FINAL PROJECT REPORT WTFRC Project Number: CP-08-800

Project Title: Defining natural enemy biology and phenology to improve IPM

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Cooperators: Jay Brunner, WSU-TFREC; Qing-He Zhang, Sterling International, Inc., Spokane

Other funding sources

Agency Name: USDA-CSREES SCRI
Amount awarded: $2.244M

Total Project Funding: Year 1: $132,478 Year 2: $137,978 Year 3: $135,378

Budget History:
Organization: WSU-TFREC **Contract Administrator**: ML Bricker, Kevin Larson
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Item	Year 1	Year 2	Year 3
Salaries[1]	43,604	45,176	47,162
Benefits[2]	7,203	8,004	7,792
Wages	8,000	8,320	8,653
Benefits	1,256	1,498	1,359
Equipment	0	0	0
Supplies	3,500	3,640	3,786
Travel[3]	3,500	3,640	3,786
Total	67,063	70,278	72,538

[1]half-time project manager (Nik Wiman); 0.33FTE Associate in Research (Callie Baker).
[2]Wiman (7%); Baker (34%).
[3]Within state travel for surveys

Budget History 2:

Organization: USDA-ARS **Contract Administrator**: Janet Tsukahira

Telephone: 510-559-6019 **Email**: jtsukahira@pw.ars.suda.gov

Item	Year 1	Year 2	Year 3
Salaries*	38,782	37,231	43,638
Benefits	11,635	11,169	18,702
Wages	0	0	0
Benefits	0	0	0
Equipment	1,450	0	0
Supplies	500	500	500
Travel	0	0	0
Miscellaneous	1,200	1,200	0
Total	53,567	50,100	62,840

* Salaries are for a term appointment with 13, 12, and 11 months in 1st, 2nd, & 3rd years, respectively

Budget History 3:

Organization: Agriculture & Agri-Food Canada **Contract Administrator**: Karen St. Martin, Goewin Demmon

Telephone: 250-494-7711 **Email**: KSM stmartink@agr.gc.ca, GD demmong@agr.gc.ca

Item	Year 1	Year 2	Year 3
Salaries	0	0	0
Benefits	0	0	0
Wages[1]	0	10,500	0
Benefits	0	2,100	0
Equipment	0	0	0
Supplies[2]	0	3,500	0
Travel[3]	0	1,000	0
Miscellaneous	0	500	0
Total	0	17,600	0

[1] Summer student wages with 20% benefits plus inflation in year 2.

[2] Supplies in year 2 include cost for synthesizing several grams of Ascogaster pheromone for group.

[3] Travel costs are for local travel within Okanogan Valley

Objectives:

1. Characterize the phenology of key natural enemies using banding, beat-tray sampling, and attractant-trapping.
2. Evaluate various semiochemicals as a method of monitoring natural enemy abundance / phenology and impacts of control treatments.
3. Use video monitoring to identify predator species attacking codling moth and develop a polyclonal antibody for expanded predator gut content analysis of codling moth.
4. Further investigate the life history of tachinid parasitoids of leafrollers and their potential for enhancing management of leafrollers.
5. Integrate the information on natural enemy phenology and abundance into the WSU-Decision Aid System to help users gauge the impact of pesticide sprays at different times of the season.

Significant Findings and Accomplishments:

- WTFRC funding for this project was leveraged to bring in substantial additional funding ($2.2M) through a CSREES Specialty Crops grant; moreover, data collected for the WTFRC project were included as preliminary results in the justification section of the SCRI grant proposal.
- Beating trays have severe limitations for sampling natural enemies, but do show that our aphid feeding ladybird beetles and spiders tend to have only a single generation in the orchard; lacewings, and some of the predatory bugs show 2+ generations.
- The phenology model for the lacewing *Chrysopa nigricornis* is nearly complete and works on apple, cherry, and walnut. Pesticide impacts on pears obscure the phenology in that crop, but more analysis will be performed.
- Pesticide distortion of phenology may become a very sensitive way to evaluate pesticide impacts on natural enemies.
- We evaluated release rates of semiochemical-based attractant lures over time in both laboratory and field conditions and now have a lure system that gives a consistent release rate for at least 30 days with all materials; the release rates are constant even in direct sunlight over that period.
- We completed 14 different attractant studies over the past three years and now have lures for at least three species of lacewings, three species of syrphid flies, and a broad range of parasitoids. We can also “design” attractant blends so that we can enhance or reduce capture of certain species to make trap checking easier.
- Lab studies on four ground dwelling predators showed that earwigs and daddy-long legs fed on free-living fifth instar codling moth larvae but not cocooned (overwintering) larvae; wolf spiders and a predatory ground beetle fed on both life stages
- Gut content analysis of field collected predators showed that 6, 2, 4 and 10% of the daddy-long legs, earwigs, spiders, and ground beetles, respectively, scored positive for having fed on codling moth larvae over the previous 24-hour period.
- Adult tachinid parasitoids (*Nilea erecta*, *Nemorilla pyste*) were both heavily impacted by the normal field rate of Esteem® residues. Full field rates of Intrepid® reduced *Nemorilla* survival, but not *Nilea* survival.

Significant Progress:

Objective 1. Our sampling produced phenology data from three data sources: (1) overwintering bands that were placed in orchards last fall and brought to outdoor shaded shelters by early December; (2)

Table 1. Comparison of the abundance and phenology of the lacewing *Chrysopa nigricornis* measured in Washington apple orchards using beat-tray samples and attractant traps during 2009.

	Initial Capture		**Last Capture**		**Total Captured**	
Orchard	**Beat Tray**	**Attractant**	**Beat Tray**	**Attractant**	**Beat Tray**	**Attractant**
1	22-Jul	24-Apr	22-Jul	15-Oct	1	7,158
2	24-Jul	13-May	4-Sep	6-Oct	4	13,770
3	none	18-May	none	6-Oct	0	9,108
4	11-Aug	21-May	8 Sept	19-Oct	5	3,195
5	18-Aug	4-Jun	10 Sept	30-Sep	2	717

beating tray samples collected in eight orchards in the Wenatchee and Yakima areas from early spring to fall; and (3) attractant-baited trapping in the same eight orchards.

We caught 33,948 *Chrysopa nigricornis* lacewing adults using four attractant traps in five orchards. In contrast, beat-samples conducted concurrently in the same orchards captured 12 lacewings. This is the second year in which beating trays have severely underestimated lacewing abundance and/or activity (see Table 1).

At each site, the attractant baited traps caught *C. nigricornis* both earlier and later in the season, and in dramatically higher numbers (Table 1). This information shows that adult lacewings emerge earlier in the spring (≈75 days earlier) and that they continue to fly later in the fall than expected based on beat samples (≈43 days late). Our data show that while beat-samples may have its place for estimating populations of certain natural enemies, it is very clear that certain other species are not effectively monitored using trays. For example, looking at the C. nigricornis data from beat-samples, it would appear that this predator is rare, when it is actually extremely abundant.

While beating trays are much less effective at capture of some natural enemies, they also provide information that most attractant traps don't provide, namely the presence of both adult and immature stages. We collected beat tray samples in eight orchards (4 in Yakima area, 4 in Wenatchee area) over the first two years of this grant. Dave Horton has taken the lead on analysis of this data and several interesting things appeared in the analysis. First, all aphid-feeding ladybird beetles appear to have only a single generation per year (Fig. 1). Spiders also showed only a single generation per year (data not shown).

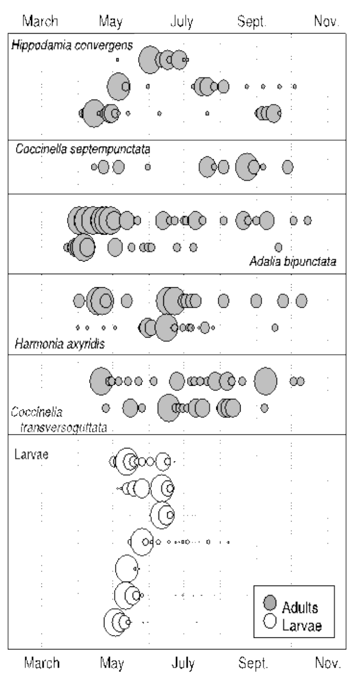
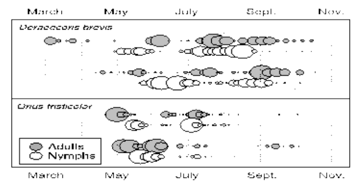


Fig. 1. Beat tray data of the capture of several species of adult ladybird beetles in WA apples. Each row of circles is a separate orchard. Size of circle is

Phenological results for ladybird beetles and spiders suggest that these predators may thus recover only very slowly from disruption caused by pesticides. Our lacewings tend to have 2+ generations per year, a life history trait shared by some of the predaceous bugs (*Orius* and *Deraeocoris*) (Fig. 2). We are currently analyzing these data in conjunction with pesticide use patterns and surrounding vegetation surveys to determine if there are landscape level determinants of natural enemy species abundance and diversity.

Fig. 2. Beat tray data of the capture of *D. brevis* and *O. tristicolor* in WA apples. Size of the circle is proportional to the number collected; each row of



Objective 2A. Determine release rates of semiochemicals. We investigated a total of 14 lures for longevity and release rate over time in both lab and field settings at WSU-TFREC. The polyethylene tubing lures we developed provided a stable release rate for each compound that is a function of membrane thickness and temperature. In year two, we finished field-testing lures that were deployed inside a normal white delta trap.

Our work in Objective 2B showed that we could reduce unintended honeybee capture and increase capture of other natural enemies by switching to yellow sticky panels. The switch to yellow sticky panels would result in the lures being directly exposed to the sun – thus we needed to evaluate lure longevity in the direct sun. This past summer, we tested 21 different lures for 13 different attractants. Lure release rate was slightly higher when exposed, and lure depletion was only an issue with two of the attractants. In those two cases, we were able to increase the lure load and bring lure longevity back to the normal 30+ days.

Objective 2B. Evaluate field effectiveness and spectrum of activity of the different attractants. Over the past three years, we have run 14 field trials to evaluate and improve our attractant traps. In 2010 alone, we ran five tests that: (1) evaluated sixteen different attractant blends (a 2 × 2 × 2 × 2 factorial experiment) using all possible combinations of the presence or absence of acetic acid (AA), acetophenone (AP), phenylacetaldehyde (PAA), and 2-phenylethanol (PE) in three different orchards to get the spectrum of activity of these new lures; (2) tested 8 blends (a 2 × 2 × 2 factorial experiment) using all possible combinations of the presence or absence of methyl salicylate, acetic acid, and PAA for lacewing attraction; (3) examined (as a 2 × 2 × 2 factorial experiment) AP, geraniol (GER), and PE with yellow sticky panels, focusing on improving trap catch of syrphid flies (key predators of aphids); (4) evaluated (as a 2 × 2 × 2 factorial experiment) AP, GER, and the *Campylomma* pheromone, in an attempt to increase efficiency of the *Campylomma* pheromone; and (5) analyzed season-long phenology (objective 5).

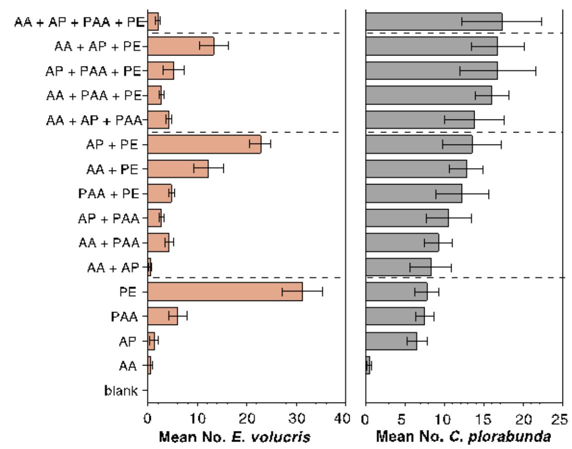
***Results**:*

AA×AP×PAA×PE study. This factorial experiment was run in two apple orchards in the Wenatchee area and one in the Yakima area. In an attempt to evaluate the importance of these attractants in mixtures, we ran an all-possible combinations experiment (factorial) - this required us to test 16 different treatment combinations (each replicated 4 times per orchard). This trial was also run in the SCRI project in pear and walnut orchards. To date, only the apple data are complete enough to evaluate effects on specific natural enemies.

The complete factorial design is very cumbersome and expensive, but it provides us a very clear picture of how the different attractant combinations work in the field. For the syrphid fly, *Eupeodes volucris*, it was clear that its response was similar in all apple orchards, with the best attractant being

2-phenylethanol (PE) by itself (Fig. 3). Addition of any of the other compounds did not improve capture, and many combinations actually decreased the capture over PE alone. This is in contrast to the lacewing *Chrysoperla plorabunda*, which responds to a wide range of blends and nearly always responds better with two or more of the attractants. For *C. plorabunda*, the top binary blends were not significantly different from either the three or four component blends.

Fig. 3. Trap capture of the syrphid fly, *Eupeodes volucris* and the lacewing *Chrysoperla plorabunda* to all possible combinations of acetic acid (AA), acetophenone (AP), 2-phenylethanol (PE), and



AP×MS×AA. This study was run to evaluate an attractant blend that was developed in Europe for the lacewing *Chrysoperla carnea*. The addition of acetic acid to the blend was thought to be a major factor in attraction and the authors suggested that it might be so for other members of the genus *Chrysoperla*, which are not predators as adults (adults are pollen feeders). We found that AA was not attractive by itself, but synergized the activity of PAA and was super additive when combined with MS and PAA for capture of *C. plorabunda*. For *E. volucris*, similar to the above studies, the single component of PAA was better than the combination of multiple attractants.

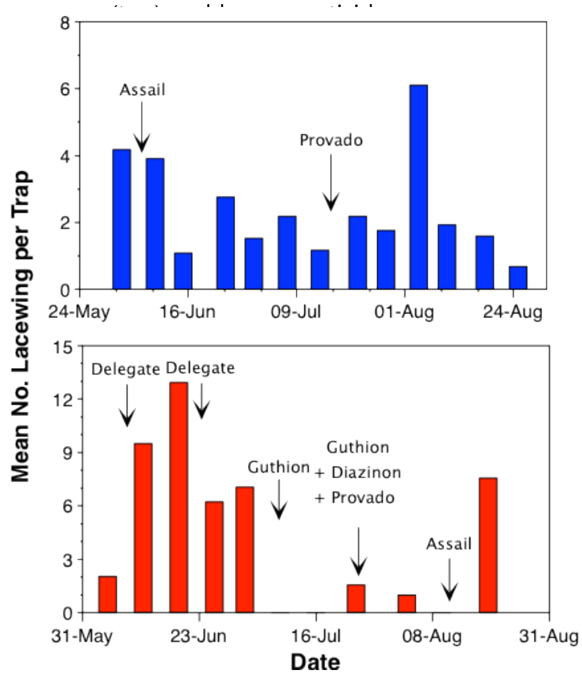
AP×GER×PE Yellow Card Study. The yellow panel study showed that trap catch of *C. plorabunda* was not improved significantly by addition of multiple components over use of PE alone. This is similar to the results from the AA×AP×PAA×PE study above if the results of that study are restricted to the AP×PE elements. The lack of activity of GER alone and the lack of either MS or AA (which tend to act as a synergist) breaks the general trend of *C. plorabunda* responding best to a mixture. The results with the syrphid *Eupeodes* were similar to the other tests where the single component PE was not significantly different than any mixture.

Overview of trapping experiments

Running full factorial experiment allows us to custom tune a blend to attract a range of natural enemies and reduce capture of those of less interest. Once the data sets from the SCRI data are completed for walnut and pear, we will design blends that attract the desired range of natural enemies and test them in the field next year. For example, in our apple data, we could use several of the three component blends (*e.g*., AA + AP + PAA or AA + AP) to limit catch of *E. volucris*, while still capturing *C. plorabunda*. We will also run one more factorial this coming year on our SCRI project that will combine the best of attractants that we tested in 2009 and 2010 to finalize our blends down to 3-4 attractants targeting key natural enemy taxa.

Evaluations of insecticide impacts: The efficacy of our attractants permits us to document how natural enemy populations are influenced by insecticide sprays. Focusing on lacewing populations, our data last year showed that reduced-risk insecticides had less impact on the lacewings, while organophosphates appear to decimate lacewing populations (Fig. 4). In one orchard near Quincy with a minimal pesticide program, we found that lacewing populations experienced typical oscillations but never "crashed" (Fig. 4 top). A different orchard in the same area saw its lacewing population decline sharply and remain low for approximately four weeks, during which two applications of azinphos-methyl (Guthion) were applied (Fig. 4 bottom). During this same four week period at other Quincy orchards, our trapping indicated that lacewing populations were rising. The trapping data show that the attractant lures can be used to evaluate pesticide applications and these lures have been used in apple, cherry, walnut and pear to evaluate pesticide impacts on natural enemy populations in the SCRI project this year.

Fig. 4. Comparison of the trap catch of *Chrysopa nigricornis* in an orchard with minimal pesticide



Objective 3A. In 2008 and 2009, video monitoring of predation on CM cocoons deployed in the field proved technically problematic but suggested that most predation was caused by vertebrates and not insects. Observations of 192 camera hours in 2008 identified three predation events by birds. Recordings of 1,114 hours in 2009 showed 11 predation events by mice (7), ants (3), and an earwig (1). This suggests that predatory arthropods on the orchard floor may have less impact on CM than vertebrates. To better understand this, the Unruh lab conducted predator-feeding studies in the laboratory in 2010 using likely CM predators. Gut content analyses (in objective 3b) will validate whether these predators do indeed discover and eat CM larvae in the field. In 2011, additional visual field measurements of predation on CM will be presented.

Results: Four arthropod taxa that were large enough to be capable predators of free living or cocooned CM larvae were collected by pitfall trapping and tested in the lab. These were harvestmen (Opiliones or "Daddy long legs"), several large wolf spiders (Lycosidae), the predatory ground beetle *Pterostichus melanarius* (Carabidae), and the European earwig (*Forficula auricularia*). Each predatory species was offered either late instar CM larvae or cocooned CM larvae and their behavior and prey consumption were monitored in 70-100 replicates/species/host types. The studies showed earwigs (93%) and daddy long legs (95%) ate free CM larvae but no larvae in their cocoons (0% for both species). In contrast, the carabid beetle, *P. melanaria* and wolf spiders ate both free 5th instar larvae and cocooned larvae equally (>95% for both host types for both species). The carabid and the wolf spiders were voracious predators; they attacked and consumed the CM larvae within one hour of presentation; cocooned CM consumption took several hours. The daddy long legs and earwigs were slower at prey consumption and took many hours (4–24) to attack and consume the free-living larvae. Some daddy long legs were injured by the free living CM.

Objective 3B. Gut content analysis methods to replace PCR: The loop-mediated DNA amplification (LAMP) protocol has been the focus of the lab for the last two years; however, this approach was dropped because of repeated lab contamination by reaction products (a problem described by many others using LAMP). This problem caused us to prepare samples in a teaching lab at Heritage University (courtesy of Dr. N. Barcenas) to separate samples from areas where reaction products were produced. Even with these precautions, we concluded LAMP was poorly suited for gut content analysis (GCA) where a bioassay that can be conducted in one lab is desirable. The GCA is ongoing with a revised PCR method that detects a CM odorant receptor gene and a recently developed buffer system that supports amplification of "dirty" (whole-body homogenate) samples.

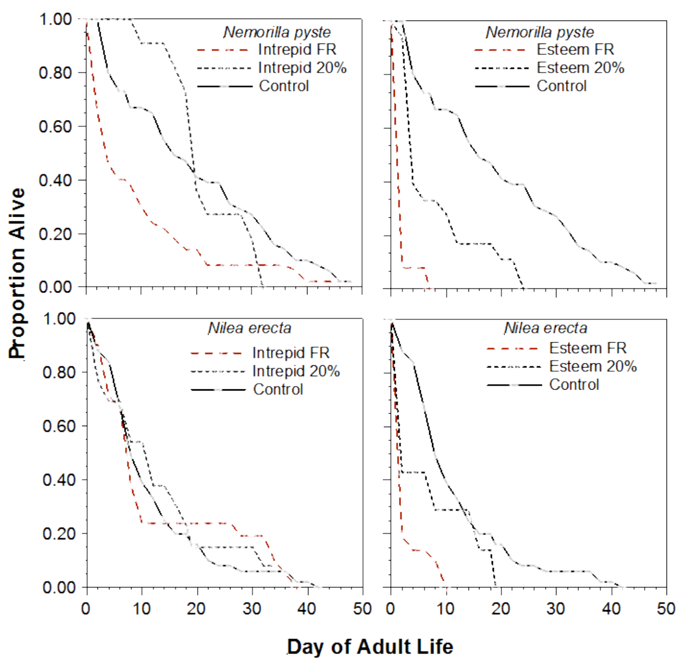
Results: Limited numbers of GCA have been conducted for Opiliones (18), earwigs (167), spiders (129), and the carabid, *P. melanaria* (48). We found that 6, 2, 4 and 10% of the Opiliones, earwigs, carabids, and spiders (respectively) tested positive for consumption of codling moth within the previous 24 hours (after 24 hours, the codling moth DNA break down and are not detectable). Specimens were collected daily from pitfall traps between mid-August to mid-September. The results to date do not completely correspond to the feeding studies: low predation rates were observed by carabids and higher than expected results were observed for daddy long legs. These results suggest that large spiders are the most potent predators of CM, which is consistent with their very aggressive behavior in the laboratory. PCR studies are ongoing and larger sample sizes should be available for the oral report. Additionally, GCA will continue through 2011 under SCRI and results will be provided to TFRC at that time.

Objective 4. Determining the impact of IGR's used for leafroller control on tachinid adults. Last year we presented data that demonstrated the effect of Esteem (pyriproxyfen) and Intrepid (methoxyfenozide) residues on longevity of *Nilea erecta*, and for *Nemorilla pyste* we presented data for Esteem only. Last year's objective was to finish evaluating the effect of Intrepid (methoxyfenozide) residues on longevity of *N. pyste* and to increase replications for the two IGRs with *N. erecta*. To obtain the desired residues, the IGRs were applied at field or 20% field rates to plastic deli cups that were then air-dried. Cups were provisioned with 10% honey-water solution. Cohorts of male and female Nilea erecta and Nemorilla pyste were placed in the treated cups individually upon the day of emergence to the adult stage, with 10% of the cohort reserved for untreated (control) cups. Cups were monitored daily to determine the day of death.

Results: The control mortality curves differed in shape between the two fly species (Fig. 5). *Nemorilla* mortality was roughly linear over their entire adult life, whereas *Nilea* mortality curves were characterized by higher initial mortality rates, which then decreased over time. When exposed to the field rate of Intrepid, the mortality curves of *Nemorilla* flies showed an increased early mortality compared to controls (≈40% by day 10), while *Nilea* mortality rates were unaffected. Reduced rates of Intrepid (20% of the field rate) had no affect on either species.

Esteem was highly toxic to both species. At field rates, maximum life expectancy was roughly 25% of untreated controls in both *Nemorilla* and *Nilea* and cohort survival was reduced to 8-20% (i.e., 92-80% mortality occurred). Even at 20% of the field rate, Esteem caused extreme early mortality, killing more than half of the cohort in 2-3 days. Clearly these parasitoids are highly susceptible to Esteem, and even reduced rates do not allow sufficient longevity to include time for mating and attacking hosts.

Fig. 5. Effect of pesticide residues on longevity of the tachinid leafroller parasitoids *Nemorilla pyste* and *Nilea erecta*.



While these trials examined the affects of IGR's on mortality, exposure to these compounds may also affect behaviors or physiological processes that are necessary for successful mating and reproduction. However, from our results we can conclude that Intrepid at field rates has a strong negative effect on populations of *Nemorilla*, which is the most common and abundant of the two flies. However, Intrepid is less problematic for biological control compared to Esteem. Esteem was highly toxic to both species at low concentrations, suggesting that this compound is entirely antagonistic with leafroller biological control. The mechanism by which the flies are affected by residues is unclear, although it likely entails ingestion of the compounds from surfaces through grooming and/or sponging which is a common occurrence in both species.

Fig. 6. Phenology of the lacewing *Chrysopa nigricornis* adults in apple, cherry, and walnut

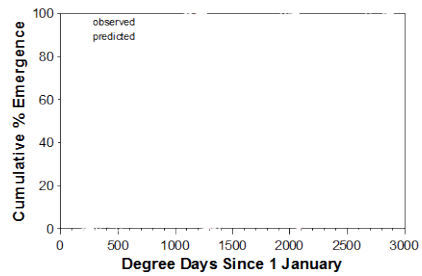
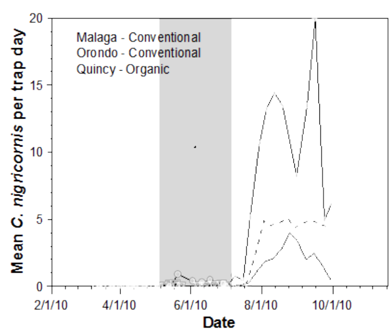


Fig. 7. First generation of *C. nigricornis* in cherries should occur in gray box, but is suppressed by insecticides and fungicides applied during that



Objective 5. We have analyzed the squalene trapping data now from apple (7 orchard sites over two years), sweet cherry (3 orchard sites over one year), pear (10 orchard sites over two years) and walnut (6 orchard sites over two years). The trapping data, along with an unpublished manuscript on temperature development of *C. nigricornis* by former USDA-YARL entomologist R. Fye, has allowed us to develop a phenology model for this key natural enemy. We found the number of flights in WA varies from 2 (cherries) to 3+ generations in warmer apple orchards. Our work on the four different crops shows that a single model works on all crops (Fig. 6), but there are some variations in flight that can be attributed to spray programs. Specifically, the first generation in cherries is completely suppressed by spray programs aimed at other pests (*e.g.*, black cherry aphid, western cherry fruit fly) or by diseases (oil applications) (Fig. 7). In pear, pesticide applications so distort the phenology that without spray records, the emergence of the different generations are difficult to ascertain. Our studies also suggest the differences in phenology can be used to help understand pesticide impacts as well.

This year, we also ran season-long phenology studies in eight apple orchards (4 in the Yakima area, 4 in Wenatchee area) using four attractants (1) squalene for *C. nigricornis*, (2) GMP (geraniol + methyl salicylate + PE) – a general lure for lacewings, syrphids, and parasitoids), (3) AP – targeted at mainly lacewings, western flower thrips and parasitoids, and (4) PAA – specifically targeted for hymenopterous parasitoids in the families Scelionidae (some species are key stinkbug parasitoids) and Eulophidae (same family as *C. florus*, the parasitoid of OBLR and PLR).

Our data from the long-term phenology data should provide enough information to develop phenology models for another lacewing, *Chrysoperla plorabunda*, which is common in both the Wenatchee and Yakima areas on apples. Likewise, with our data combined that from the different SCRI crop systems (walnut, pear) and the cherry data this coming year we should be able to develop phenology models for at least two species of syrphid flies, *Campylomma* bug, and hopefully the parasitoid of the woolly apple aphid, *Aphelinus mali*. These models should begin to appear on WSU–DAS next winter as each is developed and we can start making changes to management timings to reduce impact on natural enemies while maintaining the necessary efficacy against the pests.

Executive Summary:

This grant served as the basis for our $2.4M SCRI grant to enhance biological control in western apple, pear, and walnut orchards. It not only helped to provide matching funds, but it also supplied the initial data sets that showed the SCRI grant panel that the work was possible and had a strong applied basis. In addition, the work done in the first year of this grant also served to convince our colleagues in California and Oregon that we had technologies in apple that could be useful in pear and walnut orchards and that it would be to our mutual benfit to work on these areas (as well as others) to enhance biological control in western orchards.

The results of experiments performed in this grant have radically changed our understanding of the diversity and abundance of natural enemies in apple orchards. We have developed new sampling methods using Herbivore-Induced Plant Volatiles (HIPV) released in a consistent fashion by lures developed by this project. Over all the studies with HIPV lures that we have performed in the last 3 years, we have now developed a highly active and specific attractant for *C. nigricornis* (squalene), a very general attractant (Geraniol + Methyl Salicylate + 2-phenylethanol) for lacewings, parasitoids, and some syrphid flies. In addition to these two attractants, our testing protocols showed us that attraction to certain natural enemy groups could be almost completely shut down by the addition of a particular component and use of different trap types, which can also enhance capture of specific natural enemy groups. Some of our blends are already highly attractive to Scelionid (many stinkbug parasitoids) and Eulopid parasitoids (same family as the leafroller parasitoid *C. florus*), and several blends that are also attractive (although not strongly so) to predaceous hemipterans. Further studies on HIPVs will still be needed to refine some of the blends, and we hope to finish most of this work using the remaining research funding from the SCRI grant.

The combination of the banding, beating trays, and HIPV lures has given us the data set to develop natural enemy phenology models that will be used to improve timing of our management actions. We currently have a phenology model for the lacewing *Chrysopa nigricornis*, which was the most abundant predator collected in our studies. Combined with our data taken in the USDA-SCRI grant, we should also have the data to develop at least five more natural enemy models to help refine management programs.

The work with the Tachinid flies shows how an important leafroller natural enemy can be greatly impacted by "reduced-risk" insecticides. Esteem was particularly harsh on newly emerging flies and caused 80-92% mortality within 2 days. Even at 20% of the field rate, Esteem caused extreme mortality of both species, killing more than 50% of the flies by 2-3 days. Intrepid is much less toxic, having no real effect on *Nilea*. However, *Nemorilla* flies experienced increased mortality over untreated flies by roughly 40% on day 10. Our current recommendations on WSU–DAS should reduce the impacts of both insecticides, because we recommend no sprays during the last two leafroller instars when the tachinids are most active. However, these data do show that even with those caveats, that pesticide choice is still a key component of leafroller management.

In terms of future work, we see a great potential to using our natural enemy lures to evaluate the impact of different pesticides on natural enemies and the resulting pest supression in the orchard. In particular, we see the possibility of manipulating natural enemy spatial distributions in the orchard by deploying lures into high pest areas to "jump-start" the egg laying and predation in a particular area. We feel that it is unlikely a reasonable decision to place the lures into an area for all season, because it would disrupt the ability of the natural enemies to use the HIPV to locate their prey and may act similar to mating disruption and reduce the reproductive rate of the natural enemy. However, for this to be successful, we need to know more about the attractive range and evaluate which lures are the best for suppression of key pest groups. This approach is one of the components of the new grant being submitted by Jones and Chambers this winter.