2. Implementation

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Codling moth, *Cydia pomonella* L., Apple

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This was the initial year of a 3-5 year SARE (Sustainable Agriculture Research & Education) project investigating the "Production of Apples Without the Input of Broad-spectrum Insecticides". The purpose of this study is to directly compare the ecology and economics of red delicious apple orchards managed without using broad-spectrum insecticides or managed conventionally. Demonstration orchards were established at six locations, three in northcentral Washington (Bridgeport, Chelan, Orondo), two in the Yakima Valley (Wapato, Yakima) and one in Oregon (The Dalles). Each orchard was divided into a 10-acre conventional (CONV) block and a 10-acre no broad-spectrum insecticide (NBSI) block. In addition, a no class I (NOC1) management program was evaluated in a third 10-acre block at the Bridgeport, Orondo and Wapato sites.

Arthropod pests and natural enemies: Pheromones (mating disruption) replaced insecticides as the primary control for codling moth (CM) in the NBSI blocks. Isomate-C+, was applied at the full label rate of 400 dispensers per acre (d/a). This treatment alone was as effective as conventional azinphosmethyl sprays at two sites. Relatively high CM pressure at four sites necessitated supplementing the NBSI pheromone treatment with two other "soft" controls, mineral oil and parasitoid releases. Trichogramma wasps were released bi-weekly (ca. 100,000 adults/acre) along the highest pressure border at each site. The combination of pheromone, oil and biological control successfully controlled CM at two sites, but populations of this pest increased in abundance at the other two sites and over 4% of the fruits were infested. However, adjacent blocks treated with four conventional organophosphate insecticide sprays also had over 1.5% fruit injury at harvest. Most of the CM damage in NBSI blocks was found along the orchard edge. Currently, this appears to be the Achilles heel of the CM mating disruption program, as there are no "soft" strategies available to control this pest when populations become established on orchard borders.

Leafrollers are considered the greatest potential problem in selectively managed orchards in the first years of transition to less reliance on broad-spectrum insecticides. Good control of this pest was achieved in all CONV blocks through the use of broad-spectrum insecticides. This included a delayed dormant application of chlorpyriphos for control of aphids, mites, scale and leafroller, and multiple in-season azinphosmethyl sprays for CM control. In contrast, leafrollers established populations in four of the six NBSI blocks. Summer generation larvae had infested up to 15% of the shoots by August, and failure to detect increasing leafroller populations earlier in the summer resulted in the application of too few bacterial insecticide (*Bacillus thuringiensis* or *Bt*) treatments to prevent damage. Two or more *Bt* sprays did limit leafroller fruit injury to less than 2% in three blocks. Unfortunately *Bt* was not applied at one site, and 8.9% leafroller injury was observed in harvest samples.

Other arthropod pests were generally at low levels in the NBSI orchards. Substantial numbers of campylomma nymphs were detected at the Chelan site (4.3 nymphs per tray).

Since this was above the treatment threshold, the orchard was treated with Neemix 4.5 at a rate of 7 oz. per 100 gal. (200 gal./acre). Post-treatment beating tray samples indicated a 50% reduction in campylomma densities. Natural enemies contributed to the suppression of several potential pests. Mite and aphid predators, and the leafminer parasitoid, *Pnigalio flavipes*, were especially abundant in NBSI blocks. Three pest species, white apple leafhopper, green apple aphid and tentiform leafminer, reached population densities that required intervention with insecticides in at least one of the CONV orchards. No controls were targeted specifically for these pests in NBSI blocks. However, oils applied as a supplemental control for codling moth in NBSI blocks had the additional benefit of suppressing leafhopper and leafminer populations without affecting their natural enemies.

Development or demonstration of new monitoring techniques: Pheromone traps were used to monitor leafroller adults throughout the season in all SARE blocks. Traps were highly attractive, often capturing over 50 moths per week. However, the number of moths captured did not correlate well with larval densities and fruit injury. High moth catches occurred in orchards with no detectable resident population, and low moth catches did not always indicate low levels of larval activity. Thus, we initiated studies this year that hopefully will lead to the development of a better leafroller pheromone trapping system. Preliminary results indicate that reducing the attractiveness of lures is a useful first step toward achieving this goal.

Pheromone traps may also be useful for monitoring campylomma populations. Pherocon 1CP traps baited with lures containing the sex pheromone of campylomma were placed in all SARE blocks at a density of 1 trap/2.5 acres. Traps were checked weekly over a 7-week period beginning in mid-August. Fall adult capture in traps may provide a good prediction of campylomma nymph densities during bloom of the following year, especially in blocks where they are not controlled by a post-bloom application of chlorpyriphos. Adult captures of more than 80/trap were recorded in NBSI blocks at two sites (Chelan, Yakima). Adult captures of about 40/week have been correlated with damaging nymph densities the following spring (Reding, personal communication).

Arthropod biodiversity: Two methods are being used to document broader changes in arthropod biodiversity during the course of this project. Sweep net samples of the orchard ground cover and soil samples were taken once in August of 1994 and three times during the 1995 season. To date, 1400 soil and sweep net samples have been collected in SARE blocks. We have run through a berlese and identified specimens in 520 soil samples but have 180 remaining from the August 1995 collection date. We have also identified to family specimens collected in 360 sweep net samples. Our preliminary data suggest that conventional pest management practices have suppressed soil fauna quantity, but no clear changes in biodiversity are evident. It is too early to speculate on differences in our sweep net samples because our baseline data is from August 1994 and we have yet to process our August sample from 1995. We have identified 87 separate families, mostly representing 8 orders of insects and mites.

Economics: Detailed records of management inputs have been kept for each pair of NBSI and CONV orchards and will be used to compare the economic risks and benefits of these two management programs. Most of the fruit harvested from SARE orchards are in storage, thus yield and cullage information required for economic analysis will not be available until fruit is packed this winter and in the spring of 1996.