FINAL PROJECT REPORT

Project Title: Improving biological control of insect pests of cherry

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Total Project Request: **Year 1: $38,802** **Year 2: $40,683**

Other funding Sources

Agency Name: USDA/CSREES Specialty Crop Research Initiative
Amt. awarded: $2.24 million
Notes: Enhancing biological control to stabilize western orchard IPM systems. $2.24 million awarded to WSU. 2008-2013. V. P. Jones PI, P. W. Shearer Co-PI.

WTFRC Collaborative expenses: none

Budget 1
Organization: OSU MCAREC **Contract Administrator:** L.J. Koong
Telephone: 541-737-4066 **Email address:** l.j.koong@oregonstate.edu

Item	Year 1	Year 2
Salaries[1]	9,126	9,582
Benefits[2]	5,476	5,845
Wages[3]	2,000	2,100
Benefits[4]	160	168
Equipment	0	0
Supplies[5]	2,400	2,520
Travel[6]	325	341
Total	19,487	20,556

Footnotes:
[1] 25% FTE Technician
[2] benefits at 60% yr 1, 61% yr 2
[3] student (time slip) summer help
[4] benefits at 8%
[5] includes traps, chemicals, field supplies
[6] within state travel

Budget 2

Organization: WSU-TFREC **Contract Administrator:** Mary Lou Bricker, Kevin Larson

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KL 509-663-8181 x221 **Email:** kevin_larson@wsu.edu

Item	Year 1	Year 2
Salaries[1]	9,434	9,811
Benefits[2]	3,585	3,728
Wages[3]	2,000	2,163
Benefits[4]	296	308
Equipment	0	0
Supplies[5]	2,400	2,520
Travel[6]	1,600	1,680
Total	19,315	20,127

Footnotes:

[1] **25% FTE Technician**

[2] **benefits at 38%**

[3] **student (time slip) summer help**

[4] **benefits at 14.8%**

[5] **includes traps, chemicals, field supplies**

[6] **within state travel**

Objectives:

1. Assess natural enemy complex of cherry arthropod pests from representative OR and WA cherry orchards using herbivore-induced plant volatiles (HIPV), visual inspections, and beating tray sampling.
2. Determine phenology of key natural enemies in OR and WA cherry orchards.
3. Validate predictive emergence models for key natural enemies that occur in OR and WA cherry orchards.

Significant Findings:

- Herbivore-induced plant volatiles (HIPV), when used as natural enemy attractants, are providing us with new information about which natural enemies are present in WA and OR cherry orchards.
- HIPVs are useful to determine what time of year natural enemies are present or absent from these orchards.
- HIPVs provide additional information in natural enemies that are difficult to sample with beating trays and when used together provide a more complete understanding of which species and life stages of various natural enemies are present at a particular point in time.
- It appears that natural enemy populations in cherry orchards are found at levels lower than apple and pear.
- We can use these attractants and levels of natural enemy abundance to help understand the impacts of spray programs on these and other beneficial insects.
- We are finding similar trends in natural enemy phenology in apple and pear orchards that increases the likelihood that we will be able to develop natural enemy phenology models for PNW orchard crops.

Results and Discussion:

Objective 1. Assess natural enemy complex of cherry arthropod pests from representative OR and WA cherry orchards using herbivore-induced plant volatiles (HIPV), visual inspections, and beating tray sampling.

We used the same three orchards (six total) in both Oregon and Washington that were used last year. In Oregon, all three orchards were managed conventionally. Lat year in Washington, the Orondo and Malaga orchards were conventionally managed and the Quincy orchard was organic; this year the Quincy orchard transitioned back to conventional management. Each orchard was sampled weekly using beating trays and three different natural enemy attractants (geraniol + methyl salicylate + 2-phenylethanol [=GMP], squalene [SQ], and 2 phenylethanol + methyl salicylate [PE+MS]) paired with white (SQ, PE+MS) or yellow panel traps (GMP). In year 1, we used all lures with white delta traps, but studies in our labs suggested that we would have fewer undesirable non-target insects on the panel traps.

All of the beating tray data for year 1 has been processed, but not completely analyzed. We have not yet completed processing all of this years' beating tray data but preliminary results for 2011 from Oregon indicate that HIPVs capture more *Deraeocoris, syrphids, and adult lacewings (Brown, Chrysopa nigricornis* and *Chrysoperla plorabunda*) than beating trays (Table 1). This is partially due to the fact that beating trays are a snapshot measurement conducted once per week while the HIPV traps can catch insects continually on a week-by-week basis. More importantly, though, the above insects, especially syrphids and lacewings, don't readily fall on to beating trays so aren't readily captured or identified. However, immature insects don't have wings and can't fly to these traps thus, these stages of insects and spiders are more readily captured with beating trays.

We hope to have all the cherry beat tray specimens identified by early winter and would be happy to provide that information at meetings next year. We have not yet received the spray records for some of the orchards, but hope to have that information by Thanksgiving.

Table 1. Comparisons of insects captured with beating trays versus HIPV traps

	Total number found in Oregon sites	
	Sampling Method	
Natural Enemy	Beating Tray	HIPV
Coccinellid adults	141	138
Deraeocoris brevis adults	24	341
Spiders	754	N/A
Syrphids	N/A	250
Lacewing larvae	61	N/A
Brown Lacewing adults	17	120
Chrysopa nigricornis adults	N/A[1]	3319
Chrysoperla plorabunda adults	N/A[1]	911

[1]Green lacewing adults (*C. nigricornis* and *C. plorabunda*) were recorded using beating trays but the adults could not be identified to species using this sampling method. The total number of green lacewings recorded from beating trays was 20 adults.

All the insects have been identified on the HIPV traps for years 1 & 2. The diversity of natural enemies was much greater in year 2, probably because the panel traps are more efficient and incorporate a visual component as well as the chemical lure. Year two also had significantly more black cherry aphids at all Washington locations but they were still absent for the most part in Oregon orchards with the exception of the Mosier orchard. The presence of black cherry aphids likely contributed to the greater diversity of aphid specific predators and parasitoids we observed and was correlated with the presence of *Deraeocoris brevis* in the Mosier, OR orchard early to mid-May (Fig. 1).

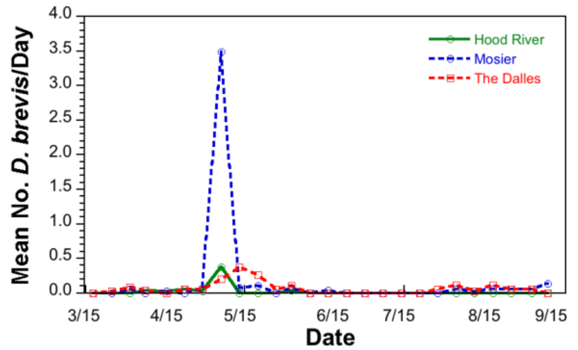

Figure 1. Abundance of *D. brevis* captured on HIPV traps in OR, 2011.

In 2011, we identified over 33 different species of natural enemies from the Oregon sites. The most common were (in order) lacewings including *Chrysopa nigricornis* (Fig. 2), *Chrysoperla plorabunda* (Fig. 3), and brown lacewings; an unknown ichnuemonid wasp; over 15 species of syrphids (Fig. 4), many of which are predacious against aphids including two Platycherus spp., *Eupeodes fumipennis*, and *Syrphus opinator*; over 7 coccinellid species (=lady bird beetles) which feed on aphids and motes including *Coccinella transversa*, *Adalia bipunctata*, and *Stethorus* (= spider mite destroyer) (Fig. 5). In Washington, the most common NE groups (in order) included two green lacewings, *Chrysopa nigricornis* (Fig. 6) and *Chrysoperla plorabunda*, an ichnuemonid wasp (still being identified), the ladybird beetle *Stethorus*,

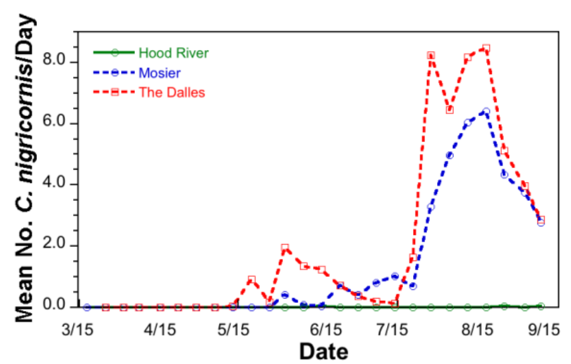

Figure 2. Abundance of *C. nigricornis* captured on HIPV traps in OR, 2011

a mixture of syrphid flies that prey on aphids (*Syrphus* spp., *E. americanis*, *E. fumipennis*, *E. volucris*, *Scaeva pyrastri*, + small numbers of another 4 species) (Fig. 7), the parasitoid *Ceranius menes* (a parasitoid of western flower thrips), *D, brevis*, *Trichogramma* spp. (egg parasitoid of moths), and a mymarid parasitoid of leafhoppers. In addition, there were an additional 50 species of natural enemies found in at least one of the three orchards, but generally in small numbers. Overall, natural enemy abundance appeared to be greater in the Washington orchards compared with those found in Oregon.

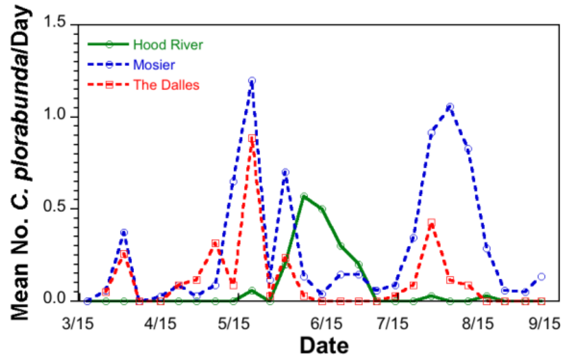

Figure 3. Abundance of *C. plorabunda* captured on HIPV traps in OR, 2011

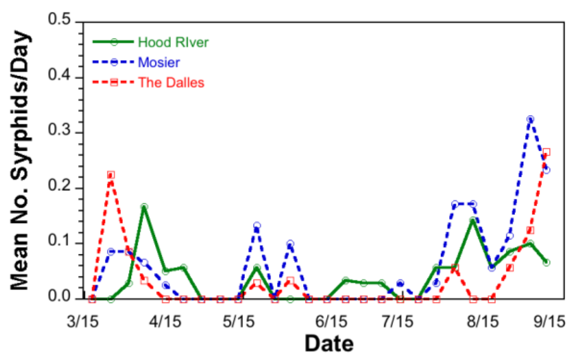

Figure 4. Abundance of syrphids captured on HIPV traps in OR, 2011

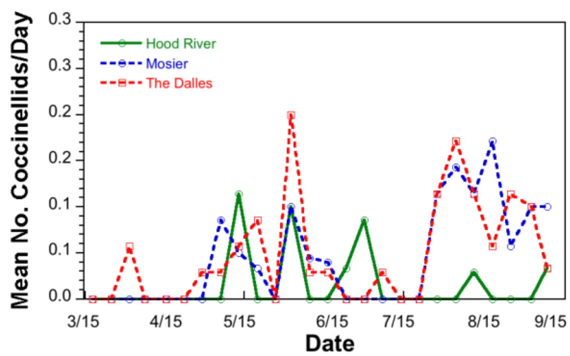

Figure 5. Abundance of Coccinellids captured on HIPV traps in OR, 2011

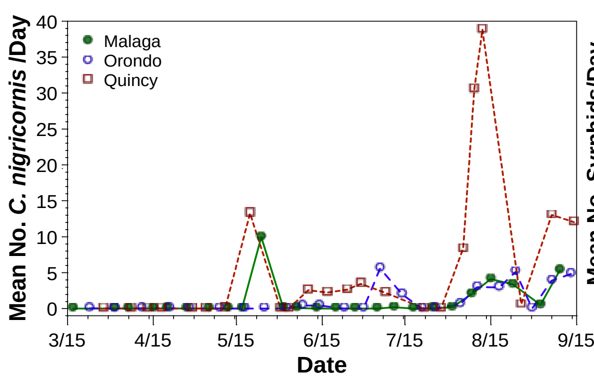

Figure 6. Abundance of *C. nigricornis* captured on HIPV traps in WA, 2011

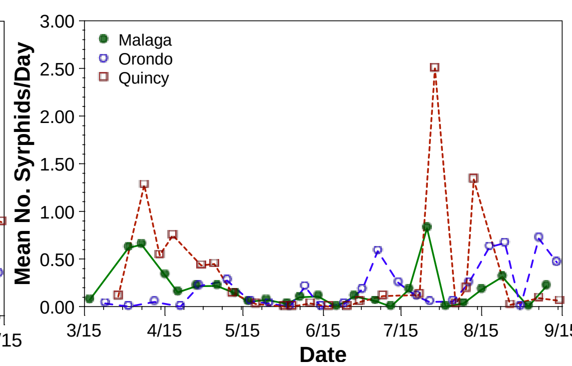

Figure 7. Abundance of syrphids captured on HIPV traps in WA, 2011

Objective 2. Determine phenology of key natural enemies in OR and WA cherry orchards.

As with last year, the natural enemy abundance was extremely low during the period from mid-May until harvest. This is likely a result of pesticide applications to suppress black cherry aphid, powdery mildew, western cherry fruit fly and spotted wing drosophila. For example, the complex of syrphid flies emerge early, but nearly disappeared during the mid-May to harvest period, likely because of either the pesticides or suppression of black cherry aphid. As with last year, it appears that the first generation of the most abundant lacewing, *C. nigricornis*, is nearly completely suppressed during the same period, but after harvest, the second generation moves in from other locations. We also can say with certainty that the lack of *C. nigricornis* in the Hood River orchard from mid-July on was a result of two applications of Danitol applied for SWD and CFF (Fig. 4). This product appears to have a long lasting effect.

Objective 3. Validate predictive emergence models for key natural enemies that occur in OR and WA cherry orchards.

The development of phenology models for the lacewings and potentially for the more common syrphid flies is underway using the larger data sets from the SCRI project which includes apple, pear, and walnut information. To date, we have shown that the cherry data fits well for the lacewing *Chrysopa nigricornis* with the exception of the "missing" first generation in cherry. The model for *Chrysoperla plorabunda* is being developed this fall and will use the cherry data as well as data from apple, pear, and walnut. The other models will be developed over the next year and will be reported back as soon as they are completed and evaluation is completed.

Executive Summary

Project Title: Improving Biological Control of Insect Pests of Cherry

The results of this study add to our knowledge about the usefulness of using herbivore induced plant volatiles (HIPVs) to monitor natural enemy populations in orchards. These chemicals, when combined with sticky traps, allow us to determine which of several natural enemies are present in orchards, evaluate the impacts of IPM programs on natural enemy abundance and are providing information for developing predictive models that simulate when these beneficial insects may be present in an orchard. Ultimately this information will benefit pest managers by providing them with new tools to for making pest management decisions that incorporate natural enemies in their IPM programs.

We are conducting similar research in other cropping systems including pears, apples and walnuts as part of a western SCRI grant. Information from both grants will enhance our knowledge about natural enemies which should enable end-users to have more information on natural enemy impacts. This information will be applicable to other cropping systems.

We are fine-tuning HIPV-baited traps that selectively capture key natural enemies. We are narrowing down the list of useful HIPVs and trap types in order to develop a few combinations that will be useful to pest managers. We are investigating ways to provide information to the fruit industry on how to conserve natural enemies and use and interpret HIPV-baited traps. We are developing biological control short courses using information from this grant and the SCRI grant that will be offered to the industry in WA, OR, and CA early next year. Among other things, these short cources will train participants on how to identify of natural enemies, present information on the importance of incorporating biological control into IPM programs, the costs associated with using or disrupting natural enemies in orchard systems and how to use HIPVs. For more information on the short course and about these two projects, please see the following website: http://enhancedbc.tfrec.wsu.edu/