Project title: Biological control in areawide organic and "super-soft" pear orchards

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Objectives:
1. Examine the effects of endemic biocontrol in areawide organic pear pest management using direct measurements by exclusion and inclusion cages.
2. Examine the effects of endemic biocontrol in areawide organic pear pest management using indirect measurements for determining predator densities.
3. Determine the potential natural enemies in vegetation surrounding the areawide organic pear project.

Significant findings:
- The cumulative totals of predators collected from Conventional, Soft or Organic environments (orchard plus surrounding vegetation) were not significantly different.
- Significantly more biocontrol agents were present in native vegetation adjacent to orchards than in orchards themselves.
  - Organic orchards had significantly more natural enemies in surrounding vegetation, followed by Soft orchards, then Conventional.
- Significantly more natural enemies occurred 5 m into Soft orchards than into Conventional orchards, with Organic orchards intermediate.
  - No differences occurred 25 m and 50 m into the orchards.
- Natural enemy densities increased in the late season in all orchard programs.
  - Increase was greatest in Organic orchards.
  - Increase was correlated to an increase in pear psylla densities.

Methods:
To monitor predator densities in pear orchards and surrounding vegetation and examine biological control of pear orchard pests, nine transects were established in the Peshastin Creek valley in central Washington State. Three transects each were established using pear orchards under Organic, Soft, and Conventional type management. Conventional orchards had no restrictions on insecticides used, Soft orchards used primarily organic materials and insect growth regulators for pest management, and Organic orchards were certified organic and thus strictly limited to organic insecticides. Each transect was 75 m long, extending 25 m into the surrounding vegetation from the first orchard row and 50 m into the orchard. Sampling points in the native vegetation were located at 10 m and 25 m from the 0 point (the orchard edge), and into the orchard at 5 m, 25 m and 50 m. Where access roads or canals separated native vegetation from the orchard margin, the 10-m sample point was adjusted into the nearest vegetation. The 5-m point in the orchard was located at the second row of trees, between 4 m and 7 m from the border depending on orchard spacing.

Insect (pest and predator) samples were collected weekly by beating tray method from each transect point. Sampling began in late April and continued into September, with the final two samples at two and three-week intervals. Beginning with the 12 June sample, all insects from the vegetation, and all unknown insects from the orchard, were collected and brought to the lab for identification. Sampling was conducted at night at two sites.

Exclusion cages were used to determine direct predation of sentinel prey by natural enemies. Exclusion sleeve cages were constructed of 125-count silkscreen cloth to prevent predation of sentinel pear psylla in control treatments along transects; sentinel prey exposed to predation served as the experimental treatment. Several techniques were examined in a WSU-TFREC experimental orchard to validate the methods before placing them in the Peshastin Creek Areawide Organic Project; subsequently, trials were established at four of the nine transects in the project area. For sentinel pear psylla, pear shoots infested by pear psylla were collected from the TFREC experimental orchard and were trimmed into sections with one to three leaves. Under 20x magnification in the lab, we removed pear psylla eggs and nymphs to leave a population of only ten nymphs. The remaining nymphs were all between the first and third instars. The proximal ends of the resulting shoots were placed in small floral tubes with water. Small vials affixed to pear tree limbs held the floral tubes in the canopy (1.5 m high on a main scaffold) at each of the sample points in the orchard, and three-foot stakes with wire hoops on them held the cages suspended in the vegetation at points in the surrounding vegetation. Four repetitions of paired shoots—caged (excluding predators) and open (allowing predation)—were arrayed at each sample point. For open cages, the cloth sleeve cage was affixed adjacent to the shoot. After one to four days in the field the shoots and cages were brought back to the lab and psylla nymphs were re-counted.

Sentinel prey were also established using clean pear leaves from greenhouse cuttings, which were artificially infested either by hand-transferring psylla nymphs from orchard shoots or by inoculating with psylla eggs by caging females with the shoots. These shoots were caged and placed in the orchards in the same way as the naturally infested shoots.

Sitotroga eggs, a commonly used food for rearing predatory insects in the lab, were also tested as substitutes for pear psylla in later trials. Frozen Sitotroga eggs were purchased from Rincon-Vitova, Visalia, CA. A dilute 1:10 solution of mucilage was used to glue 20 flash-frozen eggs onto 1.5 x 4.5 cm tags of card stock. The cards were then caged and deployed in the same manner as the shoots.

Results and discussion:

In a preliminary analysis of data (i.e. only known specimens or generic categories e.g. wasp included in data) from the first year of monitoring along transects some differences were found, as expected. The mean densities of predators on entire transects over the season were not significantly different between programs (Fig. 1). Within-season variation in predator density influenced this variation; great fluctuations in density occurred through the 18 weeks of sampling, with particular increases in density late in the season (Fig 2).

Fig. 1. Mean total density of predators on transects in three different pest management programs over the 2003 season.

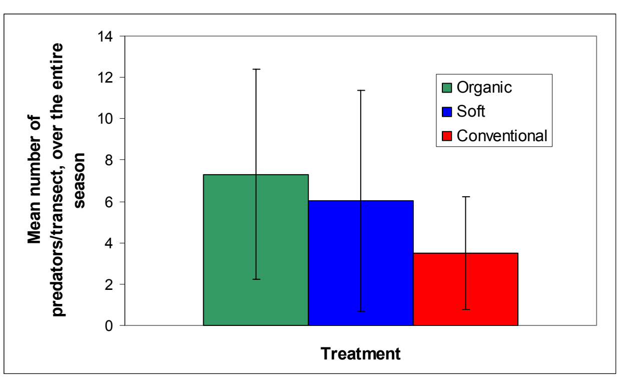
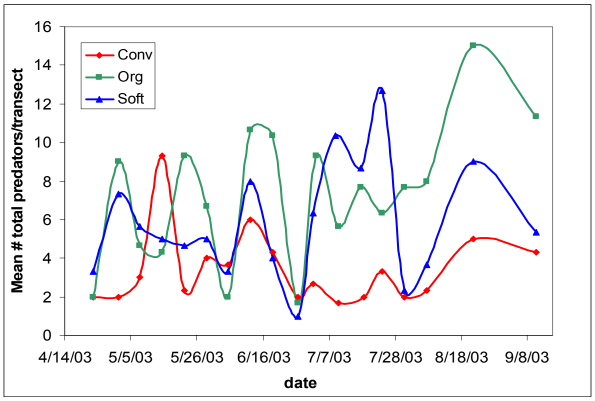


Fig. 2. Mean weekly density of predators along transects in three different pest management programs.



Location along the transect also had a significant effect on predator densities (Fig 3). Predator densities were highest in surrounding vegetation. For Organic orchards, predator populations were higher 25 m into the surrounding habitat than the other programs and did not decrease 10 m from the orchard border. Alternatively, the predator populations in vegetation surrounding Conventional orchards were reduced compared to Organic and declined in the samples closer to the orchards. Soft orchards were found to have a trend intermediate to the Organic and Conventional orchards. The mean densities of predators at sample points in the surrounding vegetation were all significantly different, with highest densities in vegetation adjoining Organic blocks and lowest densities outside Conventional blocks. The diversity of vegetation types in the adjoining landscape my contribute to the variation in predator densities between transects.

Predator populations within the orchards were on average higher in Soft programs than Conventional programs. However, on a point by point basis only the 5 m point showed a significant difference in predator densities, and an analysis of individual transects shows only a single transect to have within-orchard predator densities significantly different from other transects. This was a Soft transect and had higher predator densities in the orchard than all others.

Fig. 3. Mean density of predators at five locations on transect in three different pest management programs. Transects originate 25 m outside of orchards and terminate 50 m into orchards.

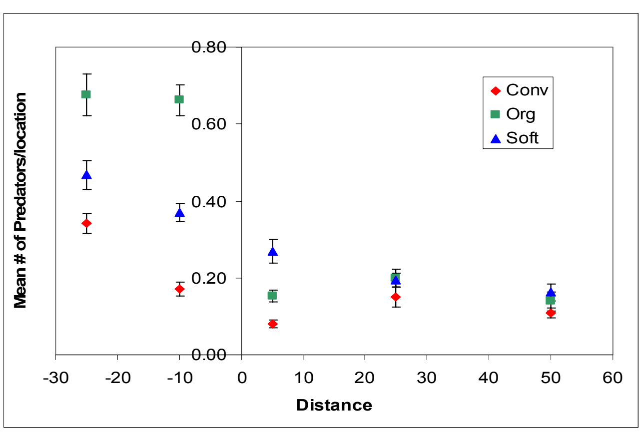
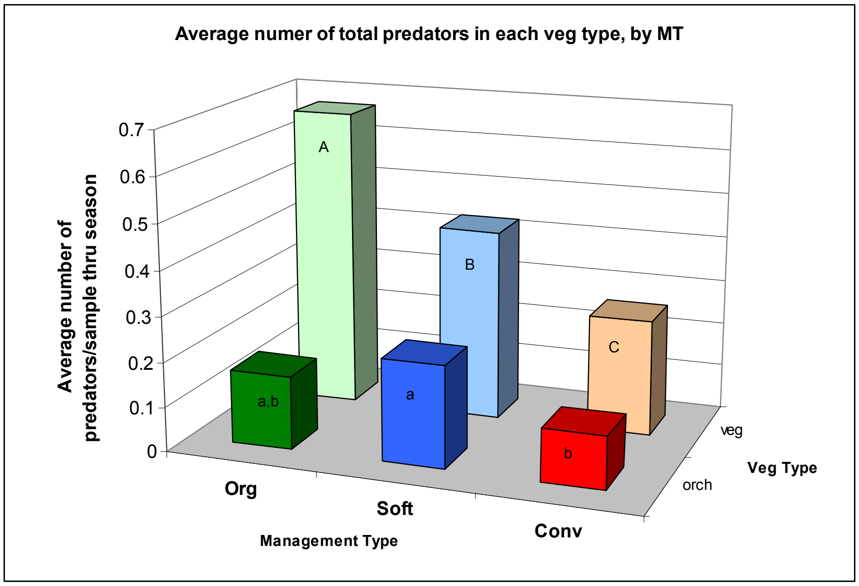


Fig 4. Mean density of predators in orchard and surrounding vegetation under three different pest management programs.



Because this experiment takes place within the Peshastin Creek Areawide Organic Project, comparisons can be made with predator densities, sampled weekly from 41 sites (17 Organic, 19 Soft, and 5 Conventional) within the region. Fluctuations in predator densities were moderated when observed over the entire region, and the increase in predator densities in the late season is quite marked (Fig. 5). The late-season increase was greatest in the Organic blocks, but there were also increases in Soft blocks. Pear psylla densities also rose at this time (Fig. 6).

Fig. 5. Predator densities in the Peshastin Creek Areawide Organic Project, 2003.

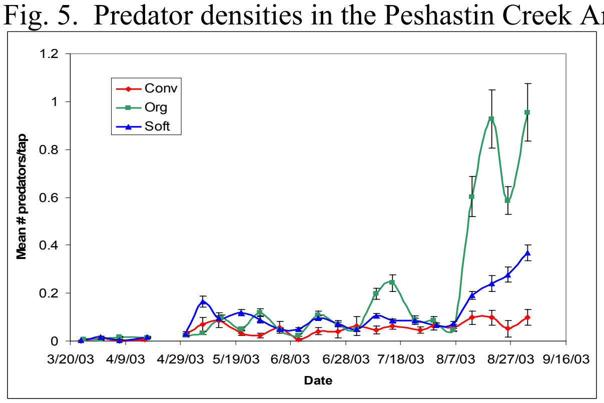
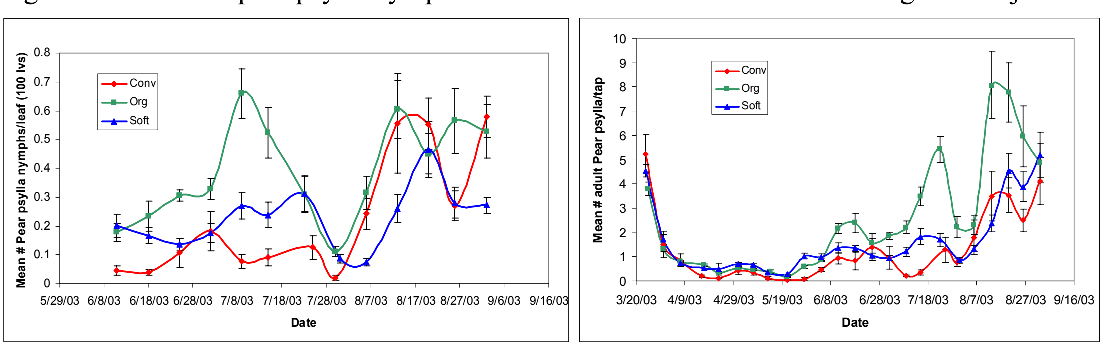


Fig. 6. Densities of pear psylla nymphs and adults in the Peshastin Creek Organic Project.



Results from the sentinel prey trials were preliminary and were used to develop the methodologies that will be used in 2004. Several limitations to the technique were identified, and the methods were modified to overcome them. For example, several time periods of exposure to predation were examined for using pear psylla nymphs on shoots. Even a short time period is difficult during hot weather; the shoots quickly dehydrate, and the nymphs leave the leaves or die. Shoots with nymphs will be used only in the early season in 2004, along with Sitotroga eggs. The relationship between predation on pear psylla nymphs and on Sitotroga eggs will then be examined, and the Sitotroga eggs will possibly be used as surrogate prey. This comparison will also be conducted in the early season using *Deraeocoris brevis* and *Campylomma verbasci* in the laboratory, in both no choice and choice tests. Orchard irrigation and unexpected cloudbursts also caused problems with exclusion cage trials.

The monitoring along transects will be continued at the same sites in 2004. Additionally, the sentinel prey (both pear psylla nymphs and Sitotroga eggs) will be placed at the sampling distances along transects. The presence and impact of biological control will be better quantified following a second year of study.