FINAL PROJECT REPORT: PR-07-702

Project Title: Quantifying biological control of pear psylla in a cover crop system

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Other funding sources

Agency Name: Western SARE
Amount awarded: $121,092 (2008-2009)
Notes: Expands the sampling part of the study to 3 commercial organic pear orchards

Agency Name: WSU Center for Sustaining Agriculture and Natural Resources (CSANR): Organic Cropping Research for the Northwest
Amount awarded: $63,807 (2009-2010)
Notes: Expands the sampling part of the study to 3 commercial organic pear orchards

Total Project Funding: **Year 1:** $25,000 **Year 2:** $20,000 (revised) **Year 3:** $0 (revised)

Budget History: USDA-ARS

Item	Year 1 (revised)	Year 2 (revised)	Year 3 (revised)
Salaries	11,750	12,500	
Benefits	2,180	1,000	
Wages	4,500		
Benefits	500		
Supplies	1,070	1,500	
Total	20,000	15,000	0

Budget History: WSU

Item	Year 1 (revised)	Year 2 (revised)	Year 3 (revised)
Salaries	3,148	3,273	
Benefits	1,133	1,178	
Supplies	719	549	
Total	5,000	5,000	0

OBJECTIVES:

1. Estimate levels of psylla biological control in large plots of an alfalfa cover crop vs control (grass understory) plots;
2. Estimate movement rates of predators from orchard floor to tree and determine whether colonizing predators will then attack pear psylla (by simultaneous use of protein markers [Jones] and gut contents analysis [Unruh]).
3. Test whether alfalfa cover crop leads to increased nitrogen in trees having the alfalfa understory.
4. Expand project into 3 commercial organic orchards (funding by SARE and CSANR).

SIGNIFICANT FINDINGS AND ACCOMPLISHMENTS:

- Densities of generalist predators were substantially higher in understory of alfalfa plots than grass plots.
- Despite the high densities of predators in the alfalfa cover crop, we found no statistical increase during 3 yrs of sampling in densities of predators in the canopy of trees having the alfalfa understory, and no effects on psylla densities.
- Over 4000 specimens were collected from orchard floor and tree canopy for assessment of marker presence (markers applied to orchard floor vegetation). The specimens were assayed for presence of markers using ELISA. We saw evidence for movement from orchard floor into tree by several predator taxa, but no striking differences between alfalfa and control plots.
- Specimens are currently being analyzed with ELISA for gut contents (to assess presence of pear psylla remains).
- We observed increased nitrogen levels in trees having the alfalfa understory.
- Funding was obtained from Western SARE ($121,092) and CSANR-WSU ($34,178) to expand project into 3 commercial organic orchards; plots were set out and planted in spring 2008. Sampling began in 2009. We saw no effect of alfalfa on predator counts in trees. Psylla and predator counts were very low in all 3 orchards. Grower cooperators were e-mailed with sampling results at regular intervals.

RESULTS AND DISCUSSION:

Methods used in studies

Plot design. The studies were done at the Moxee farm (5-8 year old Bartlett trees). We had 4 blocks, each composed of an alfalfa cover crop plot (planted spring 2006) and a control grass plot (Figure 1). Plots were also established at 3 commercial organic orchards (Figure 2). Plots were each 0.3 to 0.5 acres in size. The alfalfa was planted in April 2008 as ½ meter wide strips down the centers of aisles. Movement and feeding studies were limited to the Moxee farm.

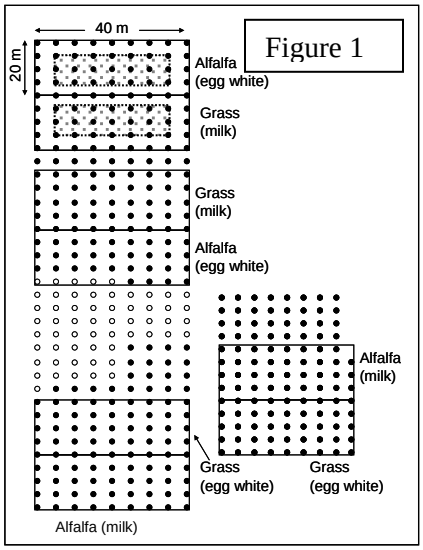


Figure 1

Psylla and predator densities. We monitored densities of prey and predators in trees and orchard understory. Pear psylla numbers were monitored with beat trays and leaf samples (eggs and nymphs). Predator numbers were assessed using beat trays (trees), sweep nets (understory), and sticky traps (Moxee only); the sticky traps were placed at two heights: 1 foot and mid-tree canopy.

Protein marker methods. At the Moxee site, cover crop and grass control plots were sprayed with a 10% liquid egg white solution or 20% whole milk solution, splitting the two markers so that both cover crop and grass control plots received both types of marker (see Figure 1); this design was chosen to overcome differences in marking efficiency of the egg and milk markers. The solutions were sprayed using a 25 gallon weed sprayer attached to an ATV, fitted with a 3 meter long boom having 7 flat fan tip nozzles.

Predators were collected from the tree by jarring limbs with a rubber hose, and trapping the dislodged insects on a section of cardboard that has been coated with a thin layer of tanglefoot. The predators were removed from the adhesive in the field using wooden toothpicks, and transferred singly into 1.5 ml microtubes. Similar methods were used to obtain arthropods from the ground covers, except that the vegetation was shaken over the top of the cardboard sheet. Marker presence was determined using ELISA (Jones); the same specimens are then to be assayed for presence of psylla proteins (Unruh).

Leaf nitrogen. Pear leaves were collected from control and cover crop plots for N-analysis.

Results and Discussion

Moxee site

Psylla and predator densities. Generalist predators in the tree canopy and orchard understory were dominated by true bugs, ladybird beetles, green lacewings, and spiders. Densities of predators in the orchard floor vegetation were several-fold higher in the alfalfa plots than the grass plots (Fig. 3). There was a significant presence all season of predators in the alfalfa cover crop, except immediately following mowing (Fig. 3). Tray counts of predators were, if anything, larger in the grass plots than the alfalfa plots (Fig. 4). Sticky trap catches of generalist predators are shown for canopy-height traps (Fig. 5, upper panel) and ground-level traps (Fig. 5, lower panel). Numbers of predators on traps were similar in the alfalfa and grass plots (Fig. 5). Trap catch was dominated by the true bugs and lacewings. Densities of adult psylla were statistically similar in grass and alfalfa plots (Fig. 6). Counts of psylla eggs and nymphs were also similar in grass and alfalfa plots (Fig. 7).

Marker results. Marker results are shown for the 2009, tree-collected specimens (Table 1); data from previous years and from the orchard floor specimens are still being analyzed. Results support the hypothesis that certain predatory taxa moved between orchard floor vegetation and the tree canopy. Lacewings may have been especially mobile. No striking differences were noted between alfalfa and grass plots.

Gut contents results. Specimens are still being assayed.

Leaf nitrogen. Pear leaves were collected from each plot on one date in both 2008 and 2009, and assayed for nitrogen content. Results suggest strongly that an alfalfa understory led to increased levels of nitrogen in the pear tree canopy (Fig. 8).

Commercial orchards

Counts of natural enemies and psylla were very low in all 3 orchards in 2009 (data not shown). Grower cooperators were updated with e-mail at regular intervals summarizing results of the sampling.

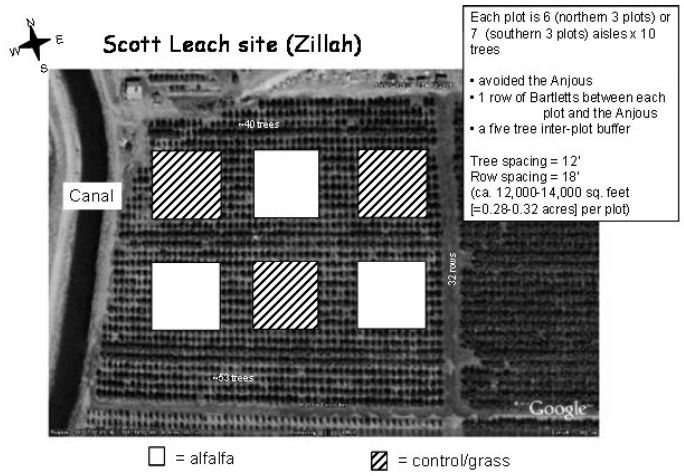
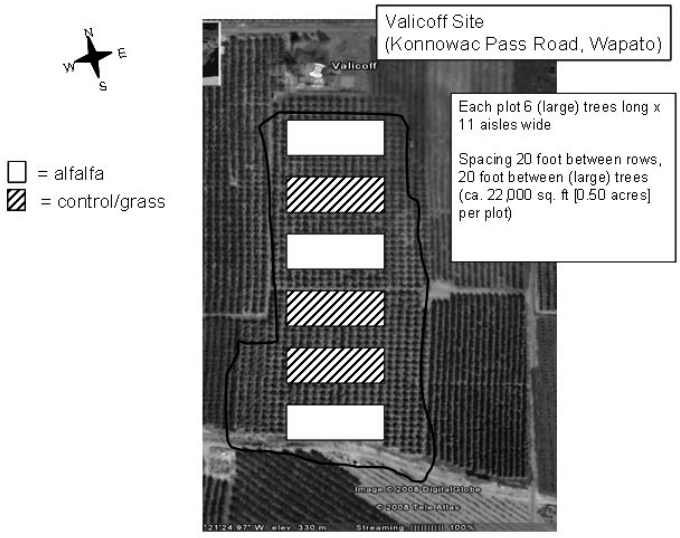
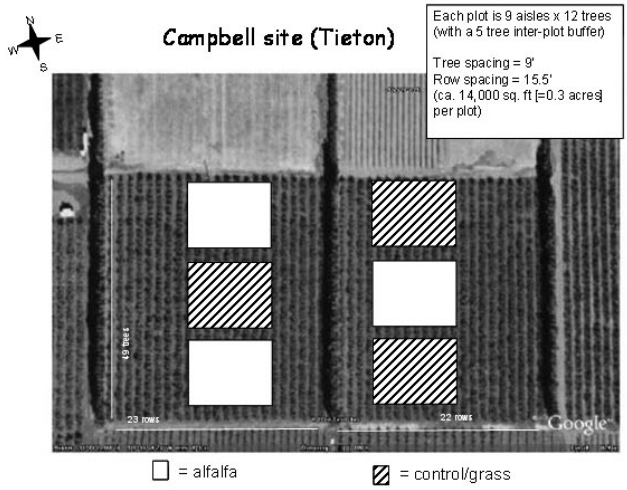


Figure 2. Plot design at each of 3 commercial organic orchards.





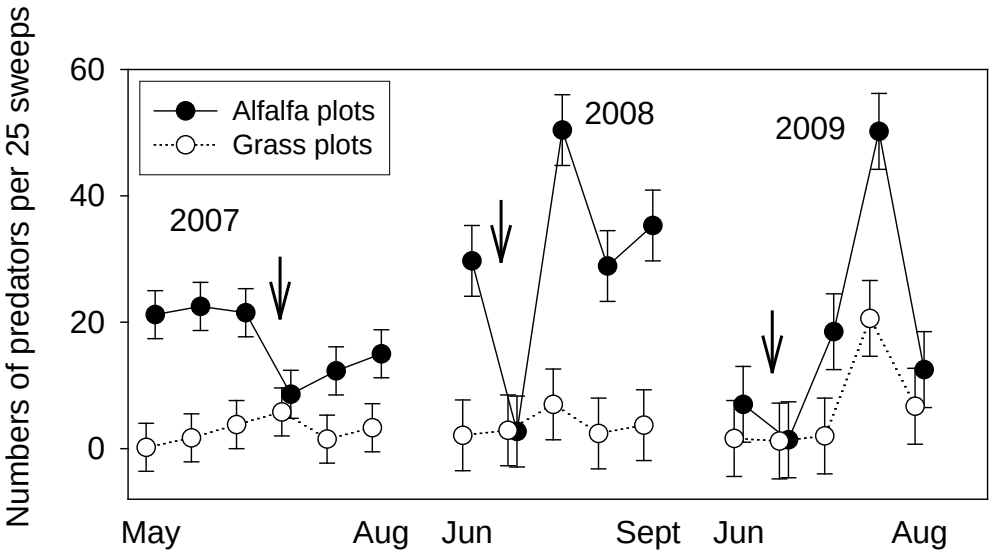


Figure 3. Predators per 25 sweeps

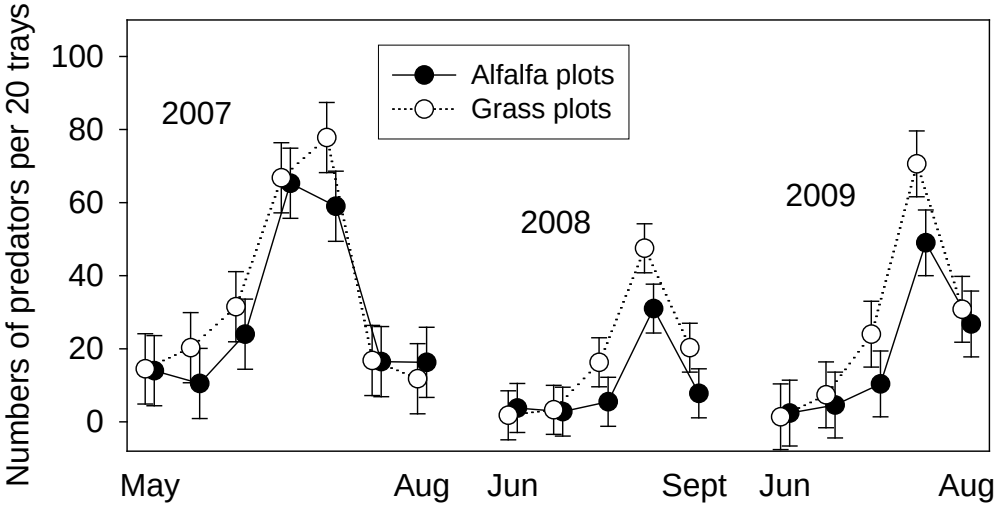


Figure 4. Predators per 20 trays

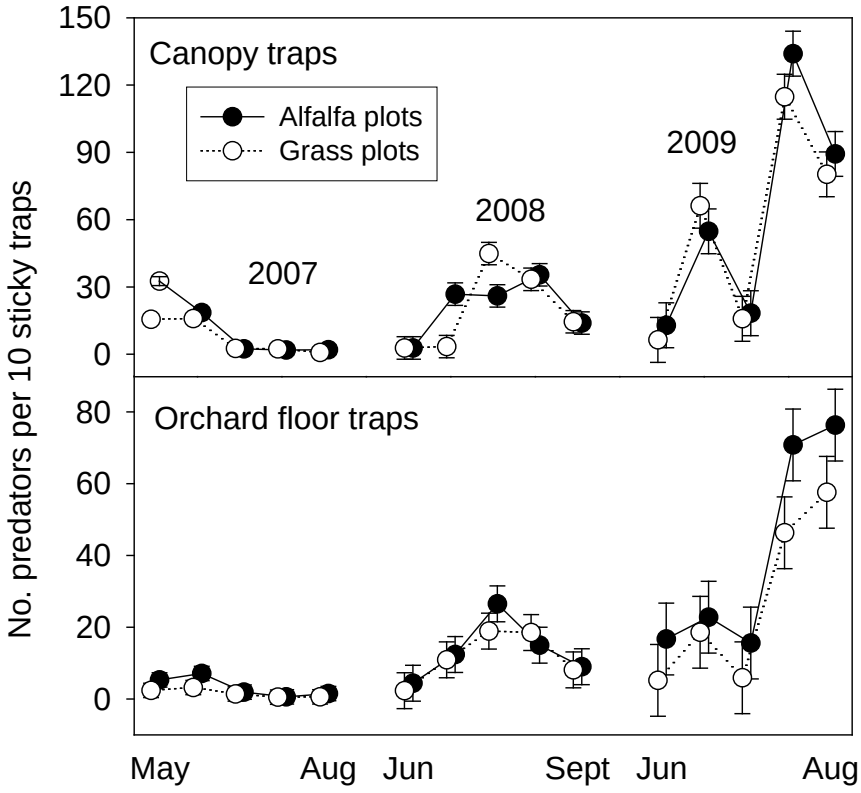


Figure 5. Predators per 10 sticky traps

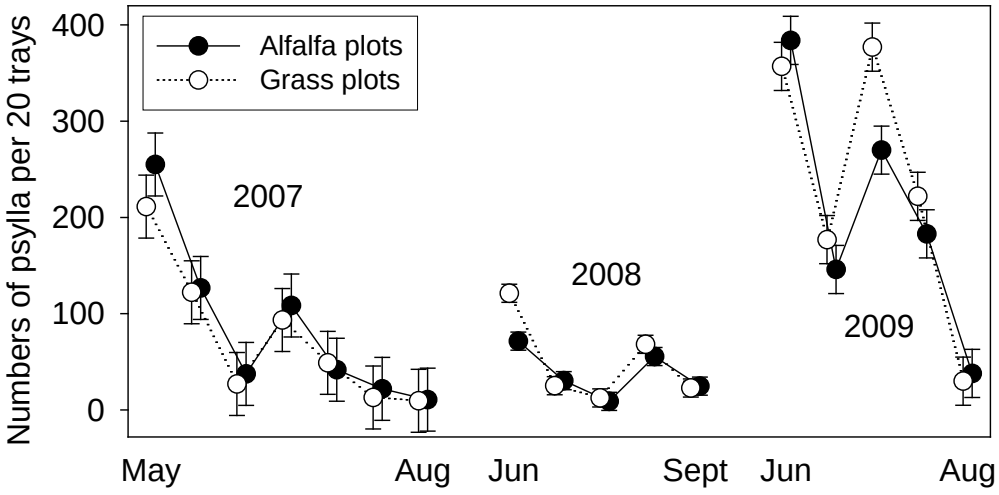


Figure 6. Adult psylla per 20 trays

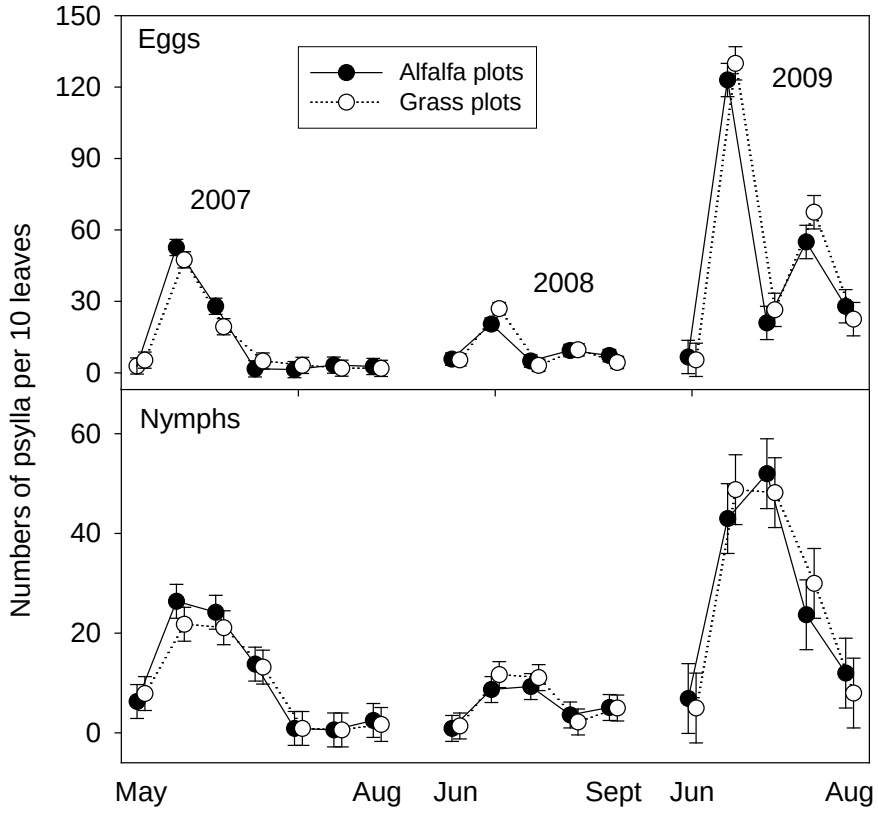


Figure 7. Immature psylla per 10 leaves

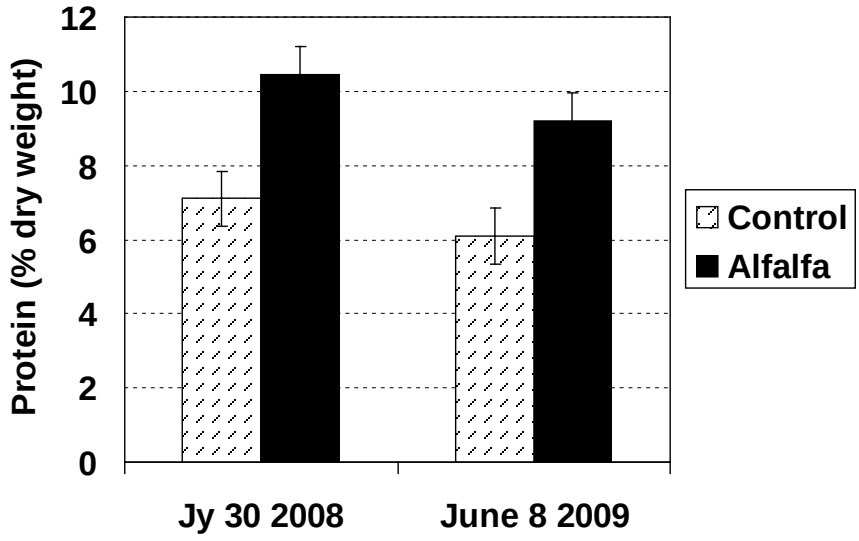


Figure 8. Nitrogen levels in pear leaves

Table 1. Number of marked / total (% marked) predators collected from tree canopy in alfalfa and control plots; summer 2009 data.

	June 2009			August 2009	
	Alfalfa	Control		Alfalfa	Control
TRUE BUGS					
Anthocoris	1/28 (3.6)	0/8 (0)		4/71 (5.6)	8/101 (7.9)
Deraeocoris	5/127 (3.9)	0/93 (0)		12/85 (14.1)	4/81 (4.9)
Orius	0/4 (0)	0/5 (0)		0/2 (0)	0/3 (0)
Nabis	--	--		1/1 (100)	--
TOTAL	**6/159 (3.8)**	**0/106 (0)**		**17/159 (10.7)**	**12/185 (6.5)**
LACEWINGS					
Hemerobius	0/1 (0)	0/1 (0)		0/1 (0)	--
Eremochrysa	4/31 (12.9)	5/23 (21.7)		18/48 (37.5)	5/16 (31.3)
C. plorabunda	6/17 (35.3)	1/17 (5.9)		5/35 (14.3)	5/14 (35.7)
C. nigricornis	1/1 (100)	0/3 (0)		5/23 (21.7)	0/3 (0)
C. coloradensis	0/1 (0)	1/10 (10.0)		--	--
TOTAL	**11/51 (21.6)**	**7/54 (13.0)**		**28/107 (26.2)**	**10/33 (30.3)**
LADYBIRD BEETLES					
Hippodamia	0/1 (0)	0/1 (0)		6/27 (22.2)	8/42 (19.0)
Stethorus	0/2 (0)	0/1 (0)		1/5 (20.0)	0/12 (0)
C. transversoguttata	--	0/1 (0)		--	--
Harmonia	--	--		2/6 (33.3)	3/17 (17.6)
Chilocorus	--	--		0/1 (0)	1/6 (16.7)
Hyperaspis	--	--		14/65 (21.5)	0/5 (0)
C. septempunctata	--	--		2/8 (25.0)	1/6 (16.7)
unknown	--	--		0/1 (0)	0/4 (0)
TOTAL	**0/3 (0)**	**0/3 (0)**		**25/113 (22.1)**	**13/102 (12.7)**
SPIDERS	**11/99 (11.1)**	**1/76 (1.3)**		**5/84 (5.9)**	**5/68 (7.4)**

FINAL PROJECT REPORT: EXECUTIVE SUMMARY
WTFRC Project Number: #PR-07-702

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Address: 5230 Konnowac Pass Road, Wapato, WA 98951

Outside Funding: $121,092 (Western SARE); $63,807 (CSANR)

Total Project Funding: $45,000
Budget History (Fresh Pear/Processed Pear Committees):

Item	**Year 1:** (2007)	**Year2:** (2008)	**Year 3:** (2009)
Salaries	$14,898	$15,773	
Benefits	$ 3,313	$ 2,178	
Wages	$ 4,500		
Benefits	$ 500		
Supplies	$ 1,789	$ 2,049	
Total	$25,000	$20,000	$0

SUMMARY
Effects of an alfalfa cover crop on biological control of pear psylla and tree nutrition was assessed. The bullet points below summarize findings.

Experimental Orchard (Moxee)

- substantial increase in predator densities on orchard floor associated with alfalfa cover crop
- no correlative effect on predator numbers in trees
- no effects of cover crop on psylla densities
- ca. 2% increase in pear leaf nitrogen in alfalfa plots
- evidence for movement between orchard floor and tree by some predator taxa (especially lacewings and ladybeetles), but no striking differences between cover crop and grass plots (data still being analyzed)
- gut contents of predators that moved from orchard floor to tree to be assessed using ELISA (specimens still being assayed)

Commercial Orchards

- Study expanded to 3 commercial organic orchard (SARE and CSANR funding)
- Minimal build-up of natural enemies in alfalfa, apparently due to frequent mowing
- Very low pest and predator densities in trees

Plans for 2010 (CSANR)

- Determine whether mowing of alfalfa prompts movement by natural enemies into tree

PUBLICATIONS
Horton, D.R., V.P. Jones, and T.R. Unruh. 2009. Use of a new immunomarking method to assess movement by generalist predators between a cover crop and tree canopy in a pear orchard. *American Entomologist* 55(#1): 49-56.