**These are research reports only, NOT management recommendations.**
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71ST ANNUAL PACIFIC NORTHWEST
INSECT MANAGEMENT CONFERENCE
JANUARY 9TH AND 10TH, 2012

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PROGRAM

71ST ANNUAL PACIFIC NORTHWEST INSECT MANAGEMENT CONFERENCE


MONDAY, JANUARY 9TH

Registration 9:30AM
Call to Order Business Meeting 10:00AM
Section II and Section III 10:30AM
Lunch 11:45AM
Section IV and Section V 1:00PM
Break 3:00PM
Section VI and Section IX 3:30PM
Adjourn 4:00PM

TUESDAY, JANUARY 10TH

Registration 8:00AM
Call to Order 8:30AM
Section I 8:35AM
Break 10:00AM
Section I 10:30AM
Lunch 11:45AM
Section I 1:00PM
Final Business Meeting 3:30PM
Adjourn 4:30PM
SECTION I
INVASIVE & EMERGING PESTS
Section I
Invasive & Emerging Pests

Wheat Stem Sawfly Blank Heads in Bayer I Trial Nick SWSW

By Dr. David Bragg, WSU Extension Entomologist and Dr. Diana Roberts, Extension Agronomist

Protocol. All white heads were pulled 1 week after anthesis began. Fusarium culmorum heads were pulled and discarded. Heads showing the chewing damage of the larva or containing a larva were counted per 9 meter square replicate. Poisson distribution is shown, as is typical of winged insects. Wheat Stem Sawfly, Cinctus cephi is increasing each summer in this site location. It is a major pest of spring wheat in Montana and Canada, and was found to be present on the Columbia Plateau of the PNW by Dr. Wendell Morrell of MSU in 1995. There are no known natural enemies in the field in WA at present. But Bracon cephi is used extensively in Montana and in Alberta.

Experiment 1. Wheat Stem Sawfly Raw Data

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Experiment 2. One-Way AOV for: WSSF heads per 9 square meter replicates

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<th>Source</th>
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<td>11</td>
<td>12.1295</td>
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<td>Within</td>
<td>36</td>
<td>47.0156</td>
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<td>Total</td>
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<tr>
<td>Grand Mean</td>
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<td>CV 81.73</td>
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Homogeneity of Variances

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<th>Test</th>
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<tr>
<td>Levene's Test</td>
<td>1.12</td>
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<tr>
<td>O'Brien's Test</td>
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<td>0.7149</td>
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<td>Brown and Forsythe Test</td>
<td>0.37</td>
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Welch's Test for Mean Differences

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<tr>
<td>Within</td>
<td>14.1</td>
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Component of variance for between groups -0.05083
Effective cell size 4.0
Observations per Mean 4
Standard Error of a Mean 0.5714
Std Error (Diff of 2 Means) 0.8081

Experiment 3. LSD All-Pairwise Comparisons Test for mean WSSF white heads per 9 square meters

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<tr>
<th>Treatment</th>
<th>WSSF per 9 square meters</th>
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<td>9</td>
<td>2.0000 A</td>
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<tr>
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<td>12</td>
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<tr>
<td>6</td>
<td>0.7550 A</td>
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<td>11</td>
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<td>8</td>
<td>0.5075 A</td>
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Alpha 0.01 Standard Error for Comparison 0.8081
Critical T Value 2.719 Critical Value for Comparison 2.1976

Conclusions: There are no significant pair wise differences among the means of Cinctus cephi damage. None of the Treatments had any effect on the WSSF. No natural enemies were observed. The distribution in Experiment 1 Raw data shows the extent of spread from the river grasses to the upper trial area = 360 feet from bottom near road.
Section I
Invasive & Emerging Pests

Wheat Stem Saw Fly in Bayer 2011 II Variety Express SWSW

By Dr. David Bragg, WSU Extension Entomologist PI and
Dr. Diana Roberts, WSU Extension Agronomist
P O Box 190 Pomeroy WA 99347 braggd@wsu.edu robertsd@wsu.edu

Raw data for WSSF per 9 square meters

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One-Way AOV for: Wheat Stem Saw Fly

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<td>CV 151.17</td>
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Homogeneity of Variances

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<td>Levene's Test</td>
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<td>O'Brien's Test</td>
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<td>0.3856</td>
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Welch’s Test for Mean Differences

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<th>Source</th>
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<td>Within</td>
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<td>Component of variance for between groups</td>
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<td>Effective cell size</td>
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<tr>
<td>Observations per Mean</td>
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<tr>
<td>Standard Error of a Mean</td>
<td>0.5234</td>
<td></td>
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<tr>
<td>Std Error (Diff of 2 Means)</td>
<td>0.7402</td>
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### LSD All-Pairwise Comparisons Test for Wheat Stem Saw Fly distribution Meter Square

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean infested fly heads just after anthesis</th>
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<tbody>
<tr>
<td>3</td>
<td>1.51 A</td>
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<tr>
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<td>8</td>
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<td>0.26 A</td>
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</table>

**Alpha** 0.01  **Standard Error for Comparison** 0.7402  
**Critical T Value** 2.797  **Critical Value for Comparison** 2.0704  
There are no significant pairwise differences among the means.

**Conclusions:** WSSF exhibits a Poisson distribution in the raw data and no pattern was shown compared to Nick in Bayer I. The actual numbers of infested stems is lower and Express matured for harvest nearly a month earlier than Nick which has very late in August. While wheat stem sawfly number were low it needs to be stated again that up to 80% loss of yield occurs in breakout years in the North Central States and in adjoining Canadian Provinces. Biological Control is used in these areas using *Bracon cephi* which Braconid seems to be host specific. There are no pesticides.
Section I.
Invasive and Emerging Pests

Wheat midge a possible new wheat pest in Washington State

Diana Roberts and David Bragg
Washington State University Extension
Pullman, WA 991634

droberts@wsu.edu and braggd@wsu.edu

The wheat midge (Sitodiplosis mosellana) was found in several eastern Washington counties in 2011, with the potential to damage spring wheat crops. However, WSU scientists do not recommend that farmers apply insecticides unless they know they have an economic infestation.

The midge (Fig 1) is also called the ‘orange wheat blossom midge’ because it is orange in color and it infests wheat at pollination (flowering). It originated in Europe and has been an economic pest in the Canada and the northern US, including most recently; Bonner, Boundary, and Kootenai Counties in Idaho.

The 2011 situation

In 2011, scientists put out pheromone traps for the wheat midge because we suspected it would move in from Idaho. The insect was captured in low numbers in pheromone traps in Stevens County (Colville and Chewelah), Spokane County (Peone Prairie, Valleyford, and Nine Mile Falls), Lincoln County (Waukon and Mondovi), and Garfield County. The midge is probably also in other easternmost counties in the high rainfall zone.

The wheat midge has been reported previously in Washington, so this is not a new finding for the state. However, we don’t know the background population levels of the midge, and whether this year’s data represent an increase in numbers.
The pheromone is a sex hormone that attracts only the adult male wheat midge. Because the pheromone draws in insects from across large fields, the trap is a sensitive indicator of the presence of the midge but it is not a reliable measure of its population density in the field. However, closer examination of wheat fields did not reveal midge populations that would likely cause economic damage this season.

Consequently we did not recommend that growers go out immediately and spray their crops because that kills beneficial insects such as ladybird beetles.

**Action plan**

We are in contact with researchers in Canada and the Midwest who have biological control agents for this pest. While the midge populations are still at low levels, we will take the opportunity to bring in the biocontrols.

We will also seek funds to enable us to determine the extent of this infestation and to track population changes. The trap catches from this season (2011) will serve as baseline data.

**Identifying the wheat midge**

The adult orange wheat blossom midge (Fig 1) is a fragile insect with a body type similar to a mosquito, but about half the size. It has an orange body, conspicuous black eyes, 3 pairs of long legs and one pair of wings. The female lays eggs on the awns and heads of wheat plants. The eggs hatch into larvae (Fig 2) that crawl inside the floret and feed on the developing grain, causing yield loss and shrunken kernels.

The larvae are about the same size, shape, and color as the anthers of the wheat floret (Fig 3). Spring wheat crops (Fig 4) are most susceptible to infestation (egg-laying) by the midge from heading until the anthers hang out of the florets. After that time the midge causes little damage.
Winter wheat and barley crops are seldom affected. In addition, the midge needs warm temperatures, calm weather, and moisture for successful egg laying.

During the day the adult midges hide deep in the crop canopy. The best time to scout for the midge is on calm, clear evenings within 1 hour of sunset. The adults may be seen flying in the canopy or sitting on wheat awns with their heads facing upwards (Fig 1).

**Take care with identification!** There is a lookalike fly that has an orange, but fat, body and it rests head downwards in the wheat. And other tiny, orange blobs on the wheat head may actually be aphids (Fig 5).

Various other insects were also found in the pheromone traps in 2011(Fig 6).

**Economic thresholds for the wheat midge**
There are no established economic thresholds for midge infestations in Washington State. In North Dakota, the thresholds are 1 midge per 5 heads for hard red spring wheat or 1 midge per 7 heads for durum wheat.

**For further information** contact Diana Roberts at WSU Spokane County Extension, phone 509-477-2167 or E-mail robertsd@wsu.edu.

North Dakota State University has a Wheat Midge bulletin at: [http://www.ag.ndsu.edu/pubs/plantsci/pests/e1330.pdf](http://www.ag.ndsu.edu/pubs/plantsci/pests/e1330.pdf)

The team working on the wheat midge includes Ed Bechinski (UI Extension Entomologist), David Bragg (WSU Entomologist) and Keith Pike (WSU Entomologist). With acknowledgements to Howard Nelson (Central Washington Grain Growers) and Rory Eggers (Primeland).
Figure 6. A variety of insects were captured in wheat midge pheromone traps in 2011. They included the wheat midge, gall flies, and thrips. They are all shown here for reference - to show relative sizes – and thus to aid in correct identification of the wheat midge. The black squares are 1-inch demarcations drawn on the sticky paper in the trap.
Section I.
Invasive and Emerging Pests

A MODEL ESTIMATING SPOTTED WING DROSOPHILA OVERWINTERING MORTALITY

Oregon State University, Corvallis, OR
P.W. Shearer, S. Castagnoli
Oregon State University, MCAREC, Hood River, OR
cooipl@science.oregonstate.edu

A model that estimates overwintering mortality of the spotted wing Drosophila (SWD), *Drosophila suzukii*, based upon chilling degree-days (DDs), is undergoing active development, and is intended to be used for varying climates and habitats. Recent laboratory cold temperature mortality studies (Dalton et al. 2012) used 5 constant temperatures with no freeze interval and recorded survival for up to 84 days. These data were converted to chilling DDs using thresholds from 10.6 to 12.8 degrees C (51 to 55F). After a lowest error (C.V.) comparison, a threshold of 11.7C (53F) was selected to compute chilling DDs. These results were then fitted to an exponential saturation function (Fig. 1) to allow estimation of a given mortality rate for a given accumulation of chilling DDs. The model was then confronted with data from: a) the same study with an added 7-day freeze; and b) field monitoring data from the mid-Willamette Valley and Hood River, Oregon (Fig. 3). The model gave a reasonable fit to these data, once a factor was included for the field data to account for SWD behavior seeking rural and human/urban related refuges from winter cold temperatures. This refuge factor (Rf) was developed from 800 meter resolution GIS data, NOAA stable lights 2010 (Fig. 2), which provides a continuous range of nighttime light intensity. We adapted these data as a proxy for the tendency of SWD to seek shelter from the cold over a range from rural (open space with minimal protection, Rf=0.15) to human/urban influences (with maximal protection, Rf=0.60). These preliminary refuge factors were estimated in part from the data from the field data as shown in Fig. 3, and from a general failure to trap flies before June or July in most rural/open areas in 2011 in Hood River and Wasco Counties and other cold winter regions. With the resulting model, we developed maps for the Pacific Northwest (Fig. 4) and for CONUS USA that predict average SWD overwintering mortality rates. The model is intended to serve as a test of our current understanding and data on differential winter mortality and resulting spring population incidence levels. One use of the model could be to help determine springtime monitoring efforts for a given location. This model, once it is further refined and tested in particular to improve refuge factor estimates for a range of habitat types, should also be useful as a component within other models predicting SWD population dynamics.
Fig. 1. A model of SWD overwintering mortality developed from constant temperature laboratory data based on accumulation of chilling degree-days (DDs).

Fig. 2. NOAA Earth Observation Data Center “2010 Stable Lights” calibrated to represent potential SWD overwintering refuges based on urban/human caused development, currently varying from 0.15 (most exposed or rural, darkest) to 0.60 (most protected or urban, lightest). Shown for NW Oregon with a) urban boundary data (red), and b) yellow box around region monitored for data displayed in Fig. 3, Left. Within this area, the average refuge factor is 0.25, used to reduce chilling DDs by 25%. 
Fig. 3. SWD overwintering mortality model estimates vs. mid-Willamette Valley (WV) and Hood River (HR) winter-long adult monitoring data, Left side: WV 2009-10 and 2010-11, adjusted to relative initial population sizes, with model refuge factor (Rf) of 0.25 (see Fig. 2). Right side: HR 2020-11 with model Rf of 0.60 (urban), for backyard raspberries. Monitoring data adjusted slightly for relative outdoor temperatures affecting SWD adult activity.
Fig. 4. SWD overwintering mortality model application to Pacific Northwest region. Upper left – SWD chilling DDs (53 degrees F threshold; derived from 1971-2000 PRISM 30 year average climate data), which reflects laboratory (no refuge) situation. Upper middle – NOAA 2010 Stable Lights, tinted reddish to show potential range of urban refuge/protection effects. Upper right – combined results showing currently estimated overwintering mortality values, ranging from 99% mortality (red areas) to nearly 100% mortality (darkest areas).
The spotted wing Drosophila (SWD), *Drosophila suzukii*, was first reported in the Pacific Northwest in 2009. Because the fly is able to oviposit directly into intact ripe and ripening fruit it is of great concern to the small fruit industries in our region. Nationwide, Washington and Oregon are the top two producers of raspberries and 2nd-3rd in wine grapes, and both are top producers of blackberries, blueberries, cranberries and strawberries. The short generation time and infestation inside the fruit of this pest make control challenging. In cooperation with researchers in Oregon, California and Washington we have now completed our second field season of research to understand the biology of the fly, develop monitoring and management programs and educate growers of susceptible crops on how to effectively manage this new pest.

**Research Highlights:**
- Where has the fly spread since we last met?
- Identifying a better attractant and building a better trap.
- Improved larval monitoring techniques
- Insecticide application strategies
- Dispersal in and out of the field
- Resistance monitoring
Where is SWD currently located?

2009
British Columbia

2011, distribution map is subject to change and based on Oct 2011 records
Drosophila suzukii (SWD), an invasive vinegar fly native to SE Asia, made its first appearance in Oregon in the fall of 2009. Since then, SWD has been confirmed in 17 Oregon counties. The pest is known to lay eggs in an extensive range of small and stone fruits, resulting in crop losses if not managed. In addition to commercial crops, the host plant range of SWD includes wild fruits and berries found in many areas of the Pacific Northwest. Development of sound, effective management practices therefore 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.

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 in trees were placed at 3 levels, including ground, 6 feet (2m), and over 13 feet (4m).

Initial SWD trap catches were observed in June, in traps placed in trees. Over time, trap catches rose within blueberry plants and along the perimeter of the crop, becoming more evenly distributed through the crop during the blueberry harvest period (Fig. 1). 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.

SWD abundance in crop, perimeter, and tree trapping locations increased through mid-November, long after blueberry harvest was complete (Fig. 2). 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. 3). Evaluation and analyses of landscape data will continue through the winter of 2011 and well into 2012.
Figure 2. Seasonal phenology of male and female SWD in a mass-trapped blueberry field between 6/15/11 and 11/16/11.

Figure 3. Seasonal phenology of male and female SWD in crop and perimeter traps placed in a blueberry field between 6/23/10 and 6/8/11.
**Figure 1.** Spatial and temporal mapping of SWD trap catches in blueberry crop, perimeter, and tree trapping locations during pre-harvest, mid-season harvest, and post-harvest periods. Trap catches per week are represented by the following color scale: no color to light gray (0-5 flies); medium gray (5-20 flies); dark gray (20-500 flies); very dark gray (over 500 flies).
Section I
Invasive & Emerging Pests

**Using protein marker technology to determine spotted wing drosophila movement between border and field**

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**Introduction**

*Drosophila suzukii*, the spotted wing Drosophila (SWD), is a new pest that has a major economic impact in berry and stone fruit crops. In 2009, reports of yield losses range from negligible to 80% in Pacific coast states (Bolda et al. 2009). SWD is native to Southeast Asia and was first discovered in California in 2008 and has since spread across the United States as well as Europe, establishing SWD as a global pest. Adult flies lay eggs in ripening fruit. Eggs develop into larvae and feed on the fruit interior, decimating the crop. The host range is large and ranges from cultivated and wild berries to stone fruits. We suspect the mobility of the fly allows it to move between wild and cultivated crops. One of the preferred hosts in the wild is Himalayan blackberry (HB), *Rubus discolor*, an invasive and noxious weed commonly found in the Willamette Valley of Oregon. In the Willamette Valley, if bordering areas of cultivated fields are left unmanaged, HB is one of the common plant species found there. The effects of HB on SWD population dynamics, presence and movement between cultivated fields and bordering areas need to be studied as HB is currently believed to provide the primary overwintering habitat for adult SWD. Researchers and growers currently hypothesize that SWD is using HB as a primary secondary host and overwintering habitat, but the influence on crop infestations due to HB neighboring grower fields has not been quantified.

Insect dispersal, movement and trophic interactions can be observed using various markers (Hagler & Jackson 2001). An ideal insect marking material is durable, inexpensive, nontoxic (to the insect and the environment), easily applied, and clearly identifiable. Furthermore, the marker should not hinder or irritate the insect or affect its normal behavior, growth, reproduction, or life span. The selection of the most suitable marker for each insect is species dependent as an ideal marker for one insect species may be useless for another (Su et al. 1991). In 2011 we identified markers suitable for studying SWD dispersal in the field. We determined that of all of the potential marks studied egg white is the superior choice for field studies (persistence of the mark, cost and easy to apply). Results of the laboratory studies are presented below (Table 1).
Our objective is to determine the dispersal (spring and fall) of SWD to and from field margins (HB present or absent) to susceptible small fruit fields in Oregon. We predict that HB positively influences fly populations in neighboring cultivated host fields by providing an alternative larval host and a primary overwintering site. If the presence of HB is found to significantly influence SWD population dynamics and dispersal into neighboring fruit fields, removal of HB may help mitigate SWD infestations.

Table 1. Laboratory results of SWD treated with egg, milk or soy proteins.

| Days after Trt | % Leaf Discs Positive after application in the field | % Positive SWD adults after exposure to treated surface | % Positive SWD after direct exposure | % Positive SWD after treated with water | % Positive SWD after treated with water
<table>
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<tr>
<td></td>
<td>Egg</td>
<td>Milk</td>
<td>Soy</td>
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<td>100</td>
<td>74</td>
<td>70</td>
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</table>

*ELISA on-going

2Negative control flies were treated with water and assayed with egg, milk or soy ELISA.

Experimental Design-Spring Movement
A red raspberry field in the Willamette Valley of Oregon either with HB present or absent along its margins was identified. Six 2-acre (0.81 ha or 90 x 90 m) plots 10-20 m from the field margin were sampled at each site (Figure 1). All field margins were 10-20 m in width and 90 m in length along the adjacent fruit crop. Each plot contained 2 transects of five SWD traps per transect (Figure 2). Two traps were placed in the crop border 30 m apart and 20-30 m from the first traps along the crop perimeter. Subsequent traps were placed every 28 m. Fly traps were made of plastic cups with 15 small 3/16 inch holes near the top and a screened reservoir containing apple cider vinegar and a yellow sticky card (Figure 3).

Experimental Design-Fall Movement
The same experimental plots were used to evaluate SWD movement from the raspberry field back into the field borders (HB or non-host)
as described above with the following modification (Figure 4). Each plot will contain 3 transects of three SWD traps per transect.

Methods
To study movement from the field borders into the crop, we sprayed field margins adjacent to each plot (HB or a non-host crop such as wheat) beginning in May 2011 with 10% egg white protein using a Jacto cannon sprayer (Figure 5). Egg protein is detectable for up to 10 days after application (Jones et al. 2006, Hagler and Jones 2010, Klick et al. unpublished data). Thus, we reapplied the protein every 7 days until harvest was complete. To study movement from the crop back to the field borders in the fall, we sprayed the raspberry field in late October 2011 for approximately 6 weeks with 10% egg white protein. We monitored fly traps once a week. On each collection date, the sticky card was removed from the trap, covered with wax paper and replaced and the vinegar refreshed. Sticky cards were returned to the laboratory and frozen until adult SWD can be removed and analyzed for the presence of the egg white mark with ELISA.

Analysis
Up to 45 flies caught on each sticky card on each sample date will be analyzed using indirect ELISA (Crowther 2001). If more than 45 flies are present per trap, 45 random flies will be selected for the ELISA analysis. Each fly will be carefully removed from the sticky card with a disposable toothpick and placed in 1 ml of protein extraction buffer (TBS). The sample will be stirred on a platform mixer for ≥ 1 h at 100 rpm. Trap location and number of SWD captured per trap will be recorded. SWD obtained from our existing laboratory colony will serve as ELISA negative controls as described in detail by Jones et al. (2006) and Hagler and Jones (2010).
Literature Cited
Section I
Invasive & Emerging Pests


Dr. David Bragg, WSU Extension Entomologist & Dr. Diana Roberts, WSU Extension Agronomist
braggd@wsu.edu

Protocol: Since Wheat Stem Sawfly was identified in Washington back in 1995 by Dr. Wendell Morrell of MSU, populations at CFRF are increasing each year for the last 4 years. The wasp attacks the node below the head at anthesis. The heads turn white, are blank, and are easily pulled for examination of the stem to verify WSSF feeding. Counts were made July 23, 2011

Raw Data
1 0 0 1
2 0 2 4
0 0 0 1
4 1 2 0

One-Way AOV for: WSSF per Treatment of 4 replicates in 9 square meters

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<th>DF</th>
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Homogeneity of Variances

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Welch’s Test for Mean Differences

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<tr>
<td>Within</td>
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Component of variance for between groups 0.18625

Effective cell size 4 4.0

Standard Error of a Mean 0.6103

Std Error (Diff of 2 Means) 0.8631

LSD All-Pairwise Comparisons Test for WSSF per Treatment

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<tr>
<th>Treatment</th>
<th>Mean WSSF Heads 9 Meters Square</th>
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<tr>
<td>1 Nipsit™Inside w/o Metconazole check</td>
<td>1.75 A</td>
</tr>
<tr>
<td>3 Nipsit™Inside + Metconazole 4 double</td>
<td>1.01 A</td>
</tr>
<tr>
<td>2 Nipsit™Inside + Metconazole 2 standard</td>
<td>0.26 A</td>
</tr>
<tr>
<td>4 UTC</td>
<td>1.50 A</td>
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</tbody>
</table>

Alpha 0.01 Standard Error for Comparison 0.8631

Critical T Value 3.250 Critical Value for Comparison 2.8051

There are no significant pairwise differences among the means. Field variation is the Poisson distribution factor. This trial was at the bottom of the field adjacent to the river grass land.
The process of monitoring the spotted wing Drosophila (SWD), *Drosophila suzukii*, has involved several designs and protocols toward achieving an optimum standard trap. An effective trap is one that can detect a pest early at its low density to allow for timely management. Yeast/sugar solutions did not seem optimal for growers, due to spoilage, non-specificity, and non-transparency for easy identification in the field. Eventually, a soapy vinegar solution was preferred over the yeast traps.

One test of the effectiveness of a SWD trap is the ability to attract the fly in the off-season. At an earlier site for the color trials, traps were placed in a hot spot in raspberries until the end of January 2011. In February, various traps were reintroduced to a cherry orchard, comparing yeast and vinegar for clear and red cups, as well as vinegar in the other color cups. Attempts to capture live flies led to placement of red and clear cups along a fence line where wild blackberries encroached, using Heinz apple cider vinegar saturating cotton plugs. The total catch from combined counts during the winter and spring is shown in Figure 1, compared with the previous year catch in blueberry fields using similar traps.
Figure 1. Comparison of total catch in the off seasons, 2010, 2011

A powdered fly experiment was conducted in the laboratory, greenhouse and field to determine flight distance. Two fluorescent colors were used (yellow and pink); the rate of 2 mg per 30 flies per shaker vial was discovered to be optimum for retaining the mark for 7 days. In the laboratory, flies marked with this method experienced a 33% mortality within one week while control unmarked flies experienced 20% mortality. Flies were released at opposite ends in the greenhouse and strawberry plots, and vinegar traps were set up to attract and retrieve flies. During three mark-recapture trials in the greenhouse, 10.7%, 10.2%, and 14.9% of pink powder-dusted flies were recaptured (~1000 released each time), and 8.5%, 9.5%, and 19.3% of yellow powder-dusted flies were recaptured in a 7-day period. Flies were captured near the release point (2-3 m) and on the opposite end of the greenhouse (~11.5 m). All flies retained their powder mark in a 7-day period. During two mark-recapture trials in an experimental strawberry field, 0.68% and 1.92% of pink powder-dusted flies were recaptured, and 0.48% and 0.84% of yellow powder-dusted flies were recaptured. 11 unmarked flies were also captured during the second trial. Most flies were recaptured at the point of release or 5 m away (Figure 2).
A study was set up to monitor various fruit sites with different trap types in several states and Canada during the ripening stages to get clear results leading to a standard trap for most monitoring research purposes. This report compares traps in three berry crops around Corvallis where no sprays were applied.

Results were consistent among the crops in that 1/8\textsuperscript{th} inch hardware cloth incorporated in the traps (Dreves, Haviland mesh, van Steenwyk) tended to outperform traps with ten 3/16 inch holes (clear, Haviland holes) and the trap with two entry holes (commercially available Contech trap). The notable exception was the “red cup” with holes, which remained consistently near the top catching trap (Figure 3).
Three of the most effective colors were retested with standard clear and white in a field experiment during the summer of 2011. A random number generator was implemented to place each colored cup in one of 5 stakes located in each of 6 blocks in raspberries, blackberries, and cherries. Black was favored, red next, consistent with greenhouse cage results, but different from the previous season where relatively low counts in black traps in raspberries affected the overall results (Figure 4).
Summary
High populations of SWD can be detected without fruit present, especially in the fall after harvest. Hardware cloth-containing traps outperformed traps with holes, although red cups with holes were competitive. Vinegar traps can be effectively used to recapture marked flies to determine flight distances. Red, black, and orange are preferred colors for SWD attraction in lab and field. Red has been commercially adopted and incorporated in traps. Future trap design and testing, incorporating color and hardware cloth, is suggested.
Section I
Invasive & Emerging Pests

RECENT TRENDS AND TREATMENTS ASSOCIATED WITH NON-NATIVE INSECTS INTERCEPTED WITH IMPORTED WOOD ARTICLES

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Imported wood articles, such as firewood and wood packing material (WPM), can serve as an unintended vector for non-native wood-boring insects, many species of which, if established, could become serious plant pests. Governments enact several safeguarding measures to mitigate this risk, including pretreatment, port-of-entry inspection, post-entry inspection, and survey monitoring programs. Detection surveys monitor for wood-boring insect pests domestic sites for based on the perceived risk of introduction and establishment.

Interception records were reviewed for wood-associated pests intercepted at international U.S. ports of entry in Oregon and Washington. Data reviews particularly focused on insect belonging to the families Cerambycidae, Scolytidae, Buprestidae, Siricidae, Cossidae, Curculionidae, Platypodidae, and Sesiidae, intercepted from September 2005 through December 2011.

A total of over 1060 insect interceptions were reported from northwest U.S. ports of entry over the past six years. Imported firewood from Canada is a main source for interceptions, although many species are native to Oregon and Washington. Despite improvements in regulatory pretreatment requirements, live woodboring insects continue to be found in certified imported WPM from Asian countries. Generic and species-level results will be presented, and specific examples of pathway risk will be discussed.

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<th>families</th>
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<tr>
<td>Cerambycidae</td>
<td><em>Apriona, Arhopalus, Ceresium, Monochamus, Stromatium, Tetropium, Trichoferous</em></td>
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<td>Cossidae</td>
<td>“species of”</td>
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<tr>
<td>Curculionidae</td>
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<td>Platypodidae</td>
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<td>Scolytidae</td>
<td><em>Hylastes, Hypothenemus, Phloeosinus</em></td>
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<td>Sesiidae</td>
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<td>Siricidae</td>
<td><em>Urocerus, Sirex, Tremex</em></td>
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Section I
Invasive & Emerging Pests

RANGE EXPANSION OF THE CALIFORNIA FIVESPIINED IPS, *IPS PARACONFUSUS* (COLEOPTERA: SCOLYTIDAE) INTO WASHINGTON STATE

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The California Fivespined Ips (CFI) (*Ips paraconfusus*) is a native pine engraver and a known pest of both young and mature pine trees. Historically, CFI’s most northern range has been the Willamette Valley, OR in the Western Cascade Mountains. In 1999, CFI was first reported causing significant damage to newly established ponderosa pine orchards (*Pinus ponderosa*) in the Willamette Valley. In subsequent years, additional outbreaks have occurred in Western Oregon (Flowers & Willhite 2010).

In 2010 a landowner in the Columbia River Gorge reported multiple trees with top dieback within neighborhood landscapes. Specimens collected from damaged ponderosa pines were identified as CFI. After referencing regional insect collections in Washington State, Idaho and Oregon, this collection was the first recorded specimens of CFI in Washington State. Subsequent landowners reported tree mortality consistent with CFI damage throughout 2010 and 2011.

Using CFI pheromone baited lindgren funnel traps, multiple locations were trapped to determine the presence and flight pattern of CFI during the season of 2010 and 2011. As of 2011, CFI has been collected in Washington as far west as Vancouver, east to Lyle, and north to Toledo (Figure 1). Recent fires and other climatic factors have compromised ponderosa pine health in Klickitat and Yakima counties. Authors will expand the survey area in 2012 to record the range of CFI.
The significance of range expansion of CFI is not realized. During the 2010 areal surveys, approximately 100 acres in the Columbia River Gorge showed symptoms of CFI infestations. CFI has been identified as a bark beetle species that has the capacity to cause landscape-wide damage and has the potential to be affected by changing climates (Bentz et al. 2010).


Figure 1. Newly recorded range of California fivespined Ips (Ips paraconfusus) in Washington State.
Section I
Invasive & Emerging Pests

**Improved monitoring of the spotted wing Drosophila, Drosophila suzukii**

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The spotted wing Drosophila (SWD), *Drosophila suzukii*, is a significant problem in many countries, negatively impacting the fruit industries of places it is introduced. Adult females lay their eggs in ripe and ripening fruit. The larvae hatch and feed on the fruit, causing the fruit to collapse and deteriorate, sometimes while still on the plant. The larvae then pupate either in the fruit or after having dropped to the ground. The current recommended method to monitor adult SWD is using clear plastic cup traps containing apple cider vinegar (ACV) as an attractant and drowning solution. However, even when using these traps, growers may still experience low levels of fruit infestation in the absence of adult captures. This project was undertaken to identify a defined attractant and trap design with improved sensitivity to monitor the presence and population density of SWD in the field.

Two attractants commonly being used are apple cider vinegar (ACV) and red wine. Acetic acid and ethanol are important components of vinegar and wine respectively, and other research (Landolt et al, 15 Jun 2011, Journal of Applied Entomology) shows that acetic acid is an attractant for SWD and ethanol may work synergistically with acetic acid to increase attractiveness. In order to test the most attractive levels of these compounds, mixtures with different levels of acetic acid in ACV and ethanol in wine were compared:
The difference in catches between 2 and 6 percent acetic acid indicates lower levels are preferred by SWD. Lower concentrations could be explored to find the ideal concentration. There is no difference in SWD captures between any of the ethanol levels tested. Further research on higher or lower concentrations could reveal a preferred alcohol content attractive to SWD.

The current traps are not effective at monitoring for low level infestation. Odors that are found to be as or more attractive than ACV can be analyzed to determine the attractive compound and potentially concentrated in a mixture to create a more effective attractant.

The lures on the graph were found to be as attractive as ACV. Other lures tested that were not as attractive as ACV were balsamic vinegar, raspberry vinegar, ume plum vinegar, balsamic cherry vinegar, balsamic honey vinegar, Bird Shield, and a water control.

All the acetic acid, ethanol, and other attractants were field tested by pouring 150 mL of the lure and two drops of soap in a clear cup trap. The catches were collected and the odor changed every week. To compare the capture numbers of the different treatments, the factor of attractiveness compared to ACV was figured by dividing the mean captures of the treatments by the mean captures of ACV. The vinegars and soy sauce were bought from the supermarket, Insect Bait and NuLure are insecticide adjuvants and the control is soap water.
Section I
Invasive & Emerging Pests

Japanese beetle introductions at PDX, 2011

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*Brief power point presentation of historic JB interceptions at PDX vs. 2011 catches.

An alarming number of JB’s have turned up at PDX this year, 17 catches.

*How are JB’s getting introduced?

Cargo carrier companies utilizing direct flights from infested areas and also ground transportation has recently become highly suspect.

*Why does it matter?

The ramifications of a Japanese beetle establishment in Oregon would be a disaster on many different levels, ie., damage to commodities of major Oregon industries including nurseries, vineyards and grass seed production. Also affected would be our quality of life in relation to golfing, arboretums, rose gardens and home gardening etc. An arising problem would be the potential for overuse of pesticides administered by the public.

*What will be our plan of action for 2012?

Delimitation trap distribution protocols will be implemented. A new prototype trap that sends an image of the trap can to a web site will also be utilized. There will be pesticide applications strategically administered. A new product, Acelepryn, may be a good alternative to previous products because of less applications required and low toxicity.

*How will eradication efforts be funded?

Stakeholders such as FED EX and Port of Portland are in current negotiations. Possible future considerations may involve the OAN (Oregon Association of Nurseries) amongst other affected industries.
*Conclusion

2012 and beyond. Cooperation and public outreach and awareness will be crucial, as well as funding. A stable isotope study which asserts a generalized birthplace of an individual JB (Eastern US vs, Western US) may be of great help in establishing JB introduction dynamics.
Section I
Invasive & Emerging Pests

SPOTTED WING DROSOPHILA:
PREVENTION TOOLS ARE UNDERWAY

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Spotted wing Drosophila, *Drosophila suzukii* (Diptera: Drosophilidae; SWD), an invasive pest of berry and stone fruits, is now found in 27 states and a larger threat in several European countries. This vinegar fly prefers ripe fruit, as opposed to overripe and fallen fruit that are infested by most of the other *Drosophila* species. For this reason, harvesting fruit in a timely manner is important to avoid oviposition. Greater adoption of prevention-oriented IPM practices (e.g., timely harvesting, sanitation, cold storage) will increase opportunities for growers to widen their options for managing SWD.

It has been found that Oregon’s fruit crops are at more of a risk during mid to late season, if not controlled with chemicals. SWD moves from one fruit crop to another as the season progresses and populations build up in the mid-Willamette valley to higher numbers by August, and exponentially increases during the October to December months after most commercial fruit are harvested as detected in monitoring traps (figure). The first deeper winter freeze greatly reduced the population. Fall-emerging flies (September - October) can overwinter. These overwintering flies go through a reproductive diapause and will lay eggs the following spring/summer on early ripening fruit. It is still unknown where exactly SWD overwinter and how well this pest will overwinter under various environmental conditions throughout Oregon. There is great potential for continual re-introductions, whether they survive the winter or not.

**Management**

There are a team of Oregon, California, Washington, and Canadian researchers addressing such questions as SWD overwintering capability, behavior, phenology, effects of temperature, and influences from the landscape. With this new knowledge, management strategies and control recommendations are being developed as new data is being presented. Monitoring trap designs and attractive baits for more sensitive detection of SWD throughout a season; and as a means of controlling the pest are being investigated further. In 2010 and 2011, many of the researchers used 1 ½-inch of 5% apple cider vinegar (ACV) in a 32 oz cup with ten,
3/16-inch holes punched around sides, serviced weekly. However, yeast mixture (1 package of Brewer’s yeast, 4 teaspoons of sugar and 12 oz of water) was used in traps and compared to ACV at a no-spray blueberry farm. The yeast mixture significantly attracted more flies than apple cider vinegar during most parts of the year, but had its limitations (smelly, not as specific to SWD, less of a preservative for flies).

Cultural and preventative practices such as sanitation techniques (to reduce the fly’s breeding sites) and cold storage treatments in conventional, IPM, and organic fruit systems will be presented in this paper. Post-harvest treatment options are limited. Preliminary data on cold treatments of infested blueberries showed promising results that slowed development, reduced survival of SWD inside the fruit and maintained quality. Growers in the Willamette Valley began observing that when they placed freshly-picked fruit in cold storage after picking, they saw less of a SWD problem. Thereafter, preliminary studies were initiated by OSU-USDA in the fall of 2011 on susceptible late-season blueberries, ‘Aurora’ and ‘Elliott.’ Batches of 105-170 berries infested with SWD eggs or young/old mature larvae were placed in a grower’s cold storage chamber with temperatures ranging from 34-38ºF for exposure periods of 24, 48 and 72 hr. Treatments were replicated 4 times per exposure period. Results were promising, not only were there less larvae, but development of the larvae was reduced. Reductions in survival of younger (figure) and older larvae ranged from 83-97% and 34-59%, respectively.

Sanitation is also a necessary and key management tool to prevent the spread and build-up of SWD populations. Use of sanitation practices often makes suppression strategies unnecessary. Small-scale field studies were performed in 2010 and 2011 utilizing bagging, crushing, burying, solarizing, and leaving infested fruit on the ground. Clear and black bagging killed a good percentage of larvae without escapade from the bag. Solarization (1-2ml clear plastic over fruit) was an effective method, however when testing any of the sanitation methods during increased precipitation and cooler temperature periods, a higher percentage of larvae survived.
Zebra Chip (ZC) was confirmed in the Columbia Basin potato production area of Oregon and Washington in 2011. This is a serious disease first documented in Saltillo, Mexico in 1994. In 2000 the disease was identified in South Texas and since then, ZC has been reported in Arizona, California, Colorado, Kansas, Nebraska, Nevada, and New Mexico. Besides Mexico, internationally, ZC has been reported in Honduras, Guatemala and New Zealand. The potato psyllids, *Bactericera cockerelli* (Sulc.) was associated with ZC and the bacteria *Candidatus Liberibacter solanacearum* (LSO) is associated with the disease.

**ZC arrival in Oregon and Washington**

Symptomatic tubers from five different cultivars were brought to the OSU-Hermiston plant disease diagnostic facility. Tubers originated from multiple locations. Tubers presented early ZC stripes which were difficult to differentiate from internal necrosis (Fig. 1). Earlier, growers observed foliar symptoms in the field similar to another disease commonly found in the region, Beet Leafhopper Transmitted Virescence Agent (BLTVA) or more commonly called purple top or Columbia purple top disease. Because some plants at first tested positive for BLTVA, plants were not tested for ZC. As foliar symptoms in the region increased, and with the onset of tuber symptoms depicting typical ZC symptoms (Fig. 1), tubers were tested and confirmed by PCR to be positive for this disease.

A meeting with growers and fieldmen from the area helped to establish when foliar symptoms were first seen in the region. Given that foliar symptoms are reported to develop in plants approximately 3
weeks after infection, it was estimated that potato psyllids carrying the Liberibacter initially entered and fed on plants between June 15-25th.

**Occurrence of potato psyllids in the Columbia Basin**

Potato psyllids are commonly found in the Columbia Basin but generally not until mid-season when the potatoes are in the vegetative stage. In Texas, psyllids are found at plant emergence. Psyllids are generally surveyed using yellow sticky traps (Fig. 2). Psyllids are apparently present earlier in the season but at low levels, or at levels beyond the detection limit of yellow sticky traps. This was particularly true in 2011 when psyllids clearly were present based on the production of foliar symptoms (June 15-25th) but were not trapped until mid-July (Fig. 3). Several samples of potato psyllids were tested for *C. Liberibacter solanacearum*. By then, a great greater percentage were found positive.

**Fig. 3.** Population dynamics of the potato psyllids, Hermiston OR 2011.
Why ZC damage in commercial potato fields
This was a particular “low” year for “classic” potato pests such as aphids, beet leafhoppers or potato tuberworm, so growers practicing Integrated Pest Management did not use or use reduce amounts of insecticides. Review of insecticide applications from fields with significant ZC disease incidence showed no insecticides applied, for the most part, from late May to early August when potato psyllids (Fig. 4) were thought to have entered the Columbia Basin (around June 15-25). Further, much of the insecticide used would not necessarily be effective against the potato psyllid. For now, most of the information is coming from Texas and elsewhere.

Whether or not ZC is found in the Columbia Basin next year is unknown. At this point there is no data that suggests that potato psyllids overwinter in the region and therefore must move from southern latitudes each summer. In addition, even though potato psyllids traditionally come each year to the PNW, they obviously do not always carry the bacterium. This may suggest that ZC may not occur next year in the Pacific Northwest.
Section I
Invasive & Emerging Pests

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 exist for this insect pest in PNW potatoes.

The first recommendations for this insect will be unveiled at the 71st Pacific Northwest Insect Management Conference. At the time this report was prepared, the recommendations had not been finalized. A final set of recommendations will be presented at the Conference.
SECTION II
ENVIRONMENTAL TOXICOLOGY &
REGULATORY ISSUES
NEW APPROACHES TO POTATO INSECT PEST MANAGEMENT

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The potato industry no longer has access to Temik, Furadan, endosulfan and Monitor. Also, growers have increasingly adopted a tactic of using a neonicotinoid insecticide at planting. I estimate as much as 90% of eastern Washington potato acres are treated with a neonicotinoid on the seed piece, at planting or at cracking/layby. While this is a very cost effective strategy, the intermediate and long term consequences and cost to the industry may be greater than are immediately apparent. Wide spread reliance on neonicotinoids are likely to be related to increase in thrips and lepidopterous (worm) outbreaks. The increased reliance on neonicotinoid insecticide increases the likelihood of resistance to this important class of potato insecticides. The loss of the former products and the increased use of the latter products leave growers with a narrow set of more traditional products, particularly for post planting foliar insect control. Many of the remaining products are pyrethroid insecticides or package mixes that contain pyrethroid and/or neonicotinoid insecticides. Use of pyrethroid insecticides after mid June increases the likelihood of a mite or aphid outbreak. Use of a neonicotinoid or package mix containing a neonicotinoid insecticide following use of a neonicotinoid insecticide at planting creates a significant risk factor for resistance.

Complicating this situation is increasing number of insect pests. Thrips became a more apparent problem in the mid 1990s. Foliarly feeding worms became a regularly treated pest about 10 years ago. Beet leafhopper was identified as a pest in 2003. Two years later potato tuberworm was identified as a problem, and in 2011, potato psyllids psyllid vectoring a disease appeared over a wide array of the Pacific Northwest.

The requirements for federal registration of a pesticide tend to favor products that are more selective in their spectrum of control. As a result most products that are becoming available to growers control a narrower range of insect pests than older products. Unfortunately, Washington potato growers increasingly have to control mixed assemblages of insect pests, and
several of the newer products (Coragen, Avaunt, Fulfill and Beleaf) are more selective in the pests they control.

Spirotetramat (Movento) is registered on potatoes, but has not been commercially launched by Bayer CropSciences. Dow AgroSciences intends to register sulfoxaflor (Transform) prior to the 2012 use season. DuPont plans to register cyazypyr during 2012. Syngenta intends to register a package mix containing cyazypyr shortly thereafter.

These new products have significant potential for the Washington potato industry and may serve a critical role in reducing the overreliance on neonicotinoid insecticides and preventing the development of resistance. There are significant questions to be answered in regards to how these products work on potatoes and what their best fit is in the potato industry.
The Washington State Commission on Pesticide Registration was formed in 1995 to help obtain and maintain pesticide registration for minor uses in Washington. It has a budget of $500,000. In 1999, the mission of the WSCPR was expanded to cover all aspects of research, demonstration and implementation of integrated pest management. Its budget was $1,000,000. The legislation placed the WSCPR budget within WSU’s budget. Due to an agreement between the two institutions, whenever WSU receives a reduction from the state legislature, the WSCPR receives a concomitant reduction in funding.

In the past four years, WSU has received a 54% reduction in state funding. The WSCPR has received a similar level of reduction. The WSCPR funding is currently at $495,000 per year. The Commission expects to receive a retroactive cut from WSU due to further legislatively mandated cuts with in the current fiscal year.

WSU has been able to stave off some of the impacts of the reduction in state funding by increasing its ability to source federal funds. It is my opinion that these funds will be reduced in the near future, further reducing its ability to engage in research and extension activities.

The significance and ramifications of projection reduction in public sector of agriculture research will be discussed. It will not be a happy presentation.
SECTION III
FIELD CROP PESTS –
CEREALS & VEGETABLES
Efficacy of Coragen® and Avaunt® Insecticides for Pre-Harvest Control of Mint Root Borer in Western Idaho.

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INTRODUCTION
With the introduction of the insecticides Coragen® (Chlorantraniliprole) and Avaunt® (Indoxacarb), new approaches are possible for Mint Root Borer (MRB) control. Both of these insecticides are known to be effective ovicides as well as larvacides and they have a significant amount of residual activity. This opens the possibility of controlling the MRB in the egg stage. This could be very useful, especially in furrow-irrigated mint where post-harvest MRB control can be difficult. In addition, both of these insecticides also control foliar feeding cutworms.

Materials and Methods
Two identical trials were established in production, furrow irrigated peppermint fields. Experiment one was located near Wilder Idaho; experiment two was in the Deer Flat area of Idaho. Plots were arranged in a randomized block design. Plots of 18’ x 20’ were replicated five times.

Treatment dates were determined by using local data from the Nampa, ID Agri-met 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 850 DD, 1000 DD, 1150 DD and 1300 DD. The peak egg-laying time occurs around 1100 DD. These four dates were determined to give a good spread of times that should determine when is the best time to apply the Coragen or Avaunt. In addition, one treatment had the insecticides applied twice, once before and once during the peak egg laying. The fields that contained experiments one and two were swathed on 8-30 and 8-31-2011 respectively.

RESULTS AND DISCUSSION
Due to the very cool spring, the chosen accumulated degree-days occurred approximately thirteen days later than the historical average.
There were no significant foliar feeding cutworm infestations in July so no data was collected on the efficacy of cutworm control from either experiment.

The results of both experiments had similar trends. None of the single applications of Coragen significantly (p=0.05) reduced the MRB larvae level, compared to the untreated check (table 1). However, there was a trend in both experiments, where the mean MRB levels were numerically lower or equal to the untreated check. Of these single applications, all were statistically similar to each other, in both experiments. The first application date of July 11 had the lowest mean MRB larvae level compared to the other single Coragen applications (table 1).

The most positive result of both experiments was that the double application of Coragen lowered the MRB levels significantly compared to the untreated check (table 1). It appears that the double application had an additive effect in controlling the MRB eggs and/or larvae.

The applications of Avaunt caused no significant decrease in the MRB levels in either experiment. There are not even any trends that indicate the Avaunt controlled any MRB.

Table 1.
Mint Root Borer levels after harvest from pre-harvest applications of Coragen and Avaunt insecticides near Wilder Idaho (experiment one), and at Deer Flat Idaho (experiment two), Summer 2011.

<table>
<thead>
<tr>
<th>Trmt. #</th>
<th>Treatment</th>
<th>Amount of product per acre</th>
<th>Applications date(s)</th>
<th>Mean number of live mint root borer (Per sq. ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Exp. 1*</td>
<td>Exp 2**</td>
<td></td>
</tr>
<tr>
<td>1 UTC</td>
<td>8.5 bc</td>
<td>4.59 bcd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Coragen</td>
<td>5 fl oz 7-11</td>
<td>4.4 ab 3.47 ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Coragen</td>
<td>5 fl oz 7-18</td>
<td>5.8 abc 3.61 abc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Coragen</td>
<td>5 fl oz 7-25</td>
<td>5.2 abc 3.79 abc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Coragen</td>
<td>5 fl oz 8-2</td>
<td>5.9 abc 4.59 bcd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Coragen</td>
<td>5 fl oz + 7-11 &amp; 5 fl oz 7-25</td>
<td>2.8 a 2.09 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Avaunt</td>
<td>3.5 oz 7-11</td>
<td>9.3 c 5.57 cd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Avaunt</td>
<td>3.5 oz 7-18</td>
<td>8.4 bc 5.84 d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Avaunt</td>
<td>3.5 oz 7-25</td>
<td>8.1 bc 5.90 d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Avaunt</td>
<td>3.5 oz 8-2</td>
<td>8.5 bc 5.31 bcd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Avaunt</td>
<td>3.5 oz + 7-11 &amp; 3.5 oz 7-25</td>
<td>9.1 c 4.42 bcd</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LSD 4.1 1.98

*Mint Root Borers sampled after September 13.*
**Mint Root Borers sampled after September 12.
Experiment one CV=46.8%
Experiment two CV=34.6%
Sample means were compared with Fisher’s Protected LSD (p=0.05).
Means with the same letter are not significantly different (Petersen 1985).

This research indicates that Coragen could be an effective way to control MRB in the egg or first instar larva stage. With the unusually cool spring and early summer weather it would be wise to repeat this trial to see if similar results are obtained a second year.

There is at least, a 30-day difference between when the degree-day model shows 50% of the MRB in the hibernaculum stage and when the MRB were actually found at 39% in the hibernaculum stage (table 2). This discrepancy in the timing of the hibernaculum raises the question of how accurate the degree-day model is in predicting the egg-laying times. The degree-day model states that the model is only “partly validated”.

It would also be wise to further calibrate the degree-day model for Western Idaho. If the degree-day model is not accurate the pre-harvest insecticide timing may not be optimal.

**Table 2**
Comparison of untreated Mint Root Borer in the hibernaculum stage at different dates to the IPMP degree-day model for Idaho. (2011)

<table>
<thead>
<tr>
<th>Sample date (Year 2011)</th>
<th>Actual percent mint root borer in hibernaculum stage from samples</th>
<th>Predicted percent mint root borer larvae in hibernaculum stage according to DD model*</th>
<th>Accumulated degree days*</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-23</td>
<td>0</td>
<td>5</td>
<td>1856</td>
</tr>
<tr>
<td>9-7</td>
<td>0</td>
<td>50</td>
<td>2156</td>
</tr>
<tr>
<td>9-12, experiments 1 &amp; 2</td>
<td>0</td>
<td>50+</td>
<td>2241</td>
</tr>
<tr>
<td>10-4, experiments 2 &amp; 3</td>
<td>39</td>
<td>50+</td>
<td>2610</td>
</tr>
<tr>
<td>10-24, experiment 3</td>
<td>91</td>
<td>50+</td>
<td>2700</td>
</tr>
</tbody>
</table>

* Temperature data used from the Agri-met station located near Nampa ID.
CONCLUSIONS

Single, pre-harvest applications of 5 oz/ac Coragen did not significantly reduce MRB levels but there was a trend indicating there was some reduction in the MRB levels. A double application of Coragen did significantly reduce the MRB levels. The timing of the pre-harvest Coragen application did not have a significant impact on the effectiveness of the MRB control, but there was a slight trend for the earliest treatment to be the most effective.

Avaunt appeared to have no effect on reducing the MRB levels when applied pre-harvest. The degree-day model may not be completely accurate as indicated by the discrepancy between the degree-day model and the actual time of the MRB entering the hibernaculum stage.
MANAGEMENT OF EUROPEAN ASPARAGUS APHID IN ORGANIC 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. Conventional asparagus growers control the aphid via an emergency exemption for lambda cyhalothrin. 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.
Section III
Field Crop Pests

Efficacy of Coragen and Mocap for Post-Harvest Control of Mint Root Borers in Furrow Irrigated Mint in Western Idaho.

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Materials and Methods
Two identical trials were established in the same production, furrow irrigated peppermint fields.

Experiment one was located near Wilder Idaho; experiment two was in the Deer Flat area of Idaho. Plots were arranged in a randomized block design. Plots of 18’x 20’ were replicated five times. The Coragen and Lorsban treatments were broadcast applied with a C02 powered backpack sprayer in 20 GPA of water. No surfactants or adjuvants were added to any treatment.

The granular Mocap was weighed out and hand sprinkled on each plot. All treatments were applied after harvest but before the corrugation and the first irrigation.

The Mocap treatments for both experiments were applied approximately eleven days before the furrow irrigation on 9-3-2011. The Coragen and Lorsban applications for both experiments were applied approximately eight days before the first furrow irrigation on 9-6-2011.

The first furrow irrigation started on approximately 9-14-2011 for both experiments. There was a rain event also on September 15. The exact amount of rain is unknown but it is estimated to be between 0.1 to 0.2 inch. The Nampa Agri-met station reported 0.44 inch but the Parma station only reported 0.1 in. The rainfall was very uneven in this rain event.

The plot areas of both fields were corrugated, before the first irrigation, with a double disk. This implement threw very little soil on top of the row. The soil was very dry at the application time of both experiments.

The application rates, dates and results are listed in table 1
Experiment three was sampled starting on October 24 (approximately 40 days after irrigating). Experiment four was sampled starting on October 4, (approximately 20 days after irrigating). The sample date had to be moved up for experiment four because the field was being removed.

RESULTS AND DISCUSSION

Table 1.
Application dates, rates and levels of MRB control from Coragen, granular Mocap and Lorsban, applied to furrow-irrigated peppermint, post-harvest in the Wilder and Deer Flat Idaho areas. (Experiments three and four)

<table>
<thead>
<tr>
<th>Trmt. #</th>
<th>Treatments</th>
<th>Rate/acre (product)</th>
<th>Application date</th>
<th>Mean number of live MRB larvae sq. ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Untreated check</td>
<td>6.6 c</td>
<td>4.8 c</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Coragen 18.4% ai</td>
<td>3.5 fl oz 9-6</td>
<td>3.3 b 4.6 c</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Coragen 18.4% ai</td>
<td>5 fl oz 9-6</td>
<td>2.7 b 4.4 c</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Mocap 15G</td>
<td>20 lb/a 9-3</td>
<td>0.1 a 1.0 ab</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Mocap 15G</td>
<td>40 lb/a 9-3</td>
<td>0.1 a 0.4 a</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Lorsban 4E</td>
<td>64 fl oz 9-6</td>
<td>2.0 ab 3.1 bc</td>
<td></td>
</tr>
</tbody>
</table>

LSD 2.0 2.2

Experiment one CV=61.4%
Experiment two CV=55.3%
Sample means were compared with Fisher’s Protected LSD (p=0.05).
Means with the same letter are not significantly different (Petersen 1985).
Experiments three and four were furrow irrigated starting around 9-14-2011

CONCLUSIONS

Coragen applied after harvest, had mixed results for MRB control. One experiment had significant MRB control with post-harvest application of Coragen, while in the other experiment the Coragen treatments had no significant reduction of MRB levels. The early sampling date of one experiment may have caused the poor control by the Coragen.

There was no significant difference in the amount of MRB control between the 5 oz/ac and 3.5-oz/a rate of Coragen applied after harvest.

The standard application of 2 qt/ac Lorsban controlled the MRB as well or slightly better than either Coragen treatment. Both rates of Mocap were highly effective in controlling the MRB.
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 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, but did not always increase potential profitability. The most effective insecticides for controlling thrips were Lannate™ (methomyl), and Radiant™ (spinetoram). The insecticides Agri-Mek™ (abamectin), tolfenpyrad, cyazypyr and Movento™ (spiracetremat) provided adequate control of thrips. Lannate, Radiant, and Movento all decrease thrips populations when applied via chemigation as well. Different in season nitrogen applications regimes did affect thrips population trends.

Introduction
Thrips infestations are a perennial, persistent and ubiquitous problem throughout Western US dry bulb onion fields. Some very basic research is needed to ascertain which thrips species are economically damaging and developing resistance to current pest management technologies. Thrips’ mobility and biology can impact control strategies, and impact insecticide performance in controlling thrips. Cultural practices including different water carrier gallonage application rates and delivery pressures to optimize thrips control require increased investigation.

When we initiated this thrips control program in 2001 most onion fields in Washington State were treated with multiple insecticides for thrips control. Lambda-cyhalothrin was the predominant insecticide used for thrips suppression. At registered rates it cost approximately
$14 per acre per application. Lamda –cyhalothrin has been ineffective since 2003. Insecticides registered since 2001 are all substantially more expensive then 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 several 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 continuing thrips research program evaluates insecticide efficacy, water carrier rates, and has identified and quantified thrips species and abundance 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, 2011, 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 CO₂ 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 16 June 2011. 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. 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 most treatment regimes increased bulb size and yield. All treatments except for the untreated check, ‘program’ and ‘soft early’ sequence resulted in increase profitability in this study (results not statistically different from one another).

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

Figures 2 & 3 depict data from a trial evaluating weekly applications of insecticides to control thrips in onions. The data indicates that Lannate and Radiant were the most effective treatments in the efficacy trials. In Figure 2, cyazypyr performed well when applied both as a foliar application and when chemigated. In Figure 3, the AgriMek, tolfenpyrad, Lannate, Radiant, and pyrethroid all provided significantly better control than the untreated check, but not different from one another. It may be important to note that this is the first time in six years that a pyrethroid has been effective, this may be in part due to the location in which the trials were conducted.
Figure 2. 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 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 2 and Figure 4 depict chemigation treatments. In Figure 2, the cyazypyr applied by chemigation was providing control that was significantly better than the untreated check, and was numerically, but not statistically better than the foliar application of the cyazypyr. In Figure 4, the Lannate, Radiant, and Movento all provided control of thrips that was significantly better than the untreated check. In earlier weeks of the evaluation (Data not shown), Movento did not
perform as well as Lannate and Radiant, probably due to the slower mode of action of Movento. These results need to be repeated, but suggest that Radiant may be used later in the season as a chemigation treatment.

Figure 4. 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).

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, tolfenpyrad and AgriMek provided good suppression of onion thrips. Many 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, Movento, and cyazypyr. 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, Westbridge Inc., Dow Agrosciences, and DuPont. Technical assistance and in kind support was provided by: Greg Jackson, Two Rivers, Bob Middlestat, Clearwater Supply.
Section III
Field Crop Pests

Nipsit ™ Inside + Metconazole Combination for Cereals

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Protocol: to reevaluate the effect of Metconazole fungicide as a systemic leaf rust inhibitor at the registered rate and a double rate compared to Nipsit alone at the standard insecticide rate a trial was established at Central Ferry WA. The only variables in the trial will be leaf rust inhibition in Jefferson DNS prior to mature plant resistance. A UTC included will show efficacy of the package treatments for wire worm and rust. (Limonius californicus). The Trial was seeded May 12 at Central Ferry in a RCDB with 4 replications per treatment. A Hegi Cone seeder was used. 2010 trials showed positive rust control plus excellent wire worm control by the now labeled and patented combination.

Experiment 1. LSD All-Pairwise Comparisons Test for Yield

<table>
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<th>Mean</th>
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Alpha 0.05    Standard Error for Comparison 0.0743
Critical T Value 2.179    Critical Value for Comparison 0.1619

There are 3 groups (A, B, etc.) in which the means are not significantly different from one another.

Conclusions: The only yield reducing factor in this trial was leaf rust damage during jointing. The Nipsit only treatment w/o fungicide was literally burned up as was the UTC. Wire worm was also a factor as all Nipsit treatments were similar for wireworm. Both Metconazole treatments were not SD for rust indicating doubling the rate did not show an increased fungicide treatment to be more effective than the label rates of Nipsit + Metconazole at 2 floz cwt. Conclusions: Leaf rust is a yield reducing factor in spring wheats w/o a fungicide at jointing stage. A systemic fungicide in the plant from germination does prevent rust injury w/o needing an application. The combination with a powerful insecticide seed treatment is effective in insect and rust control. These data are similar to those from 2010.
Section III
Field Crop Pests

Valent Nipsit + Metconek 2011 Trials

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Protocol: to reevaluate the effect of Metconazole fungicide as a systemic leaf rust inhibitor at the registered rate and a double rate compared to Nipsit alone at the standard insecticide rate. a trial was established at Central Ferry WA. The only variables in the trial will be leaf rust inhibition in Jefferson DNS prior to mature plant resistance. A UTC included will show efficacy of the package treatments for wire worm and rust. (Limonius californicus). The Trial was seeded May 12 at Central Ferry in a RCDB with 4 replications per treatment. A Hegi Cone seeder was used. 2010 trials showed positive rust control plus excellent wire worm control by the now labeled and patented combination.

One-Way AOV for: NA NM2 NM4 UTC

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</table>

Observations per Mean 4
Standard Error of a Mean 0.0525
Std Error (Diff of 2 Means) 0.0743

**Experiment 2. LSD All-Pairwise Comparisons Test for Yield**

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<th>Variable</th>
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<td>Nipsit + Metconazole 4</td>
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<td>0.7600 B</td>
</tr>
<tr>
<td>UTC</td>
<td>0.4350 C</td>
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</table>

Alpha 0.05 Standard Error for Comparison 0.0743
Critical T Value 2.179 Critical Value for Comparison 0.1619
There are 3 groups (A, B, etc.) in which the means are not significantly different from one another.

**Conclusions:** The only yield reducing factors in this trial was leaf rust damage during jointing and wire worm in the untreated check. The Nipsit only treatment w/o fungicide was literally burned up by rust. Wire worm was a factor in the UTC and reduced stand at emergence. The UTC also had rust during jointing. Both Metconazole treatments were not SD indicating doubling the rate did not show an enhanced fungicide treatment to be more effective than the label rates of Nipsit + Meconazole. Conclusions: Leaf rust is a yield reducing factor in spring wheats w/o a fungicide at jointing stage and beyond. A systemic fungicide in the plant from germination does prevent rust injury w/o needing an aerial application of fungicide. The combination with a powerful insecticide seed treatment such as Nipsit is an effective seed treatment in insect and rust control.
SECTION IV
POTATO PESTS
We report the results from two chemical trials conducted at the Oregon State University Hermiston Agricultural Research and Extension Center (HAREC) during the 2011 growing season. The main objective was to evaluate the efficacy of various seed and foliar treatments against aphids and Colorado Potato Beetle. The potato seed variety used was Russet Ranger; plot size: length 11.33 ft x width 30 ft. The experimental design was a randomized complete block with 4 replications per treatment. Field plots followed commercial standards and procedures. Potatoes were planted 19 April, and fertilizer was applied 30 March (pre-plant fertilizer), 14 June, 21 June, 30 June, 6 July, 13 July, 21 July, and 27 July (30 lbs N Solution 32). Herbicides were applied on 7 May (Glyphosate at 24 oz/acre) and 26 May (Matrix at 1 1/2 oz/acre, Dual at 16 oz/acre, and Senecor at 1/3 lb/acre). Fungicides were applied on 6 July (Dithane at 1.5 lbs/acre), 12 July (Bravo at 1.5pts/acre), 20 July, 27 July, 27 July, 2 August, 11 August, 16 August (Dithane at 1.5 lbs/acre). For the seed insecticides treatments tubers/seed pieces were treated on site just prior to planting. Slurry rates were adjusted to allow sufficient coverage of seed pieces.

Insect counts began on 1 June 2011 and continued weekly until 25 August 2011. Aphids were sampled using the “bucket method”, a technique recommended for the region. Ten plants per plot were randomly selected from the two inner rows in each plot each week. A plastic bucket was placed below the stems of each potato plant, and the stems were shaken for 5 seconds to allow aphids to drop into the bucket. All aphids that dropped into the bucket were identified, counted and recorded. Colorado Potato Beetles were visually inspected. Number of eggs, larvae, and adults were counted from 5 individual plants per plot.

The response variables were aphid or Colorado potato beetles counts per plant. Insect counts were analyzed for each sampling date and fitted with a linear model: \( y_{ij} = \mu + \alpha_i + \beta_j + \alpha_i \beta_j + \epsilon_{ij} \), followed by means separation with least significant difference (LSD) tests. Since insect counts involved sub-sampling plots, we used the Type III mean square for the block*treatment interaction as an error term to test the hypotheses of no treatment effect. This error term was
also used for the LSD tests. Means were considered significantly different when \( P \) values were \( \leq 0.05 \).

**Results and Discussion**

*Seed treatment efficacy against aphid and Colorado potato beetle*

Aphid population levels were low throughout the 2011 growing season. On only one occasion did aphid counts exceed one aphid per plant in control plots. Subsequent to 29 July, aphid levels dropped and remained low throughout 25 August when we terminated our sampling regime (Fig. 1). At 65 d, 72 d and 86 d post planting means separated indicating significantly lower aphid counts on plants where seeds potato received insecticide or fungicide/insecticide combinations treatments. Under low aphid pressure, seed treatments can provide more than 80 days of protection. Similar situation was observed for Colorado potato beetle.

*Efficacy of Cyazypyr against aphids*

An application of insecticides was made on 14 Jun after at least 10% of sampled plants had at least one aphid per plant. Plants were sampled weekly post application. The mean number (±SE) of aphids per plant by treatment for all trial samples dates from 1 June to 17 Aug. Despite application, aphid population levels remained above one aphid per plant in all trial plots through 29 June. A second application of insecticides was made to potato plants on 1 July. All treatments reported significantly lower aphid populations than control plots. Aphid populations remained very low in all trial plots throughout the duration of the trial. A certain level of significance was also observed in the control of the Colorado potato beetle.

Fig. 1 Effect of seed insecticides on populations of aphids, Hermiston, OR 2011. Maxim 4FS (Control).
FEW ECOLOGICAL ASPECTS OF THE BEET LEAFHOPPER (*CICULIFER TENELLUS* BAKER) IN THE LOWER COLUMBIA BASIN

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The beet leafhopper, *Ciculifer tenellus* Baker, is widely distributed throughout the western United States (Cook 1942). Beet leafhoppers (BLH) can be a severe pest of tomatoes in California where they are known to vector curly top virus (Chen et al. 2010). In California, large populations of infected BLH migrate from weedy breeding areas to agricultural fields (Severin 1930, Cook 1942, Chen et al. 2010). According to Hills (1937) and Cook (1942), the Columbia Basin is a breeding area for BLH. In fact, the sugar beet industry that was originally established in the Columbia Basin in the early 1900’s was essentially abandoned as a result of high BLH populations that vectored beet curly top disease (Hills 1937). Less than a century later, in 2002, the BLH became a pest of potatoes in the Columbia Basin (Munyaneza et al. 2005).

Beet leafhoppers transmit a phytoplasma that causes purple top disease in potatoes (Munyaneza et al. 2005). This phytoplasma was formally identified as beet leafhopper-transmitted virescence agent (BLTVA) (Crosslin et al. 2005). BLTVA can significantly reduce potato yields and have a negative impact on tuber quality (Munyaneza et al. 2005). The disease produces aerial tubers, shortened internodes, and causes the upper foliage of the plant to turn purple (Crosslin et al. 2005, Munyaneza et al. 2005). The BLH spends a majority of the year feeding on weed hosts located in the Columbia Basin, but during the summer months most of these hosts die, and BLH are forced into irrigated crops, like potatoes (Cook 1942). We have limited information regarding the role that these alternative, early-season hosts play in BLH movement later in the season, and moreover, we do not know if weeds serve as a reservoir for the diseases transmitted by BLH. As little research has been done on this insect since the
1930’s, we are currently investigating several aspects of BLH ecology and biology. A brief overview of the current research regarding BLH in the Columbia Basin is provided below.

1. **BLH/BLTVA complex.** Approximately 30% of BLH collected from the field transmit BLTVA. Phytoplasmas enter the insect's body through the stylet, move through the intestine, and are then absorbed into the haemolymph. Once established, phytoplasmas will be found in most major organs of an infected insect host. Where, when and how BLH acquire the phytoplasma in the Columbia Basin is unknown. This spring we will be studying the overwintering aspects of the phytoplasma and the role of weeds in BLH overwintering and transmission.

2. **Identifying the economic threshold for BLH in potatoes.** This research has been underway since 2009. Timing of insecticide sprays targeted against the BLH and developing treatment (action) thresholds are currently being evaluated.

3. **BLH population dynamics.** Using a combination of BLH monitoring data and weather variables, we have been able to investigate some of the environmental factors that influence BLH populations.

References Cited


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, Pike, Alvarez and Rondon contains the official recommendations for management tactics for potato insects in Washington, Oregon and Idaho. There are currently no control recommendations for thrips due to the lack of information on the pest. The one product that is commonly used for thrips control is Monitor, and it was removed from the market place in 2009/2010. There exists very little information on what products are effective against thrips now that Monitor is exiting the market place. Schreiber conducted a single successful efficacy trial in 2007. There are no nonchemical control methods recommended for use on potatoes.

Data are presented on 2011 research on thrips biology, efficacy and field biology.
Over the last six years, the Hermiston Agricultural Research and Extension Center (HAREC) Entomology program, under the direction of Dr. Silvia Rondon has set out insect trapping stations along various routes in Umatilla and Morrow counties. The purpose of these insect trapping stations is to alert growers regarding the presence of key insect pests of potatoes.

Insect trapping data reports including aphid populations [green peach aphid, *Myzus persicae* (Sulzer); potato aphid, *Macrosiphum euphoribae* (Thomas); other aphids] had been gathered since the late 1970’s. Over the last six years, this data has been expanded to include beet leafhoppers (*Circulifer tenellus* Baker), other leafhoppers, and the potato tuber moth (*Phthorimaea operculella* Zeller). This data in the form of insect counts by station is reported in a weekly “Potato Update” newsletter emailed and published online during the growing season (http://oregonstate.edu/dept/hermiston/trap-reports). This report presents data collected in 2011 in Umatilla and Morrow counties.

**Methods**

Thirty four (34) insect trapping stations were set out at various locations along a 200 plus mile route through Umatilla and Morrow counties. Each station consisted of three insect traps: (1) a Delta trap with a pheromone lure attached to the center of a white sticky card to attract male potato tuber moths, (2) a yellow sticky card to trap leafhoppers, and (3) a yellow five gallon bucket filled approximately half-way with water to trap winged adult aphids.
Delta traps and sticky cards were set out beginning 21 April and removed from fields on 1 October. Yellow water buckets began trapping aphids beginning 16 June and ending on 11 August. All traps were served each week and returned for processing to our laboratory in Hermiston, OR. New white sticky cards for the Delta traps and yellow sticky cards were set out each week. Pheromone lures within Delta traps were replaced with new lures on a monthly basis. During aphid trapping, all winged aphids in yellow water buckets were collected, placed in vials containing 100% ETOH, marked with date and the trap designation, and returned to our laboratory for identification. The water in yellow buckets was replaced each week. White sticky cards and yellow sticky cards collected from the field were examined using a dissecting microscope. All winged aphids collected from the field were identified utilizing a dissecting microscope with reference to keys contained in “Aphids of Western North America North of Mexico” authored by Keith Pike (Washington State University). Insect counts were summarized as number of insect per trap per date.

Results and Discussion
Aphid populations were low throughout the season (Fig. 1). Historically aphid data is also presented (Fig. 2). In 2011, green peach aphids reached peaks on 30 June and 28 July. Potato aphid populations peaked on 7 June with a mean slightly higher than 0.25 aphids per trap per date. Other aphids combined reach a peak of 0.65 aphids per trap on 30 June. By 4 August, almost no aphids were being found.

Beet leafhopper populations were also low in 2011 (Fig. 3). Beet leafhoppers reached 2.28 per trap on 30 June and peaked a week later. In 2010, beet leafhoppers were trapped at higher rates as compared to 2011.

Few potato tuber moths were trapped in 2011. Populations began to rise after 11 August, and then peaked on 31 August. However, populations did not exceed 0.18 tuber moths adult per trap which was a level below action thresholds and very low compared to recent years.
Fig. 1 Population dynamics of green peach aphids, potato aphids and other aphids in Morrow and Umatilla counties during the 2011 growing season.

Fig. 2. Historical phenology of aphids in Morrow and Umatilla counties, 1977-2011.
Fig. 3 Population dynamics of beet leafhoppers in Morrow and Umatilla counties during the 2011 growing season.

Fig. 4 Population dynamics of potato tuber moths in Morrow and Umatilla counties during the 2011 growing season.
SECTION V
PESTS OF WINE GRAPE & FRUIT
The population of yellow spider mite (YSM), *Eotetranychus carpini borealis* (Ewing), had exceeded our provisional economic threshold of 25 motile mites/leaflet several weeks after harvest of ‘Meeker’ red raspberry at the WSU NWREC field site. Acaricides field-tested included experimentals Fujimite (Nichino America Inc.) (32 fl oz/ac) and BAS 921021 (13.7 and 27.4 fl oz/ac) compared with standard Acramite (Chemtura Corp.) (1 lb/ac).

Treatments were applied on 6 September, replicated five times and plots measured 30 feet long by 10 feet wide. Applications were applied with a tractor-mounted Rear’s hydraulic plot sprayer equipped to deliver 130 gpa at 1.4 mph with 2-D1-45 TeeJet™ nozzles on top of the boom, with both vertical arms each equipped with 7-D1-45 nozzles at 150 psi. The non-ionic silicone surfactant R-56 at 0.25% was used for each spray solution. Motile life stage counts were made by randomly collecting 25 terminal leaflets from primocanes at chest height from both sides of the row, brushing them with a mite brushing machine onto glass plates coated with a thin film of dishwashing detergent. Counts were made under a 10X stereomicroscope (Table 1). Motile stages of the phytoseiids predator, *Neoseiulus fallacis* (Garman) were also sampled from the same glass plate (Table 2).

### Table 1. Yellow spider mite control on red raspberry, Mount Vernon, WA, 2011

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Means within columns followed by the same letter are not significantly different (Fisher's Protected LSD, P<0.05), PRC ANOVA SAS.
Results
Late season pre-counts of motile stages of YSM on 6 September indicated their population levels had exceeded our PNW provisional threshold of 25 motiles per leaflet on red raspberry. YSM population dynamics in the untreated check plots averaged a 4.3-fold increase at 17 DAT (Table 1). September was unseasonably cool and showery earlier in the month.

All acaricides were comparable to each other and FujiMite was significantly different from the untreated check out to 17 DAT (Table 1). Compared with the untreated check, FujiMite provided about 7-fold numerical suppression of the motile life stages of YSM at 17 days posttreatment. Following the 1/3-1/2 drop in predatory mite density at 3 DAT, *N. fallacis* population levels responded numerically in the acaricide treatments compared with the untreated check plots (Table 2). Compared with Acramite, both acaricide chemistries also indicated selectivity or inactivity to this spider mite biological control agent.

Field performance by FujiMite and Acramite indicate their potential as rotational partners in an IRM/IPM spider mite management program in red raspberries in western Washington.

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<th>Ptm</th>
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<th>6 DAT</th>
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</tr>
</tbody>
</table>

Means within columns followed by the same letter are not significantly different (Fisher's Protected LSD, *P*<0.05), PRC ANOVA SAS.
Location of the Mechanism of Resistance to the Large Raspberry Aphid, *Amphorophora agathonica*, in Red Raspberry

D. Lightle\(^1\), M. Dossett\(^2\), E.A. Backus\(^3\), & J.C. Lee\(^4\)

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The aphid *Amphorophora agathonica* Hottes is an important virus vector in red (*Rubus idaeus* L.) and black (*Rubus occidentalis* L.) raspberries in North America. Host plant resistance in the form of a single dominant gene named *Ag*\(_1\) has been relied upon to help control aphid-transmitted plant viruses; however, the mechanism of resistance is poorly understood.

Aphid feeding was monitored using the electrical penetration graph (EPG) technique on a resistant red raspberry ‘Tulameen’ and compared with a susceptible control, ‘Vintage’. There were no differences in feeding behaviors of aphids probing in the epidermis or mesophyll of the leaf tissue. Once in the phloem, aphids feeding on resistant plants spent significantly more time salivating than on susceptible plants, and ingested significantly less phloem sap. This suggests that a mechanism for resistance to *A. agathonica* is located in the phloem.

Reduced ingestion of phloem may result in inefficient acquisition of viruses and is a likely explanation for the lack of aphid-transmitted viruses in plantings of resistant cultivars.
Figure 1. Proportion of time (%) spent performing each feeding behavior by aphids on resistant ‘Tulameen’ (n=18) and susceptible ‘Vintage’ (n=17) during 12 h of EPG monitoring. Behavior definition: non-probing – stylets withdrawn from plant; pathway – stylet activities in epidermis & mesophyll including cell punctures; E1 – salivation into phloem sieve elements; E2 – ingestion from phloem sieve elements; G – ingestion from xylem.
Major research emphasis for the 2011 season was to explore non-invasive methods to make commercial applications of insecticides at initial blueberry ripening and through the harvest period. The three control tactics researched that will enable growers with different economic constraints good options for successful management outcomes were: trellising, helicopter application and micro-sprinkler chemigation. Trellising and good pruning practices will allow a grower more flexibility with his standard orchard sprayer while minimizing fruit drop, facilitating handpicking, machine harvesting and other cultural management activities such as mowing. Helicopter applications provided excellent contact knockdown of active adult populations in a blueberry canopy laden with ripening fruit. Micro-sprinklers give the grower flexible timing options for field-wide applications given SWD population level, weather conditions such as wind and rain, harvesting schedules and opportunity to tank mix pesticides. The main challenge for this unique chemigation system is to calibrate each stand-alone system to consistently deliver the recommended field rate on target with minimal wash-off and drift of the insecticide.

**Trellising to maintain alleyway access**
Two unreplicated, 1.5 acre blocks of un-trellised and trellised ‘Bluecrop’ and two similar blocks of ‘Bluejay’ were established in Woodland, WA. Both six-years-old and heavily pruned prior to placing #12 gauge high tensile wire approximately 4 ft above the ground. The wires were held in place by 12 in hooks attached to metal posts in the row spaced at 18 ft and anchored at both
ends with traditional wooden end posts. The grower applied a protective spray of Brigade WSB (1 lb/ac) on 20 July and Mustang Max (4 fl oz/ac) on 26 July 2011 with a conventional orchard air blast sprayer. Five replicates of 5 mature blueberries each (n = 25) were randomly sampled from each of the 4 treatment blocks after 12 hrs. Five berries were placed in a standard Petri dish with a small wedge of water moistened dental wick. Five even aged SWD adults were placed in each Petri dish and percent mortality assessed after 1 DAT for the Brigade and Mustang Max field treatments.

Brigade residual on berries from un-trellised ‘Bluejay’ and ‘Bluecrop’ provided poor contact mortality to adult SWD of 50 ± 50 SEM, 26.7 ±43.5 and 3.3 ± 7.5 and 3.3 ± 7.5 percentages at 1 and 6 DAT, respectively. However, the trellis and upright architecture of ‘Bluejay’ resulted in very good coverage for Brigade with 100 and 90 percent mortality at 1 and 6 DAT, while the fuller profile of ‘Bluecrop’ showed large variability and only 43 and 30 percent adult mortality. Mustang Max provided excellent adult knockdown of SWD after 1 and 3 DAT for both trellised and un-trellised ‘Bluejay’ and ‘Bluecrop’. This observation for Mustang Max was also corroborated from lab bioassays, helicopter and micro-sprinkler trials on blueberries as well. An approximation of berries dropped 2 DAT after an air blast Mustang Max application with a 1 ft² tile showed 1.7-fold and 1.9-fold more berries dropped from un-trellised ‘Bluecrop’ and ‘Bluejay’, respectively.

**Helicopter aerial applications**

Four commercial helicopter applications were monitored for contact knockdown at 24 hr after treatment and field residual on foliage from random bushes in a large ‘Aurora’ blueberry block near Salem, OR, 2011. Aerial applications of Malathion 8 (2 pts/ac, 3 July), Success (6 oz/ac, 30 July), Lannate LV (1.5 pts/ac, 10 August) and Lannate LV (1.8 pts/ac, 2 September) were applied at 10 gal/acre. Droplet size and distribution patterns from the helicopter were with water sensitive paper attached to screened-plastic lids placed over 16 fl oz deli cups containing 5 adult SWD and a water saturated cotton core. Adult mortality was assessed at 2, 12 and 26 hrs posttreatment. The adult sentinel cages were placed on the top, middle and lower positions from five randomly selected bushes. In addition to the sentinel cages, three leaves were collected at each level from both sides of the five bushes for a total of 30 individual sites. Sets of three leaves, along with five SWD adults were placed in standard disposable Petri dishes (30 units) and mortality assessed after 24 hours.

The average aerial knockdown for the three positions after 26 HAT were: Malathion 8 (47.3 ± 24.5), Success (44.0 ± 11.6), Lannate (96 ± 2.3) and Lannate (85.3 ± 12.7). The contact toxicity and warm weather fuming activity of Lannate was excellent through the canopy of mature sized ‘Aurora’ bushes, especially in early August. The 1 and 6 DAT residual mortality of Lannate on
Micro-sprinkler chemigation

A novel chemigation application method using Netafim® micro-sprinklers for control of SWD was field tested on a 22 acres mixed block of 7-year-old ‘Elliott’, ‘Liberty’ and ‘Aurora’ near Salem, OR. The 139 Supernet #90 nozzles/acre were installed seven years ago to cool maturing blueberries when temperature reach 95 °F. The nozzle size is .069 in and operates at about 23.8 GPH, 23 ft diameter wetted coverage and are space 12 ft apart in every other row. This spacing and offset of 6 ft between rows of micro-sprinklers resulted in an overlapping spray pattern whereby each bush is covered by three sprinklers. Mustang Max at 4 fl oz/ac was chemigated through the main pumping station on 10 August. Challenge was to calibrate this system to provide an 8-minute application wave from the nearest and furthest area of the field. Gallonage required to deliver 4 fl oz/ac of Mustang Max was about 350 gallons. One hour after application, the injector lines were purged for 8 minutes. Sentinel traps with 10 adult SWD each were placed at two sites in 4 middle rows at the top, middle, lower and inside locations (i.e., 8 x 4 = 32 sentinels). The average adult mortality for all of the sentinels was 83.8 ± 5.1 after 1 DAT. The top position averaged 98% mortality while the inside position was 70%. Field-aged residuals were bioassayed for 3 leaves per sentinel site and placed in Petri dishes with 5 SWD adults. These were scored for mortality after 24 hrs. Average percent mortality for all foliage collected 2 and 6 DAT was 95.3 ±3.0 and 71.9 ± 1.8, respectively. Blue dye will be used to determine lag time from the in-line injectors for the 22 acres for the next chemigation on the farm. Without the dye, we aren’t certain that our predetermined calculation for an 8-minute injection period for this 22 acre block is on the mark. Though our contact and residual activity with live flies indicated good precision and placement throughout the blueberry canopy.

After replacement of two shut off valves, the researchers felt confident that the next chemigation applied on 17 September with Mustang Max at 4 oz/ac + Activator 90 (16 fl oz/ac) would make a more accurate application than the previous Malathion 8 chemigation that may have under dosed the 22 acre block. Row 10 (‘Elliot’), row 72 (‘Liberty’) and row 110 (‘Liberty’) were randomly selected and 4 bush sites were randomly selected in each row. Six leaves were collected from each bush replicate for a total of 24 samples. The six leaves were divided in half and each 3 leaf subsample were placed in Petri dishes with 5 adult SWD and a moisten portion of a standard dental wick. Mortality was assessed after 24 hours. Calibration of the chemigation with blue dye and placement of the first micro-sprinkler at the head position of each row in a 5 gal bucket corroborated accurate injection and cessation of the 8 minute injection period for Mustang Max. The bioassay for adult mortality on foliar aged residues at 1,
4 and 7 DAT was 99.2 ± 0.8, 100 and 91.9 ±10.9. These results are very encouraging and reflect the precision of a calibrated micro-sprinkler system to deliver an accurate field rate of Mustang Max during blueberry harvest.
The impact of adult carabid beetles on below- and above-ground pests and fruit yield was examined in the laboratory and a two-year strawberry field study. In the laboratory, adults of *Carabus nemoralis* Muller, *Nebria brevicollis* (F.), *Pterostichus algidus* LeConte, *Pterostichus melanarius* (Illiger), and *Scaphinotus marginatus* Fischer (Coleoptera: Carabidae) consumed black vine weevil, *Otiorhynchus sulcatus* (F.) (Coleoptera: Curculionidae) eggs, larvae and/or pupae placed on the surface. The same five carabid species showed no impact or low removal rates of *O. sulcatus* larvae that had burrowed into the root of potted strawberry plants. In an assay with only *P. melanarius*, adults consumed *O. sulcatus* larvae placed on the soil surface more frequently than larvae buried 1.3 or 5 cm below. In a field study, the density of adult carabids, predominantly *P. melanarius*, was manipulated with augmented, exclusion, and open control plots (2 m x 2 m). Manipulating carabid density had no impact on the removal of sentinel *O. sulcatus* larvae and pupae that were buried belowground which is consistent with laboratory observations. Increasing carabid density within augmented plots led to greater removal of red clover seeds, *Trifolium pratense* L., placed on the soil surface in the first year. Decreasing carabid density within exclusion plots resulted in fewer marketable fruits compared to control plots in both years. These results suggest that certain adult carabids may have limited impact belowground, and some beneficial impacts above-ground with pest control and crop protection.

Trials were conducted on the WSU NWREC on 7 year-old ‘Duke’ blueberries. Plots were single bushes replicated four times in a RCBD. Treatments were applied with a CO₂ backpack sprayer equipped with an 8002VS nozzle, delivering 100 gal/ac at 60 psi. All treatments contained the R-56® spreader sticker. Other than Lannate LV, the following chemicals are not labeled or registered for commercial application on blueberry. Eleven treatments were evaluated and samples for each treatment were taken from four random bush replicates from which three leaves were removed after 2, 4 and 7 DAT. The three leaves were placed in standard Petri dishes, infested with five adult SWD and evaluated after 24 hrs. The insecticides evaluated were: Lannate LV (1.5 & 3 pts/ac), unregistered Group 28 HWG86 10SE (13.5 fl oz/ac, 13.5 fl oz/ac + NIS, 20.5 fl oz/ac + NIS), standard Mustang Max (4 fl oz/ac), untreated check and combination formulations of Endigo ZC (lambda-cyhalothrin + thiamethoxam) (4.5 fl oz/ac), Brigadier (bifenthrin + imidacloprid) (6.14 fl oz/ac), Leverage (β cyfluthrin + imidacloprid) (5.1 fl oz/ac) and Warrior II (lambda-cyhalothrin) (2.56 fl oz/ac).

We feel the leaf bioassay is a more accurate bioassay of commercial efficacy when applying dilute rates of SWD protective sprays by ground equipment to blueberries. Both field and lab bioassays of treated blueberries reflect the difficulty of achieving good coverage on all surfaces of the blueberry fruit cluster 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. After 2 DAT, all of the selected insecticides and combinations provided > 90% adult mortality except Brigadier at 85%. Leaf residual at 4 DAT showed compounds with ≥ 90% were HGW86 (13.5 fl oz/ac), HGW86 (13.5 fl oz/ac + 1 qt/100 NIS) and Endigo ZC. Compounds ≥ 80% were HGW86 (20.5 fl oz/ac + NIS), Leverage and Warrior II. By 7 DAT, field aged residual on blueberry foliage had dramatically declined to ≤ 40% for all of the insecticides. These data for field-aged
residues strongly indicate the need to conduct further research to repeat and replicate similar field trials to determine more precise spray intervals when managing field rotations for different classes of insecticides within the context of IRM. This research is often mitigated by environmental parameters such as temperature and rain that are often seasonally different from year to year and from region to region as well. Another season’s research will provide data and understanding about the rotation of different MOA chemistries during the long blueberry harvest.
SECTION VI
PESTS OF TURF &
ORNAMENTALS
Amber snails (Succineidae) are small semi-aquatic snails that are established in many nursery production sites and considered plant shipment contaminant pests. The goal of this research was to investigate strategies to disinfest nursery plants prior to shipment. Two separate chemical trials were conducted: Trial 1, in September of 2010; and Trial 2 in March of 2011. In each trial, six treatments were compared to an untreated control for their effect on snail mortality 24 hours after treatment. The treatments were carbaryl, methiocarb, cinnamon oil, metaldehyde, capsaisin + mustard oil, and limonene. In Trial 1, each treatment had five replications which consisted of four-inch containers filled with potting mix simulating a nursery plant. One day prior to treatment 20 snails were applied to the potting media of each container. In Trial 1, carbaryl and methiocarb, provided effective control of amber snails within 24 hours (90% and 88% mortality respectively). Two of the botanically-based products, limonene (78%) and capsaisin + mustard oil (71%), demonstrated good activity against the snails. Percent mortality of metaldehyde (37%) and cinnamon oil (27%) were not statistically different than the untreated control (17%). In Trial 2 with the naturally infested plants, only carbaryl, methiocarb, and metaldehyde were significantly different from the untreated control.
SECTION VII
MEDICAL & VETERINARY PESTS
SECTION VIII
NEW & CURRENT PRODUCT DEVELOPMENT
SECTION IX
EXTENSION & CONSULTING:
UPDATES/NOTES FROM THE FIELD
The regional insect pest survey was established to monitor important insect pest populations in the Columbia Basin of Washington and report up to date information to the potato industry. It functions as an early warning system that prompts growers to intensify scouting in and around their potato fields when pests are detected in the region. The survey targets three key insect pests: green peach aphid (*Myzus persicae*) (GPA), beet leafhopper (*Circulifer tenellus*) (BLH), and potato tuberworm (*Phthorimaea operculella*) (PTW). Each of these pests should be monitored closely and managed as needed to minimize yield and quality losses that can result from the insects feeding, and in the case of GPA and BLH from the plant pathogens they transmit to potatoes. In addition to targeted pests, other foliar arthropod pests (thrips, spider mites, lygus bugs, caterpillars, etc.) and insect predators (big-eyed bugs, damsel bugs, etc.) are monitored and reported on when their numbers are significant. As well as providing current information about insects in potato fields, the survey contributes to a better understanding of how insect pests migrate, build up populations, transmit pathogens and/or damage potato crops in the region.

**Materials and Methods**

Thirty-six potato fields across the Columbia Basin of WA were surveyed for insects in 2011. Survey routes were established in the “North Basin” (Moses Lake, Warden, Othello, Connell), “Mattawa” (Mattawa), “West Basin” (Royal City, George, Quincy, Ephrata), and “South Basin” (Basin City, Eltopia, Pasco, Burbank, and Patterson). Aphids were sampled using a small bucket placed under a potato plant, which was vigorously shaken to dislodge insects into the bucket. This method was established by Dr. Keith Pike over several years of conducting his regional aphid survey. The bucket is easy to handle and prevents most of the insects from blowing, flying, or leaping away before they can be counted. Aphid counts were recorded on a per plant basis, and at least fifteen plants were sampled in every field. Other insects and arthropods collected in the bucket were also counted, especially thrips, Colorado potato beetles, lygus
bugs, spider mites, big-eyed bugs, and damsel bugs. Fields were sampled in the same location every week. Sampling was initiated a few weeks after emergence and concluded at vine kill. Beet leafhoppers were monitored using yellow sticky cards (5.25 x 3.75 inches) mounted on small stakes about 3 inches above the soil surface. Two cards were located near each potato field on the survey route, either at the field edge, on a ditch bank, or at the open field corner (away from irrigation). Flights of adult male PTW moths were monitored using delta traps with pheromone lures on sticky liners. The traps were hung from PVC pipe stands that suspended them about 12 inches from the ground. One trap was placed near each potato field on the survey route. Beet leafhopper and PTW moths collected on traps were counted weekly from mid April to October.

**Reporting**

Results of the insect pest survey were reported to the potato industry via weekly e-mails, a.k.a. “potato pest alerts”. The alerts summarized current survey results and included web links to connect subscribers to further information, including maps to show insect counts at each location, graphs of insect population trends, and pest management recommendations. Reports on other pests or diseases of concern in the region were often included in the alerts, including information from Dr. Dennis Johnson’s late blight hotline. Alerts and other information about insect pests of potato are archived on the project website at [http://www.potatoes.wsu.edu/survey/PotatoInsectSurvey.html](http://www.potatoes.wsu.edu/survey/PotatoInsectSurvey.html).

**“Potato Pest Alerts” Impact**

The local potato industry’s response to the e-mailed “potato pest alerts” has been very positive. There are 260 subscribers as of December 2011 (almost a 300% increase in the number of subscribers since the first alert was emailed in May 2010). Subscribers are mostly potato growers and crop advisors in the Columbia Basin. In December 2010, an online survey was sent to subscribers to get some feedback about the alerts. Response rate was 30% (57). Among respondents, 100% indicated that they found the potato pest alert system useful. A typical comment from respondents was, “It’s an excellent tool for crop advisors and growers. I hope the program continues”. More than 50% of the respondents indicated that they forwarded pest alerts via e-mail to other people. When asked how they used the pest alerts, 90% indicated that they used them to track regional insect populations, 68% indicated that they used them to know when to scout for insects in their fields, and 42% indicated that they used them to learn about insect pests and strategies for managing them in the field. Finally, 28% of respondents indicated that they applied strategies recommended in the alerts to manage pests in their fields.
Insect Population Trends

Results of the weekly surveys were evaluated at the end of the season to study insect population trends over time. Some of the more interesting results are reported here. Figure 1 shows weekly aphid sampling data in 2011; the graph includes the average percentage of fields in which we found aphids each week, and the average number of aphids per plant each week. Aphids were detected in as few as 27% of the surveyed potato fields and as many as 84% of the fields over the course of the season, but the populations rarely exceeded counts of 1 aphid per plant. The highest count in a field during the 2011 season was 8.3 aphids per plant on the August 25th sampling date; this is a small number compared to previous years of the survey, where counts of more than 500 aphids per plant have been recorded. Figure 2 shows the average percentage of fields in which we observed big-eyed bugs and damsel bugs each week in 2011. These were the most common predator insect species observed in potato fields. Figure 3 shows the average weekly BLH trap counts in 2011 vs. the average for five-years (2007-2011). Beet leafhoppers were very slow to appear in 2011, and counts remained lower than usual for the entire season. Figure 4 shows the average weekly PTW moth counts on the South Basin route in 2011 vs. the average for five-years (2007-2011). Moth population development in the South Basin in 2011 was similar to populations observed over most seasons. As in most years, PTW moths were not observed on any of the other survey routes. These and other data are posted on the project website and are presented to the potato industry at the annual Washington State Potato Commission research review meetings in February.

Insect population data from the survey will also be used by WSU entomologists, Dave Crowder and Bill Snyder, to study how landscape, especially adjacent crops, impact insect populations in potato fields.

This project is funded by the Washington State Potato Commission.
Figure 1. Aphid Population Trends in the Columbia Basin
Weekly Potato Field Sampling Data in 2011

Figure 2. Beneficial Insect Observations in the Columbia Basin
Weekly Potato Field Sampling Data in 2011
**Figure 3.** Beet Leafhopper Population Trends in the Columbia Basin
Weekly Trapping Data in 2011 vs. Five Year Average

**Figure 4.** Potato Tuberworm Moth Population Trends
Weekly Trapping Data (SOUTH Basin) in 2011 vs. Five Year Average
Commercial berry fields and wild brambles were trapped for Spotted Winged Drosophila \textit{(Drosophila suzukii)} using lidded 16 oz. plastic cups, drilled with 5 mm holes and baited with apple cider vinegar. Samples of berries were also collected and held in paper bags to rear adults and check for infested fruit. Trapping was continued in the backyard site trapped in 2010, using the same trap locations.

Seasonal population fluctuations in the backyard site were similar to 2010. Only eight SWD were trapped from February through July. Traps caught flies each week in August and September, but catches were low (<0.5/trap/day) until the end of September. There was an abrupt increase in trap catches in early October and trap catches remained high (60 to 600/trap/day) until the beginning of December. Trap catch plummeted to less than three/trap/day by mid-December. A total of 65701 SWD were trapped from Feb. 1 through Dec. 19, with more than 98% caught in October and November. These traps caught twice as many SWD as in 2010.

SWD trap catches in commercial berry fields and wild brambles followed the same pattern as the backyard site. Only a few flies were trapped from May through July, and trap catches increased in August and September. Large numbers of flies were caught in traps left in wild brambles through October and November. SWD were caught in all blackberry fields and in 2/3's of the blueberry fields that were trapped. SWD were only trapped in 1/3 of the strawberry fields; but the traps were removed from strawberries more than a month earlier than in blackberries or blueberries. Overall, the 2011 season had a greater percentage of berry fields infested with SWD and higher numbers of flies trapped than in 2010.

SWD were reared from fruit in 80% of the blackberry fields and 17% of the blueberry fields that were sampled. All but one of these fields received insecticide sprays for SWD. In two cases SWD were reared from fruit collected during the week that the first flies were trapped. None of the commercial fields with infested fruit had economic losses to SWD.
were also reared from two strawberry fields and from two sites with wild brambles (Himalayan blackberry).

**Additional Observations:**

On 9/22/2011, samples of wild Himalayan blackberry at different stages of maturity were collected for rearing. The trap at this site caught 43 SWD during the preceding seven days. Large numbers of SWD emerged from all of these fruit samples with 4/berry in red fruit and 13/berry in ripe fruit. A second *Drosophila* species also emerged and was identified as *D. melanagaster* by Josh Vlach (ODA). Oddly, more than 75% of 269 *D. melanogaster* were found in the sample of red fruit and only four emerged from ripe or overripe fruit.

At the backyard site two identical traps placed 20m apart have had a five-fold difference in SWD catch in 2010, and a ten-fold difference in 2011. The lower counts are from a sparse row of raspberry canes and the higher counts are from a trap placed in the dense shade of a patch of Oregon grape. Placement may be as critical as trap design or bait for increasing SWD trap catches.
### SWD Trapping Summary 2011

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<th>No. Fields</th>
<th>No. Fields w/ SWD</th>
<th>No. SWD Trapped</th>
<th>Trapping Period</th>
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**Other Sites**

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### SWD Rearing Summary 2011

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<td>3</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**Other Sites**

<table>
<thead>
<tr>
<th>Crop</th>
<th>No. Fields</th>
<th>No. Fruit Samples</th>
<th>No. SWD Infested</th>
<th>% SWD Infested</th>
<th>Fields Infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild Bramble</td>
<td>2</td>
<td>7</td>
<td>7</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Backyard</td>
<td>1</td>
<td>8</td>
<td>4</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>