FINAL PROECT REPORT

Project Title: Conservation biological control of pear psylla in PNW pears

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Total Project Request: **Year 1**: $71,571

Other funding sources: None

Budget 1
Organization Name: OSU MCAREC **Contract Administrator:** L.J. Koong
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Item	2013
Salaries	$35,253
Benefits	$19,741
Wages	$11,520
Benefits	$957
Equipment	$0
Supplies	$2,500
Travel	$1,600
Miscellaneous	
Plot Fees	
Total	$71,571

Footnotes:
Postdoctoral Researcher: 9 months year 1.
OPE Postdoctoral Scholar: 56%
Hourly help: 1 person, 6 month, $12/hour,
OPE Hourly help: 8.31%
Supplies: Traps, pheromone lures, natural enemy attractants, sampling supplies,
Travel: to field plots

Project Title: Conservation Biological Control of Pear Psylla in PNW Pears

Objectives:

1. Determine why large-scale, area-wide mating disruption for codling moth in pear results in reductions in pear psylla population levels and insecticide sprays to manage it.

2. Develop actionable deliverables for use by pear industry, university Extension and researchers.

Significant Findings:

- Large-scale, area-wide mating disruption for codling moth in pear orchards and overall reduction of pesticide sprays for codling moth and pear psylla control can result in stabilized pest and natural enemy populations in Mid-Columbia pear orchards. This is the third study we have observed this in.

- Established natural enemy populations can be difficult to disrupt with pesticides sprays.

- Spiders were the most dominant predators observed during this study.

- Tree banding provided a better assessment of abundance of spiders, lacewings and earwigs than beating tray samples.

- Low populations of pear psylla were observed throughout the study period, despite the use or lack of insecticide use after the petal fall abamectin sprays. This supports previous observations regarding the benefits of codling moth mating disruption and reduced pesticide applications for pear psylla management.

Objective 1: Determine why large-scale, area-wide mating disruption for codling moth in pear results in reductions in pear psylla population levels and insecticide sprays to manage it

This study was carried out in a pear orchard in White Salmon, WA. The orchard was under a long-term area-wide codling moth mating disruption program with only rare applications of psyllicides applied after the petal fall abamectin applications. Four large green Bartlett blocks were selected from different locations within the orchard and each block was sub-divided into two sections for each treatments, i.e. non-disrupted and disrupted. Insecticides were not applied to the non-disrupted plots during the summer cover season (Table 1). A mixture of Altacor, Delegate and oil (Omni Supreme Spray) at high label rate was applied to the other plots on 25 May and 12 June, 2013 to disrupt natural enemies. We then assessed effects of disruption on pear psylla and natural enemies.

Table 1. Insecticide applications for test sites.

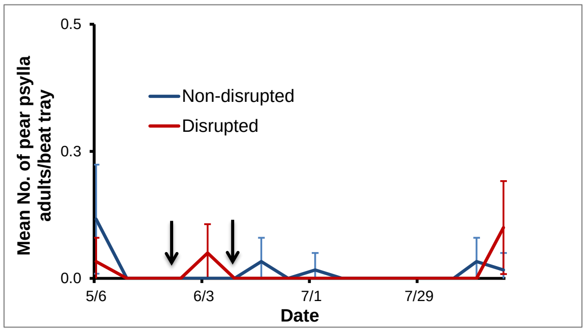
Application Dates	Product	Active ingredient	Rate/ acre	Disrupt	Non-disrupt
24-Feb-13	Omni Oil	Mineral Oil (98%)	3-4 gal	X	X
8-Mar-13	Omni Oil	Mineral Oil (98%)	2 gal	X	X
	Esteem 0.35 WP	Pyriproxyfen (35%)	5 oz		
1-Apr-13	Nexter	Pyridaben (75%)	8 oz	X	X
	Penncozeb 75 DF	Ethylenebisdithiocarbamate (58.1%)	8 lb		
21-Apr-13	Penncozeb 75 DF	Mancozeb (75%)	8 lb	X	X
	Surround WP	Kaolin (95%)	50 lb		
10-May-13	Zoro	Abamectin (1.9%)	20 fl oz		
	Omni Oil	Mineral Oil (98%)			
25-May-13	Delegate	Spinetoram (25%)	7 oz	X	
	Altacor	Chlorantraniliprole (35%)	4 oz		
	Omni Oil	Mineral Oil (98%)	2 qt		
12-Jun-13	Delegate	Spinetoram (25%)	7 oz	X	
	Altacor	Chlorantraniliprole (35%)	4 oz		
	Omni Oil	Mineral Oil (98%)	2 qt		
27-Jul-13	Omni Oil	Mineral Oil (98%)	2 qt	X	X
	CYD-X HP	Codling Moth Granulosis virus (0.06%)	1.5 oz		

The blocks were sampled weekly for important natural enemies using beating trays, assessing spur or shoot leaf samples, trapping of natural enemies using Herbivore Induced Plant Volatiles (HIPV) and bi-weekly banding of trees with strips of corrugated cardboard. Pear psylla eggs and nymphs were monitored weekly using spur leaves (early season) (5 spur leaves from 10 trees/block, 200 leaves/treatment/week) or shoot leaves (later in the season) (3 leaves/shoot, 1 shoot/tree, 10 shoots per block, 120 leaves/treatment/week). Weekly beating tray samples were used to monitor pear psylla adults, spiders, Coccinellids, *Trechnites*, immature natural enemies such as lacewing and Coccinellid larvae, *Deraeocoris brevis*, *Orius*, and *Campylomma verbasci* nymphs. Three types HIPV lures were used to monitor green lacewing *Chrysopa nigricornis* (Squalene), other green lacewing species (e.g. *Chrysoperla* sp.) (AMP [Acetic Acid, Methyl salicylate and Phenylacetaldehyde]), syrphids (Phenylacetaldehyde and Geraniol) in addition to using traps for *Campylomma* spp. (*Campylomma* pheromone). A trap for each lure was placed in each of the four blocks per treatment. Tree banding was conducted using a passive trap that consists of individual 1.5" wide cardboard bands placed on trunks of 20 trees per replicate (n=80 bands per treatment). These bands were used to assess the abundance of lacewing larvae, spiders and earwigs and were placed in the field twice a month and left in the field for approximately14 days. Treatment differences were analyzed with a ProcMixed model (SAS) and all significant different differences are noted on graphs using an asterisk (* = Significance at $P \leq 0.05$ (LS Means) (Proc Mixed, SAS).

Spiders collected from the beating tray samples and tree banding were stored in isopropyl alcohol and sent to USDA-ARS Wapato, WA for identifications. The results of spider identification are not yet available. All other natural enemies mentioned above and collected were identified and results are presented below.

RESULTS AND DISCUSSION:

Very few adult pear psylla were detected in beating tray samples in both non-disrupted and disrupted plots throughout the study period (Fig 1). Low numbers of psylla eggs and nymphs from spur leaves and shoot leaves were detected in the two treatments (Fig 2). Pear psylla egg, nymph and adult counts were well below economic threshold levels throughout the season.



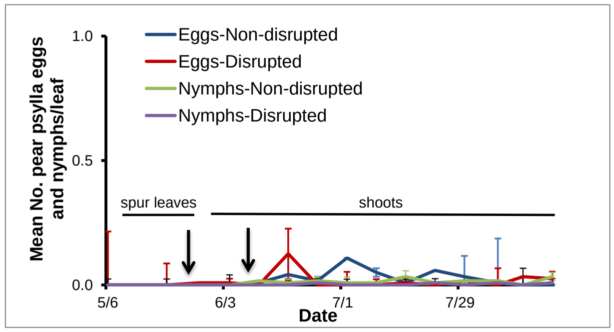
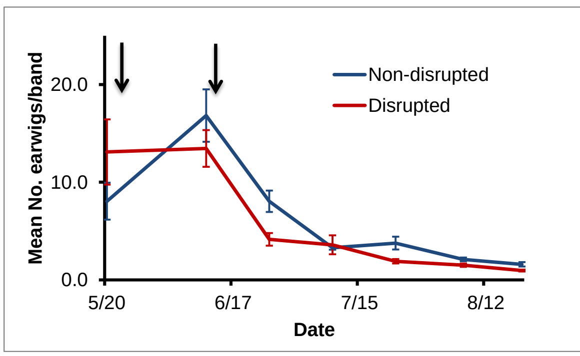


Figure 1: Mean number of pear psylla adults collected from beating trays. Arrows indicate application timings of Delegate and Altacor.

Figure 2: Mean number of pear psylla eggs and nymphs collected from spur leaves and shoot samples. Arrows indicate application timings of Delegate and Altacor.

Earwigs are important biological indicators when evaluating effects of pesticides in agricultural cropping systems. A large number of earwigs were collected from tree banding although only a negligible number were collected from beating trays (Fig 3). There was a decline in number of earwigs collected after the second spray in mid-June, but this was apparent in both treatments.



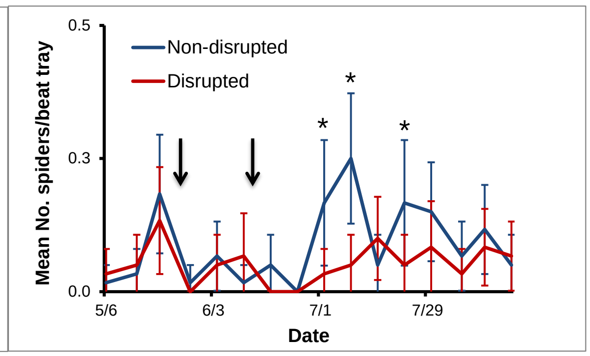
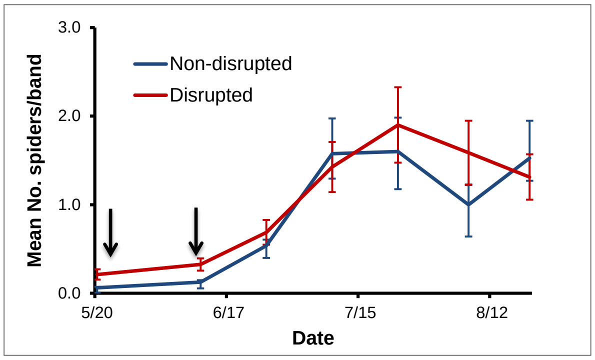


Figure 3: Mean number of earwigs collected from tree banding. Arrows indicate application timings of Delegate and Altacor.

Figure 4: Mean number of spiders collected from beating trays. . Arrows indicate application timings of Delegate and Altacor.

Spiders were the dominant natural enemy collected from beating trays and tree banding (Fig 4 & 5). We observed higher levels of spiders on beat trays in the non-disrupted block on 3 sample dates (Fig. 4). More spiders were collected from tree banding than from beating tray samples. The spider counts from tree banding demonstrate the continuous abundance of spider populations in both non-disrupted and disrupted plots. Although low in numbers, continuously high spider populations were observed from beating tray samples in non-disrupted plots.



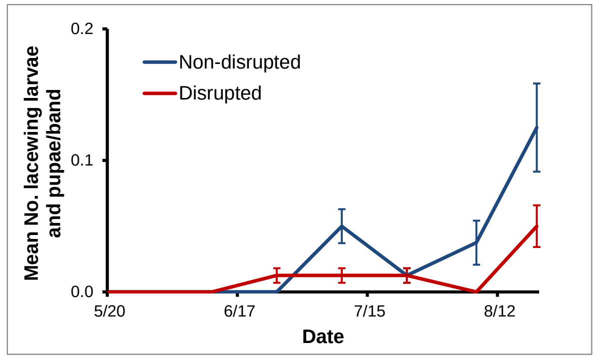
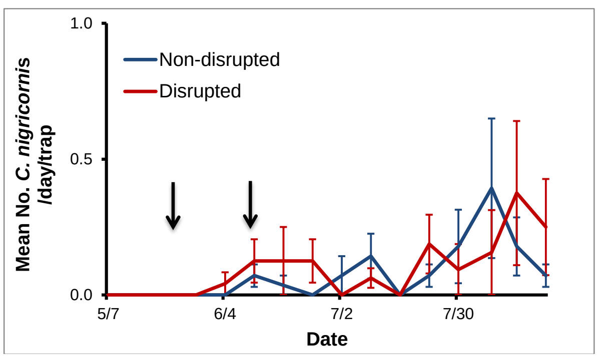


Figure 5: Mean number of spiders collected from tree banding. Arrows indicate application timings of Delegate and Altacor.

Figure 6: Mean number of lacewing larvae and pupae collected from tree banding. Arrows indicate application timings of Delegate and Altacor.

The abundance of lacewing larvae and pupae that were collected from cardboard bands attached to tree trunks tree banding were low in both non-disrupted and disrupted plots (Fig 6). The number of the green lacewing *C. nigricornis* were caught in weekly on HIPV traps was low (Fig 7). We were able to capture more *C. nigricornis* during the months of July and August than in May and June in both disrupted and non-disrupted plots. There was no difference in number of other green lacewing adults (*Chrysoperla* sp.) collected from HIPV traps placed in both non-disrupted and disrupted plots (Fig 8). Although low in numbers, *Chrysoperla* populations were continuously present in both non-disrupted and disrupted plots throughout the study period.



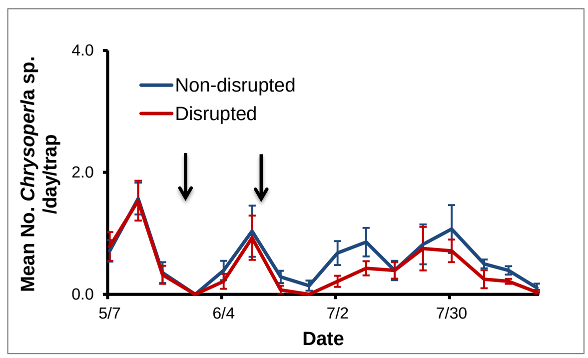
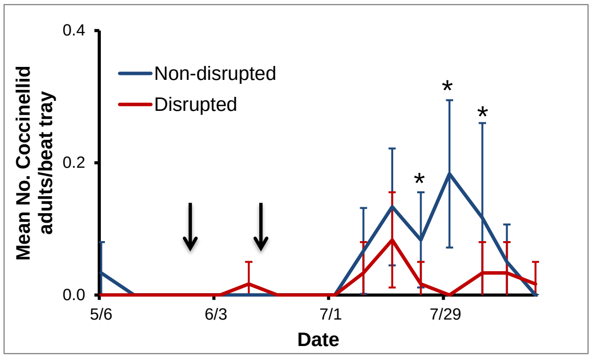


Figure 7: Mean number of *C. nigricornis* collected from HIPV traps. Arrows indicate application timings of Delegate and Altacor.

Figure 8: Mean number of *Chrysoperla* spp. collected from HIPV traps. . Arrows indicate application timings of Delegate and Altacor.

We observed a low number of adult Coccinellids from beating trays samples (Fig. 9). There were statistically more Coccinellids observed in the non-disrupted block on three sample dates. The number of Coccinellids collected increased in July after the two sprays in May and June and then gradually declined in August. Only a few Coccinellid pupae were collected from tree banding throughout the study period (Fig. 10).



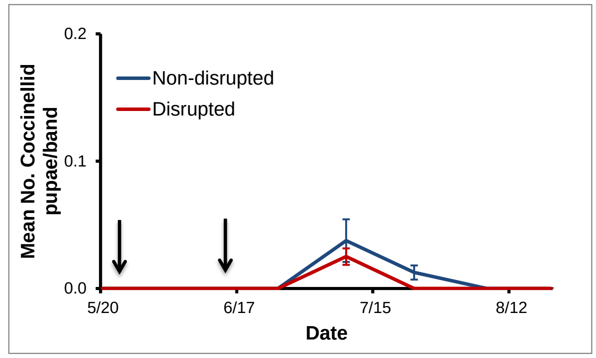
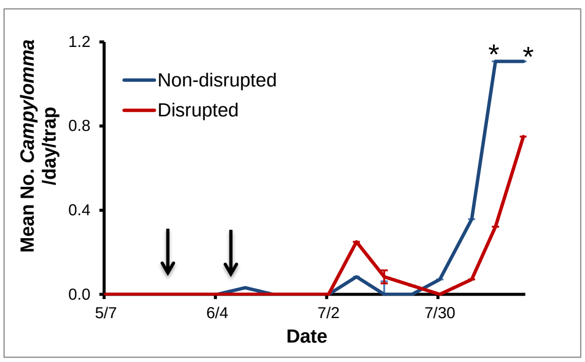


Figure 9: Mean number of *Coccinellid* adults collected from beating trays. Arrows indicate application timings of Delegate and Altacor.

Figure 10: Mean number of *Coccinellid* pupae *collected* from tree banding. Arrows indicate application timings of Delegate and Altacor.

Adult *Campylomma* verbasi started appearing in pheromone traps in early July and then the numbers rapidly increased on traps in both non-disrupted and disrupted plots (Fig 11). The traps placed in the non-disrupted plots had more *Campylomma* adults than in the traps placed in the disrupted plots suyring the last two sample dates (Fig. 11). A low number of syrphids were caught from weekly HIPV trappings (Fig 12). Syrphids were mainly caught during the months of July and August rather than in May and June in both disrupted and non-disrupted plots.



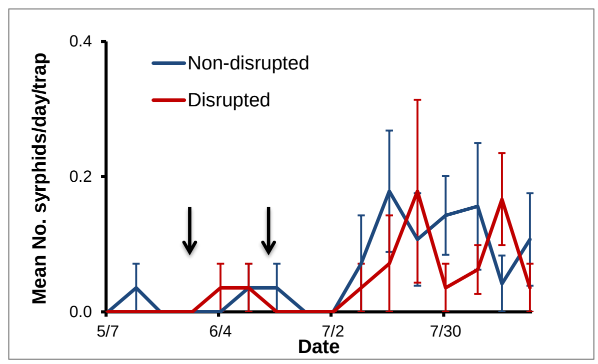


Figure 11: Mean number of *Campylomma* spp. collected from HIPV traps. Arrows indicate application timings of Delegate and Altacor.

Figure 12: Mean number of syrphids collected from HIPV traps. Arrows indicate application timings of Delegate and Altacor.

Overall, spiders were the main natural enemy in this orchard. We assume they are helping keep pear psylla populations below treatment threshold levels. Buildup of spider populations may have occurred due to the long term mating disruption of codling moth and subsequent reduction of pesticide use for codling moth and pear psylla control.

Objective 2. Develop actionable deliverables for use by pear industry, university Extension and researchers.

- Recent industry experience in Mid-Columbia pear orchards suggests that biological control of summer pear psylla is possible during the summer cover season. Results from study indicate the need for rigorous evaluation of the potential for biological control to regulate pear psylla in contemporary pear pest management programs that utilize codling moth mating disruption. However, the overall lack of differences in natural enemy abundance in the disrupted and non-disrupted blocks indicated something else might be occurring. Another theory that should be investigated is the impact or lack thereof of pesticide-induced hormolygisis, where pest reproductive output is stimulated by low dose of insecticides. These were main components that were removed from the original proposal.

- Information generated from this project will be made available to PNW growers and PCAs through ongoing outreach activities such as regional industry meetings, industry publications, and WSU DAS and Enhanced BC websites.
- Looking to the future, this project will provide a new start for collaborative PNW research on pear pest management including OSU, WSU, and ARS researchers.

Executive Summary

Project Title: Conservation Biological Control of Pear Psylla in PNW Pears

Results of this study supports previous observations that long-term mating disruption for codling moth in pears and subsequent reduction in pesticide applications for codling moth control benefits pear psylla management and biological control. Reduction in pesticide use can protect beneficial organisms that are important for pear psylla biological control resulting less fewer insecticide applications for this pest, specifically during summer months. Overall reduction in the use of pesticides in an orchard provides many benefits including lower pest management costs.

The pear orchard we used for this study was under a long-term codling moth mating disruption program. One major result is that the grower uses fewer insecticide and miticide applications, protects natural enemies and minimize pear psylla and spider mite outbreaks. The uniqueness about this particular orchard is that these circumstances have helped to build up large populations of spiders throughout the orchard. Spiders were the most dominant natural enemy detected in this particular orchard irrespective of the method of monitoring used. We detected negligible abundance of pear psylla throughout the study.

This study shows that spiders can be a dominant yet often overlooked biological control component in pear orchards and possibly an important regulator of pear psylla populations. This information that demonstrates long-term mating disruption for codling moth can lead to reduction in pesticide use, improve natural enemy abundance and reduction in secondary pest outbreaks will benefit pest managers in their IPM programs. This study suggests that biological control of summer pear psylla is possible in Mid-Columbia pear orchards during summer months.