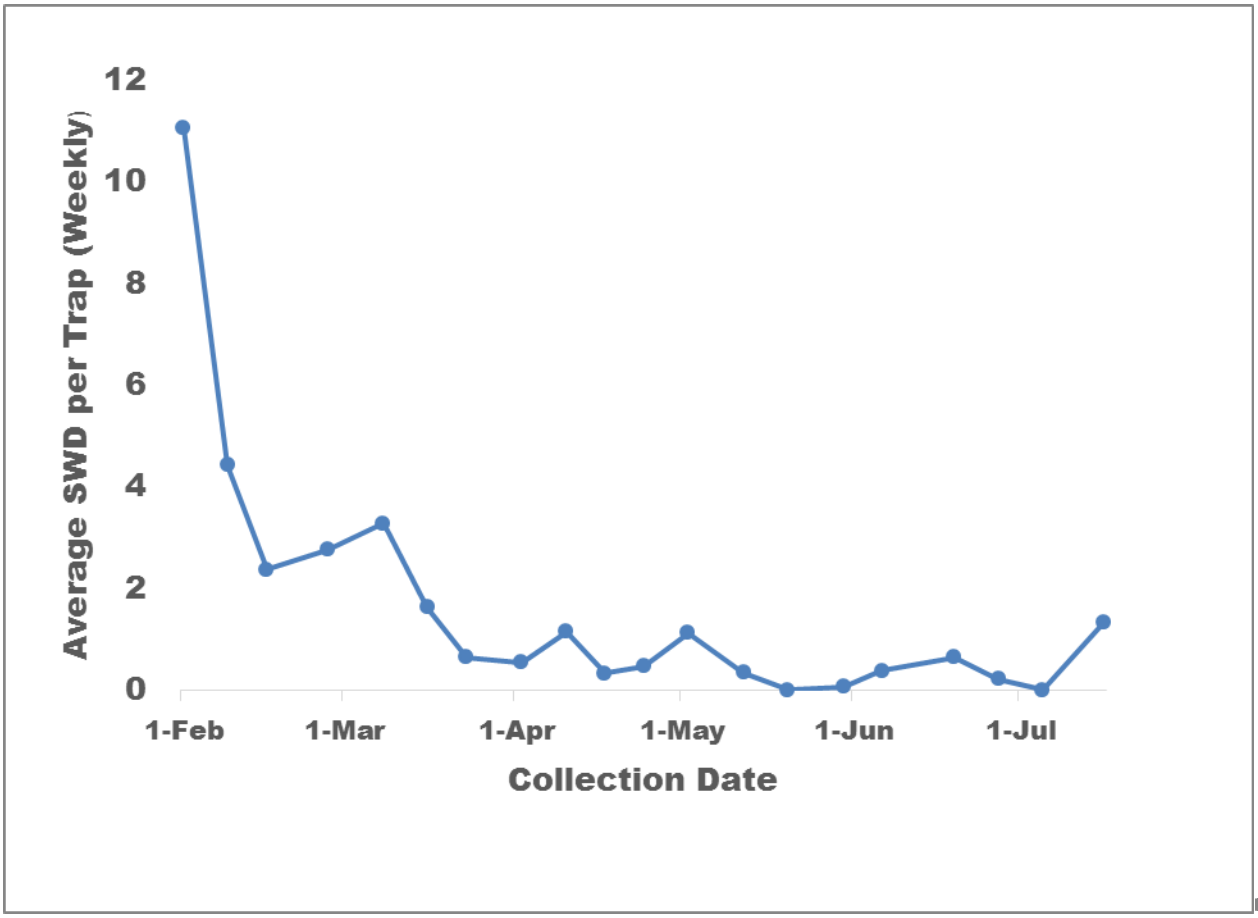

Figure 3. Average SWD catches by collection date in wild blackberry winter-spring 2012

FEEDING DAMAGE BY BROWN MARMORATED STINK BUG (*HALYOMORPHA HALYS*) ON COMMERCIAL HAZELNUT (*CORYLUS AVELLANA*)

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Insects of the family Pentatomidae, commonly called stinkbugs or shield bugs, are serious pests of many food and ornamental crops around the world. Included in those crops are almonds, pistachios, pecans and macadamia nuts. Commercially produced hazelnuts (*Corylus avellana* L.) grown in the Willamette Valley are currently not economically impacted by pentatomids. However, the rapid spread of *Halyomorpha halys,* brown marmorated stink bug (BMSB) in the area could potentially impact hazelnut growers, as wild hazelnuts are a known host of BMSB. Research into the potential damage that BMSB could cause to hazelnuts is needed so that management methods can be developed. This research includes categorizing symptoms of damaged nuts at different stages of development. A preliminary study done during the summer of 2011 showed that BMSB will feed on and damage cultivated hazelnuts. A study will be conducted in 2012 and 2013 to determine the timing of damage occurring in more resolution and to confirm the findings of the previous study. This report includes results of data collected during the 2012 field season.

25 mesh exclusion bags were placed over hazelnut braches containing buds on 9 trees (225 bags total) on May 2, 2012. Trees were located at the USDA Hazelnut Germplasm Repository, Corvallis, OR. Nut development began on June 6, 2012. Three adult male BMSB were placed in a single bag per tree and allowed to feed on developing nuts for one week per bag (branch) before being removed. This was repeated weekly for 16 weeks during nut development, until nuts matured. Unused bags were treated as control bags and were unexposed to BMSB feeding. If adult males were unavailable, 5th instar nymphs were used. Bags were collected in early October. Nuts were unshelled in the lab and examined for signs of feeding damage which was categorized based on preliminary trials the previous season: healthy (no apparent damage), blanks (no kernel), shriveled (small or malformed kernel), corking (internal dry, white necrotic tissue) and oily (darker internal regions of kernel). Clusters of developing hazelnuts (n >10 clusters per tree) were collected weekly and frozen in order to determine the average state of development for each cultivar at the time of experimental insect feeding. Trials will be repeated in 2013.

Our data indicate some trends in the timing of feeding damage. Early season feeding appears to result in blank hazelnuts (Fig. 1), compared to corking damage, which was significantly greater during the last week of the season compared to earlier weeks (Fig. 3). The mean number of nuts with shriveled or malformed damage was significantly greater for a short period mid-season (Fig. 3). Damage timing will be further compared to timing of nut development by classifying development stages from the frozen nuts to account for variations in cultivar development and to accumulated degree-days. High amounts of variation in the number of nuts per bag that were exposed to BMSB feeding will be corrected in experimental methods for 2013.

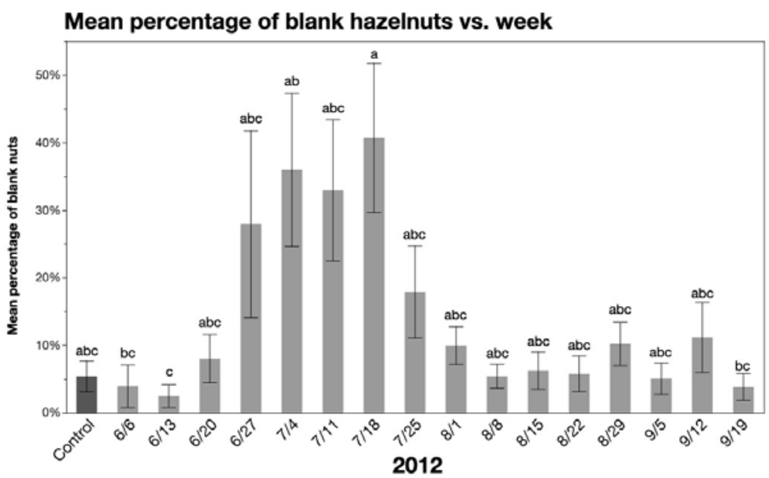

Figure 2: Mean percentage of blank hazelnuts per week, 2012. Treatments with differing letters indicate significant difference, Error bars = SE (arcsine transformation, Tukey's HSD, JMP 2012)
Figure shows untransformed data.

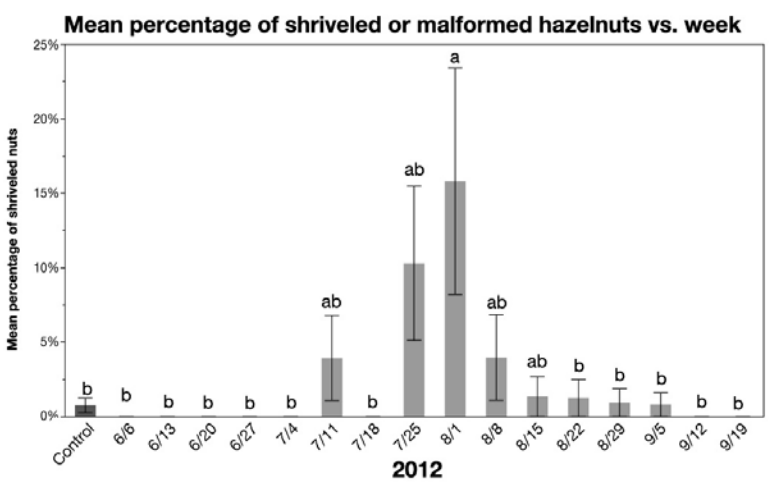

Figure 3: Mean percentage of shriveled hazelnuts per week, 2012. Treatments with differing letters indicate significant difference, Error bars = SE (arcsine transformation, Tukey's HSD, JMP 2012)
Figure shows untransformed data.

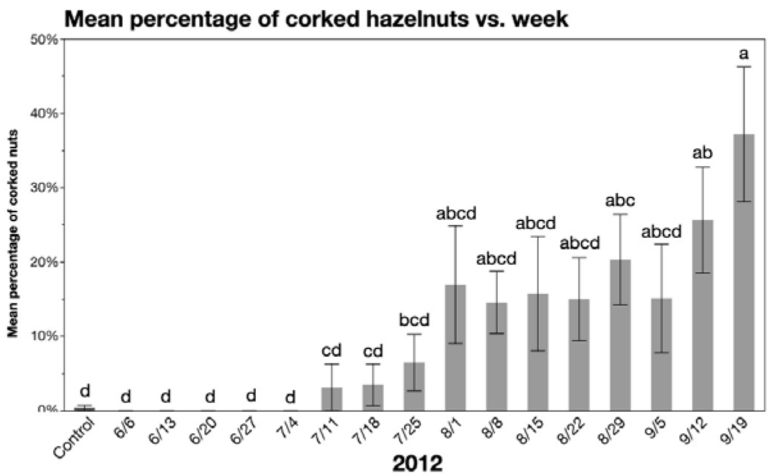

Figure 4: Mean percentage of blank hazelnuts per week, 2012. Treatments with differing letters indicate significant difference, Error bars = SE (arcsine transformation, Tukey's HSD, JMP 2012)
Figure shows untransformed data.

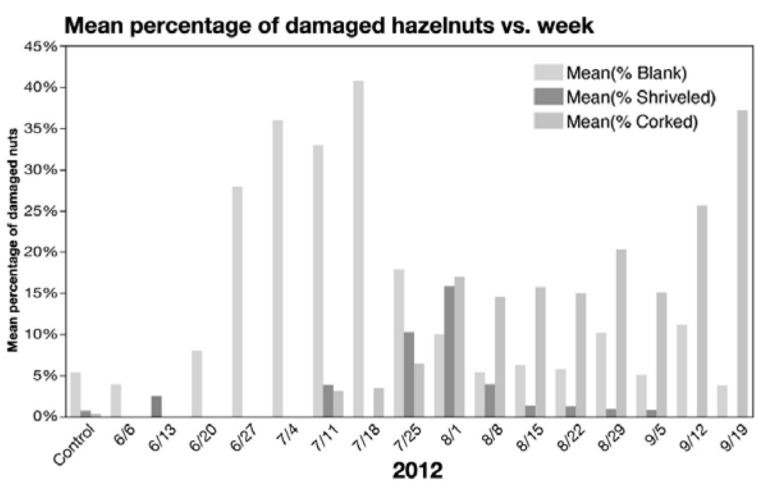

Figure 5: Summary of mean percentage of varying types of feeding damage by BMSB on hazelnuts in 2012.

DETERMINING ATTRACTIVENESS OF COMPOUNDS TO IMPROVE MONITORING OF SPOTTED WING DROSOPHILA, *DROSOPHILA SUZUKII*

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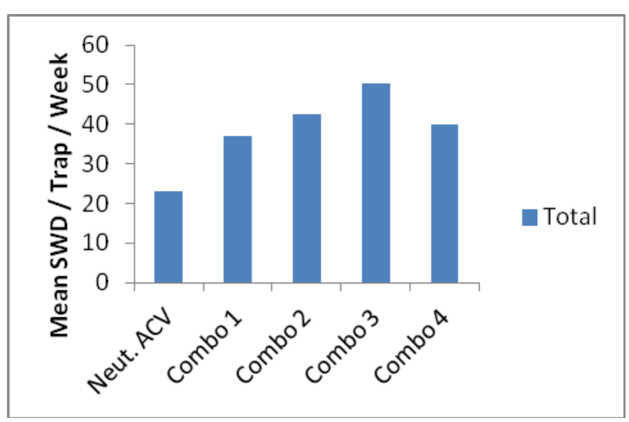
Monitoring for a pest species is an important part of any integrated pest management program: it allows monitoring of populations and movement, knowledge of infestation levels in a field, and can help farmers make management decisions. In order to have confidence in the data collected from monitoring traps, the traps themselves need to be effective enough to compete with the natural pest target and illuminate even small populations of the pest.

The spotted wing Drosophila (SWD), *Drosophila suzukii*, is an economically important pest of small and stone fruits that lacks an effective monitoring trap. Apple cider vinegar (ACV) or active yeast traps are the current recommendation for attractants of SWD, but there have been reports of larvae infesting fruit before adults are caught in the traps. In order to be able to trust that the catches in a trap are a correct and consistent picture of what's going on in a field, there needs to be a more effective trap for the SWD. This research was carried out to determine the attractiveness of compounds in known lures to the SWD.

The compounds tested were all similar to components of ACV and wine, two known attractants for the SWD. Acetic acid, ethanol, ethyl acetate and phenyl ethanol all occur in both wine and vinegar, and are all components of a *D. melanogaster* attractant. To test the biological activity of similar compounds to SWD, a range of compounds in four classes was tested: short chain carboxylic acids, short chain alcohols, short chain acetates and phenethyl esters. These compounds were presented to SWD in vials suspended in a drowning solution in a clear cup trap. Laboratory bioassays were performed to exclude deterrent compounds from field studies. Field trapping experiments were performed for the attractive compounds individually then in combination.

<u>Laboratory Bioassays:</u> Meter cubed mesh cages were set up in a greenhouse with a treatment trap and a soap water control trap. Two hundred SWD were released in each cage for 24 hours and the catches in the two traps enumerated. Treatments that caught more than the controls were determined to be attractive and used in field experiments.

<u>Individual Field Trapping Experiments:</u> The attractive compounds from the laboratory bioassays were grouped into experiments by class and presented in the field in vials suspended in a soapy ACV moat in clear cup traps. An



ACV control trap was placed in the field with the treatment traps. ACV neutralized to pH 7 was used in the moat for the acids so the acetic acid in the ACV would not interfere with the attraction of the acid being tested.

Combination Field Trapping Experiments: Vials of the most attractive compound or compounds from each class were combined and suspended in a neutralized ACV moat in the field. They were tested with a neutralized ACV control.
Combination 1: Acetic acid, ethyl acetate, methanol, phenethyl propionate
Combination 2: Acetic acid, ethyl acetate, ethanol, phenethyl propionate
Combination 3: Acetic acid, ethyl acetate, methanol, phenethyl butyrate
Combination 4: Acetic acid, ethyl acetate, ethanol, phenthyl butyrate

Although there was no significance between treatments because of high variability, there is promise since all of the combination treatments were catching numerically more SWD than the neutralized ACV control.

Conclusions: Ethyl acetate volatiles were shown to add attractiveness to ACV, but the delivery system tested in our trials is not practical for growers or scouts to use. More work is required to determine if the combinations of volatiles provide a more attractive lure that is able to detect SWD activity in the field prior to fruit becoming infested.

DEVELOPING REDUCED PESTICIDE PROGRAMS FOR *DROSOPHILA SUZUKII* MANAGEMENT IN BERRY CROPS

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Since the detection of *Drosophila suzukii,* blanket applications of broad-spectrum pesticides are made between 2 and 8 times per season to protect susceptible berry crops from infestation. As a consequence, growers are faced with the challenges of managing harvests around pesticide preharvest and restricted entry intervals, increased secondary pest outbreaks that are likely caused by a reduction in natural enemies from repeated pesticide applications, increased production costs, fruit knockdown from sprayers traveling down rows, as well as greater risks to environmental and human health.

Reduced pesticide application strategies may mitigate some of these challenges. Field studies were conducted in 2012 to determine (1) if reduced spray programs manage *D. suzukii* as well as conventional blanket sprays, and (2) the economics of the reduced spray programs.

Two to three alternate row middle and blanket applications on 49 ha of 'Saanich' raspberries were made with an airblast sprayer at 702 L of water ha^{-1} when fruit was susceptible. The experiment was performed at a single location and arranged in a RCBD with 3 replicates. *D. suzukii* adults and larvae were monitored weekly during harvest by clear-cup ACV traps and the salt extraction, respectively. Four to five border spray applications with a cannon sprayer and blanket applications with a trellis sprayer were made at 468 L of water ha^{-1} on 24 ha of 'Liberty' blueberries when fruit was susceptible. The experiment was performed at a single location and arranged in a RCBD with 3 replicates. *D. suzukii* were monitored as described above. Fruit knockdown of 12 plants per treatment from spray equipment was quantified after each spray application.

No statistical differences were found in adult and larval numbers from alternate row middle and blanket application treatments in raspberries. Similarly, no statistical difference was found in adult numbers from border and blanket applications. Four larvae were found on the last day of harvest in one replicate of the border spray treatment. Fruit knockdown were statistically similar, however, border sprays may save growers an estimated $320 per hectare. Reduced pesticide strategies such as alternate row middle and border sprays show promise as a replacement to blanket sprays for *D. suzukii* management while reducing spray area, application time and production costs. Studies are planned in 2013 to repeat these trials at additional locations to verify results over years before adoption of either technique is recommended to growers.

FACTORS AFFECTING THE EFFICACY OF A VINEGAR TRAP FOR *DROSOPHILA SUZIKII* (DIPTERA; DROSOPHILIDAE)

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The spotted wing fruit fly, Drosophila suzukii Matsumura, is a relatively new pest in the United States attacking a variety of fruit crops. Studies were conducted to develop an optimized, economical trap for monitoring. Laboratory bioassays found that flies were attracted to dark colors ranging from red to black compared with low attraction to white, yellow, and light blue. Similarly, fly catches in 237 ml plastic 'spice' jars with ten 0.48-cm holes and baited with apple cider vinegar were significantly higher in jars with red or black than white caps. The use of an alternating set of three, 1.5-cm wide horizontal red, black, and red bands (Zorro trap) significantly increased fly catches compared with the use of a 4.5-cm all-red or all-black strip. This increase was associated with a significantly higher proportion of flies first landing on the side instead of the cap of the Zorro trap compared with the all-red or all-black spice jars. These data were used to develop a predictive model to define total fly capture as a function of trap color, cumulative area of entry holes, and the length of the trapping portion of the trap. Total fly catches by the Zorro trap was compared to other red and clear plastic traps in five trials conducted in cherry, blueberry, marionberry, apricot, peach, and wild blackberry. Comparisons (n = 12) included a commercial red-capped 200-ml trap with two 0.63 cm holes and clear and red 473-ml and clear 946-ml plastic cups with six or ten 0.48 or 0.63-cm holes. The model was successfully validated suggesting that trap performance can be predicted based on a few characteristics. The Zorro trap has many advantages including its durability, small size, and availability. In addition, a lower proportion of non-target drosophilids were caught in the Zorro than the various cup traps. The Zorro trap is available from marginaldesign.com.

Argyresthia pruniella **(Clerk) 1759*,* A EUROPEAN PEST OF CHERRIES**

RECENTLY FOUND IN NORTHWEST WASHINGTON STATE

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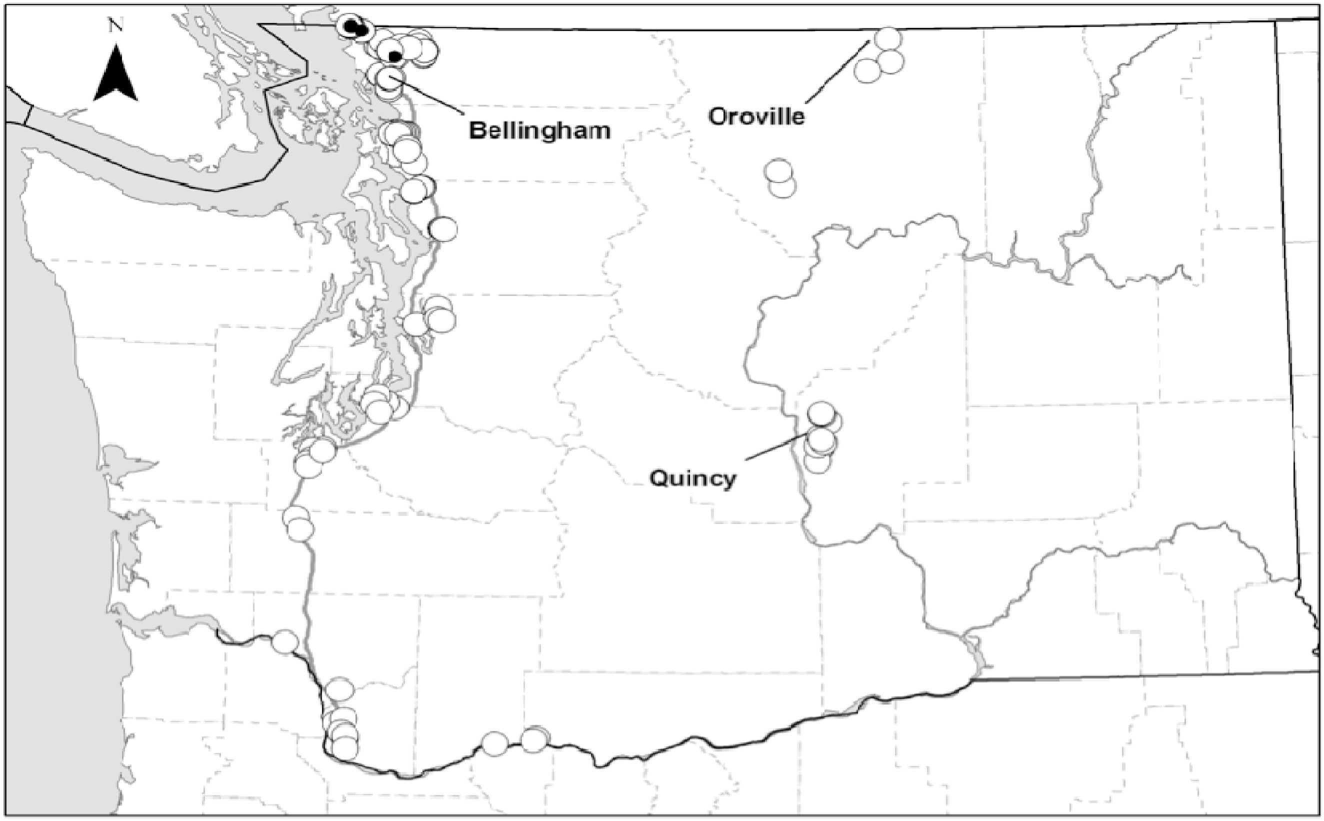
Argyresthia pruniella (Clerck), the Cherry Blossom Moth, (Lepidoptera: Argyresthiidae), is considered a moderate to major pest of cherries in Europe. Hosts include many economically important Rosaceae, including fruiting and ornamental cherry and plum. *A*. *pruniella* larvae damage young leaves, developing buds, and occasionally developing fruit (not mature fruit). First recorded in North America in a light-trap survey in Vancouver, BC, Canada (de Waard et al. 2009), this introduced European species was subsequently detected in pheromone-trap surveys in NW Washington State in 2011 and 2012.

In England, *A*. *pruniella* adults occur in late June and July and can be found on foliage and tree trunks. Eggs are laid singly on leaf scars, beneath bud scales, or in the shelter of shoots and spurs. Eggs usually hatch the following spring, although some may hatch earlier, in which case larvae hibernate where they hatch (Alford 2007). Larvae begin feeding on fruit buds in the early spring and may be present before bud burst. Each larva can consume 5-7 buds or flowers, which may result in considerable yield loss, especially in unsprayed orchards. Larvae feed on developing bud tissue and, later, in the flowers, usually hidden in excavated ovaries or young, developing fruit. When fully grown (mid- to late May in England), larvae descend to the ground and pupate in the soil. Adults emerge several weeks later (Alford 2007).

Figure 6. 2012 *Argyresthia pruniella* survey sites (dark circles = positive).



A limited pheromone-trap survey in western Washington in 2011 detected the first U.S. occurrence of the pest in Whatcom County, at three sites close to the U.S./B.C. border. A subsequent delimiting and detection survey in 2012 included other western Washington counties and two eastern Washington counties, the latter in locations near the U.S./B.C. border or with extensive fruit tree nursery stock production (Fig. 1). The 2012 survey detected the pest at 21 sites, all in Whatcom county and all within 15 km of previously positive sites or the U.S./B.C. border (Fig. 2). A total of 146 sites were trapped between 2011 and 2012, with three positive sites in 2011 and 21 in 2012 (Table 1). The differences in positive sites between 2011 and 2012 probably reflect only differences in survey execution, and not rapidly expanding *A. pruniella* populations. Traps were placed very late in the season in 2011, and likely missed most adult flight. Sites were in unmanaged cherry or plum trees, usually in roadside or residential settings. Traps consisted of septa lures containing Z11-16:ALD in Alpha-Scents reusable delta traps (red or white) with hot-applied stickum inserts.

Figure 2. 2012 *Argyresthia pruniella* sites in Whatcom County (dark circles = positive).

Figure 3. *Argyresthia pruniella* adult

Argyresthia pruniella adults are distinctively copper and white patterned moths with white head and thorax (Fig. 3). Additional diagnostic images of host feeding damage, larva, and overwintering biology are also presented.

Table 1. *A. pruniella* pheromone-trap survey sites by county, 2011/2012.

County	2011 Trap Sites (Pos.)	2012 Trap Sites (Pos.)	Total Sites 2011-2012
Whatcom	37 (3)	27 (21)	64 (21)
Skagit	10	11	21
Snohomish	0	11	11
King	0	4	4
Pierce	0	5	5
Thurston	1	5	6
Lewis	3	3	6
Cowlitz	1	1	2
Clark	5	1	6
Skamania	0	3	3
Grant	0	11	11
Okanogan	0	7	7
Site Totals	57	89	146

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TRAPPING FOR DROSOPHILA SUZUKII

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The spotted wing drosophila (SWD), Drosophila suzukii, is an economic pest that lays eggs inside ripening small and stone fruits, and is a top research priority of the Northwest Center for Small Fruits. SWD is invasive from Asia and was first reported in the mainland in 2008 from California, in 2009 from Oregon, Washington, Florida and British Columbia, and in 2010 from Utah, North Carolina, South Carolina, Michigan, and Louisiana. Current management recommendations for SWD is to treat fields when adult flies are detected and fruits color. Stakeholders expressed concern over different trapping recommendations made by various research and extension groups, and suggested that one trap standard be recommended.

In 2011, we compared the trap designs across seven states/provinces in North America and nine crop types. Between May and November 2011, we compared: a clear cup with ten side holes (clear), a commercial trap with two side holes (commercial), a Rubbermaid container with mesh lid and rain tent (Haviland), and with ten side holes and no tent (modified Haviland), a red cup with ten side holes (red), and a white container with mesh lid and rain tent (Van Steenwyk). While fly catches among traps varied per site, overall, the Haviland trap caught the most *D. suzukii*, followed by the red, Van Steenwyk and clear trap. The modified Haviland and commercial trap had low captures. Among five crop types in Oregon, a clear cup with mesh sides (Dreves) was also tested and caught the most flies. Traps with greater entry areas, found in mesh traps, caught more flies than traps with smaller entry areas. In terms of sensitivity and selectivity, traps that caught more flies likewise caught flies earlier, and all traps caught 26-31% *D. suzukii* out of the total *Drosophila* captured.

In 2012, we conducted three studies to evaluate various features of traps. In the first study, traps that were clear, white, red, yellow, and black were evaluated. In the second study, traps with two areas of volatilization (interface between bait and air) were compared. In the third study, traps with side or top entry points with or without a rain cover were compared.

[Partly published in Lee et al. 2012. Evaluation of monitoring traps for *Drosophila suzukii* (Diptera: Drosophilidae) in North America. 2012. J. Economic Entomology 105: 1350-1357.]

NEW SAWFLY SPECIES DETECTED IN WASHINGTON STATE:

RESULTS FROM (MOSTLY) THE 21st CENTURY

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The 2009 discovery in Washington state of the European alder-feeding sawfly *Monsoma pulvertum* (Retzius) highlighted how little is known of Pacific Northwest sawflies. This knowledge gap, plus other recent reports of introduced sawflies, provided motivation for a WSDA survey of Symphyta in the region. Several pestiferous sawfly species from Europe and Asia that impact specialty crops formed an ad-hoc body of survey target pests (Table 1). The survey also provided an opportunity to establish current baseline knowledge about native and established exotic Symphyta species. All of these data are being used to build an online Pacific Northwest Sawfly information resource, to aid identification and share knowledge buried in obscure or out of print technical literature.

Between 2010 and 2012, yellow-panel sticky traps were placed in various host plants across Washington, including alder, poplar, elderberry, hawthorn, mountain ash, cherry, pear, apple, and multiple conifer species. Hand collections of adults and larvae were also made during the same period. Most specimens were collected into ethanol, and will be provided to Dr. Nathan Schiff, USDA-FS, for DNA barcoding. This includes numerous larvae, many of which have not been associated with adult life-stages.

Ten Malaise traps were installed in Washington in 2012, primarily west of the Cascades. Three traps were installed near ports of entry, two were installed along the Columbia River, one adjacent to agricultural fields (the sole eastern Washington trap), two in mixed-use forest stands, and two in residential areas. Traps were installed in April and maintained through September. Pheromone-traps, baited with *Diprion pini* and two single component general diprionid pheromones, were placed in Whatcom, Thurston, Mason, and Lewis counties in May 2012, and maintained through October.

Sawflies in entomology collections at Oregon State University, Washington State University, the University of Idaho, The Evergreen State College, Western Washington University, and the United States National Museum (in part) were examined for evidence of previously collected, yet un-reported, introduced sawfly species. Collections were also used to obtain locality and phenology data for native and established exotic species. These baseline data will be used to generate species accounts for the Pacific Northwest Sawfly web resource.

None of the target pests of concern (Table 1) were detected with any of the survey methods. Three unexpected new species detections were made, all of which are species already recorded from other parts of North America (Table 2). Seven additional species were detected that confirmed expected ranges or represent recently established populations (Table 2). Most of these are European species long established in eastern North America that appear to have recently expanded their ranges into the Pacific Northwest. Most of these are not likely to become significant pests in the region, although three are likely to be sporadically problematic on landscape plants.

Table 1. Pestiferous sawfly species not detected in Washington State

Target Pest	Host Plants	Current Distribution
Hoplocampa testudinea	*Malus*	Europe, eastern North America, British Columbia
Hoplocampa brevis	*Pyrus*	Central and Northern Europe, Asia Minor, northeastern North America
Caliroa matsumotonis	*Prunus* (esp. peach)	Japan
Athalia rosae	Brassicaceae	Europe, Asia
Trichiocampus pruni	*Prunus* (esp. cherry)	Japan
Metallus pumillus	*Rubus*	Europe
Arge mali	*Malus*	Japan
Cephus pygmeus	*Triticum*, other cereals	Europe, eastern North America, California
Diprion pini	*Pinus* spp.	Europe
Neurotoma saltuum	*Pyrus*	Europe

Table 2. Newly detected species or confirmed established in 2010-2012.

Species	Host	Known Washington Location
Gilpinia hercyniae	*Picea*	Whatcom Co.
Neodiprion sertifer	*Pinus*	Whatcom Co.
Diprion similis	*Pinus*	Mason, Thurston, Whatcom Co.
Craesus alniastri	*Alnus*	Throughout Washington
Heterarthrus vagans	*Alnus*	Whatcom Co.
Metallus lanceolata	*Geum*	Throughout western Washington
Trichiocampus viminalis	*Populus*	Thurston Co.
Trichiocampus gregarius	*Populus*	Okanogan Co.
Monophadnus pallescens	*Ranunclus*	Throughout western Washington
Pristiphora geniculata	*Sorbus*	Whatcom, Snohomish, King Co.

SPOTTED WING DROSOPHILA IN CONTEXT: AN EXAMINATION OF THE CONNECTION BETWEEN FLY POPULATIONS, CROP, AND SURROUNDING LANDSCAPE

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Introduction

Development of sound and effective management practices for spotted wing Drosophila (SWD), *Drosophila suzukii*, requires a thorough understanding of SWD behavior not only in cultivated crops but in adjacent trees and wildlands, as these areas may act as a refuge and alternative food source for the fly. Trap counts and damage levels within a crop may therefore be directly impacted by adjacent vegetation.

Methods

In this study, we examined the spatial and temporal distribution of SWD in a 6-acre, no-spray, commercial blueberry field and the surrounding landscape, located in Corvallis, OR (Benton county; mid-Willamette valley). Beginning in June 2011, red traps baited with a yeast/sugar or apple cider vinegar/soap mixture were placed in blueberry plants, along the perimeter of the blueberry crop, and in trees adjacent to the crop. Traps were serviced and the contents counted weekly, though counts of trap contents were carried out once every two weeks during the late fall-winter period. Traps in blueberry plants were placed at various distances from the edge of the field. Traps were placed in adjacent trees at three levels, including ground, 6 feet (2m), and over 13 feet (4m).

SWD infestation rates were obtained from blueberries at the site. Marketable fruits from plants in trapped areas were collected 3-4 times during the harvest period and reared in individual cups in lab.

Results

Initial increases in SWD trap catches in 2011 and 2012 were observed in June, in traps placed in trees. Over time, trap catches rose within blueberry plants and along the perimeter of the crop, beginning in areas closest to trees and becoming more evenly distributed through the crop during the blueberry harvest period. Trap catches in regions adjacent to the blueberry crop were highest in areas with greatest plant diversity, protection, and shade, particularly those associated with Himalayan blackberry. Throughout the study, SWD abundance in traps placed in trees was positively correlated with trap height.

In 2011, SWD abundance in crop traps increased through mid-November, long after blueberry harvest was complete (Fig. 1). This is consistent with the results of a mass-trapping study at the same site conducted between June 2010 and June 2011, in which trap catches peaked in November and declined after a 12-hour period of freezing temperatures (Fig. 2).

Despite similar trends in crop trap catches in 2010, 2011, and 2012, increases in average trap catches in the crop were observed 2-3 weeks earlier in 2012 than in 2010 or 2011 (Fig. 3). Average trap catches surpassed 1 fly/trap/week on 7/17 in 2012, compared to 8/3 in 2010 and 8/4 in 2011. Calculations of developmental degree-days (DD) for these dates were very close, with average trap catches surpassing 1 fly/trap/week at 536 DD in 2010, 577 DD in 2011, and 517 DD in 2012.

SWD larvae were observed in fruit earlier in 2012 than in previous years. First larvae were observed in 2012 on 7/15 at trap catches of 0.2 SWD/trap/week within the crop. First larvae were observed in 2011 on 7/27, at trap catches of 0.6 SWD/trap/week within the crop. Fruit infestation rates during 2011 and 2012 harvest periods increased steadily as fruit ripened, with samples reaching maximum infestation rates of over 40% in 2011 and over 50% in 2012. Infestation rates within the crop were highest in areas adjacent to diversified vegetation, reflecting the trend found in trap catches.

Conclusion

Ultimately, the knowledge gained in this study will lead to preventative and sound management practices. An understanding of SWD phenology as it relates to degree-day development models will aid in predicting SWD fly events, leading to appropriate timing of treatments and reduced use of unnecessary treatments. Features of the landscape adjacent to a crop may lead to the identification of risk factors that determine the vulnerability of the crop. Once potential hotspots of SWD activity are identified, management tactics can be targeted to these areas. Correlations between trap catches and crop infestation rate may be of great help in establishing damage thresholds.

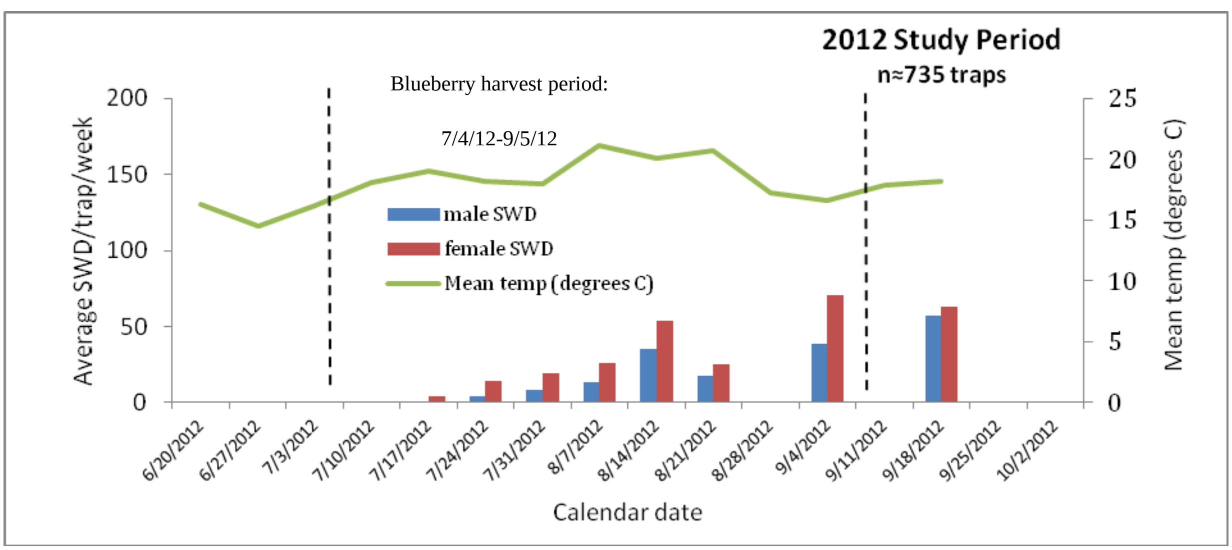

Figure 3. Seasonal phenology of male and female SWD catches in traps placed in a blueberry field between 6/20/12 and 9/18/12 in the mid-Willamette Valley (Benton county).

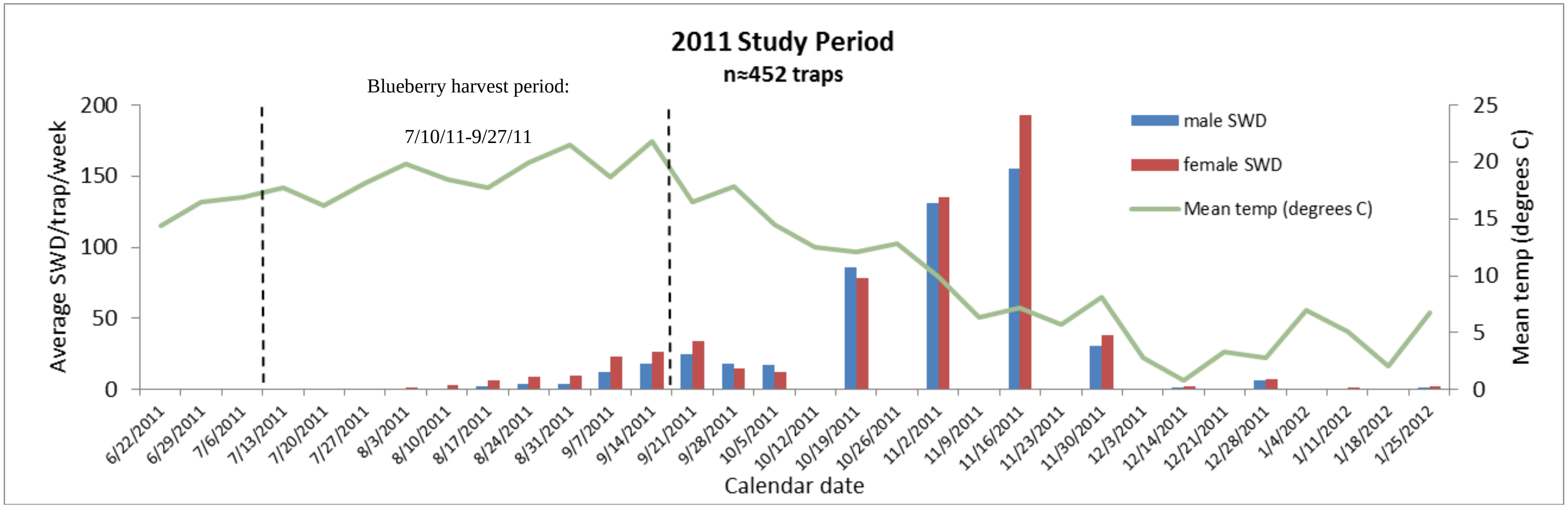

Figure 1. Seasonal phenology of male and female SWD catches in traps placed in a blueberry field between 6/22/11 and 1/25/12 in the mid-Willamette Valley (Benton county).

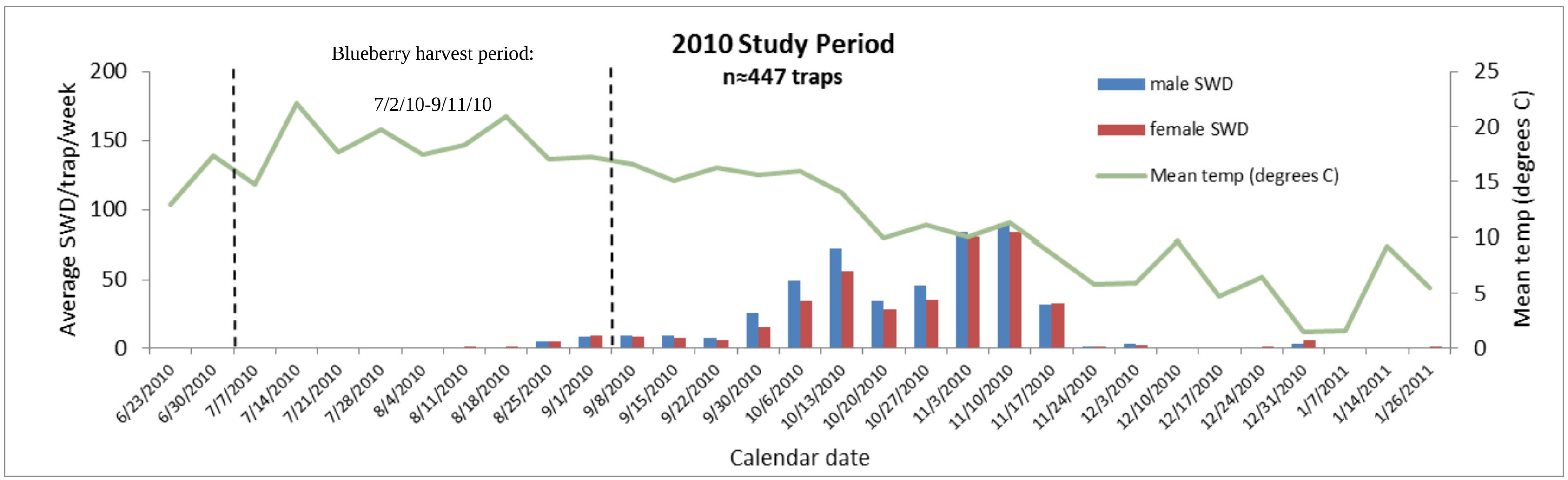

Figure 2. Seasonal phenology of male and female SWD trap catches in a mass-trapped blueberry field between 6/23/10 and 1/26/11 in the mid-Willamette Valley (Benton county).

A BOLD PROPOSITION: USING COI BARCODES AS A DIAGNOSTIC TOOL FOR MICROLEPIDOPTERA SURVEY

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While there may some lingering debate over the comparative validity of molecular and morphological taxonomy, genetic analysis is an increasingly prevalent identification tool in arthropod surveys. Molecular identification can be especially useful for insects because of their small size, the paucity of taxonomic experts, unavailable technical literature, and the often marginal condition of specimens. One approach that has gained recent traction is to compare cytochrome c oxidase I sequence data – the so-called COI barcode (Hebert et al. 2003). Barcoding has been used successfully for rapid Lepidoptera surveys, detecting both cryptic species and new exotics (de Waard et al. 2009).

In an effort to both test the utility of barcoding as an identification tool for specimens of various age and collecting method, and to facilitate identification of unknown specimens, WSDA submitted legs from 950 Pacific Northwest microlepidoptera specimens to the Barcode of Life Data System (BOLD) based in Guelph, Canada (Ratnasingham and Hebert 2007). Specimens ranged in collection date from 1996 through 2011, and were either collected by hand (including lab-rearing), with light traps into carbon dioxide or ammonia, or on sticky traps. Specimens from sticky traps were treated with citrus-based solvents to separate moths from the trap surface and to remove adhesive. The majority of specimens were collected with light traps (589), with the remainder split approximately evenly between sticky traps and hand collecting (Fig. 1).

BOLD processing includes attempting to amplify the COI gene and generate a high-quality sequence that can then be compared to the existing barcode library. Sequences for specimens that were successfully amplified were compared to the existing library, and processed using the BOLD Identification System (IDS). This process may match a specimen to an existing species, or return a series of “percent matches” with other sequences in BOLD or ancillary databases.

118 of the 950 specimens submitted did not amplify. Generally, amplification failure rates increased with specimen age, although variation in sample size and specimen handling across collecting methods are an important caveat that limits analysis (Fig. 2). Variability across all the

data suggest that individual handling and circumstances may be as important as age to amplification success, but there are no data to clarify what some of these effects (e.g. storing specimens in excessive heat) could be.

416 of the amplified specimens could be definitively matched to a species using the BOLD-ID engine. Twenty-three of these appear to represent new detections in the state, region, or continent, although more research is needed to confirm this.

416 of the submitted specimens amplified did not return a definite “species match”. This can occur due to poor sequence quality, lack of sequences in the database, or because the COI region is not particularly informative for a certain taxon. Species in recently derived lineages in particular can prove difficult to identify via mitochondrial molecular data (e.g. Kaila and Ståhls 2006). Thirty-one of the sequenced, yet unmatched, specimens may represent new detections in the state, region, or continent, or undescribed species. Like the BOLD-matched specimens, these require more investigation to determine their significance.

These results generally support using COI as another tool for pest or biodiversity survey. Fresh specimens offer the best chance for amplification, but even some specimens more than ten years old can be usefully barcoded. Finally, even when barcoding may not return definitive taxonomic answers, the results can be used to identify and select the most interesting species or problems from a sea of unidentified specimens.

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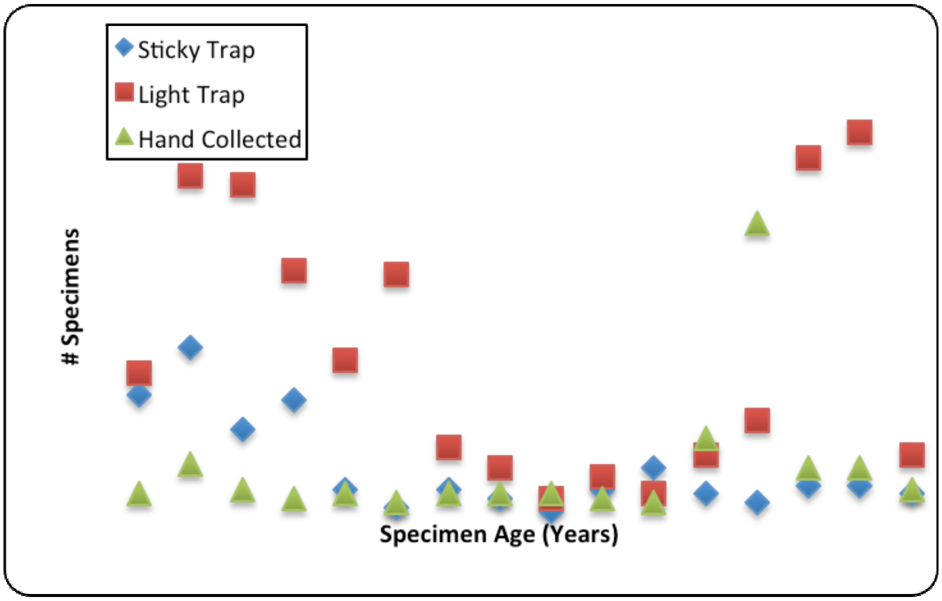

Figure 1: Number of specimens analyzed for each collecting method.

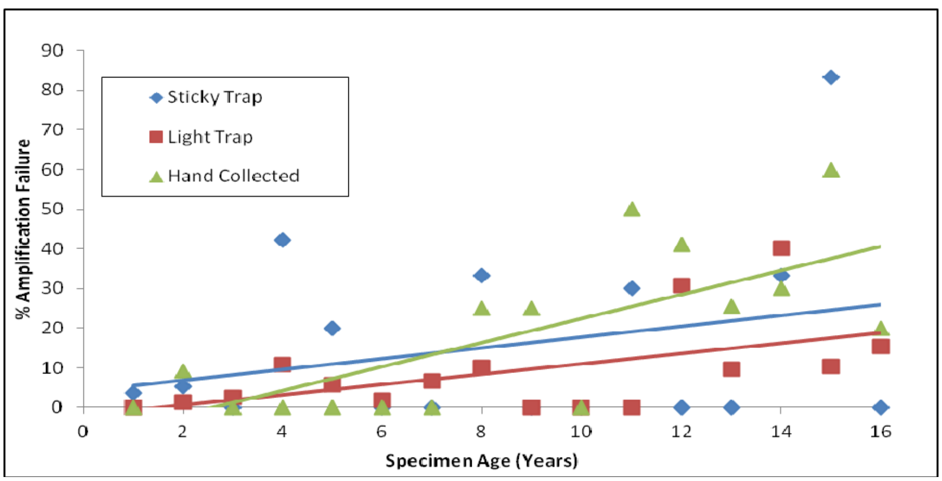

Figure 2: Percentage of microlepidoptera specimens that failed to amplify, by specimen age.

POTATO PSYLLID CONTROL IN PACIFIC NORTHWEST POTATOES

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Potato psyllids have been known to occur in potatoes for years, however during 2011 the first detection of zebra chip, a psyllid vectored disease, was found throughout the Idaho, Oregon and Washington potato industry. No control recommendations existed for this insect pest in PNW potatoes. Schreiber, Jensen and Rondon developed the first set of management guidelines for potato psyllids for the Washington, Oregon and Idaho potato industry.

Schreiber conducted a set of four efficacy trials in Washington in 2012; a 9 treatment and an 11 treatment brace of chemigation trials, a 22 treatment at planting/season long program trial and a 38 treatment foliar only efficacy trial. Of the eighty treatments, 60 yield data useful in the management of potato psyllid. General conclusions drawn from the trial was that 1) psyllid pressure was light throughout the trial, 2) psyllids appeared to have a very low rate of infectivity by the bacteria that causes zebra chip, 3) a large number of products seem to have some degree of efficacy against psyllids in a low pressure situation.

Results from the 2012 efficacy trial will be presented and their implications for management of psyllids will be reviewed.

EFFECT OF HUMIDITY ON DEVELOPMENTAL PARAMETERS

AND FIELD CATCHES OF *DROSOPHILA SUZUKII*

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Studies examining the effect that temperature has on developmental rate of spotted wing Drosophila (SWD) have been completed. However, the role that humidity might play has not yet been determined. We monitored for SWD in an organic managed blueberry field, located in the Willamette Valley for the past three years using apple cider vinegar traps. Trends were observed where trap catches were higher in different areas of the field. We hypothesized that humidity may be an important factor in determining the potential population increase of SWD and may account for this trap catch variability within a site. During the 2012 field season, HOBO data loggers were placed in two different areas of the field to track humidity and temperature in conjunction with the capture of flies, in traps baited with apple cider vinegar. SWD eggs and adults were exposed to five different relative humidity levels under controlled laboratory conditions. We recorded the time of development, longevity, and fecundity to determine the effect of humidity in a controlled setting. Results from these experiments will be synthesized and discussed to illustrate the importance of humidity as a factor for SWD population growth rate.

DISTRIBUTION OF BROWN MARMORATED STINK BUG IN OREGON AND RISK FOR SPECIALTY CROPS

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The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae), is a severe agricultural pest that has been established in Oregon since 2004. Until recently, BMSB had a limited distribution in OR, and has been primarily confined to urban areas where it has been a minor nuisance pest for homeowners. This pest was also regarded as an urban nuisance in Mid-Atlantic States for more than a decade following its initial detection in 1996, but has caused significant economic damage in a wide variety of crops since 2010. The ability of BMSB to feed on a multitude of crops and wild hosts, its strong capacity for flight, hitchhiking, population increase and its ability to tolerate many insecticides makes this pest difficult to manage. As of 2012, BMSB has been found in 38 states and economic problems continue to emerge in eastern states.

Here we report on our field surveys and pheromone trapping efforts from 2012 that were used to determine the distribution of BMSB, examine host plant use and to determine potential presence and impacts of BMSB on crops such as hazelnuts, tree fruits, small fruits, vegetables and ornamentals. Survey efforts were concentrated in important agricultural regions including the Willamette Valley, Columbia Gorge, Columbia Basin and Southern Oregon. For surveys, beat sampling was used for detection of adults and nymphs, and visual sampling was used for detecting egg masses in areas with established populations. For trapping, we evaluated season-long capture of adults and nymphs in large black pyramid traps baited with methyl decatrienoate and the USDA lure #10 compared with un-baited traps in commercial nursery and cranberry crops. Traps were also deployed for detection and monitoring in select commercial crops where BMSB was detected or thought to be present.

Two hundred and forty sites were sampled, covering more than 244 km of ground on foot across the state in our search for BMSB (**Fig. 1A**). These surveys resulted in new detections of BMSB and improved understanding of host plant use. Large, established populations of BMSB were found in four new counties. Three of these were in the Willamette Valley: Benton, Linn, and Lane counties. The fourth established population was found in Hood River County. All of these counties were given the designation of established because multiple BMSB stages were present, populations were found in multiple locations or high numbers of adults were found. The BMSB was also detected in three new counties: Jackson, Wasco and Union. The designation of detected reflects on the finding of smaller number of individuals of a single life stage. These survey results suggests that BMSB now present throughout the Willamette Valley, is spreading east through the Columbia Gorge and may be establishing in Southern Oregon (**Fig. 1B**). Sampling methods allowed for relative density estimations, which are discussed in our presentation.

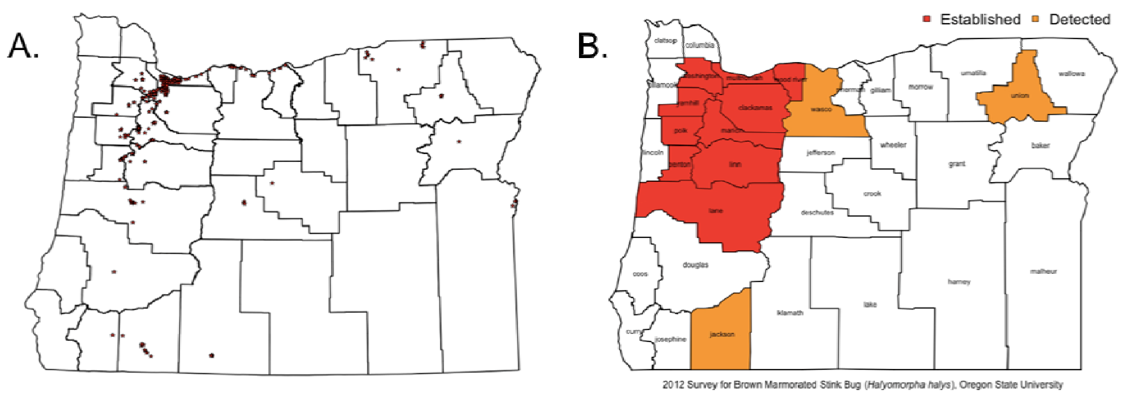

Figure 7. Distribution of sampling sites (A), and status of BMSB by county (B) in 2012.

Other significant findings from 2012 are the detection of BMSB in commercial crops for the first time in Oregon. There were 11 farms in the Willamette Valley where BMSB was found. The crops produced on these farms included hazelnuts, caneberries, winegrapes, vegetables and ornamentals. Generally, on-farm populations of BMSB were low, but in select cases numerous BMSB were detected in or proximate to crops by beat samples, visual sampling or pheromone traps. In one case, reproducing populations and high densities were found in the crop. It is important to note that economic damage to commercial crops was not detected, but clearly there is increasing cause for concern. Most of the farms that had BMSB were concentrated in one region of the Willamette Valley, which we now consider to be high-risk for future economic problems from BMSB. This area and other risk factors will be discussed in more detail in the presentation.

COMPARING ATTRACTANTS FOR SPOTTED WING DROSOPHILA MONITORING

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Since the first detection of spotted wind drosophila (SWD) in the northwest, field monitoring of SWD has been relied on traps filled with apple cider vinegar (ACV), which appears to be one of the strongest attractants for SWD. SWD has been present in Asian countries such as China for some time, reviewing literatures found rice and sorghum based Chinese vinegars (CV) were widely used not only as an attractant for monitoring, but served as an effective bait with other ingredients in mass trapping to achieve remarkable control of SWD in many fruit crops.

To compare ACV with CV in monitoring traps, we hope to determine if the CV is a better attractant than the ACV, and if other additives such as brown sugar and berry juices will affect the overall quality of the attractants. A commercial mature blueberry field was chosen in Hillsboro, OR for setting up two bait trials from January to May 2013. Soil and temperature loggers were install on site to provide year around soil temperature and air temperature data. The attractants in the first trial were ACV, CV, brown sugar, and banana in a factorial arrangement with controls for contrast comparisons. The attractants used in the second trial were: ACV, 25%CV, yeast, hard apple cider, beer, raspberry and blackberry juice with either ACV or CV in a factorial design. There are five replications for each treatment for both bait trials and traps were sampled every 7-10 days. Male and female SWD and other drosophilids were counted under a dissecting microscope. Only average total SWD per trap count is reported.

Observations from both attractants trails indicated that Chinese vinegar seemed to attract more SWD fliers than ACV in most sampling dates (Fig 1-2). Brown sugar addition increased the effectiveness of the CV attractant, while banana had no oblivious effects (Fig 1), which were in contrary to findings from the Chinese literature. Addition of raspberry juice and blackberry juice in both ACV and CV had no affect on the baits. Hard cider, yeast solution, and beer alone performed no better than ACV as trap baits. Average minimum temperature of 20 F seemed to keep SWD population in check for a few weeks. The main ingredients of Chinese vinegar used in the experiments were sticky rice and wheat bran fermented at the presence of sugar and salt. It will be very interesting to analyze the volatile compounds of the CV to dissect its attractive nature to SWD.

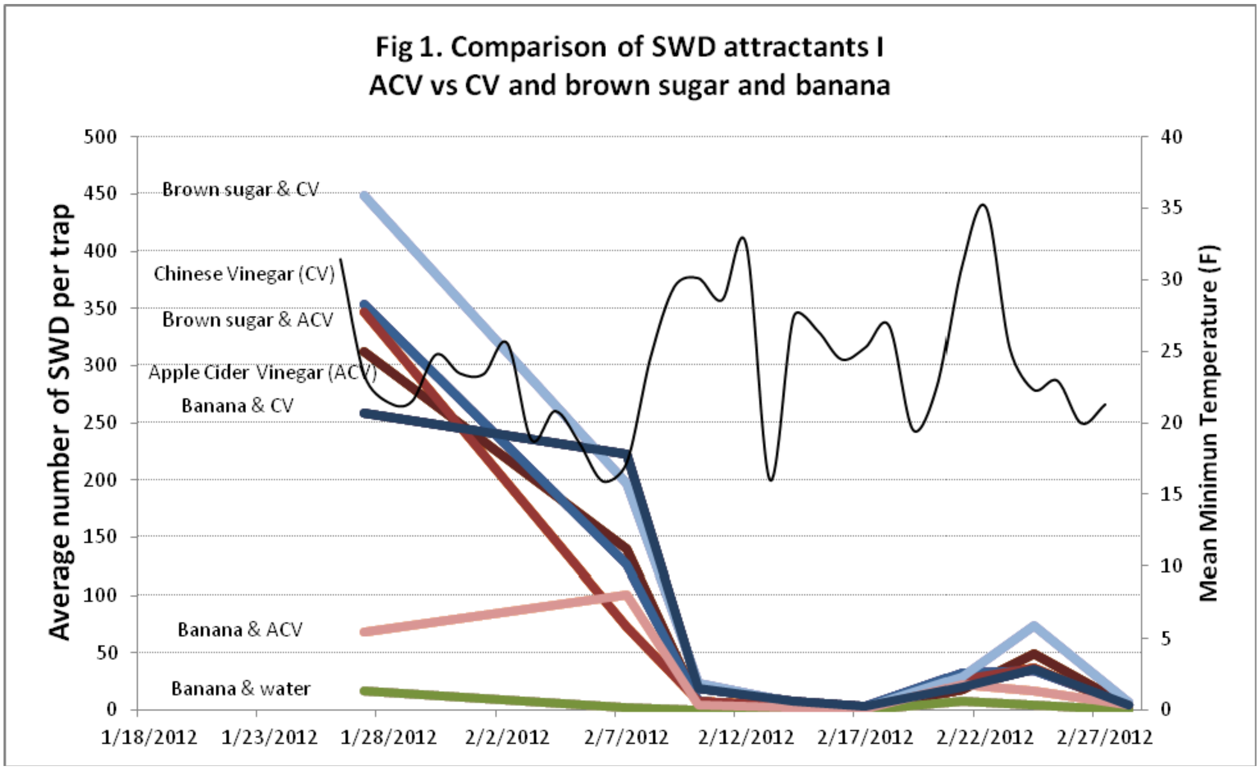
Fig 1. Comparison of SWD attractants I
ACV vs CV and brown sugar and banana
Average number of SWD per trap
Mean Minimun Temperature (F)
Brown sugar & CV
Chinese Vinegar (CV)
Brown sugar & ACV
Apple Cider Vinegar (ACV)
Banana & CV
Banana & ACV
Banana & water
500
450
400
350
300
250
200
150
100
50
0
40
35
30
25
20
15
10
5
0
1/18/2012
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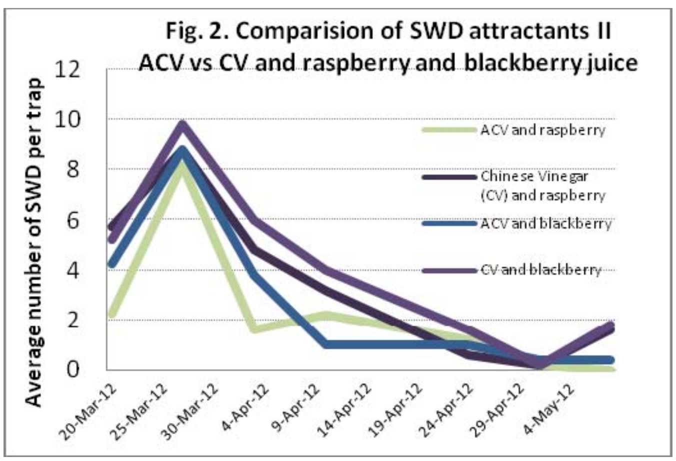
Fig. 2. Comparision of SWD attractants II
ACV vs CV and raspberry and blackberry juice
Average number of SWD per trap
ACV and raspberry
Chinese Vinegar (CV) and raspberry
ACV and blackberry
CV and blackberry
12
10
8
6
4
2
0
20-Mar-12
25-Mar-12
30-Mar-12
4-Apr-12
9-Apr-12
14-Apr-12
19-Apr-12
24-Apr-12
29-Apr-12
4-May-12

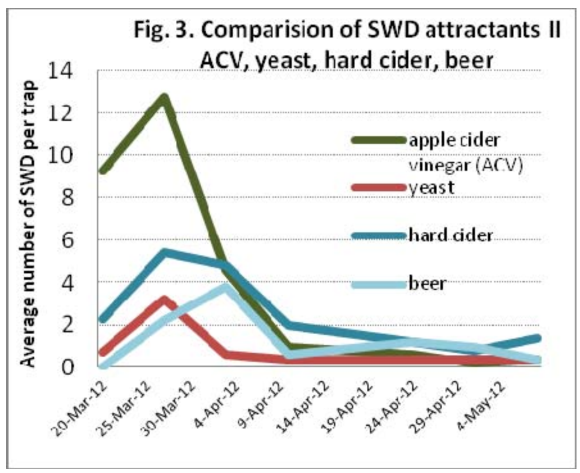
Fig. 3. Comparision of SWD attractants II
ACV, yeast, hard cider, beer
Average number of SWD per trap
apple cider vinegar (ACV)
yeast
hard cider
beer
14
12
10
8
6
4
2
0
20-Mar-12
25-Mar-12
30-Mar-12
4-Apr-12
9-Apr-12
14-Apr-12
19-Apr-12
24-Apr-12
29-Apr-12
4-May-12

SECTION II
ENVIRONMENTAL TOXICOLOGY & REGULATORY ISSUES

Moderator: Joe DeFrancesco

THE IR-4 PROJECT AND ITS RELEVANCE TO PEST CONTROL IN MINOR CROPS

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The Western Region IR-4 is part of a national USDA program which facilitates the registration of new crop protection tools for specialty crop growers. Located at UC Davis, the Western Region works closely with western land grant universities and extension specialists to prioritize appropriate projects and generate residue data for label expansions. Today's discussion will focus on the IR-4 process and its relevance to Pacific Northwest pest control in crops like caneberries, pome fruits and hops.

THE EFFECT OF POLLEN DIVERSITY AND ARTIFICIAL PROTEIN SUPPLEMENT ON HONEY BEE (*Apis mellifera* L.) HEALTH, PHYSIOLOGY, AND IMMUNOLOGY

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Introduction

The pollination requirement is huge for commercial agriculture in the United States. Honey bee pollination is estimated to be worth more than $20 billion in the U.S and worth $2 billion in the Pacific Northwest. Our current agricultural production involves extensive monocultures and enclosed greenhouse production with routine pesticide use. These production systems are without the presence of cover crops, which had once provided supplemental pollen sources for honey bees (Dimitri, 2005). Within this current system, honey bees are left with few pollen species in their diet for a significant amount of time as they are transported from bloom to bloom. These landscapes may not provide pollen from enough sources in order to maintain a healthy nutritional diet. Poor nutrition is correlated with a weakened immune system and heightened susceptibility of pathogens (Ritz and Gardner 2006, Eischen and Graham 2008, Alaux et al., 2010). Without proper nutrition, colonies may generate enough stress to negatively influence other important health factors (Stanley and Linskens 1974). Stress resulting from mono-cropping and habitat loss has been speculated to be one of the contributing factors for current colony population decline (Oldroyd 2007, Naug 2009).

The goal of this project is to evaluate effects of pollen diversity and artificial protein supplements on honey bee physiology, colony growth and immunology. This project will enable us to distinguish differences in colony fitness of more pollen-diverse and protein-rich pollen diets.

Materials and Methods

Pollen collection

Pollen loads were collected from foragers by fitting standard pollen traps onto hives that visit each pollinated crop. Almond, cherry, meadowfoam, and blueberry were the targeted crops. Pollen traps were installed on the hives when the bloom was 70 to 100 percent on target crops. Pollen from traps underwent analysis light microscopy and acetolysis in order to identify the floral resources in each pollen collection. Pollen treatments were formulated to represent a wide range of pollen diversity. Almond is a monofloral source and was used as the least diverse treatment diet. The 3 other treatments held increasingly large amounts of pollen species.

Experimental Design

Colonies were established in 5-frame nucleus boxes with naturally-mated sister queens and equal numbers of adult bees and stores. The nucleus colonies were situated in flight cages placed within the same apiary. Top feeders with 50% sucrose solution and external water feeders were applied to all colonies. One frame in each colony was empty built-comb; pollen treatments were inserted into these frames by distributing the raw pollen into the cells followed by a spray of 50% sucrose solution. This simulated workers to pack pollen into the cells thus initiating the pollen processing procedure (Dreller and Tarpy, 2000). Bee-Pro®, MegaBee®, and Global Patties® are three commonly used artificial protein supplements and served as three treatments groups for artificial diets.

Measurements

Honey bee physiology will be assessed by measurements of total gut proteolytic enzyme activity and hypopharyngeal gland protein quantification. Total gut proteolytic enzyme activity is associated with digestibility rate in the gut and will follow the same procedure as Sagili et al. (2005) and Michaud et al. (1995). Hypopharyngeal gland protein quantification within 'nurse' bees conveys the total amount of protein fed to developing brood. Nurse bees will be cold euthanized, their hypopharyngeal glands will be dissected and analyzed for protein using Bradford assay described by Sagili et al. (2005).

Phenoloxidase (PO) and prophenoloxidase (ProPO) enzymes are part of humoral immune responses that are present in the hemolymph of honey bees. PO and ProPO are associated with wound healing response and immunity. PO and ProPO analysis will be prepared following the method of Laughton & Siva-Jothy (2010). Measurements will be reported as optical density per minute and normalized by total protein (mg) using a standard BCA assay. Glucose oxidase (GOX) is associated with social immunity of the colony. GOX is utilized in nurse bees' hypopharyngeal glands to sterilize food before administered to developing brood. GOX measurements will be performed following the methods of Ohashi et al. (1999).

The various measurements of colony growth will be used to assess whether or not treatment diets can translate to the colony-level. A standardized grid will be used to assess colony resources: open brood, capped brood, pollen stores, nectar/honey stores (Pankiw et al., 2004). Colony growth was evaluated every 7 days. Queen supersedure and laying production (i.e. spotty-brood syndrome) was monitored as well.

Significance

This study will help us better understand the role of protein nutrition in colony growth and survival. Results will lead to a better understanding of how the quality of foraging landscapes and supplemental protein feed influence the nutritional health of colonies.

This project is underway and no data has been statistically generated yet. However, if diets with less pollen diversity are shown to be harmful to honey bee health, this project provokes pesticide use on forage landscape effects. Heavy pesticide use may constitute less diversity of bee-collected pollen within agricultural landscapes.

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SECTION III
FIELD CROP PESTS

Moderator: Tim Waters

BIRD CHERRY-OAT APHID RESEARCH REPORT

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Rosalosiphum padi, is a cosmopolitan aphid pest of many crops, primarily causing economic damage by vectoring host specific yellows viruses. In cereals, the virus is Barley Yellow Dwarf Virus, which causes stunting and yellowing resulting in yield losses of up to 40% in barley and fall seeded wheat. Increased acres of sweet corn, a preferred host plant, for export to Japan in the Columbia Basin, has increased *R. pad*i population. Alate flights upriver from the Basin to the Columbia Plateau and Palouse regions begin as the corn dries. Alate aphids arrive in fall seeded wheat (and other cereals) from emergence to hard freezing. Apterous aphids, produced by alates shortly after landing in wheat, are washed down in to leaf axils by fall rains and are very hard to locate without destructive sampling of the seedling plants. Virus is spread to the wheat by alate aphids ca. 12+ hours after arrival. Apterous aphids continue to vector virus by intrafield movement from plant to plant. The length of alate flight time and ambient temperatures allowing apterous movement determines the amount of virus vectored.

A large on farm experiment in RCB was established by seeding WPB528 soft white winter wheat on 10/12/2012, using 13 foot drills in rows of wheat treated with Thiomethoxam at 0.35 lb. aia as insecticide control, and rows of the same width as UTC treatments. (No wire worm activity was present due to heavy Imidacloprid application the previous winter).

Sampling in the fall of 2012 was from emergence of the wheat on to the time of cold rain on three subsequent sampling dates 10/19 (DPE), 11/1 (13 DPE), and 11/15. Sampling consisted of counts of aphids per 20 plants in 5 locations across and down a strip 360 feet long in each of four replicates. Means of alate and apterous aphids per strip were calculated from these data.
The trial will be evaluated for BYDV plant percentage in February, and then harvested by plot combine strips in July to obtain comparative yield data.

Data for fall 2012 aphid activity were no aphids in insecticide treatments on any sampling date and:
10/19 1 leaf stage 5 alates 100 plants mean UTC

11/01   3 leaf stage 20 alates and 40 apterous mean UTC

11/19   4-5 leaf stage 15 alates and 40 apterous mean UTC showing fewer flying aphids. A rain event occurred 11/22 ending the sampling.

INVESTIGATING ROOT HEALTH BENEFITS WITH FARMORE FI500 IN ONIONS

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The development of Farmore FI500 was initially driven by a need to deliver an improved system for management of seedcorn maggot, *Delia platura*, and onion maggot, *Delia antigua*, at and immediately after planting onions. These pests are responsible for reduced stands, plant quality, and yields where pressure is high. During this development effort, improved plant health and yields were observed in onions even in the absence of significant pest pressure. In leguminous crops, thiamethoxam seed treatments have been documented to result in improved root health and yields. This study was conducted to investigate the effects of Farmore FI500 on root health and yield in onions.

Farmore FI500 seed treatment in onions contains 5 active ingredients. Fungicides: mefanoxam, fludioxinil, and azoxystrobin. Insecticides: thiamethoxam and spinosad. Plots were planted at the Oregon State University Hermiston Ag Research Station in May 2012 in a field intentionally manipulated to increase seedcorn maggot pressure. Plant roots were harvested twice and scanned using a root scanner. Total root length, diameter and surface area were measured. Yields were measured at harvest. Data will be presented during this presentation.

MANAGING SYMPHYLANS BY ESSENTIAL OIL-BASED PESTICIDES ON VEGETABLES

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Symphylans or garden centipedes, *Scutigerella immaculata*, are not insects; they belong to the arthropod Class Symphyla that is related to centipedes and millipedes. Symphylans are occasional pests that feed on young roots of all plants and decaying organic matters. Their feeding on crops could stunt and kill the plants that might cause no yield in patchy areas of fields. The reasons of "why and when" that cause outbreak of the pest in different sites of fields are still not fully understood. The only strategy for managing the pest is conducting preventive tactics of applying pesticides in the hot-spot of past years in suppressing their activities to maintain the potential yield of the crops. The objective of the study was to investigate the effectiveness of essential oil-based pesticides for the management of symphylans on vegetables.

Fig. 1. Symphylans collected in the field by potato station

Management on Artichoke

A 10-acre perennial artichoke field with 2.5-acre of severe symphylan damage reported in the past years (hot-spot) at a commercial farm near Lompoc, CA was selected for the trial. The trial was conducted from October 2009 through June 2010.

Treatments

The perennial artichokes were chopped in early October 2009 and the EcoTec G was applied in the 2.5-acre hot-spot on the following day. EcoTec was then applied monthly from late October to February 2010 in the 10-acre field, except a 0.25-acre for Sesamin EC treatment and a 0.75 acre for EcoTec G treatment (Fig. 2). EcoTec G was applied on the artichoke beds and incorporated in 2-3 inch soil; whereas EcoTec or Sesamin EC was applied through the drip irrigation system.

1. *Treatment 1 on a 1.5-acre hot-spot*: 28 lb EcoTec G per acre was applied once in October 2009 and 32 oz EcoTec per 100 gal water per acre (+ 0.5% Widespread Max) was applied monthly from November 2009 through February 2010.
2. *Treatment 2 on a 0.25-acre (1-row) next to Treatment 1 in the hot-spot*: 28 lb EcoTec G per acre was applied once in October and 1 gal Sesamin EC per 100 gal water per acre was applied monthly from November through January 2010.
3. *Treatment 3 on a 0.75-acre next to Treatment 2 in the hot-spot*: 28 lb EcoTec G per acre was applied once in October 2009.
4. *Treatment 4 on a 7.5-acre next to Treatment 3*: 32 oz EcoTec per 100 gal water per acre (+ 0.5% Widespread Max) was applied monthly from October 2009 through February 2010.

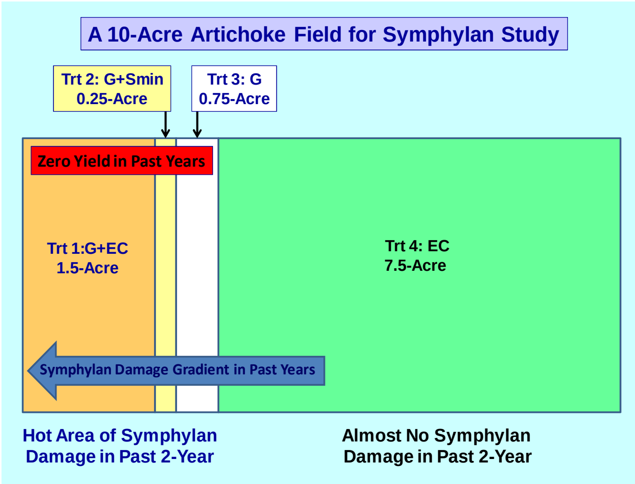

Fig. 2. The experimental design of the artichoke field.

Results and Discussions

The artichokes were harvested for 8 times weekly from April to June 2010. However, only the yield of Treatments in some reserved areas of the field were recorded and analyzed in this study. A 75-ft bed was reserved in 3 rows of Treatment 1, 1 row of Treatment 2, 2 rows of Treatment 3, and 3 rows of Treatment 4 in estimating the yield. The reserved areas were harvested on April 15, April 27, and May 5 2010.

The artichokes harvested in each treatment were categorized accordingly to the marketing value of artichokes at15 per box, 18 per box, 24 per box, and 30 per box. The mean number of artichokes harvested and the percentage of the yield potential reserved were calculated and presented in the following bar graphs (Figs. 2 and 3). The highest mean yield (Total) of the 3 harvesting dates was Treatment 4 having 67.3 artichokes per harvesting day, followed by Treatment 3 with 61.3 artichokes, then Treatment 2 with 57.3 artichokes. The lowest mean yield was Treatment 1 that had 55.3 artichokes per harvesting date (Fig. 3).

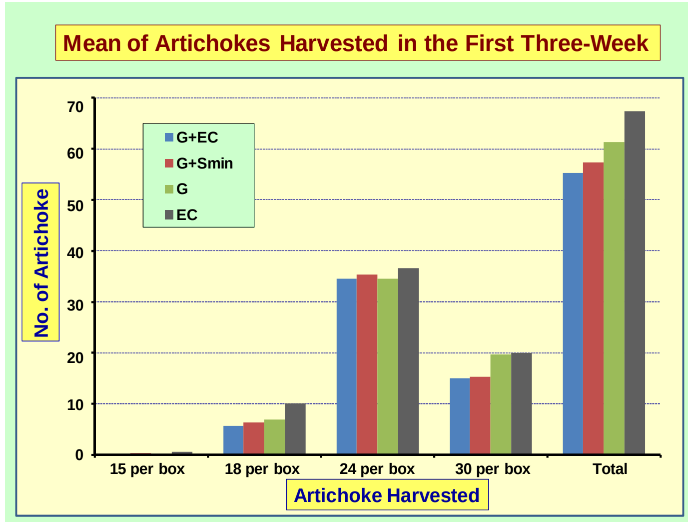

Fig. 3. Mean yield of artichokes harvested in a 75-ft row of the first 3-week of Field.

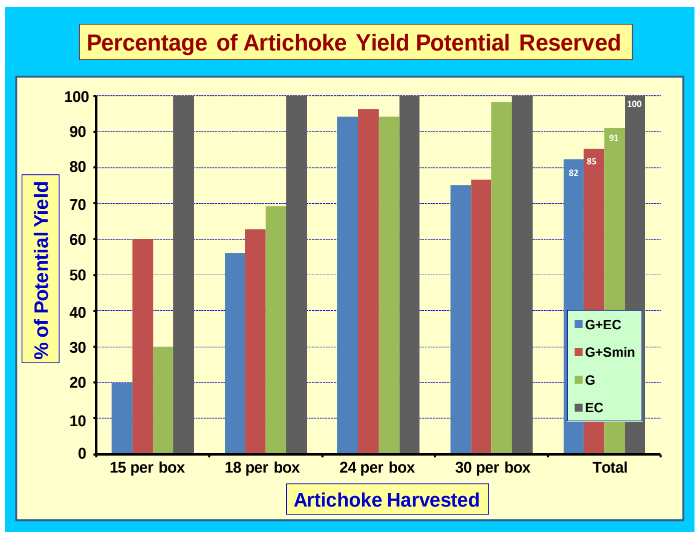

Fig. 4. The percentage of yield potential reserved by all treatments in the first 3-week

In the past 2-year, the 2.5-acre hot-spot with severe symphylan damage in the field had almost no yield because of stunting and killing of the plants by the pests (Personal Communication with the Farms). Thus, no untreated areas were reserved in the field for this study. Instead of comparing an untreated treatment with severe damage and no yield, the objective of the study was focused on reserving the potential yield of the field by the assigned treatments.

Based on the observations in the past years by the Farms, the 10-acre field of the study was believed to have a gradient of symphylan activities with extreme damage on one side and almost no damage in the center and on the other side of the fields. Hence, Treatments 1, 2, 3, and 4 were assigned for the highest to the lowest symphylan damage areas, respectively (Fig. 2).

The results of the study demonstrated that the yield of all treatments were coincident with the symphylan damage gradient in the past years with the highest yield on the lowest symphylan activity areas and the lowest yield in the highest activity sites (Figs. 2, 3, and 4). There was no symphylan damage observed on all treatments during the study; furthermore, the highest yield was Treatment 4 and the lowest yield was treatment 1. Using the yield of Treatment 4 with low or no symphylan damage recorded in the past years and year 2010 as a 100 % in yield; Treatments 1, 2, and 3, reserved the artichoke yield potential as 82.2, 85.1, and 91.1% in 2010, respectively (Fig. 4). In other words, Treatments 1, 2, and 3 increased the yield of 0% in the past years to more than 82% in 2010. The results of this study indicated that the essential oil-based pesticides, including EcoTec G, EcoTec, and Sesamin EC had strong impact in suppressing or controlling symphylan activities on perennial artichokes.

Management on Tomato

Further investigation of the EcoTec effectiveness on symphylans was conducted on tomato (about 1/4 acre) at the University of California Cal Poly Organic Farms in 2012. The results demonstrated that even the tomato transplants were stunted by the symphylans after transplanted; however, after two applications of 40 fl oz EcoTec through the drip irrigation system, the tomato plants were protected by the EcoTec and fruits were harvested in two months at the Organic Farms.

Management on Vegetables

Further investigation of the EcoTec G effectiveness on symphylans was conducted on vegetables at the hot-spot in the past years (about half-acre) at the Organic Farms of the University of California Santa Cruz in 2012. The results showed that applications of 28 lb EcoTec G that was incorporated in 1-2 inches soil once during planting or transplanting, the essential oil-based pesticide could protect the vegetables from symphylan damage and reserved the potential yield of the crop. Moreover, no symphylan damage was observed in the hot-spot and vegetables were harvested in two months at the Organic Farms.

Conclusions

For short-term control (3-week) of symphylans on annual crops by essential oil-based pesticides, such as on direct seeded vegetables; applying 28 lb EcoTec G and incorporated into 1-2 inch of soil during planting.

For long-term control (seasonal) of symphylans on perennial crops by essential oil based pesticides, such as artichokes; applying 28 lb EcoTec G and incorporated into 2-3 inch of soil, and/or applying 32-64 fl oz EcoTec plus organic or convectional adjuvant through the drip irrigation system during the last watering cycle in every 2-4 weeks, depending on the symphylan pressure.

POST-HARVEST CONTROL OF MINT ROOT BORER IN FURROW IRRIGATED MINT USING CORAGEN®, MOCAP, AND LORSBAN, IN WESTERN IDAHO

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INTRODUCTION

Coragen insecticide is still relatively new to the mint industry and it is unknown if the rate of Coragen used affects the amount of Mint Root Borer control in furrow irrigated mint. Mocap has also been registered relatively recently. Last years' trials showed Mocap to be very effective in controlling Mint Root Borer larvae at the lowest labeled rate. It was decided to test Mocap again at the lowest rate and a rate lower than the label lists. In addition, Lorsban was surprisingly effective in last year's trials. Coragen may become the standard insecticide for Mint Root Borer control if Lorsbans' uses are limited or eliminated, so Coragen should be thoroughly tested.

OBJECTIVE

Test the efficacy of Coragen and Mocap at different rates, for post-harvest control of Mint Root Borers in furrow irrigated mint.

MATERIALS AND METHODS

Two identical trials (Experiments 3 and 4) were established in production, furrow irrigated peppermint fields. Experiment 3 was located near Wilder, Idaho; Experiment 4 was near Greenleaf, Idaho. Plots were arranged in a randomized block design. Plots of 18'x 20' were replicated six times. The Coragen and Lorsban treatments were broadcast applied with a CO_2 powered backpack sprayer in 20 GPA of water. No surfactant or adjuvant was added to any treatment. The granular Mocap was weighed out and hand sprinkled on each plot.

Experiment 3 was swathed around August 24 and Experiment 4 was swathed around August 13. All the treatments were applied on August 30 and August 20 for Experiments 3 and 4, respectively. For Experiment 3, the field was corrugated and irrigated about four days after the treatments were applied. Experiment 4 was corrugated before the treatments were applied. For Experiment 4, the furrow irrigation was started as the treatments were applied. The furrow irrigation on Experiment 4 had the water running down every sixth furrow, so the whole plot was not irrigated on the day the treatments were applied. The rows of mint were approximately 33 inches wide. With only one in six furrows being irrigated, little of the plot area was wet when the treatments were applied. These areas that were irrigated as the treatments were applied were not sampled.

There was a light rain event on September 22. The exact amount of rain is unknown but it is estimated to be between 0.1 or less of an inch. The Nampa Agri-met station reported 0.02 inch on Sept. 22.

The corrugation of both experiments was done with a double disk. This implement threw very little soil on top of the row. The soil was dry at the application time of both experiments. In Experiment 3, at the time the treatments were applied, it was observed, that there was an unusual amount of dead leaves from this year's crop, on the soil surface. In addition, there were also many dead stems from previous crops, on the soil surface. It was speculated that this layer of dead plant material might intercept the Coragen or Lorsban from reaching the soil surface.

Experiment 4 had little dead leaf material on the soil or old stems compared to Experiment 3. Experiment 4 did have approximately half of the plot area randomly infested with field bindweed. It is unknown if the bindweed had any effect on the MRB populations.

Evaluation of the MRB control was done by digging eight, 0.75 ft^2 soil samples in each plot. The soil was shaken off the mint rhizomes and sifted through a 0.25" screen. The rhizomes were placed in Berlese funnels until dry and the total number of MRB larvae was combined with that found from soil sifting. The application rates, dates and results are listed in Table 1.

Experiment 3 was sampled approximately 45 days after the treatments were applied, while Experiment 4 was sampled approximately 55 days after treating. Both experiments were sampled starting on October 15 and sampling was completed by October 20.

RESULTS AND DISCUSSION

Both experiments had lower MRB levels than expected. In Experiment 3, the MRB populations decreased due to natural causes between the end of August and the October 15 sampling date. The low MRB populations make it difficult to determine differences in the amount of control that a treatment may have caused.

Experiment 3 had no significant differences between the untreated check and either Coragen treatment (Table 1). Both Mocap treatments and the Chlorpyrifos treatment did have a significantly lower MRB level than the untreated check, but were not significantly different from each other. It is speculated that the heavy layer of dead plant material may have reduced the effectiveness of the Coragen. It is unclear how much, if any of the Coragen that contacts the soil is taken up by the mint roots. It is also unclear how, much if any, of the Coragen that comes in contact with any green plant material, enters the mint rhizomes and controls the MRB larvae.

Experiment 4 had no significant differences between any treatment and the untreated check. In Experiment 4, both Mocap treatments and the Chlorpyrifos treatment did have numerically lower MRB levels than the untreated or Coragen treatments, but the differences were not significant.

Experiment 4 also had less fresh organic material on the surface of the soil yet; the Coragen results were no more positive than in Experiment 3.

Table 1. Application rates and levels of Mint Root Borer control from Coragen, granular Mocap and Chlorpyrifos (Lorsban), applied to furrow-irrigated peppermint, post-harvest in the Wilder Idaho area (Experiment 3) and Greenleaf Idaho area (Experiment 4).

Trmt. #	Treatments	Rate/acre (product)	Mean number of live MRB larvae sq. ft.	
			Exp. 3	Exp. 4
1	Untreated check		1.4 b	2.9
2	Coragen 18.4% ai	3.5 fl oz	0.7 ab	2.4
3	Coragen 18.4% ai	5 fl oz	0.9 ab	2.6
4	Mocap 15G	15 lb/a	0.3 a	1.3
5	Mocap 15G	20 lb/a	0.4 a	1.5
6	Lorsban 4E	64 fl oz	0.4 a	1.6
	LSD		0.73	NS

Experiment 3: Coefficient of Variation=92.9%,
Experiment 4: Coefficient of Variation=84.4%
Sample means were compared with Fisher's Protected LSD (p=0.05).
Means with the same letter are not significantly different (Petersen 1985).

CONCLUSIONS

Coragen applied after harvest, appeared to provide little to no MRB control for either rate in either experiment, compared to the untreated check. There was no significant difference in the amount of control between either rate of Coragen.

Both rates of Mocap and the Chlorpyrifos provided significant control of the MRB larvae, in only one of the two experiments. There was no significant difference in the amount of control between the 20 lb/ac and the 15 lb/ac rate of Mocap.

Mocap and Chlorpyrifos again provided overall better results than the Coragen treatments in both experiments but Mocap and Chlopyrifos did not perform as well in 2012 as they did in 2011.

The high amount of fresh organic material in Experiment 3 did not seem to affect the Coragens' control of the MRB larvae when compared to Experiment 4 that had much less organic material.

The low levels of MRB larvae in both of these experiments, partly clouds the results and makes it difficult to be confident in any conclusions drawn from these 2012 experiments.

Further research should be conducted to determine why Coragen has failed to be as effective in these experiments, as it has been previously.

EFFICACY OF CORAGEN AND AVAUNT INSECTICIDES APPLIED PRE-HARVEST FOR CONTROL OF MINT ROOT BORER IN NORTHEAST OREGON

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INTRODUCTION

Coragen (chloroantraniliprole) and Avaunt (indoxacarb)are registered for control of foliar feeding cutworms, but have been used little because they cost more than the other commonly used products. However, Coragen and Avaunt are systemic, have a longer residual than other products, and they have ovicidal properties. This combination could provide pre-harvest control of the Mint Root Borer (MRB) in the egg and/or first instar stage, instead of controlling it post-harvest.

OBJECTIVE

Test efficacy of Coragen and Avaunt when applied at different pre-harvest dates for control of mint root borers.

MATERIALS AND METHODS

Three sites were located in production peppermint fields near La Grande, Oregon. At each site, a randomized block design with five replications was set up on four separate treatment dates.

The four separate treatment dates were determined by using local data, and the degree-day model for MRB found on the IPMP website (mint.ippc.orst.edu). It was determined that the four application dates would coincide with the accumulated Degree-Days (DD) of 750 DD, 900 DD, 1100 DD, and 1250 DD. The peak MRB egg-laying time occurs around 1100 DD. In addition, one treatment had the insecticides applied twice, once before and once after the peak egg-laying period.

Experimental plots were 18' x 20' sections of production peppermint fields. Treatments were applied with a CO_2 backpack sprayer (20 GPA at 35 psi). A mentholated seed oil/organosilicone surfactant blend called SYL-TAC was added at a rate of 1% V/V to each treatment. All Coragen treatments were applied at the maximum rate of 5 fl oz/ac while all the Avaunt treatments were applied at the maximum rate of 3.5 oz/ac.

The third experiment was not evaluated due to the MRB levels being too low.

For experiment one, on the third application date, it rained heavily approximately 2.5 hours after the treatments were applied. No other significant rain events or irrigations occurred within 24 hours of any application.

In experiment one, numerous MRB moths were observed on July 9, when the first treatment was applied. Only a few MRB moths were observed on the next three application dates.

Sampling for the MRB larvae took place about ten days after swathing for experiment one and 28 days for experiment two. Evaluation of the MRB larvae control was done by digging eight, 0.75 ft^2 soil/rhizome samples in each plot. The soil was shaken off the mint rhizomes and sifted through a 0.125" screen. The rhizomes were placed in Berlese funnels until dry and the total number of MRB larvae (combined data from soil sifting and Berlese funnel extraction) was recorded. The application rates and dates are listed in table one. Experiment one was swathed on 8/13/12 while experiment two was swathed on 8/11/12.

Table 1. Application dates and rates of Coragen and Avaunt applied to peppermint, pre-harvest in the La Grande, Oregon area. (Experiments one and two)

Trmt. #	Treatments	Rate/acre	Application dates	Accumulated degree-days in La Grande area using Imbler Agmet data and MRB degree-day model.
1	Untreated check			
2	Coragen 18.4% ai	5 fl oz	7- 9	737
3	Coragen 18.4% ai	5 fl oz	7-18	919
4	Coragen 18.4% ai	5 fl oz	7-24	1023
5	Coragen 18.4% ai	5 fl oz	8-4	1219

6	Coragen 18.4% ai	5 fl oz	7-18 +	919 +
		5 fl oz	8-4	1219
7	Avaunt 30 WG	3.5 oz	7- 9	737
8	Avaunt 30 WG	3.5 oz	7-18	919
9	Avaunt 30 WG	3.5 oz	7-24	1023
10	Avaunt 30 WG	3.5 oz	8-4	1219
11	Avaunt 30 WG	3.5 oz	7-18 +	919 +
		3.5 oz	8-4	1219

RESULTS AND DISCUSSION

The accumulated degree-days in 2012 were approximately three days behind the 30-year average. By comparison, the accumulated degree-days in 2011 were approximately 14 days later than the 30-year average. With 2012 being a nearly normal year for degree-day accumulation, the 2012 application dates were about 12 calendar days ahead of 2011.

No data was collected on the efficacy of cutworm control from either experiment. The growers treated all three fields containing the experiments with Orthene, eliminating most cutworms.

Experiment one clearly shows that the first three application dates, and the double application of Coragen, significantly lowered the MRB levels compared to the untreated check (table 2). This is the first documented control of mint root borer, pre-harvest, with any insecticide labeled for mint. The heavy rainfall that occurred 2.5 hours after the Coragen was applied in experiment one, had no apparent negative effect, on the control of the MRB. The last application date of Coragen and all of the Avaunt treatments did not lower the MRB larvae levels, compared to the untreated check.

It is curious that the MRB levels in the untreated check level are lower than all of the Avaunt treatments and last Coragen treatment. This may be due to sampling error caused by some of the untreated plots being sampled about four days earlier than the rest of the plot area.

This earlier sampling may have affected the extraction of the MRB larvae, from the rhizomes, in a negative way.

In experiment two, the MRB larvae levels were low, and unevenly distributed, as indicated by the Coefficient of Variation being high (126%). Yet two of the Coragen treatments provided significantly lower MRB levels than the untreated check. Experiment two follows the same trend as experiment one, with all the treatments except the last application date, providing the most MRB control. In addition, the last application date provided the least MRB control in both experiments.

The double application of Avaunt is numerically lower than any other Avaunt treatment but is still not significantly lower than the untreated check. The Avaunt treatments generally provided little to no control of the MRB larvae.

Table 2 Experiments one and two.

Pre-harvest applications of Coragen and Avaunt insecticides for control of Mint Root Borer eggs/ first instar larvae. (La Grande, Oregon Summer 2012)

Trmt. #	Treatment	Accumulated Degree-days Imbler, Oregon	Application date(s)	Average live mint root borer (Per ft^2)	
				Exp.1	Exp.2
1	UTC			4.5 b	1.07 bc
2	Coragen	737	7- 9	0.67 a	0.03 a
3	Coragen	919	7-18	0.13 a	0.17 ab
4	Coragen	1023	7-24	1.03 a	0.3 ab
5	Coragen	1219	8-4	7.67 cde	1.04 bc
6	Coragen	919 +1219	7-18 + 8-4	0.1 a	0.1 a
7	Avaunt	737	7- 9	9.37 e	0.5 ab
8	Avaunt	919	7-18	6.5 bcde	0.6 ab
9	Avaunt	1023	7-24	8.17 de	1.53 c
10	Avaunt	1219	8-4	5.8 bcd	0.63 abc
11	Avaunt	919 + 1219	7-18 + 8-4	5.13 bc	0.2 ab

LSD	2.96	0.9

Experiment one CV=52%, Experiment two CV=126%
Sample means were compared with Fisher's Protected LSD (p=0.05).
Means with the same letter are not significantly different (Petersen 1985).

CONCLUSIONS

Applying Coragen once at 5 oz/ac around 750 to 1000 accumulated DD, pre-harvest, provided significant control of the MRB. In addition applying it twice at approximately 900 and 1200 DD also provided significant MRB control. The single application of Coragen at 1200 DD appears too late to provide any significant control. This research shows that Coragen can control MRB in the egg and/or first instar stage before harvest. Avaunt appears mostly ineffective in controlling MRB eggs and/or first instar larvae at any date. This experiment should be repeated to verify if pre-harvest control with Coragen could be consistent.

EFFICACY OF CORAGEN® APPLIED BY TWO METHODS AND WATERED-IN WITH DIFFERENT AMOUNTS OF IRRIGATION WATER, FOR CONTROL OF MINT ROOT BORER, IN NORTHEAST OREGON

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INTRODUCTION

Coragen insecticide (chloroantraniliprole) can be applied by chemigation or by ground sprayer, and then incorporated with overhead sprinkle irrigation, for control of Mint Root Borers (MRB). Some growers find it more convenient and accurate to ground apply the Coragen and water it in, than to chemigate it.

Coragen insecticide has been proven to be highly effective in controlling Mint Root Borer larvae when they are in the mint rhizomes. However, in the fall of 2010, and 2012, some mint fields in the La Grande, Oregon area, that had Coragen sprayed on them and then incorporated with irrigation, had poor to no control of MRB. It was speculated that too little water was applied on the first irrigation to incorporate the Coragen. This study was designed to test this idea.

OBJECTIVE

Compare the efficacy of Coragen, when applied with a ground sprayer and watered in with different amounts of water, to chemigating Coragen with different amounts of water.

MATERIALS AND METHODS

A single experiment was established post-harvest, in a production, wheeline-irrigated mint field infested with mint root borer larvae. This field was swathed on Aug. 13, 2012. The wheeline that irrigated the field had shutoff valves attached to the sprinklers over the plot area so that no water was applied from the wheeline.

The maximum rate of Coragen (5 fl oz/a) was applied to the dry soil on treatments two through five on Aug. 28, 2012. These four treatments were applied using a $C0^2$ powered backpack sprayer with 20 GPA of water. No surfactant or adjuvant was added to any treatment. An untreated boarder of two feet was left around each treatment. Plots were 18' x 20', in size, and were replicated five times, in a randomized block design.

Water from a nearby mainline was used to hand water each plot with watering wands, approximately 24 hours after the 5 oz/a Coragen was applied (table 1).

The simulated chemigation treatments were applied on Aug. 29, 2012. The simulated chemigation was accomplished by saturating the soil with water, applying the 5 oz/a Coragen with a $C0^2$ backpack sprayer, then immediately continuing watering (table 1). The total amount of water applied during this simulated chemigation included the water that was applied before and after the Coragen was applied.

The water for these chemigation treatments also came from the nearby main line and was applied with hand-held watering wands. The correct amount of water was determined by measuring the amount of water that came out of the watering wands for a measured amount of time. It was then determined how long a plot had to be watered to obtain the correct amount of water.

No more water from the wheeline was applied as of Sept. 13, 2012. However on Sept. 14 and 15, 2012, garden sprinklers were used to irrigate the entire plot area. This second irrigation was needed because the mint in the treatments that received less than 2 inches of water, were struggling to survive due to drought. One more irrigation was applied by the grower around September 27 with about 3.5 inches of water. There was no significant rainfall after harvest before the sampling was completed on October 10. The treatments, dates, and amounts of water applied are listed in table 1.

Table 1. Coragen treatment dates and amounts of water applied with different application methods. (La Grande, Oregon 2012)

Trmt. #	Treatment	Amount of Coragen (18.4% ai)	Date Coragen applied.	Amount of water applied (Inches / acre)	Date water applied.
1	Untreated check			2.0	8-29-12
2	Coragen applied, and	5 fl oz	8-28-12	0.75	8-29-12

	watered in later.				
3	Coragen applied, and watered in later.	5 fl oz	8-28-12	1.0	8-29-12
4	Coragen applied, and watered in later.	5 fl oz	8-28-12	1.5	8-29-12
5	Coragen applied, and watered in later.	5 fl oz	8-28-12	2.0	8-29-12
6	Coragen chemigated	5 fl oz	8-29-12	0.75	8-29-12
7	Coragen chemigated	5 fl oz	8-29-12	1.0	8-29-12

Rhizome and soil samples were taken between October 4th and 10th, or 36 to 42 days, after the treatments were incorporated by water. Twelve, 0.75 ft^2 rhizome/soil samples were dug from each plot. The soil was shaken off the mint rhizomes and sifted through a 0.25" screen. The rhizomes were placed in Berlese funnels until dry and the total number of MRB larvae collected from the Berlese funnels were combined with the larvae found from soil sifting.

RESULTS AND DISCUSSION

The Mint Root Borer populations were lower than expected, and the population densities were highly variable, as shown by the Coefficient of Variation being high at 116%. The low level of MRB larvae make it more difficult to clearly see the differences between the results caused by the treatments, and natural variation that occurs in the MRB population.
All treatments reduced the MRB levels significantly, at the p=0.05 level compared to the untreated check (table 2). In addition, none of the treatments were significantly different from each other (table 2).

There is not even a trend indicating that the amount of water applied after spraying on the Coragen made any difference in the effectiveness of the Coragen. There was also no trend indicating that chemigating is any more effective than broadcast spraying and watering the Coragen in a day later.

Table 2. Coragen applications of 5 fl oz/ac using different amounts of water to incorporate, different methods of applications and dates of water applications. (La Grande, Oregon area 2012)

Trmt. #	Treatment	Date Coragen applied.	Amount of water applied (Inches/acre)	Date water applied.	Mean Number Live Mint Root Borer per ft^2.
1	Untreated check		2.0	8-29-12	2.8 b
2	Coragen applied, and watered in later.	8-28-12	0.75	8-29-12	0.3 a
3	Coragen applied, and watered in later.	8-28-12	1.0	8-29-12	1.2 a
4	Coragen applied, and watered in later.	8-28-12	1.5	8-29-12	0.5 a
5	Coragen applied, and watered in later.	8-28-12	2.0	8-29-12	0.3 a
6	Coragen chemigated	8-29-12	0.75	8-29-12	1.0 a
7	Coragen chemigated	8-29-12	1.0	8-29-12	1.0 a
				LSD	1.54

Coefficient of Variation=116%; Sample means were compared with Fisher's Protected LSD (p=0.05).
Means with the same letter are not significantly different (Petersen 1985).

CONCLUSIONS

All Coragen treatments reduced the MRB larvae levels significantly after harvest, however the low number of MRB larvae and the variation make the results less conclusive than they appear.

The total amount of water applied (under 2 inches) after the Coragen was sprayed on, does not seem to impact the effectiveness of Coragen in controlling the MRB.

Chemigating does not appear to be any more effective in controlling MRB than spraying Coragen and watering it in a day later.

Further studies should be done to determine what factor(s) affect Coragen's ability to control MRB larvae after harvest.

EFFICACY OF CORAGEN® AND AVAUNT® INSECTICIDES, WHEN APPLIED PRE-HARVEST, FOR CONTROL OF MINT ROOT BORER IN FURROW-IRRIGATED MINT LOCATED IN WESTERN IDAHO.

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INTRODUCTION

Coragen® (chlorantraniliprole) and Avaunt® (indoxacarb), are relatively new insecticides for the mint industry. Both of these insecticides are different from other common mint insecticides because they are effective ovicides as well as larvacides. They also have a significant amount of residual activity compared to some other mint insecticides. These properties provide the possibility of a new approach for Mint Root Borer (MRB) control by providing pre-harvest control. This could be very useful, especially in furrow irrigated mint where post-harvest MRB control can be difficult. Both of these insecticides also control foliar feeding cutworms. Controlling two mint pests at the same time provides the possible benefit of less insecticide applications. Both Coragen and Avaunt have very low toxicity levels and have short Restricted Entry Intervals (REI) and Pre Harvest Intervals (PHI) and are relatively safe on beneficial insects and mites compared to Orthene (Acephate) and Lorsban (Chlopyrifos).

Future restrictions on Orthene and Lorsban may also necessitate the use of Coragen and Avaunt.

A study was done in 2011 to test the effectiveness of Coragen and Avaunt for pre-harvest MRB control. The results were not conclusive but there was a trend indicating that the Coragen may help control MRB in the egg and/or first instar stage. The experiments in 2012 were designed to duplicate the 2011 experiments.

OBJECTIVE

Test the efficacy of Coragen and Avaunt, when applied at different pre-harvest dates, for control of mint root borer eggs and/or first instar larvae before they enter the rhizomes, in furrow-irrigated mint.

MATERIALS AND METHODS

Two identical experiments were conducted, in two established, production, furrow irrigated peppermint fields located near Wilder (experiment one), and Greenleaf (experiment two), Idaho. Plots were arranged in a randomized block design. Plots of 18'x 20' were replicated five times. Coragen and Avaunt were broadcast applied with a $C0^2$ powered backpack sprayer in 20 GPA of water. A mentholated seed oil/organosilicone surfactant blend called SYL-TAC was added at a rate of 1% V/V to each treatment.

The maximum rate of Coragen (5 oz/ac) and the maximum rate of Avaunt (3.5 oz/ac) were applied in all treatments of both experiments.

Treatment dates were determined by using local data from the Nampa, ID Agmet station and the degree-day model found on the IPMP website (mint.ippc.orst.edu). The degree data from the Nampa site was used for both experiments. The four application dates were chosen so they would coincide with the accumulated Degree-Days (DD) of 750, 850, 1000 and 1150 DD.

The peak egg-laying time occurs around 1100 DD, according to the model. These four dates were determined to give a good spread of times that should determine when the best time would be to apply the Coragen or Avaunt. In addition, one treatment had the insecticides applied twice, once before and once during the peak egg laying. Table 1 lists the actual application dates and corresponding accumulated degree-days for both experiments.

These two experiments were nearly identical to the two experiments conducted in 2011. The main difference between the two years was that the application dates occurred three to four weeks earlier in 2012 than in 2011. This was mostly due to weather in 2011 being unusually cool and so the 2011 treatments were delayed.

The mint was harvested around August 20 for experiment one and around August 3 for experiment two. After harvest, the MRB control was evaluated on Aug. 31 and Sept. 10, for experiments one and two respectively. Evaluation of the MRB control was done by digging eight, 0.75 ft^2 soil samples in each plot. The soil was shaken off the mint rhizomes and sifted through a 0.25" screen. The rhizomes were placed in Berlese funnels until dry. The number of MRB larvae found in the Berlese funnels were combined with those found when the soil was sifted.

RESULTS AND DISCUSSION

There were no significant differences between any treatment and the untreated check in either experiment. There is a slight trend for the double application of Coragen to lower the MRB levels in experiment one. The Avaunt did not appear to provide any control (table 1).

Table 1. Mint Root Borer levels after harvest from pre-harvest applications of Coragen or Avaunt, on two furrow irrigated peppermint experiments, located near Wilder (experiment one) and Greenleaf (experiment two), Idaho. (Summer 2012)

Trmt. #	Treatment	Accumulated degree-days (Nampa ID)	Application date(s)	Average live mint root borer larvae (per sq. ft)	
				Exp. 1	Exp. 2
1	UTC			5.9	4.2
2	Coragen 5 oz/a	766	6-20	7.0	3.6
3	Coragen 5 oz/a	875	6-25	4.6	4.7
4	Coragen 5 oz/a	963	6-30	5.4	3.9
5	Coragen 5 oz/a	1133	7-7	6.3	3.6
6	Coragen 5 oz/a	875 + 1133	6-25 & 7-7	3.6	2.9
7	Avaunt 3.5 oz/a	766	6-20	6.0	5.1
8	Avaunt 3.5 oz/a	875	6-25	8.2	3.5
9	Avaunt 3.5 oz/a	963	6-30	6.9	5.2
10	Avaunt 3.5 oz/a	1133	7-7	6.4	2.9
11	Avaunt 3.5 oz/a	875 + 1133	6-25 & 7-7	6.3	4.0
	LSD			NS	NS

Coefficient of variation, experiment one=46.3%
Coefficient of variation, experiment two=38.9%
Sample means were compared with Fisher's Protected LSD (p=0.05).

The 2011 experiments did not conclusively show that Coragen was effective, but there was a trend showing some control of the MRB with the Coragen only (data not shown). The results in 2012 show almost no effectiveness for Coragen. It is speculated that the earlier calendar date treatments in 2012, reduced the effectiveness of the Coragen by applying the product before the MRB eggs and/or larvae were present. In addition, the mint growth is very rapid in June due to the long day length; this rapid growth may have caused the new mint growth to not contain the systemic insecticide.

It is also speculated that the degree-day development model in Idaho may inaccurately predict the developmental stages of MRB to occur earlier than they do. This speculation is supported by two years of sampling data that shows the percent of MRB found in the hibernaculum stage, occur significantly later than the Idaho development model predicts (table 2). The Idaho development model is only partly validated so it is very possible that it is not accurate.

A very similar trial to these trials was done in Northeast Oregon this year and Coragen had very positive results in controlling MRB larvae with pre-harvest applications of Coragen. The degree-day model in Northeast Oregon has correctly predicted the timing of the MRB entering the hibernacula stage.

Table 2. Comparison of untreated Mint Root Borer in the hibernacula stage at different dates, to the Idaho MRB degree-day development model for Idaho. Samples taken from various fields around the Wilder and Greenleaf areas.

Year 2011			Year 2012		
Sample dates	Actual percent mint root borer in hibernacula stage	Accumulated degree days*	Sample dates	Actual percent mint root borer in hibernacula stage	Accumulated degree days*
8-23	0	1856			
			9-10	0	2727
9-12	0	2241			
			9-26	13%	2924
10-4	39%	2610			
			10-18	66%	3087
10-24	91%	2700			

* Temperature data used from the Agmet station located near Nampa ID.
The Idaho MRB degree-day model states that 50% of the MRB should be in the hibernaculum stage at 2150 degree-days.

CONCLUSIONS

Two years of trials have shown that pre-harvest applications of Coragen and Avaunt do not provide significant control of Mint Root Borers in the egg and/or first instar stage.

Coragen appeared to have some promise in 2011 but not in 2012. The Idaho Mint Root Borer development model appears to be predicting the development stages of the Mint Root Borer earlier than they really occur, based on when the MRB actually enter the hibernaculum stage. This inaccuracy in the model may contribute to Coragen not providing significant control of the Mint Root Borers pre-harvest.
Avaunt did not show any promise in controlling the MRB either year, so no further study is needed on Avaunt.

Further studies should be conducted to test if pre-harvest applications of Coragen could control MRB if they are applied at later dates. It would be valuable information to know even if Coragen doesn't control the MRB eggs and/or larvae, pre-harvest, so growers do not apply Coragen, pre-harvest, thinking they are controlling Mint Root Borers.

MANAGEMENT OF EUROPEAN ASPARAGUS APHID IN ASPARAGUS

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There exists less than 200 acres of organic asparagus in Washington. Demand exists for ten times the amount this area produces. The two limiting factors to producing organic asparagus are weed control and control of European asparagus aphid. Weed control is more of an expense than an unknown challenge. European asparagus aphid is production ending pest without a highly effective means of control. Organic growers have no means to control this pest, hence the lack of production.

Based on three year's work, we believe a means to control this pest has been developed. The control requires intensive scouting for early detection of the pest. Applications made at frequent intervals (7 days) for the duration of time the aphid is detected at any level. We assume an action threshold of 1 aphid per plant. The applications must be a tank mix of Pyganic with an azadiractin product.

Historically, growers successfully relied on Di-Syston for control of European asparagus aphid. Recognizing that this product would not be available in the future, growers supported the development of alternative product, Warrior (lambda cyhalothrin). This product is currently being used via the Section 18 process. In 2012, growers expressed dissatisfaction with use of the product when applied via chemigation and requested development of additional aphid materials.

Results of 2012 research on organic and conventional control of European asparagus aphid will be discussed. Implications for future management of aphids in asparagus will be reviewed.

THRIPS CONTROL ON DRY BULB ONIONS

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Abstract

Onion thrips are the key direct insect pest of dry bulb onions. We have evaluated candidate chemistries and sequences of currently registered products for their ability to suppress thrips populations in dry bulb onions in Washington State. Additionally, we have evaluated currently registered products when applied via chemigation and investigated the impact of in season nitrogen applications on thrips populations. All of the sequences of applications significantly reduced thrips numbers, and increased potential profitability. The most effective insecticides for controlling thrips were Lannate™ (methomyl), and Radiant™ (spinetoram). The insecticides Agri-Mek™ (abamectin), tolfenpyrad, cyazypyr and Movento™ (spirotetremat) provided adequate control of thrips. Lannate, Radiant, and Movento all decrease thrips populations when applied via chemigation as well.

Introduction

Thrips infestations are a persistent problem throughout Western US dry bulb onion fields. Thrips' mobility and biology can impact control strategies, and impact insecticide performance in controlling thrips. When we initiated this thrips control program in 2001 most onion fields in Washington State were treated with multiple insecticides for thrips control. Pyrethroids were the predominant insecticide used for thrips suppression. Pyrethroids have been ineffective since 2003. Insecticides registered since 2001 are all substantially more expensive than to apply then previously used chemistries. Our research has also documented that thrips are surviving for several months in storage and are continuing to infest over 15% of the onions in storage even after the onions received a substantial insecticide load in the production field. These residual thrips infestations reduce onion shelf life and increase the incidence of neck rots. We have also documented that in pairwise comparisons (treated for thrips vs. no treatment) among 39 onion cultivars that application of no insecticide treatment of thrips results in a 15 to 35% (depending on cultivar) decrease in bulb size at harvest among cultivars. Bulbs are graded by size and economic returns to growers decrease as bulb size decreases. Onion thrips have also been identified as the vector for Iris yellow spot virus. Our thrips research program evaluates insecticide efficacy, and application techniques in Washington State onion fields.

Materials and Methods

In the experiments detailed below field plots of onion (var. 'Sabroso' Nunhems, Parma, ID) were established at the WSU Research Farm in Pasco, WA and grown using drip irrigation and standard grower practices for agronomic and pest management inputs excluding thrips treatments. On April 1, 2012, an onion plot 120 feet wide and 350 feet long was established with two double rows of onions planted on each 44 inch wide bed. Double rows are 2 ½ inches apart with 3 inches in row spacing. Lorsban™ 15G (chlorpyriphos) was applied at planting and incorporated over the double row at the rate of 3.7 oz./1,000 row feet. Plots were established in a random complete block design with four replications. In each instance, plots were 7.5 feet wide and 30 feet long. Applications (except where specified) were made with a CO_2 pressurized back pack sprayer applying 30 gallons of water carrier per acre at 35 psi. Efficacy was evaluated four or five days after applications by counting the number immature and adult thrips per plant on 10 individual plants per plot in the field. All data for each sample date were analyzed by ANOVA and treatments means were compared to thrips population means from non-treated control plots in pairwise *t*-tests. At the end of the growing season onion yield and size were evaluated for comparison among treatments.

Results/Discussion

Sequences of insecticides were evaluated for efficacy against thrips. Applications were made weekly starting on 8 June 2012. The aim of this research was to provide producers possible insecticide management regimes to use on their farms. Figure 1 shows the average thrips count per treatment. All treatment sequences averaged significantly ($p<0.05$) fewer thrips per plot than the untreated check. The weekly count data (data not shown) followed the same trend. The total yield for the sequential applications is also illustrated in Figure 1. Yields and overall thrips pressure were low this year, and there were no statistically significant differences in terms of overall yield and bulb size. There were some numerical trends, where all treatment regimes increased yield. Figure 2 shows the various sequences evaluated in the trial. The total cost of each treatment sequence is listed in addition to the net potential increase in revenue calculated from the plot yield in Figure 2 using the market price of $240 per ton. All treatment sequences resulted in increase profitability in this study (results not statistically different from one another).

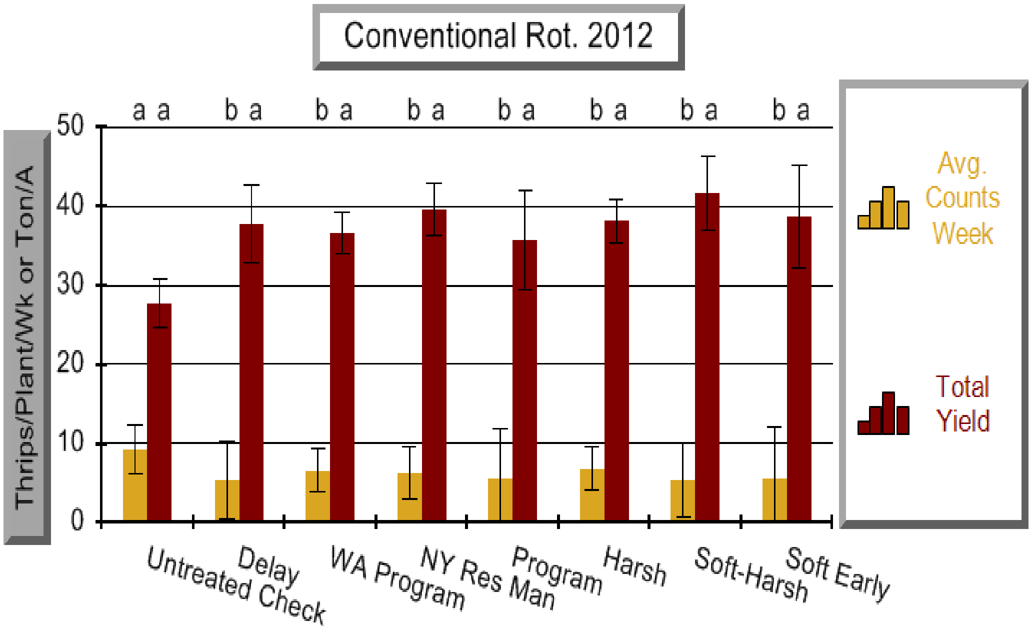

Figure 1. Thrips per plant and yield (tons/A) versus sequential chemical treatments. Treatments with the same letters are not statistically different from one another (P=0.05 Student-Newman-Keuls test)

Week	1	2	3	4	5	6	7	8	Cost/A $	yield tons/A	Net over Check $/A	Thrips/Week
Untreated Check									0	27.75	0.00	9.3 a
Delay		Radiant + Movento	Movento	Radiant	Agrimek		Lannate		275	37.83	2144.20	5.4 b
WA Program		Movento	Movento	AzaDirect + Radiant	AzaDirect + Radiant		Lannate	Lannate	303	36.59	1818.60	6.6 b
NY Res. Man.	Movento	Movento	Agrimek	Agrimek	Lannate	Lannate	Radiant	Radiant	356	39.60	2488.00	6.3 b
Program	AzaDirect + Radiant	Movento	Radiant	Agrimek		Lannate	Lannate		293	35.70	1615.00	5.6 b
Harsh	Lannate	Movento		Lannate	Agrimek	Radiant	Lannate		239	38.23	2276.20	6.8 b
Soft to Harsh	Movento	Movento	Radiant	Radiant	Agrimek	Lannate		Lannate	305	41.63	3026.20	5.5 b
Soft Early	Radiant + Movento	Movento		Radiant	Agrimek		Lannate		275	38.75	2365.00	5.7 b
Based on average retail product prices and onions selling at $240 per ton. ((Treatment yield-UTC Yield)*240)-Product cost/A.												

Figure 2. Application sequences by treatment week with cost per acre and net increase in potential revenue due to increased yield documented in Figure 2.

Figures 3 & 4 depict data from trials evaluating weekly applications of insecticides to control thrips in onions. The data in Fig. 3 indicates that Entrust was the most effective compound evaluated in that trial. In Figure 4, the AgriMek, Torac, Torac + Lannate, and Lannate all provided significantly better control than the untreated check, but not different form one another.

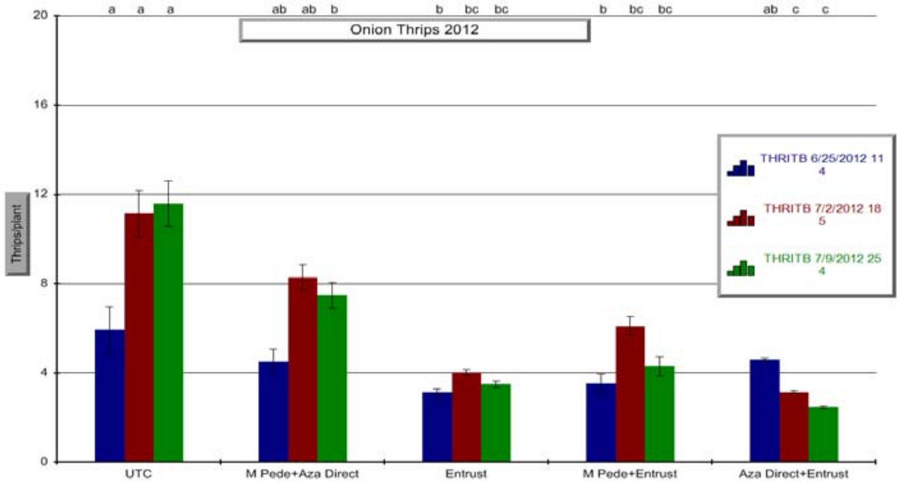

Figure 3. Thrips per plant versus chemical treatments. Weekly applications were made of each product. Treatments with the same letters are not statistically different from one another (P=0.05 Student-Newman-Keuls test)

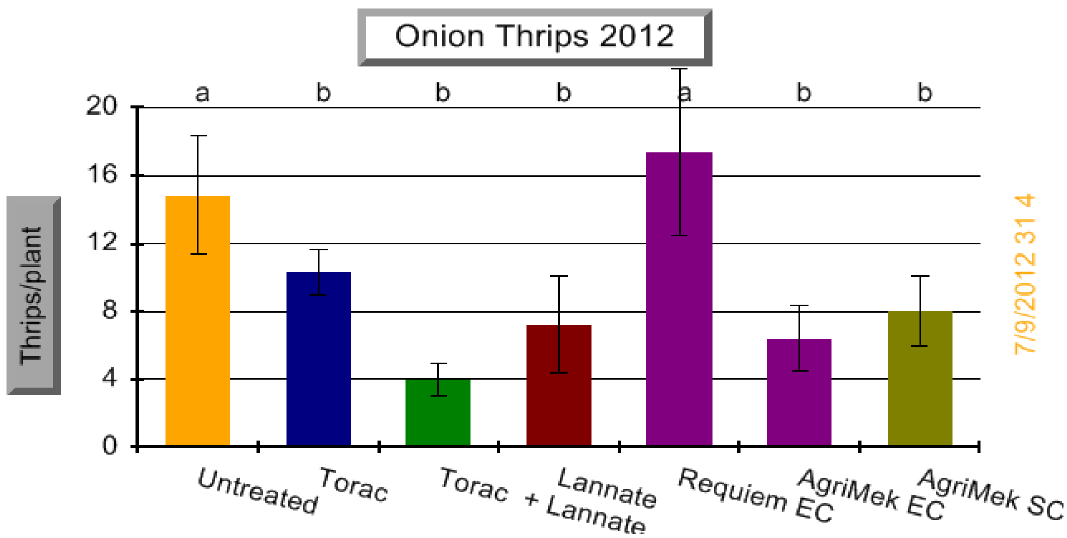

Figure 4. Thrips per plant versus chemical treatments. Weekly applications were made of each product. Treatments with the same letters are not statistically different from one another (P=0.05 Student-Newman-Keuls test)

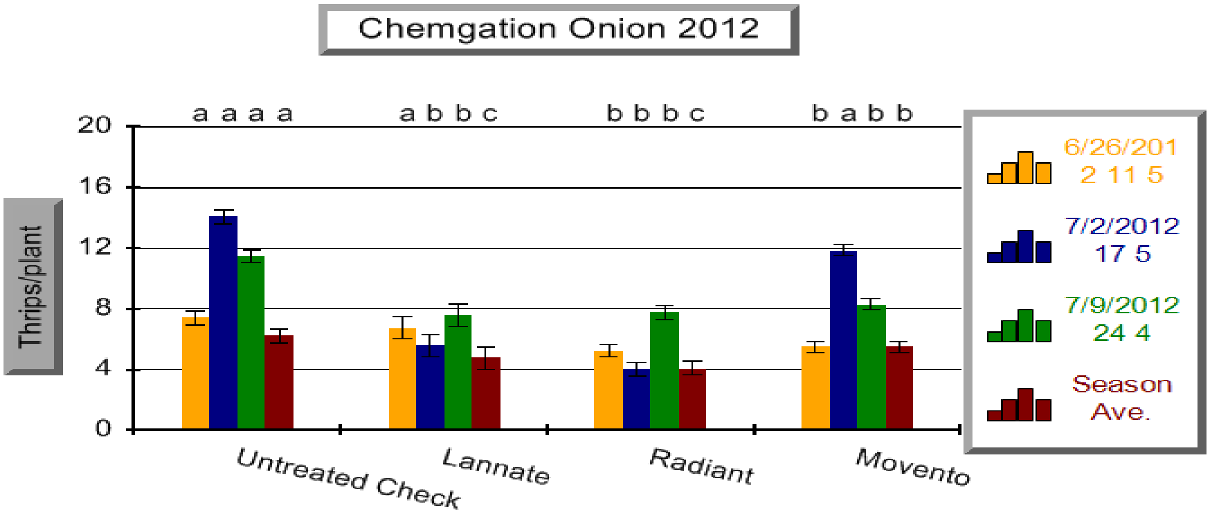

Figure 5. Thrips per plant versus chemical treatments. Weekly applications were made of each product applied with 0.1 inches of irrigation water. Treatments with the same letters are not statistically different from one another (P=0.05 Student-Newman-Keuls test).

Figure 5 depicts chemigation treatments. In Figure 5, the Lannate, Radiant, and Movento all provided control of thrips that was significantly better than the untreated check. This is the second year that this trend has occurred, making it seem likely that these compounds will perform well when applied via chemigation.

Conclusions

Using insecticides that are effective at controlling thrips increases yield and size class of dry bulb onions. Radiant and Lannate were found to be the most effective products while Movento, cyazypyr (data not shown above), tolfenpyrad and AgriMek provided good suppression of onion thrips. All of the sequential applications tested provided excellent season long control of thrips and if adopted by commercial growers could increase economic returns. Weekly applications are not always needed as shown on the sequences where applications were skipped either early during the season or at the middle of the season. It is important for producers to consider the mode of action of the different chemistries when integrating them into their control programs. Chemigation proved to be an effective way to apply Lannate, Radiant, and Movento. Nitrogen applications appear to contribute to increased numbers of onion thrips. Timing of nitrogen applications seems to be important, but further study is needed to refine this theory.

Funding for this project was provided by: the Washington State Commission on Pesticide Registration; Pacific Northwest Vegetable Association , Agraquest, Syngenta, Nichino, Gowan Co., Dow Agrosciences, and DuPont. Technical assistance and in kind support was provided by: Greg Jackson, Two Rivers, Bob Middlestat, Clearwater Supply.

SECTION IV
POTATO PESTS

Moderator: Sylvia Rondon

MONITORING THE POTATO PSYLLID IN *SOLANUM DULCAMARA*, A POTENTIAL OVERWINTER HOST PLANT IN THE COLUMBIA BASIN

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While potato psyllids have been consistently found in the region by early to mid-July each year, no Zebra Chip (ZC) disease caused by *Candidatus* Liberibacter solanacearum (Lso) was confirmed until late 2011. This confirmation included Idaho, the main potato producer in the USA. Given the great importance of potato production in the region, this disease poses a new and significant threat to production in the region. Zebra Chip, transmitted by the potato psyllid (*Bactericera cockerelli* Sulc) (Hemiptera: Triozidae) was unknown to the Pacific Northwest until 2011. In 2012 we were able to confirm that *B. cockerelli* was able to survive the winter in the Oregon-Washington border, at least under mild winter conditions. Potato psyllids were found in bittersweet nightshade, *Solanum dulcamara* L. Following the survey of *S. dulcamara* plants initiated in 2011-2012 in the Columbia Basin, a comprehensive monitoring program will be implemented in 2013. The information obtained from this study will serve to answer important questions regarding this pest such as: Are there other solanaceous weeds where the potato psyllids can survive? Do mild temperatures play a role in potato psyllid survival? When does the potato psyllid start to migrate from the potential overwintering sites to the potato fields and why?


Bittersweet nightshade occurs in a wide range of habitats including irrigation canals and marshals

POTATO PSYLLID (*BACTERICERA COCKERELLI* SULC) RESEARCH IN THE LOWER COLUMBIA BASIN IN 2012

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In the summer of 2011, Zebra chip disease (ZC), *Candidatus* Liberibacter solanacearum, was first documented in the Columbia Basin of Oregon and Washington (Crosslin et al. 2012). Zebra chip is a serious disease of potatoes, characterized by curling, purple foliage; this disease also causes brown, necrotic lesions to form in the tubers of infected plants, making the yield in marketable (Buchman et al. 2012). Though fields in 2011 were severely infected with ZC disease, economic losses were not as serious as originally anticipated. ZC remains a primary concern for potato producers in the Columbia Basin because they can potentially affect pest management decisions in the region.

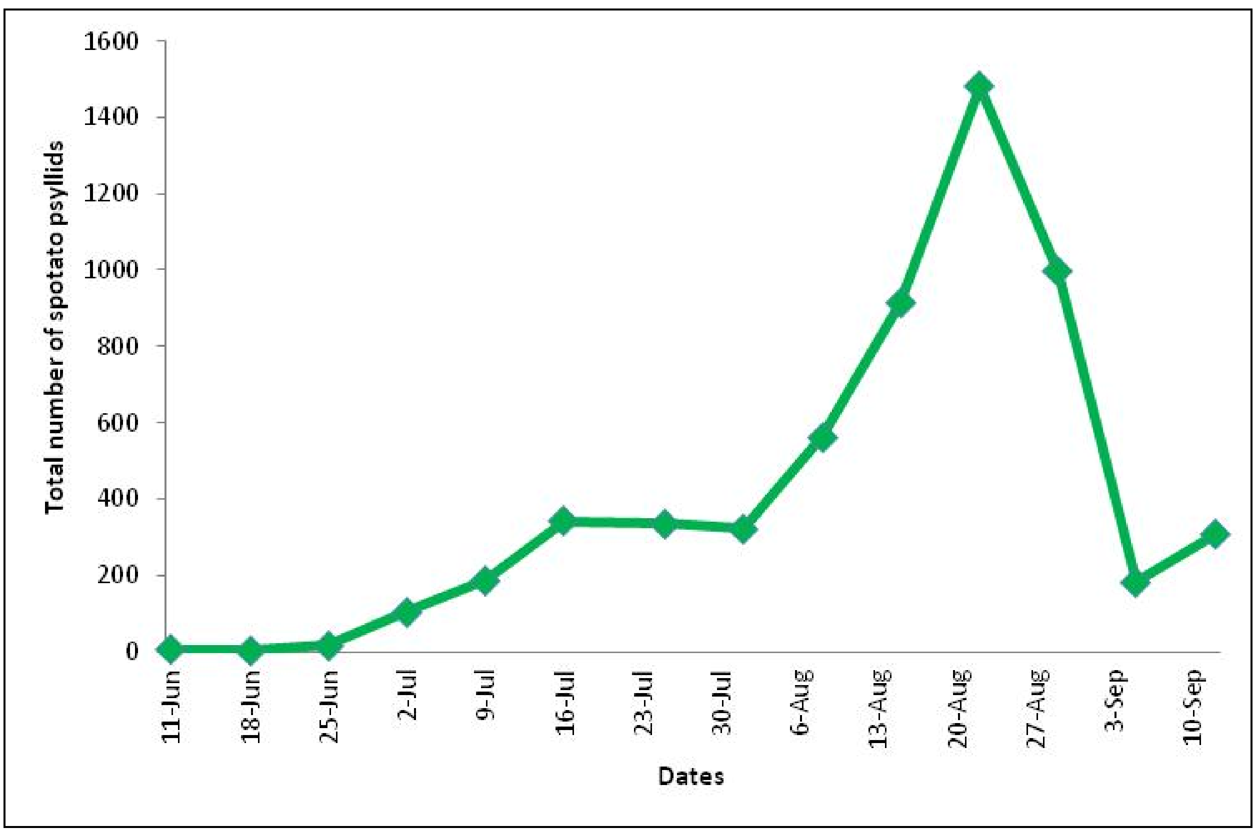
The vector for ZC is the potato psyllid, *Bactericera cockerelli* Sulc. (Hemiptera: Triozidae) (Munyaneza et al. 2007). Although the presence of the potato psyllid was previously documented in the Columbia Basin, current theories suggest that in 2011, potato psyllids infected with ZC may have migrated up to Oregon and Washington from California. However, there are still concerns that potato psyllids or ZC might overwinter on solanaceous weeds in the Columbia Basin. In the fall of 2011, Dr. Andrew Jensen observed potato psyllids surviving on a local, perennial weed known as bittersweet nightshade (*Solanum dulcamara* L.) This weed is relatively abundant along ditch banks and wetlands in the lower Columbia Basin. We examined the potential for overwintering in the Columbia Basin on *S. dulcamara*, and monitored psyllid populations in potatoes through the summer of 2012.

Overwintering in Oregon. Individual *S. dulcamara* plants were sampled for potato psyllids during the winter of 2011-2012 in Oregon and Washington at six different sites. In Oregon, a total of 40 plants were sampled using a DVAC (inverted leaf blower). Green leaves and stems were also collected from the same plants sampled. These samples were tested for the presence of ZC using PCR (Crosslin et al. 2012).

We detected psyllids on 22 March on *S. dulcamara*. Eggs collected from *S. dulcamara* were reared in the laboratory on potatoes to verify potato psyllids. Other psyllids species can be found in the area. The first spring generation of adults was documented on 16 April. Approximately 33% of the plants sampled supported potato psyllid populations. Seven percent of the plants so far tested were positive for Liberibacter.

Psyllid populations in 2012. Potato psyllids were monitored in the lower Columbia Basin using yellow sticky cards (3X5 Cascade AG yellow cards) and DVAC samples. Monitoring included 34 different sites in Umatilla and Morrow counties. The OSU-HAREC Irrigated Agricultural Entomology Program (Rondon's program) also received and recorded samples from growers and consultants in the area. A summary of psyllid samples for 2012 is shown in **Figure 1**. More information is needed in order to develop better pest management protocols and pest management frameworks.

Fig. 1. Total number of potato psyllids submitted to the OSU-HAREC Irrigated Agricultural Entomology Program (Rondon's program) in 2012.



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PRELIMINARY RESULTS CONTROLLING THE POTATO PSYLLID IN THE GREENHOUSE WITH NEW AND OLD PRODUCTS

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Zebra Chip (ZC) disease caused by *Candidatus* Liberibacter solanacearum (Lso) was confirmed in Oregon, Washington and Idaho in 2011. A number of chemical control options are available for the vector, the potato psyllid *Bactericera cockerelli* (Sulc) (Hemiptera: Triozidae). None were tested in the Pacific Northwest until 2012. A chemical efficacy trial was conducted in the greenhouse to test the immediate potency and residual effect of several pesticides such as Benevia (low and high rates), Vydate (low and high rates), Movento and Radiant against adult potato psyllids. Treatments were arranged in a Randomized Complete Block with four replications (four potato plants) per treatment. Four clip cages per plant containing five potato psyllids adults were used as experimental units. Adults were released right after pesticides had dried out. Evaluations were conducted 1, 3, 24, 72 hours and 7 days after release. Assessments were based on adult mortality. Based on the results, mortality of adult psyllids increases over time with relatively low percent mortality observed one hour after releasing the adults and high percent mortality observed 7 days after release. Applications of Benevia at high rate and Radiant apparently have high residual effect on adults.

RESEARCH ON THRIPS IN POTATOES

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Historically thrips were not thought of as a pest of potatoes. However, now there are thousands of acres of potatoes treated in Washington each year. We estimate that 10 to 25% of potato acres are treated depending on the year. The pest is most commonly a problem in longer season potatoes because the thrips have more time to build up to damaging levels. The actual damage or yield loss that occurs on a per acre basis is unknown. Thrips are only recognized as a pest of potatoes in the Columbia Basin of Washington and Oregon.

In Washington, the distribution of fields treated for thrips ranges from the southern Columbia Basin to north of Moses Lake. However, some areas of the state seem to perennially not have problems with thrips. The leading theory of why thrips have become known as a pest in potatoes is due to a shift in insecticides used on potatoes. Formerly, most potatoes in Washington were treated with carbamate (Temik, Furadan) and organophosphate (Monitor, dimethoate, Di-Syston, etc) insecticides. These products have efficacy against thrips. In the last ten years, product removals (e.g. Di-Syston), product use restrictions (e.g. Furadan) and new product introductions have significantly reduced the amount of these products used on potatoes. The widespread use of neonicotinoid insecticides, such as Admire, Platinum and Belay and highly selective insecticides such as Beleaf and Fulfill has allowed thrips populations to surge that formerly had been controlled by broad spectrum insecticides.

Due to its cryptic nature, lifecycle characteristics and recent appearance as a pest, virtually no research has been conducted on this species. The publication "*Integrated Pest Management Guidelines for Insects and Mites in Idaho, Oregon and Washington Potatoes*" by Schreiber, Jensen, Rondon, Wenniger and Thornon contains the official recommendations for management tactics for potato insects in Washington, Oregon and Idaho and recommendations for thrips were just added for the first time in 2012. There exists very little information on what products are effective against thrips now that Monitor is no longer available. There are no nonchemical control methods recommended for use on potatoes.

Data are presented on 2012 research on thrips efficacy and field biology.

DEVELOPING IPM TACTICS FOR ZEBRA CHIP: A NEW THREAT TO PNW POTATO PRODUCTION

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The PNW potato industry was recently placed on high alert by the discovery of the zebra chip (ZC) disease in the Columbia Basin of Oregon and Washington in 2011. The pathogen causing ZC is *Candidatus Liberibacter solanacearum* (Lso), a bacterium vectored by the potato psyllid, *Bactericera cockerelli* (Sulc) (Hemiptera: Triozidae). Significant concern exists within the potato industry for this newly emerging disease in the PNW due to: 1) limited information regarding the biology/ecology of this pathogen/vector complex within PNW cropping systems/climate; and 2) potential for significant economic loss associated with the high cost of season-long insect control and inability to market ZC-infected tubers. Since the disease was first reported in Texas in 2000 (Munyaneza et al. 2007a), growers in the southern U.S. have lost millions of dollars annually through efforts to control the vector and loss of crop yield/quality. Unfortunately, the pathogen and vector continues to spread to mid-Atlantic and western states.

ZC and Potato Psyllids in Oregon: Background and Occurrence in 2012

Although potato psyllids (Figure 1) are commonly found in the western U.S., the first official report of potato psyllid occurrence was documented 2005-2008 in south central Washington (Munyaneza et al. 2009). Observations also suggest that potato psyllid simultaneously occurred in the Columbia Basin of Oregon (OR) during this period. Historically, potato psyllids have not been a pest of economic concern; therefore, have not been surveyed in area-wide potato insect monitoring programs in OR. The occurrence of potato psyllid and risk for introduction of ZC in the northeastern OR certified seed and commercial potato industry was thought to be low. The potato psyllid can transmit Lso to a host potato plant within a few hours of colonization; therefore, timely insecticide application programs must start as soon as the potato psyllid is detected within a field. The discovery of ZC in 2011 in the Columbia Basin prioritized monitoring efforts for the vector and Lso testing. A need was also identified to improve monitoring techniques that would enable expansion of current area-wide programs in OR.

Figure 1. Adult potato psyllid. Photo: A. Murphy.

In 2011, field observations of potato plant damage indicated foliar symptoms similar to Purple Top (Beet Leafhopper Transmitted Virescence Agent or BLTVA). Subsequent diagnostic testing indeed proved the disease to be BLTVA. At this time, there was no evidence to suggest a need for testing potato plant foliage for ZC. As the 2011 growing season progressed, more production fields in the region expressed foliar symptoms along with the appearance of tuber damage symptoms typical of ZC (Figure 2). ZC was confirmed for the first time in the Columbia Basin in symptomatic tubers collected late August 2011 (testing conducted at the OSU-HAREC plant disease diagnostic lab, Hermiston, OR). Foliar damage within Columbia Basin potato fields ranged from none to very light to extensive.

Figure 2. Typical symptoms of ZC disease in potato tubers include browning vascular tissue. Photo: D. L. Walenta.

It takes an infected plant approximately 3 weeks to show foliar symptoms which suggests that potato psyllids carrying Lso likely infected potato plants between 15-25 June 2011 (Columbia Basin). Such observations also suggest that potato psyllid may occur earlier in the growing season but at such low numbers that sticky traps may not be the most effective monitoring tool for adult psyllids. Once ZC was confirmed in the area, it was also determined from testing potato psyllid adults that Lso incidence was high (7% - 13%) among Columbia Basin psyllid populations. Observations from 2011 also indicate that the most severe ZC-damage occurred in fields that did not receive any insecticide applications from late May until August (due to low populations of other key potato insects).

2012 proved to be an interesting year for the pathogen/vector complex in northeastern OR and the Columbia Basin of OR. A single potato psyllid was found at the end of the 2011 monitoring season in northeastern Oregon (Union-Baker Co. area) but tested negative for Lso. This find prompted us to expand our search in 2012. The first adult was captured (via DVAC) during 1-8 August 2012. Overall, the effort resulted in the capture of a significant number of adult potato psyllids; however, population levels were very low mid-season but increased as the season progressed (Figure 3). Only one psyllid sample during the 2012 season tested Lso positive (collected early August), thus, the season incidence level was a very low 0.01%. Interestingly, the production area was thought to be geographically-isolated from ZC since it is situated within the Blue, Elkhorn and Eagle Cap mountains of northeastern Oregon.

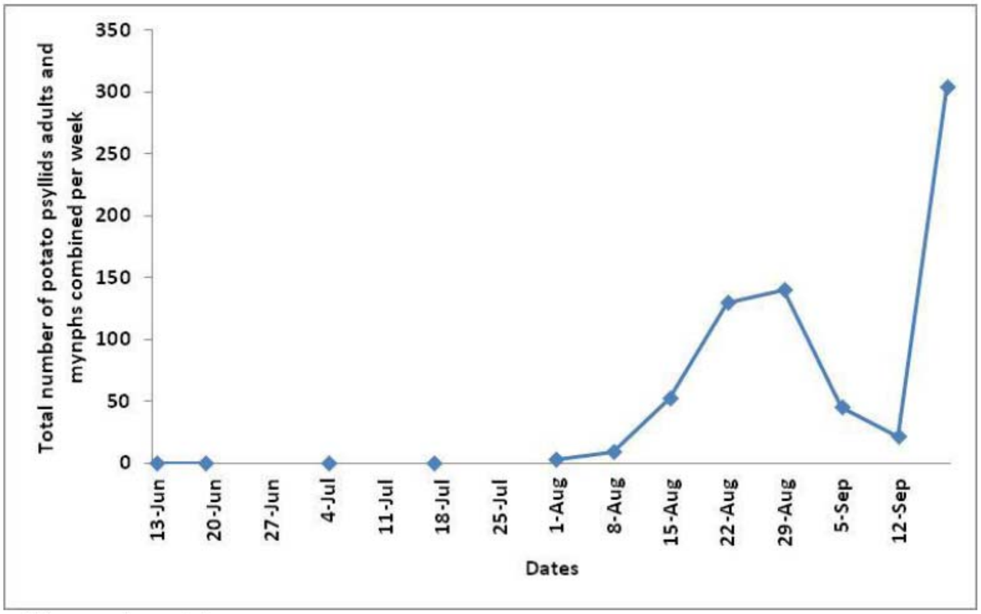
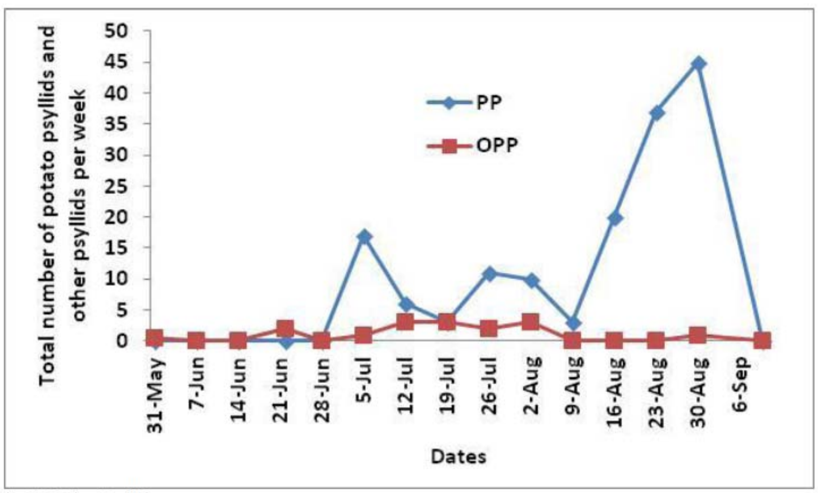


Figure 3. Population dynamics of potato psyllids in Union-Baker counties, Oregon in 2012.



PP: Potato Psyllids; OP: Other Psyllids

Figure 4. Population dynamics of potato psyllids in Umatilla-Morrow counties, Oregon in 2012.

In the Columbia Basin, potato psyllid population levels throughout the 2012 growing season were low (Figure 4). Interestingly, adult potato psyllid activity peaked three times during the growing season (5-July, 26-July, 30-August) with the highest peak occurring at the end of the season. A sub-sample of adult potato psyllids from the Columbia Basin were tested and only 1% tested Lso positive. A study conducted in Oregon, Washington and Idaho (spring 2011 through spring 2012) also confirmed the overwinter survival of potato psyllid along the Oregon-Washington border. Several sites in the Columbia Basin were found to be infested with bittersweet nightshade (*Solanum dulcamara*), a known host of potato psyllid (Figure 5).

Figure 5. Bittersweet nightshade (Solanum dulcamara).

In summary, 2012 marked the first official report of potato psyllid and ZC in northeastern Oregon (Union-Baker area) and overwintering survival of potato psyllid in the PNW. The overwintering host plant bittersweet nightshade (*Solanum dulcamara*) is known to exist in the Columbia Basin-OR and northeastern OR but at undetermined infestation levels. Potato psyllid survival during a mild winter poses great concern for the potato industry, however, it is not known how colder climate conditions will impact survival rates. Further investigation and increased monitoring for potato psyllid/ZC is warranted in northeastern Oregon and the Columbia Basin.

Actions to Date

In response to the ZC threat, a series of research and extension projects have been initiated in Oregon.

Current and on-going projects include:

- Evaluation of field scouting and potato psyllid monitoring techniques
- Investigation of seasonal migration of potato psyllid in OR/WA
- Adaptation of current area-wide potato insect monitoring programs in Oregon to include potato psyllid and Lso
- Determine incidence level of Lso in potato psyllid populations
- Evaluation of potato varieties for ZC-resistance
- Evaluation of conventional and new insecticide products for potato psyllid control
- Coordination of research efforts with fellow NW researchers
- Conduct outreach activities to keep growers, industry representatives and others well-informed of pest biology/ecology, management techniques and weekly population dynamics; enables industry to react in a timely manner to maximize pest control efforts

Future project plans include:

- Investigation of potato psyllid host preference
- Identification of alternative over-wintering host sites
- Expansion of potato psyllid over-wintering studies in Oregon (e.g. northeastern OR)
- Investigate psyllid migration into potato fields and spatial distribution within fields
- Continue outreach and engagement activities

In closing, our goal is to collaborate with other NW researchers to develop region-specific biology/ecology/epidemiology of the vector-pathogen complex and develop effective management guidelines pertinent to PNW conditions that will: 1) enable growers to mitigate potential for economic damage caused by ZC; 2) improve pest population monitoring techniques; 3) improve potato psyllid control with effective insecticide programs; 4) identify new potato psyllid control techniques; and 5) reduce potential for insecticide-resistance development within psyllid populations.

SECTION V
PESTS OF WINE GRAPE & FRUIT

Moderator: Jana Lee

2012 WASHINGTON STATE DEPARTMENT OF AGRICULTURE (WSDA) EXOTIC PEST OF GRAPES SURVEY (EPOGS)

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In 2012, WSDA placed and monitored traps targeting the following four exotic species of moths:

European Grape Vine Moth (EGVM) *Lobesia botrana*; European Grape Berry Moth (EGBM) *Eupoecilia amibuella*; Grape Tortrix (*Argyrotaenia ljunglana)*; Grape Leafroller Tortrix (*Sparganothis pilleriana*). The survey extended from June 24 through September 30, 2012 in sixteen Washington State counties using large plastic delta traps each baited with a species specific pheromone lure. Traps were checked every two to four weeks and changed at least every four weeks. All traps with suspect moths were sent to the WSDA Olympia Entomology Lab for identification.

Trap deployment focused on commercial wine and Concord grape vineyards, non-commercial, residential grape vines in populated areas, abandoned vineyards, and feral, roadside grape vines.

Host plants included grape, apple, crabapple, and other fruit trees. These types of host were targeted because they represented the greatest risk of pest introduction and reproduction.

Table 1.A – Counties Trapped for EPOGS in 2012			
Adams	Franklin	Klickitat	Spokane
Benton	Grant	Okanogan	Walla Walla
Chelan	King	Skagit	Whatcom
Douglas	Kittitas	Snohomish	Yakima

A total of 2,515 trap sites were placed and monitored in 2012. None of the four exotic species targeted in the survey were detected. Many interesting species of non-target moths were collected during the survey. In a separate survey of apples in Walla Walla and Benton Counties, WSDA detected adult Tufted Apple Bud Moth (TABM), *Platynota idaeusalis*. This species is also known to attack grapes.

Table 1.B – Trap Sites by County and Survey Type					
	EPOGS TARGET SPECIES				
COUNTY	**Grape Tortrix**	**EGVM**	**EGBM**	**Grape Leafroller Tortrix**	**Total**
ADAMS	1	4	1	1	7
BENTON	85	140	85	84	394
CHELAN	37	45	37	35	154
DOUGLAS	6	11	6	7	30
FRANKLIN	30	86	30	30	176
GRANT	76	171	75	65	387
KITTITAS	3	7	3	3	16
KLICKITAT	17	17	17	17	68
OKANOGAN	13	7	14	6	40
SKAGIT	0	71	4	0	75
SKAMANIA	3	3	3	3	12
SPOKANE	0	16	17	0	33
SNOHOMISH	0	51	3	0	54
WALLA WALLA	22	80	22	22	146
WHATCOM	0	60	13	0	73
YAKIMA	206	236	208	200	839
TOTALS	**499**	**1005**	**538**	**473**	**2,515**

SPOTTED WING DROSOPHILA AND THE WASHINGTON BLUEBERRY INDUSTRY

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Five years ago, Washington produced 18 million pounds of blueberries; in 2011 it produced 60 million pounds. The WBC estimates that in five more years it will produce as much as 120 million pounds and be among the largest blueberry growing regions in the world. The Washington blueberry industry simply has no choice but to aggressively develop export markets to help manage supply. Due to its location, quality and quantity of berries available, and the sophistication of the blueberry products Washington produces it is developing an ambitious program to develop export markets. Conversely, the loss of existing export markets would be crippling.

Unfortunately, the recent arrival of the spotted wing drosophila (SWD) into Washington has created a tremendous obstacle to development of export markets. Washington has not had to deal with a serious insect problem in blueberries and more importantly not an insect pest that occurs so close to harvest, with applications having to be made between pickings. As a result of this, Washington growers have had to make many more insecticide applications than ever before and applications closer to harvest. When faced with preharvest intervals, numbers of application limitations and efficacy limitations, growers have limited options. However this situation has resulted in residue issues. Although it is believed that growers with an aggressive SWD program can control the insect and stay under U.S/ tolerances, it was discovered in 2012 that they cannot keep under the MRL limits placed on blueberries by our major export markets.

Below is a list of US tolerances for blueberries insecticides as compared to those of our export markets. Just as the Washington blueberry industry was realizing it would have a problem in regards to MRL issues in our export market, Japan detected MRL violations in West Coast blueberries this year for Intrepid (California) and malathion (Oregon). All of the blueberries were under the U.S. tolerances and there were reasonable assurances that applications were legal and made according to the label, but the blueberry products were violative of Japanese standards. As a result, all fresh blueberry exports to Japan had to be screened for residues. This resulted in a partial shutdown of exports of blueberries because everyone was unsure of residue levels of blueberries. As this proposal was being written, Taiwan detected Sevin and Lannate in blueberries and initiated mandatory testing of blueberries from. As a result of this latest detection, South Korea stepped up its testing of U.S. blueberries. It is thought that although the violative samples were in fresh blueberries, testing is expected to be expanded to processed blueberries, our larger export market. Because the samples were found at the end of the season, we expect that the more rigorous sampling interval will be extended to the 2013 season. This is a very, very serious problem for the U.S. and the Washington blueberry industry.

Seven years ago, there was an estimated 600 acres of organic blueberries in the United States. By the end of 2013, Washington will have in excess of 2,000 acres of organic blueberries and is a leading source of this crop in the world. Acreage of this crop is expanding due to the favorable prices received and the relatively lack of insect and disease pressure the industry has enjoyed. Approximately 90% of organic blueberries are located in eastern Washington. Prior to 2012, virtually no insecticides or fungicides had been applied to blueberries grown in eastern Washington. [Blueberries produced in western Washington have significant disease and insect pressure.]

SWD was detected in eastern Washington in 2010 but was not sufficiently widespread, present in sufficient numbers or was not noticed prior to 2012. 2012 was different from previous years. Several growers deployed significant SWD programs; other growers less aware of the pest or less sophisticated in the SWD control programs suffered significant losses due to the insect.

For fresh blueberries detection of a single larvae per pallet results in rejection. Processed blueberries have lower standards, but that are still impossible to meet without a competent SWD control program. Several shipments of blueberries from eastern and western Washington were rejected due to the presence of SWD. The administrator of the Washington Blueberry Commission is under significant pressure to respond to this situation. For conventional growers, there are a number of insecticidal options available and WSU's Lynell Tanigoshi has done a good job of evaluating these products. Unfortunately to date, only a single organically approved insecticide (Entrust, spinosad, Dow AgroSciences) has been demonstrated to have sufficient efficacy against SWD. Organic blueberry growers rely very heavily on this product and the Washington (and California and Oregon) organic blueberry industry are dependent on this product. One of the challenges growers have is that there is a limit on the amount of the product that can be made during the course of the season resulting in growers using lower rates in order to extend coverage throughout the season.

There are anecdotal reports of SWD developing "resistance" and "tolerance" in blueberries in the Watsonville area of California. At the SWD SCRI meeting in Portland on November 8th, Schreiber was shown data by a private berry entomologist that indicated significant lack of control by Entrust and Pyganic in commercial fields. While strong data may be lacking demonstrating resistance in SWD to Entrust, two things are known: 1) Entrust is not working as well as it once did against SWD in the areas where it has been used the longest and 2) such heavy reliance on a single mode of action year after a year in a pest known to develop resistance is a risky situation.

FIELD EVALUTATION OF MICRO-SPRINKLERS TO CONTROL SPOTTED WING DROSOPHILA IN BLUEBERRY

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A 30-acre site, divided into six, 5-acre plots was treated with the field rate of Mustang Max®, zeta-cypermethrin (4 fl oz) on 16 August 2012. The site contained 4 highbush blueberry cultivars: 'Draper', 'Legacy', 'Aurora' and 'Bluegold' (Fig. 1). The micro-irrigation system, originally intended for fruit cooling when temperatures reach and exceed 95^{0}F, was recently retrofitted to allow chemigation of insecticide treatments through the underground pipes for application through Netafim® gray (.061") nozzles (15.3 GPH). The nozzles are on 7' risers, spaced 12' apart on alternate rows with 10' row spacing, for a total of 182 nozzles/A. This nozzle configuration provides overlapping coverage of berry bushes.

The complexity of the irrigation system and the necessity to purge the lines for EPA compliance requires 2 waves of irrigation to complete the insecticide treatment. Initially, a short misting period is required to fill the lines in preparation for the treatment. Once the lines are filled, each 10-acre block receives a 10-minute application in sequence beginning with 'Draper' and ending with 'Bluegold.' In order to adequately test residues in each of the 500' rows on either side of the main line, each row was subdivided into north (A) and south (B) sectors. In the first treatment wave, only 'Draper' 1A in both north and south sections received the 10 minute treatment of Mustang Max, followed by north and south sections of 'Draper' 2A, then 'Legacy' A, 'Aurora' 1A, 'Liberty' A, 'Aurora' 2A, then 'Bluegold' A. A second wave pushes the insecticide into the "B" sectors in the same sequence as above. A final purge is required to clear the insecticide out of the lines, completing the application. Table 1 provides a visual explanation of the sequential insecticide treatment and purge.

In evaluating the Mustang Max data, it must be noted that temperatures on 16 August 2012 exceeded the 95 ^{0}F limit, necessitating a cooling cycle to be implemented following the treatment regime described above. This cooling cycle of 5 hours began within 2.5 hours after the chemigation event. Clean water is pushing insecticide into B sector and the final system purge may result in "wash-off" in the "A" sectors. Support for this can be seen in our bioassay results. Bioassays evaluating efficacy of Mustang Max at 1DAT and 5 DAT (Fig. 2) revealed the toxicity level of the pyrethroid on both sectors "A" and "B" was adequate to kill SWD at 1 DAT but as the toxins degraded, the lower concentration of the "A" sectors showed less efficacy than the "B" sectors, which did not receive the final purge. This phenomenon was not observed for every insecticide. Danitol®, fenpropathrin (14.5 fl oz) applied on 24 September 2012 and its efficacy did not appear to be affected by the additional water in sector A (Fig. 3). Reasons for these efficacy differences between chemistries are not known.

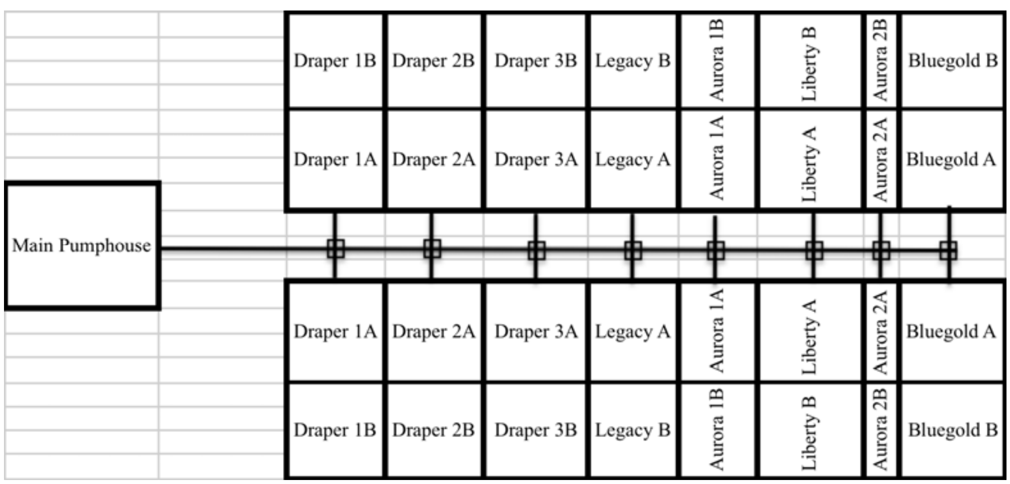

Fig. 1. Salem, OR micro-sprinkler field map, 2012.

Table 1. One-hour treatment cycle Pan America 16 August 2012. Treat = Mustang Max, Water = no insecticide, Dry = neither water nor insecticide.

Cultivar	10 minutes	10 minutes	10 minutes	10 minutes	10 minutes	10 minutes
Draper A	Treat	Dry	Dry	Water	Dry	Dry
Draper B	Water	Dry	Dry	Treat	Dry	Dry
Legacy/Aurora A	Dry	Treat	Dry	Dry	Water	Dry
Legacy/Aurora B	Dry	Water	Dry	Dry	Treat	Dry
Bluegold A	Dry	Dry	Treat	Dry	Dry	Water
Bluegold B	Dry	Dry	Water	Dry	Dry	Treat

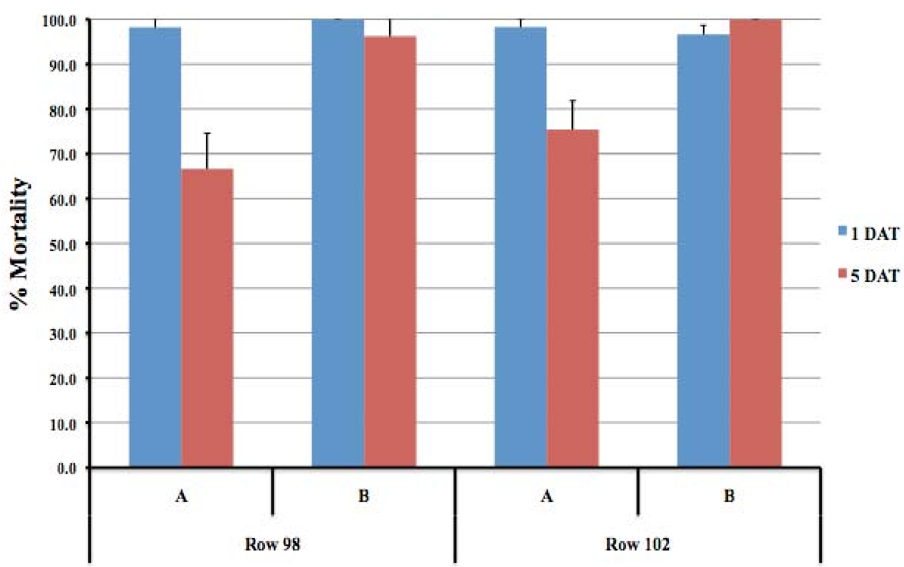

Fig. 2. Mustang Max micro-sprinkler leaf bioassay for field-aged residues to SWD.

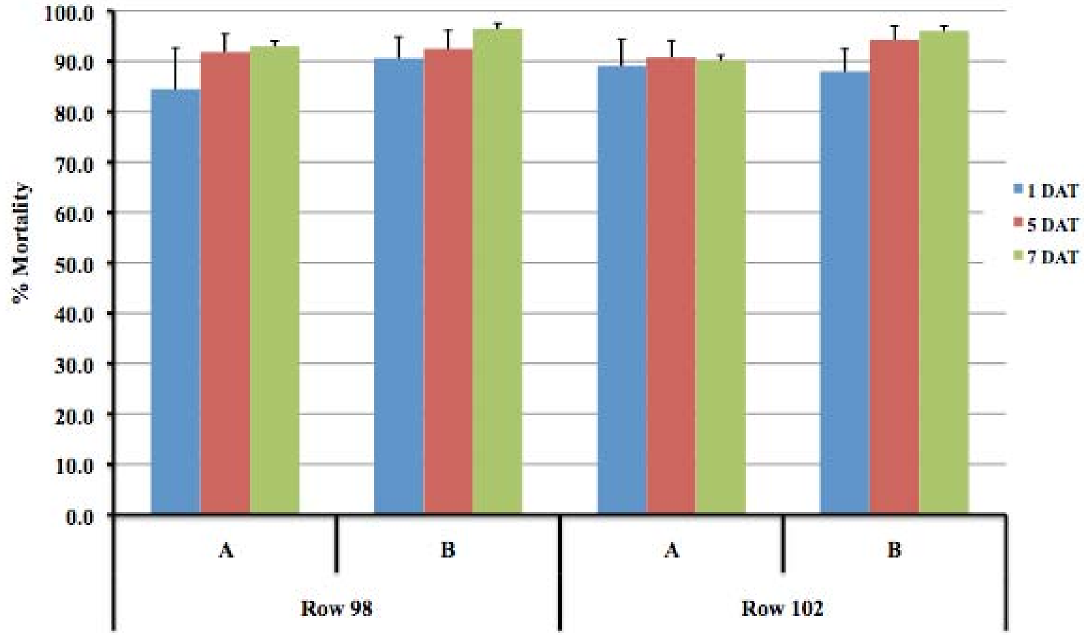

Fig. 3. Danitol 2.4EC micro-sprinkler leaf bioassay for field-aged residues to SWD.

REPRODUCTIVE READINESS OF SPOTTED WING DROSOPHILA

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Reproductive readiness of *Drosophila suzukii* (Matsumura) is currently based solely on their presence in traps. However appearance of females in traps does not necessarily correspond to oviposition capability (Gerdeman 2012 unpublished data). We have begun to analyze the ovarian condition of female spotted wing drosophila from trap samples to better understand their phenology and life history in the Pacific Northwest cropping cycles. While *D. melanogaster* is closely related and a perfect reference animal for SWD with voluminous literature, the bulk of its' research focuses on genetics. Literature on drosophila internal morphology is primarily limited to early-mid 20th century scientists including R. C. King and M. Demerec. Therefore understanding of internal anatomy of SWD and skill in micro-dissection was painstakingly acquired through hands-on experience. Approximately 200 spotted wing drosophila from trap samples representing 3 localities (two in Washington state and a localized cluster in British Columbia, Canada) and every month of the year, were dissected to determine their reproductive condition. Select specimens were slide mounted in Hoyer's medium and further studied using light microscopy (phase contrast and dark field) at magnifications from 100x-200x. Photographs were made using a Canon EOS 7D and microscope adapter. Female reproductive condition was categorized as follows:

1. No distinguishable ovarioles.
2. With distinguishable ovarioles.
3. Eggs large but no filaments.
4. Mature eggs with filaments.
5. Ovaries with few mature eggs often wrinkled, without developing eggs.

Fig. 1. A toroidal mass of sperm evident in spermathecal squash from 20-28 Oct., BC, Canada.

Observations thus far include:

- Presence of spotted wing drosophila in the field did not always coincide with egg-laying capacity.
- Viable eggs were found in dissected female SWD from mid-May-Oct (Figs. 2-3).
- Wrinkled eggs (non-viable) were found in dissected females from May and Sep Fig. 3).
- Overwintering flies - mix of different ages.

- Some overwintering females were mated (spermatozoa observed in spermathecae or seminal vesicle) (Fig. 1).
- Some overwintering females (Nov-Apr) severely starved-remaining eggs incorporated into a thin fat layer lining a hollow abdomen.

Variation in SWD activity and economic damage in 2012 was reported in west coast states from California, Oregon and southern Washington which experienced high SWD pressure, to northwestern Washington where economic damage from SWD was not reported until the end of the red raspberry season. SWD clinal variation occurs along the west coast, therefore seasonality of some but not all of the observations mentioned above may vary according to location.

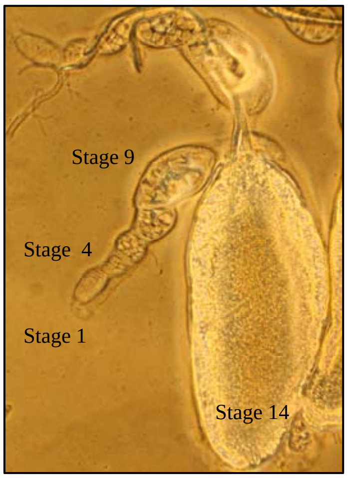

Fig. 2. Ovariole from a 15-18 day NWREC culture SWD shows a mature egg (stage 14) ready for oviposition with eggs representing stages 9, 4 and 1 seen advancing in another ovariole (behind) within the same ovary.

Fig. 3. A mix of both viable and older eggs can be seen in this 13-20 Sep SWD from BC, Canada. Viable eggs were observed in dissected SWD from mid-May through September. Older eggs were observed from late May - early June and again in September.

FIELD EFFICACY OF SEVERAL LABELED AND EXPERIMENTAL INSECTICIDES FOR SPOTTED WING DROSOPHILA CONTROL IN BLUEBERRY

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Trials were conducted on the WSU NWREC on 8 year-old 'Duke' blueberries. Four bush, unreplicated plots were randomly selected in four rows. Treatments were applied with a CO_2 backpack sprayer equipped with a 36-inch boom arranged with two, 8002VS nozzles centrally spaced 18 inches apart with two, 12-inch drop tubes each equipped with an 8002VS nozzle directed at right angles toward the bush. The boom operated to deliver 100 gal/ac at 40 psi. Seven treatments were SWD insecticides registered for use in WA and three were non-labeled insecticides worthy of IR-4 consideration. All treatments contained methylated seed oil adjuvant at 0.0025 v/v. The treatment was applied to mature leaves on 11 September 2012. Two top canopy leaves were taken from each bush from 1-10 DAT, 13-14 DAT and 28 DAT. The two leaf samples were placed in 100x20 mm Petri dishes with a 0.5" long, moistened cotton dental wick, 5 mm^3 of diet media and five even-aged SWD adults from our lab colony. Mortality was evaluated after 24 hours. We continue to feel the leaf bioassay is a more accurate technique for assessing commercial efficacy when applying dilute rates of SWD protective sprays by ground equipment to blueberries. Canopy foliage provides larger surface areas for high-pressure sprayer coverage that can mitigate resting and feeding sites for adults between their egg-laying activity. Both field and lab bioassays of treated blueberries reflect the difficulty of achieving good coverage on all surfaces of blueberry fruit clusters that are located within the foliage of a blueberry bush. Contact coverage is critical to the rapid knockdown of egg laying female SWD seeking ripening fruit.

We used a provisional mortality rate of 90% to compare our treatments with each other for daily residual activity that extended to 28 DAT. Field aging residues at 7 DAT showed the pyrethroids Danitol, Mustang Max, Warrior II and combination product Leverage 360 exceeding the threshold, followed by Brigade (87.5%) and Endigo (89.7%) (Tables 1-2). Furthermore, Danitol and Leverage continued high activity levels of 95% and 100% at 14 DAT. When we extended the leaf bioassay to 28 DAT, Leverage, Brigade and Danitol were killing adult SWD above 60% mortality with 24 hour exposures in a Petri dish. Again, we speculate that SWD populations reside for a good portion of a day on foliage and berry surfaces. This observed longevity for pyrethroids on blueberry has been report in the literature for other woody perennial plants such as roses. The incorporation of a MSO surfactant may have provided enhanced residual extension compared with our incorporation of the non-ionic surfactant R-56.

Table 1. Efficacy of SWD insecticides registered for use on blueberry.

		Percent Mortality			
Treatment	Rate/acre	1 DAT	3 DAT	7 DAT	14 DAT
Brigade WSB	16 oz	95a	71.7ab	87.5b	74.4b
Danitol 2.4 EC	16 fl oz	100a	70.4ab	95ab	95a
Mustang Max	4 fl oz	100a	43.8cd	91.4ab	5.6d
Malathion 8	32 fl oz	100a	77.5a	0c	0d
Delegate WG	6 oz	62.5bc	3.6e	0c	0d
Entrust 2 SC	6.4 fl oz	24.1de	5e	0c	0d
Lannate LV	24 fl oz	42.5cd	10e	0c	0d
Untreated check		5e	0e	0c	0d

Mean within columns followed by the same letter are not significantly different

(Fisher's Protected LSD, P<0.05), PRC ANOVA
SAS.

Table 2. Efficacy of unlabeled insecticides on SWD on blueberry.

		Percent Mortality			
Treatment	Rate/acre	1 DAT	3 DAT	7 DAT	14 DAT
Warrior II	1.92 fl oz	95a	50bcd	100a	85ab
Endigo ZC	4.5 fl oz	78.1ab	38.d3	89.7ab	57.1c
Leverage 360	3.2 fl oz	83.9ab	65abc	91.9ab	100a
Untreated check		5e	0e	0c	0d

Mean within columns followed by the same letter are not significantly different

(Fisher's Protected LSD, *P*<0.05), PRC ANOVA SAS.

EVALUATION OF SEVERAL LABELED AND EXPERIMENTAL INSECTICIDES FOR ROOT WEEVIL CONTROL IN SMALL FRUITS, 2012

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Clay color weevil bioassay

Clay colored weevils (CCW), *Otiorhynchus singularus* (L.) were collected with beat trays from the Northwood area of Lynden from a first year, 'Meeker' planting on 14 May 2012. Contact-topical treatments consisted of Actara™ (thiamethoxam at 3 oz/acre), Brigade 2EC (bifenthrin at 6.4 fl oz/acre), Mustang Max (zeta cypermethrin at 4 fl oz/acre) and unlabled Avaunt (indoxacarb at 6 oz/acre), Leverage 2.7 (imidacloprid/cyfluthrin at 3.75 fl oz/acre), Voliam flexi (thiamethoxam/chlorantraniliprole at 7 oz/acre), non-registered Cyazypyr 10 SE (cyantraniliprole at 20.5 fl oz/acre + MSO) and an untreated check. Treatment arenas consisted of an individual red raspberry leaflet placed top-side up and a moistened 0.5' long cotton dental sick in a 90x15 mm Petri dish. Each treatment was replicated 3 times with 5 CCW/dish. These arenas were treated with 1 ml of the recommended field rate for each product in the equivalent rate of 100 gal/acre with a Precision Potter Spray Tower at 15 psi. These arenas were held at lab temperature in trays under semi-dark conditions. Poking individuals assessed adult mortality with a dissecting probe to determine dead, moribund or feigning dead weevils at 24 hour intervals to 4 DAT (Table 1).

Table 1. Clay color weevil residue bioassay on red raspberry foliage, 2012

		Percent Mortality		
Treatment	Rate/acre	1 DAT	2 DAT	4 DAT
Brigade 2 EC	6.4 fl oz	100a		
Mustang Max	4 fl oz	100a		
Actara	3 oz	53.3b	93.3a	93.3a
Avaunt	6 oz	0.0d	80a	80a
Cyazypyr	20.5 fl oz	13.3cd	100a	50b
Leverage 2.7	6.4 fl oz	100a		
Voliam flexi	7 oz	33.3bc	93.3a	93.3a
UTC		0.0d	0.0b	0.0b

Mean within columns followed by the same letter are not significantly different (Fisher's Protected LSD, $P<0.05$), PRC ANOVA SAS.

After 1 day posttreatment, all CCW placed on Brigade, Mustang Max and experimental Leverage treated foliage were dead. The results for the two pyrethroids further support our extension recommendations to apply them as early spring basal applications or as foliar sprays during bud break and the formation of fruiting laterals. These applications would provide topical and contact/stomach modes of entry to adult feeding CCW. Actara is a slower acting product and performed commensurate with the unlabeled package mix Voliam flexi. Some of the Actara exposed adults scored dead or moribund at 2 DAT recovered on 4 DAT. At 4 DAT, Avaunt provided equivalent level of control with Actara and Voliam flexi as well. Cyazypyr showed significantly lower levels of control and variability between replicates because many of the weevils were scored as moribund or dying. Cyazypyr provides faster knockdown when it is ingested compared with a topically applied treatment. However, one must remember that a topically exposed CCW in the field would be re-exposed to residues on the canes or when they feed on contaminated buds and foliage that should be enough to provide complete mortality. The Czazypyr/Rynaxypyr insecticides represent a unique MOA insecticides (Group 28) that will be supported for an IR-4 residue project in caneberry and possibly strawberry. Also because DuPont has indicated that Cyazypyr does not have MRL issues like Avaunt has with Canada.

Black vine weevil bioassay

Black vine weevil (BVW), *Otiorhynchus sulcatus* (F.) adults were collected from a 3 year-old 'Totem' field in Burlington, WA on 17 July 2012. Treatment arenas consisted of an individually treated red raspberry leaflet placed top-side up in a 90x15 mm Petri dish. Each treatment was replicated 3 times with 5 BVW/dish. A moistened 0.5' long cotton dental wick was placed in the arenas that were held at lab temperature in trays under semi-dark conditions. These arenas were treated with 1 ml of the recommended field rate for each product in the equivalent rate of 100 gal/acre with a Precision Potter Spray Tower at 15 psi. Contact-ingestion treatments consisted of non-registered Cyazypyr 10 SE (cyantraniliprole at 13.5 and 20.5 fl oz//acre + MSO) and an untreated check. By 3 days posttreatment, all of the BVW adults were scored as dead, despite evidence of morbidity and recovery evident after 24 hours of exposure. As observed earlier for the CCW, Cyazypyr continued to shown consistent efficacious activity to adult root weevils common to small fruits. This group 28 new MOA chemistry will provide an excellent rotational partner with Mustang Max and other pyrethroids in small fruit crops.

SECTON VIII
NEW & CURRENT PRODUCT DEVELOPMENT

Moderator: Jamin Schmitger

THE FIT FOR SEVERAL NEW INSECTICIDES IN POTATOES AND OTHER CROPS

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The potato insect market is sufficiently large to attract the marketing attention of agricultural chemical companies and we are in the midst of the most concentrated launch of new products into this market in recent memory. The following products are coming onto the potato market; spirotetramat (Movento, Bayer CropSciences, functionally 2012), cyazapyr (DuPont, 2013), sulfoxaflor (Transform, Dow AgroSciences, 2013), Sivanto (flupyradifuron, Bayer CropSciences, 2014) and tolfenpyrad (Torac, Nichino 2015). These products have interesting and unique characteristics including spectrum of control, efficacy, rapid knockdown, systemicity, and modes of action that are unlike any products the potato industry has ever experienced.

Despite the rapidity with which these products are entering the market, there is significant information that is not known. For example, spirotetramat has chemigation on its label but is not recommended for application via that use pattern despite being registered on potatoes for three years due to lack of data. The full spectrum of control for several of these products has yet to be established. Several products lack aerial and chemigation application data against any pests for which they are being targeted.

Large market crops such as potatoes (and corn, wheat, alfalfa, apples and so on) are gateway crops or also called Tier 1 or Tier 2 crops, meaning they are manufacturer objectives for registration. Once the efficacy, use pattern and spectrum of control has been somewhat elucidated for these crops, opportunities for smaller, minor or specialty crops become apparent and specialty crop researchers try to fulfill unmet pest control needs for these commodities.

There is even more data lacking for these products on specialty crops than for Tier 1 and 2 crops. Data on these insecticides on potatoes (as a Tier 1 crop) and also on specialty crops will be presented and discussed.

SECTION IX
EXTENSION & CONSULTING: UPDATES/NOTES FROM THE FIELD

Moderator: Amy Dreves

FIELD AND LAB RESEARCH EQUIPMENT: CONCEPTS AND IDEAS FOR SUCCESSFUL OUTCOMES

Craig Collins

Slide Presentation only

INSECT IDENTIFICATION REPORT UPDATE IN EASTERN OREGON

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Accurate identification allows for the most effective means of pest control either in commercial crop fields or the home garden. Correct pest identification is an essential element of integrated pest management (IPM). The Oregon State University Extension Service provides identification services for the public and agricultural sectors to help protect and manage their resources. Extension agents throughout the state are trained to identify common insects and their close relatives such as spiders, ticks, mites, and centipedes. Extension agents trained in entomology possess background knowledge on control methods and general biology which allows the specialist to suggest information and resources for selection of efficient and cost-effective control measures. In eastern Oregon, at the OSU-Hermiston Agricultural Research and Extension Center - Irrigated Agricultural Entomology Program (OSU-HAREC-IAEP), a comprehensive insect identification service is provided.

Red circle shows Hermiston, located in eastern Oregon

Methods

At the OSU-HAREC-IAEP, homeowner and/or grower samples are typically brought to the administrative office or the entomology laboratory. Individuals requesting identification first complete an insect identification submission form with contains as much pertinent information as possible**.** This form is available in OSU extension centers/offices and can be obtained online at http://www.science.oregonstate.edu/bpp/Plant_Clinic/Insect%20ID%20Form.pdf. The sample and identification form are sent to the entomology laboratory for processing. Once the specimen and form arrived at the laboratory, the client is contacted typically within 24 hours to advise the client of the receipt of the specimen and and/or the status of the identification.

Specimens for identification

In eastern Oregon, excluding Arachnida (spiders), the top three groups that arrive for identification in 2008 through 2012 were Coleoptera, Diptera and Hemiptera (**Fig 1**). The latter was closely followed in abundance by Lepidoptera and Hymenoptera, each representing 11% of the total samples received for identification. Curculionidae, Scarabeidae, Chrysomelidae and Cerambycidae were the four most abundant Coleoptera. Within the order Diptera, Bibionidae, Drosophilidae, and Anthomyiidae were the most abundant (**Table 1**). Aphididae and Coreidae were the most abundant true bugs; aphids represented nearly half (46%) of the specimens. Sixty five% of the samples came from home owners, while nearly 35% were brought by growers or field men. In most recent years (2008-2012), the percentage of specimens brought in by growers grew by 2 % (**Fig. 2**). From a seasonal perspective, most samples were brought in during the months of July to September.

Fig 1. Distribution of samples received for identification by Order excluding Arachnida (spiders), Hermiston, OR 2008-2012

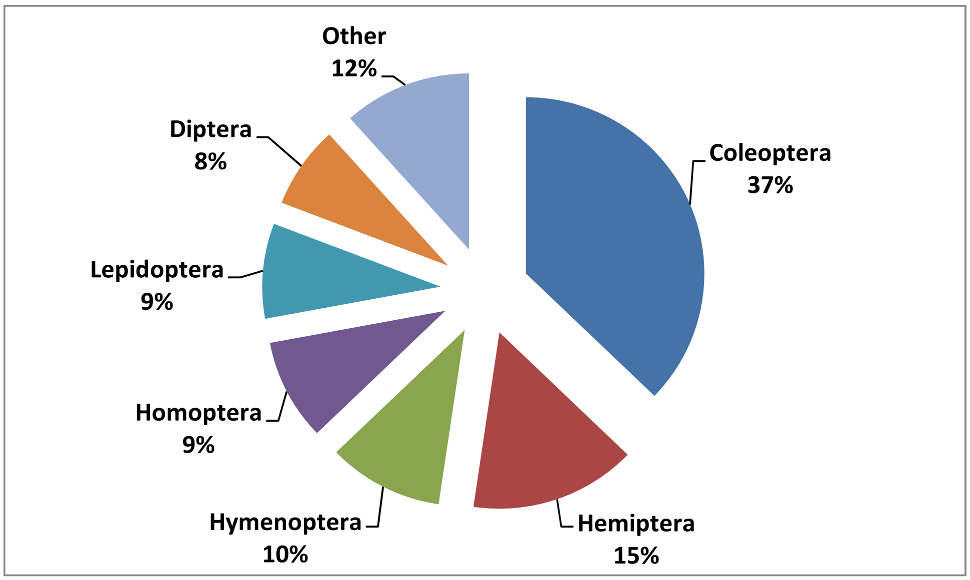

Fig 2. Origin of samples, Hermiston, OR 2008-2012

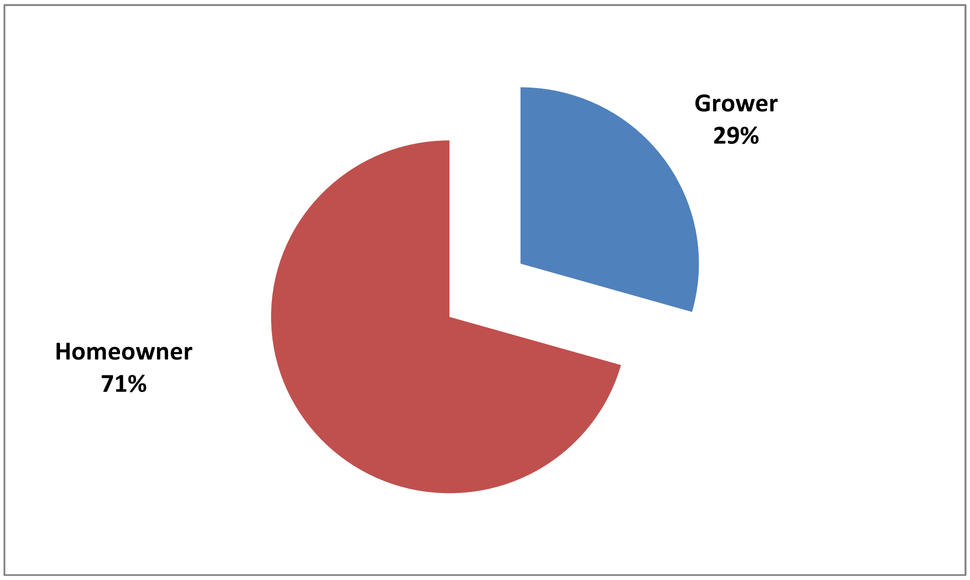

Table 1. Distribution (%) of samples brought for identification by family listed for the three most frequent orders of insecta.

Coleoptera	%	Diptera	%	Hemiptera	%
Chrysomelidae	18.5	Anthomyiidae	36.4	Aphididae	33.3
Curculionidae	16.7	Bibionidae	18.2	Coreidae	25.0
Cerambycidae	14.8	Tipulidae	18.2	Pentatomidae	12.5
Carabidae	11.1	Chloropidae	9.1	Lygaeidae	8.3
Curculionidea	3.7	Drosophilidae	9.1	Adelgidae	4.2
Dermestidae	3.7	Unknown	9.1	Belostomatidae	4.2
Elateridae	3.7			Cimicidae	4.2
Meloidae	3.7			Coridae	4.2
Nitidulidae	3.7			Rhopalidae	4.2
Scarabeoidea	3.7				
Other	13.0				

Table 2. Number of requests for identification by season, Hermiston, OR 2009-2012.

Season	**2009**	**2010**	**2011**	**2012**
January-March	2	8	1	2
April-June	15	18	17	22
July-September	17	31	24	32
October-December	6	8	6	11

More information

Hollis, B.C., S.I. Rondon, and J. Young. 2009. Identifying insects and arthropods in Oregon. Oregon State University Extension Service Publication. June. EC 1630-E
http://extension.oregonstate.edu/catalog/pdf/pnw/EC1630E.pdf

GROUND-NESTING YELLOWJACKETS, *VESPULA* SPP. (HYMEOPTERA: VESPIDAE), IN OREGON SCHOOL ENVIRONMENTS

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Photo courtesy of Kyle Goodman, Beaverton School District

Ground-nesting yellowjackets (*Vespula* spp.) form annual colonies begun by a spring queen. Species native to Oregon are a persistent pest in school environments from late summer to early fall when colonies peak in both size and aggressive foraging. Remediation of these and other pests in school environments involving use of a pesticide – by either school staff or a contracted professional – requires an applicator's license as of July 2012 (ORS 634.700-634.750); however, licensing staff or contracting out for services is often beyond the scope of resources for many Oregon school districts. In light of this, there is an emerging need for integrated pest management methods for ground-nesting yellowjackets that does not involve the use of pesticides. Oregon school districts are innovating methods for remediation of these wasps, which involve preventative techniques, including staff education and sanitation, and also mechanical removal of established colonies. In addition, pilot research examining trap efficacy on spring queen *Vespula* spp. is underway by Oregon State University's School IPM Program.

SPOTTED WINGED DROSOPHILA IN WILLAMETTE VALLEY BERRIES: 2012

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Commercial berry fields were trapped for Spotted Winged Drosophila, *Drosophila suzukii* (SWD), using lidded 16 oz. plastic cups, drilled with 5 mm holes and baited with apple cider vinegar. Fruit infestation was assessed by two methods, salt extraction of larvae and rearing of adults. For salt extraction, berries were placed in plastic bags and covered with a solution of one part salt to three parts water. After 30 minutes the solution was poured into a shallow pan and examined for Drosophila larva. For rearing, berries were sealed in paper bags for three to six weeks and then examined for Drosophila pupa and adults. Trapping continued in the backyard site trapped in 2010 and 2011, using the same trap locations.

Spring trap catches in the backyard site ranged from 5.4/trap/day in February to 0.2/trap/day in May. Spring catches were 5-10x greater than prior years. Trap catches increased during the summer, but were only 0.5 to 0.8/trap/day through the end of August. During June and July of 2010 & 2011, trap catch was only 0.01 to 0.04/trap/day at these sites. Trap catches increased dramatically in the fall, but November 2012 had only 90/trap/day compared to 150/trap/day in 2010 and 300/trap/day in 2011.

SWD trap catches in commercial berry fields followed the same pattern as the backyard site, with low numbers of overwintering flies caught during the spring, slightly higher trap catches during the summer, while fruit was ripening, and substantially higher catches in traps left in the fields during the fall. SWD adults were trapped in a higher percentage of fields compared to 2010 and 2011. The total number of flies caught in blackberry and blueberry fields was also greater than 2010 or 2011, but the catch was about the same in strawberry.

The increased trap catches of SWD in 2012, did not produce an increase in fruit infestation. Only 50% of blackberry fields had infested fruit (vs. 80% in 2011) and no blueberry fields had infested fruit (vs. 17% in 2011). The decline in fruit infestation is probably due to more intensive spray programs. Many fields received five insecticide applications for SWD in 2012; but only three or four sprays were applied to most fields in 2011.

Additional observations:

The relationship of trap catches to fruit infestation was examined in an unsprayed, backyard raspberry planting. Ripe berries collected within a 1-meter radius of a trap were placed individually in lidded, 1 oz. plastic cups to rear SWD. Adults and pupae were counted after 3-5 weeks. SWD were trapped in the raspberry bush on 6/10 & 17, but not during the following three weeks. Two percent of the berries collected on 7/8, were infested with SWD, even though adult SWD had not been trapped since 6/17. By 7/22, SWD were present in 98% of ripe fruit with an average of 13.1/berry. During this period the trap catch increased from 0 to 3.6/trap/day.

SWD trap catches in an unsprayed blackberry field (cv. Hull) ranged from two to 24/trap/day between 7/20 and 9/17. Fruit samples collected from this field between 7/27 to 9/19, had 2 to 14 SWD per berry. In contrast, a field of this variety sprayed five times between 7/18 and 8/20, had SWD trap catches ranging from 0.2 to 2.0/trap/day and fruit samples that ranged from 0.02 to 0.3 SWD per berry. The fruit infestation level was substantially lower in the sprayed field, but SWD were still detected in every berry sample.

Paired samples of Hull blackberries were collected from the unsprayed field on 8/23, 8/30 and 9/6, to compare the recovery efficiency of salt extraction and rearing. Infestation levels ranged from 5 to 12 SWD/berry. There was no significant difference ($p<0.05$) between salt extraction and rearing methods.