Project title: Development of areawide organic insect pest management in pear orchards

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Cooperators: Peshastin Creek Growers Association, Fieldmen, Blue Bird

Objectives:

1. Replace conventional pest management practices with organic practices.
   a. Organic insect pest management is the primary management strategy.
   b. Insect growth regulators (or other selective materials) are used where organic practices do not provide acceptable control.
2. Document the effects of different pest management strategies (organic, soft, conventional) on pest densities and crop damage.
3. Document the effects of different pest management strategies (organic, soft, conventional) on densities of natural enemy species.
4. Document costs of different pest management strategies (organic, soft, conventional) on costs of pest control programs.

Significant findings:

- Organic and soft pest management strategies worked very well on an areawide basis.
- Pear psylla management was very good.
- Spider mite and grape mealybug densities were low.
- Codling moth control was very good, despite significant pressure.
- Organic pest management is limited by the control of pear rust mite.
- Natural enemy populations did not increase significantly until late season.
- Costs were variable, and differences in programs were not statistically significant.
- Communication of monitoring data was increased via the web.
- Sampling frequency, area, and precision were increased.

Methods:

The project area comprises the pear orchards in the Peshastin Creek valley of central Washington State. Using GPS mapping we determined that, of the approximately 300 acres of tree fruit in the valley, 230 acres were actively sampled in the 2003 season. Sampling areas were identified in March with the input of the growers; each sample site was identified to correspond to actual management blocks rather than to areas arbitrarily defined by research. We established 41 sample sites, doubling both the sampling precision and the coverage over the same area as was sampled in 2002. A portable GPS unit was used to plot block boundaries, and GIS maps were used in conjunction with aerial photos during sampling.

Orchard management types were defined as Organic, which used certified Organic management practices; Soft, which used organic techniques when possible but allowed the use of IGRs and other selective pesticides; and Conventional, where organophosphates and other non-selective insecticides (e.g., Agri-Mek) were used. While Conventional orchards are not part of the Peshastin Creek

Areawide Organic Project, they are included in our research sampling for comparison. Of the acreage sampled, 56 acres were Conventional, 82 acres were Soft, and 91 acres were Organic.

Insect pest and natural enemy populations were monitored weekly. Sampling for adult pear psylla and predators began in late March as the psylla population began increasing due to migration from the surrounding vegetation into the orchard. Beating trays were used to sample adult psylla and natural enemies; 25-tray samples were made per sampling block, distributed throughout. Sampling for pear psylla eggs and nymphs, as well as other small pests such as twospotted spider mite, European red mite, pear rust mite and grape mealybug, was initiated in early April. During the first month of sampling, before foliar expansion, 10 fruit spurs were collected from each block and examined under magnification in the lab. Between 13 May and 5 June, 50 leaves from developing fruit spurs were collected from each block. Beginning on 11 June, summer sucker growth had progressed enough to allow two separate samples of 50 leaves to be collected from each block, one from shoots in the upper canopy and one from the lower canopy. Five leaves were pulled from each shoot to obtain a broad distribution of leaf ages: the basal, the terminal, and three mid-shoot leaves. All leaf samples were brought to the lab, and a leaf-brushing machine was used to brush insects and eggs onto a glass plate. Pests were counted over half the surface area of the plate, although rust mites were counted over 5% of the surface (13 squares of grid).

Codling moth monitoring began at the end of April. A delta trap with pheromone lure was hung in the upper third of a tree, one trap per block (average of one trap per 5.6 acre). In blocks where mating disruption was being used to manage the codling moth 10 mg lures were used, and 1 mg lures were used in those blocks not using mating disruption. Lures were changed initially every four weeks, and then every three weeks as temperatures increased. All traps were checked at least once per week. Temperature recorders were deployed at 12 locations through the valley. Temperature data were imported into a multi-pest degree-day calculator and used to estimate Codling Moth Degree-days.

Sampling for adult pear psylla, immature and small pests, and predators continued until harvest (the beginning of September), and codling moth was then monitored for an additional three weeks to ensure complete coverage of the flight (until 25 September). Fruit damage was assessed twice during the season, and pack-out records will be used to make a final evaluation of insect damage. In the first two damage evaluations we examined fruit for codling moth damage. Pack-out records will evaluate damage from other insects, as well as general fruit quality.

Codling moth damage evaluations were conducted each generation. For each sampling block, 50 trees were randomly chosen (border trees were excluded), and 10 fruits from the lower canopy and 10 fruits from the upper canopy of each tree were examined (1000 fruits sampled per block). The first damage evaluation was timed to fall between approximately 900 and 1100 codling moth degree-days, at which point first generation codling moth larvae were developing and damage was visible. The second codling moth damage evaluation was done immediately before harvest, when damage from the second generation was visible.

Results were analyzed by analysis of variance. Data were transformed to achieve normality using Box-Cox (x+1) transformations. Tests of mean separations were conducted using Fisher's Protected Least Squares Differences, both within sample dates and averaged over specific time periods (prebloom, first generation, etc.).

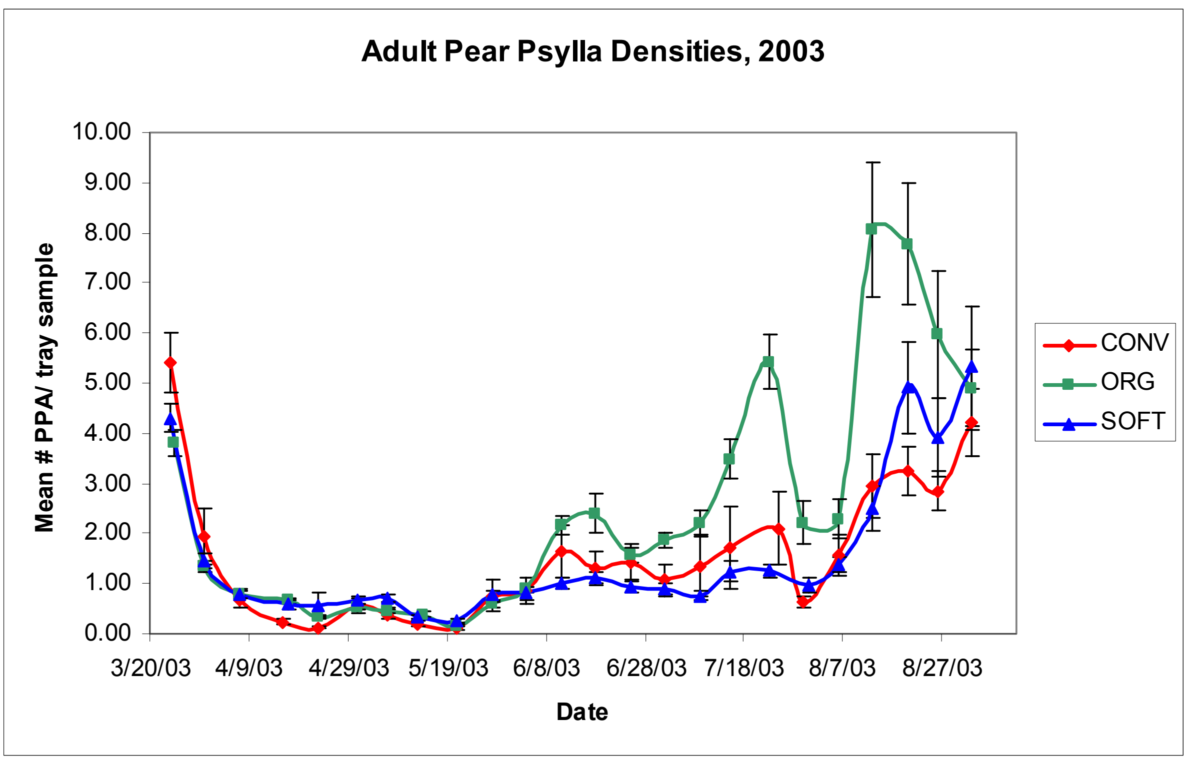
Project growers provided their spray records for the season after harvest. These records were used to verify the assignment of blocks into the three management categories. Cost per acre of the different management types was calculated using these spray records and standard industry pricing for insecticides. Programs were also analyzed in terms of the expenditure allocated to each of the main pests, pear psylla and codling moth, by dividing costs based on the primary target of each application.

To improve the communication between our lab and members of the Peshastin Creek Growers Association and to provide the growers with a timely monitoring service, a website was established (http://entomology.tfrec.wsu.edu/pearent/pcg%20home%20page.htm). Clickable maps (http://entomology.tfrec.wsu.edu/pearent/pcg%20map.htm) indicating the sampling areas were linked to charts showing pest monitoring information, which was updated weekly. Other information, including notes about the project, sampling, and management recommendations, was included. A bulletin board with the same information was installed in a central location in the project area, although the information was updated less frequently.

Results and discussion:

Results from the second year of implementation (first year as a funded project) of areawide organic and soft pest management were positive. Densities of pear psylla, historically the key pest in the Peshastin Creek area, were much lower in all three programs in 2003 relative to 2002. Over the entire 2003 season, there were significantly more pear psylla adults in Organic blocks than Conventional blocks, while Soft blocks were not significantly different from either. No differences occurred in the early or mid seasons, while psylla densities in the Organic were significantly higher than both Conventional and Soft in the late season.

Fig. 1. Adult pear psylla densities, 2003.



Densities of pear psylla nymphs were higher in the Soft blocks than Organic and Conventional blocks in the early season. There were no significant differences for nymphs mid-season, while the Organic had significantly more nymphs than the Soft program in late season, although neither was different from Conventional blocks.. No differences in egg densities occurred throughout the season.

Fig. 2. Pear psylla nymph densities, 2003. a. early season;

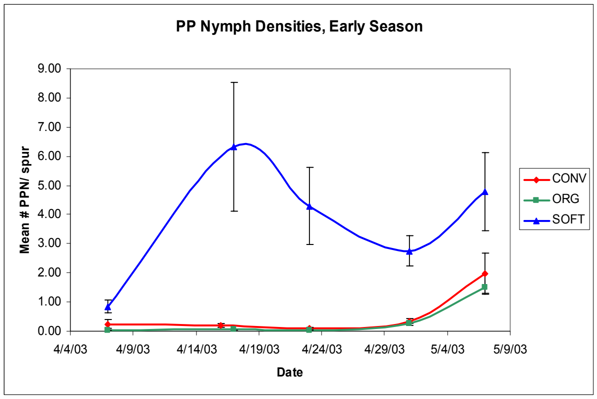


Fig. 2.b. midseason;

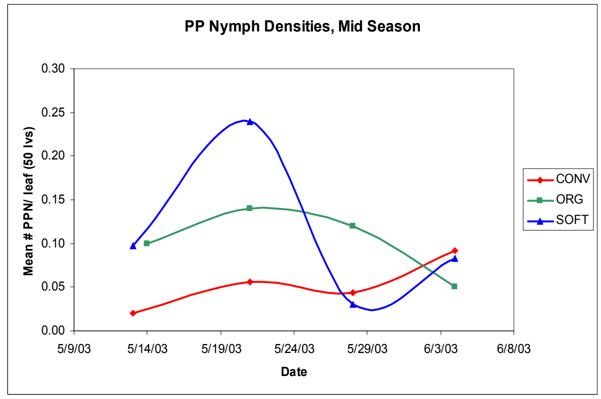


Fig. 2. c. late season.

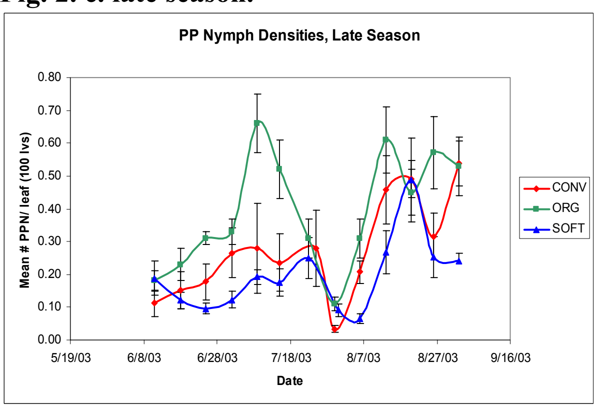
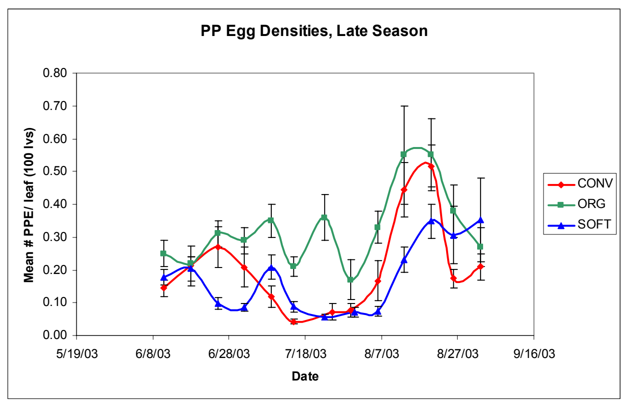


Fig. 3. Pear psylla egg densities, late season 2003.



While codling moth pressure was higher than expected, control was successful throughout the project. The codling moth trap catch for the overwintering generation (first flight) was extremely variable within the project, with the cumulative catch for the flight ranging from 0 to 310 moths per block. Damage from codling moth was very low in the first generation, even in blocks with very high trap catch; control was provided primarily by spinosad (Entrust) and granulosis virus (Cyd-X), in combination with mating disruption. Because of the excellent control, those blocks with high first flight trap catch saw greatly reduced second flight. Two blocks, one Organic and one Conventional, did have significant damage at harvest. The Organic block did not use adequate management tactics in either generation, leading to the damage. The Conventional block with 3% fruit injury was involved in a test using sprayable fibers for mating disruption, which may have interfered with the ability of the traps (10X) to adequately monitor the codling moth population. However, no statistical differences in damage occurred between programs.

Fig. 4. Codling moth trap capture for 1st and 2nd generations, 2003.

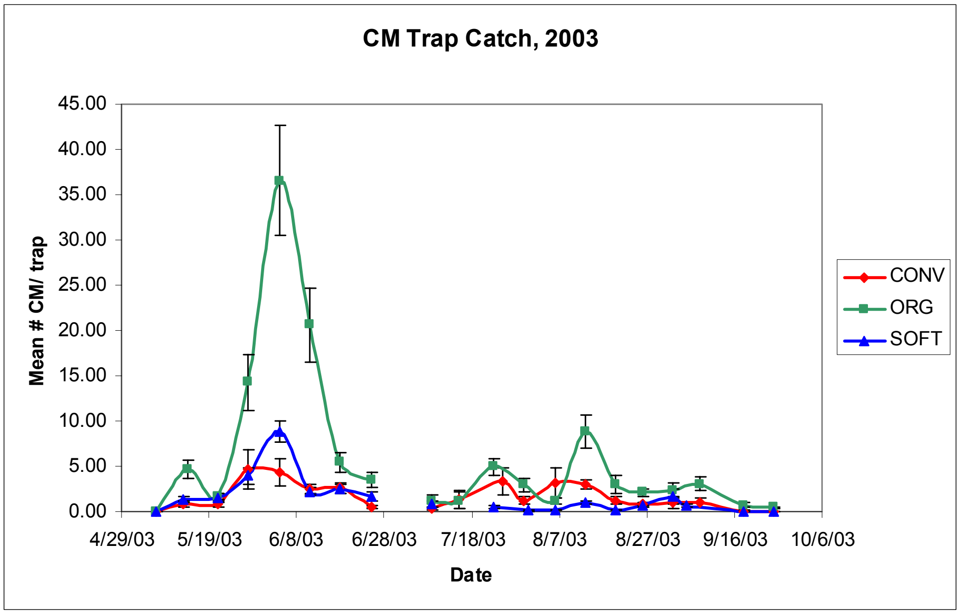


Fig. 5. Codling moth damage from 1st and 2nd generations (1000 fruits/block), 2003.

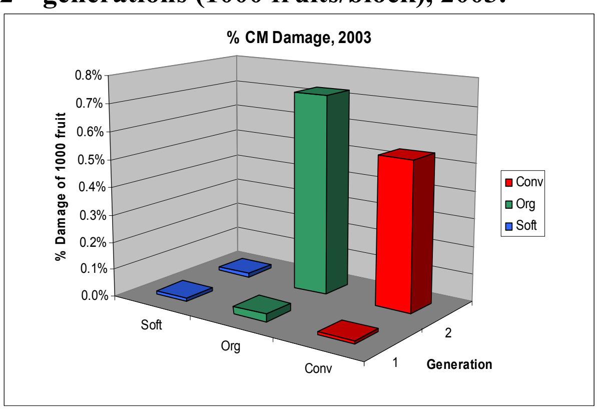
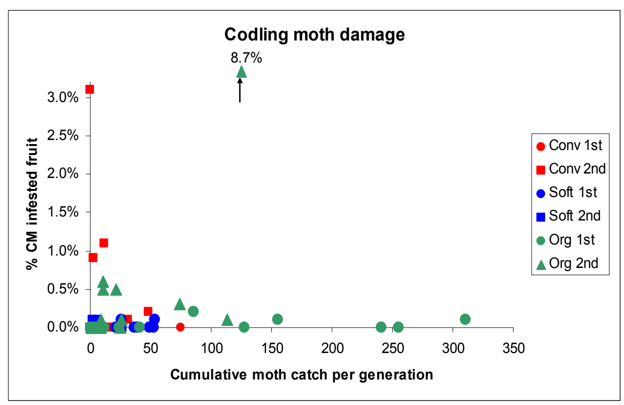


Fig. 6. The relationship between codling moth trap catch (for each program and for each generation) and codling moth fruit infestation.



Twospotted spider mite densities were very low throughout the Peshastin Creek Valley, and they did not become a problem. Grape mealybug was also very low in 2003. Pear rust mite was problematic in the Organic and Soft programs; however, there were no differences between management types. In the late season, pear rust mite increased in both Organic and Soft programs. One Organic orchard (three sample blocks) did sustain economic pear rust mite damage throughout the block; the grower had been unable to apply adequate prebloom control measures (sulfur). This orchard will not be organic in 2004, demonstrating both the potential for long-term economic damage from this pest, and the need for organic growers to be vigilant in managing it.

Fig. 7. Densities of twospotted spider mite from leaf samples, late season 2003.

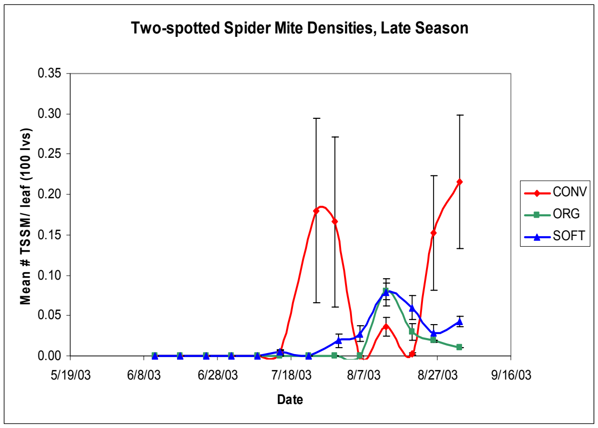
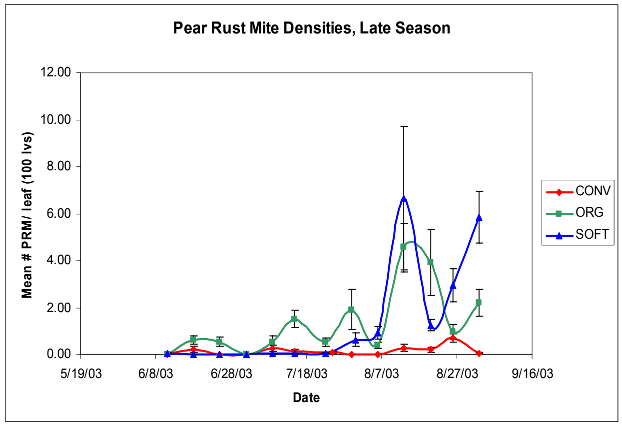
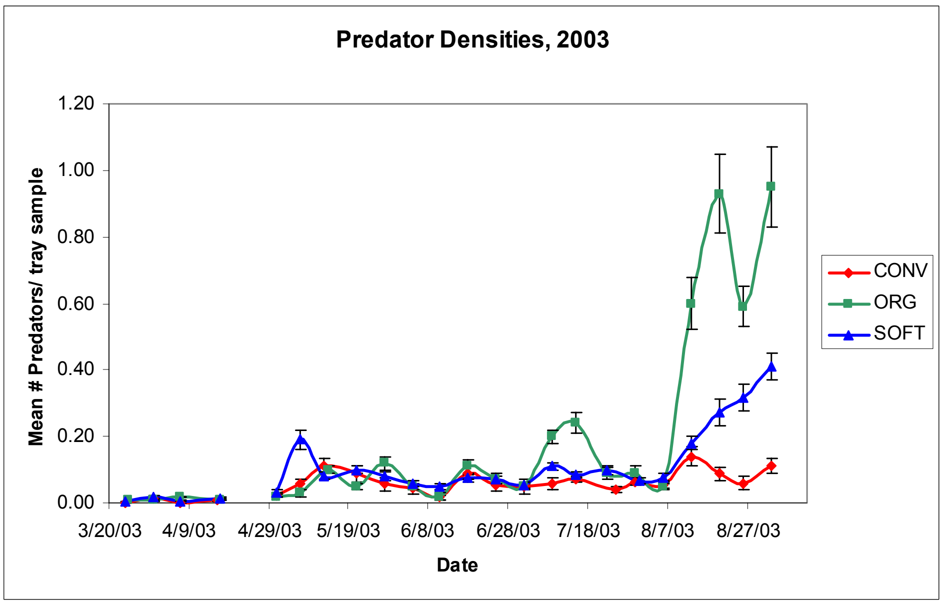


Fig. 8. Densities of pear rust mite from leaf samples, late season 2003.



Predatory insect densities were low throughout the season in the Conventional program. Densities were also low in the Soft and Organic blocks; however, there was a significant increase in late season predator populations. This increase followed the late season increase in pear psylla in those programs.

Fig. 9. Densities of predatory insects, 2003.



For 2002, there were no significant differences between program costs (p=0.74), due to the variation in pest management expenses within programs. There were again no differences for 2003 costs (p=0.49), although in general the organic programs did spend more than in 2002 (likely due to the increased codling moth pressure and the use of spinosad). Organic blocks allocated significantly more of the total spray cost to codling moth control than either Soft or Conventional, and less to pear psylla control.

Fig. 10. Mean cost per acre for insect pest control materials, 2003.

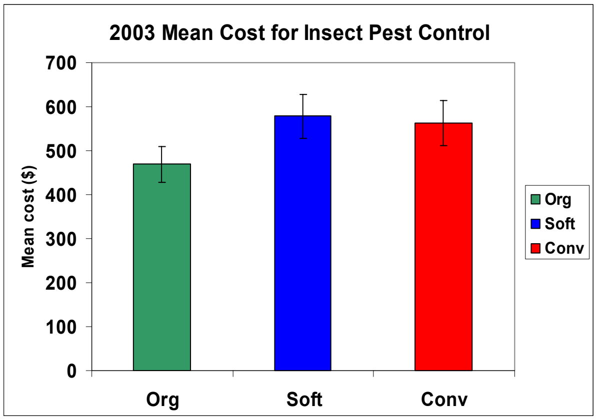


Fig. 11. Distribution of cost per acre for insect pest control materials, 2003.

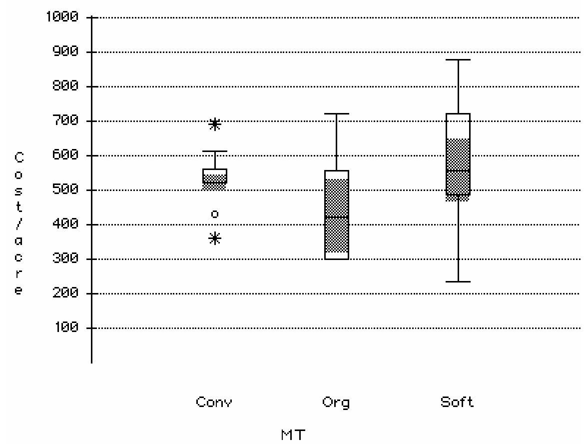


Fig. 12. Mean cost per acre allocated to the two main pests, pear psylla and codling moth, 2003.

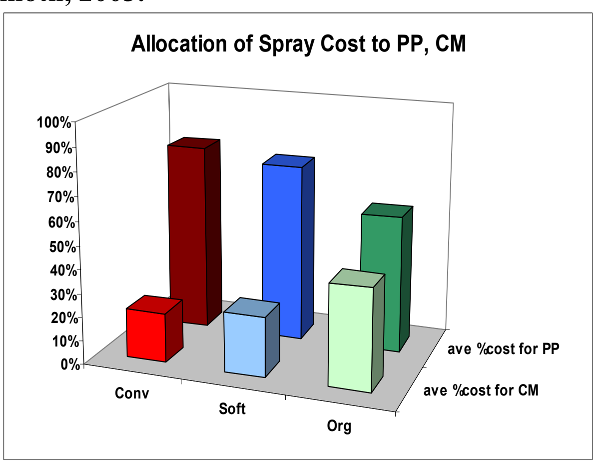


Fig. 13. Distribution of cost per acre for insect pest control materials, 2003.

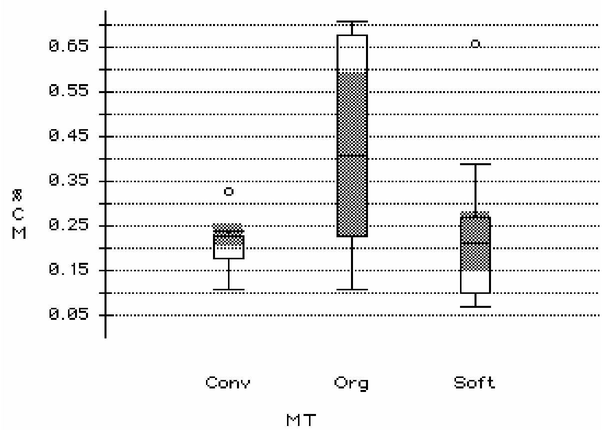


Table 1. Spray programs used in 2003.

Name	% of blocks using MD			
	Conv	Soft	Org	All
3msprayable	40%	0%	6%	12%
Nomate	10%	100%	100%	76%
	average # apps per acre			
Avaunt	0.36	0.52	0.00	0.27
Cyd-x	0.00	0.00	1.46	0.58
Entrust	0.00	0.04	1.74	0.71
Guthion	0.47	0.00	0.00	0.12
Imidan	0.39	0.00	0.00	0.10
Intrepid	0.42	1.83	0.00	0.76
Lorsban	0.52	0.00	0.00	0.13
	Conv	Soft	Org	All
Oil	6.87	7.31	8.09	7.51
Actara	0.30	0.13	0.00	0.12
Agri-mek	1.50	0.19	0.00	0.43
Assail	0.96	0.38	0.00	0.37
Azadirachtin	0.35	3.54	1.67	2.02
Carzol	0.28	0.69	0.00	0.31
Esteem	0.50	1.62	0.00	0.70
Sulfur	0.13	0.31	2.48	1.13
Surround	2.78	1.71	1.90	2.05
Thiodan	0.61	0.51	0.00	0.33
Acramite	0.72	0.12	0.00	0.22
Dipel	0.00	0.00	0.78	0.31

The use of the internet for communicating monitoring results and recommendations worked very well. This method proved particularly effective in giving areawide results and was favored over the bulletin board. In particular, timely communication of trap catch and degree-day accumulations allowed for better application of codling moth controls. Nevertheless, the bulletin board will remain at the Peshastin Creek Growers Association, for both ease of access and public information and education.

In summary, the implementation of organic and near-organic pest management on an areawide basis has been successful, relative to conventional programs, for two years. While pests can be controlled using available chemical tools (with perhaps the exception of pear rust mites), an increase in biological control has not yet been observed. The late season increase in predators seen in Organic blocks may be an indicator that biocontrol may take several years to establish. Alternatively, the correlation with pear psylla increase this year may mean that next year the predators will again decrease as pear psylla is controlled in the early season. Further study is necessary to address this critical issue.