Biological Control

Epigeal Predators in SARE Orchard Sites

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Keywords: epigeal predators, SARE, ground beetle, spider, harvestmen, earwig, centipede, apple

The focus of this study was to determine the effects of broad-spectrum, neural-active insecticides on ground dwelling predatory arthropods of Pacific Northwest apple agroecosystems. It has been postulated that regular applications of these insecticides suppress populations of beneficial arthropods in many crops. Study organisms include ground beetles (Coleoptera: Carabidae), spiders (Aranae), harvestmen (Opiliones), earwigs (Dermaptera: Forficulidae), and centipedes (Chilopoda).

Pitfall traps were set in six apple orchards containing Red Delicious plantings, five in Washington (Bridgeport, Chelan, Orondo, and two in Yakima), and one in The Dalles, Oregon. Each orchard site was divided into two, ten-acre designated blocks, one managed conventionally with broad-spectrum, neural-active insecticides (C blocks), and one a pheromone-based pest management block managed without the use of these insecticides (N blocks). Six pitfall traps per block were placed within the tree row, at the base of trees located in the center row of the block. Eight-ounce plastic cups with a 7 cm diameter were set in polyvinyl chloride (PVC) irrigation pipe buried vertically in the ground, so that the top of the cup was level with the ground surface. Approximately 50 milliliters of propylene glycol based antifreeze was used in each cup as a preservative. Plywood roofs measuring 20 cm x 20 cm were suspended 4 cm above the traps by eight-penny nails hammered into the four comers. Traps were collected every three weeks. A total of four collections was made in 1996, from 9 July through 13 September. Nine collections were completed for 1997, from 11 April through 13 September. Collected organisms were identified in the laboratory.

The absence of broad-spectrum insecticides in the pheromone mating disruption blocks allowed for rapid increases in the populations of epigeal, generalist, mobile predators. Spraying of broad-spectrum insecticides ceased in the pheromone blocks after 1994, and pitfall trapping began in June 1996.

Statistical analysis of the collection data for both 1996 and 1997 was computed as a randomized complete block design with repeated measures [ANOVA]. Results for 1996 showed that treatment effect was significant for carabids (F value = 16.79, PR>F = 0.0094) and spiders (F value = 8.10, PR>F =0.0360). Earwigs, harvestmen, and chilopods all showed a tendency toward statistical significance for treatment effect.

Results for 1997 once again showed that treatment effect was significant for carabids (F value = 11.35, PR>F = 0.0199), and for Chilopods (F value = 17.25, PR>F =0.0089), but not for spiders (F value = 1.41, PR>F = 0.2882). Earwigs were notable but not significant for treatment (F value = 5.02, PR>F = 0.0752). Opiliones did not test significant.

Carabids were consistently trapped in higher numbers in the N blocks (pheromone) of all orchards for both 1996 and 1997. Twenty-three species of Carabidae were identified from the 1996 collection, six have been reported as codling moth predators. The identifications for 1997 are ongoing. *Pterostichus melanarius* was the most often trapped species in both 1996 and 1997. Both Riddick (1994) and Hagley (1988) identified *Pterostichus* spp. as the most promising carabid predators of codling moth. Feeding studies conducted recently at WSU verify that at least two carabid species *(Pterostichus melanarius* and *Harpalus pensylvanicus)* can locate and destroy the overwintering cocoon of codling moth. *Harpalus pensylvanicus* has also been found in high numbers in our study orchards. Carabid predation of the larvae as they search for overwintering sites, and even after they have spun a hibernaculum, can decrease the numbers of first generation adults emerging into the orchard in the spring.

Spiders, which were found in significantly higher numbers in N blocks in 1996, were not significantly higher in N blocks in 1997. Free hunting wolf spiders in the N blocks, though, were collected at more than double the rate collected in the C blocks for 1997. Free hunting spiders are more apt to have an impact on overwintering codling moth populations than web spinning spiders.

Harvestmen, chilopods, and earwigs also were consistently trapped in greater quantities in N blocks for all collections in both 1996 and 1997. Harvestmen are generalist predators known to feed on aphids. They are also predators of the eggs and early instars of the Colorado potato beetle (Coleoptera: Chrysomelidae), which may indicate an ability to feed on orchard lepidopteran larvae as well. Centipedes are also generalist predators that use powerful venoms in capturing larger prey, such as lepidopteran larvae. Large populations of chilopods may also aid in reducing the population of emerging, first generation codling moth. Controversy exists over the role of earwigs in orchard systems. Carrol and Hoyt (1984) found that European earwigs, *Forficula auricularia,* played a role in controlling apple aphids on nonbearing apple trees, but in a follow-up study Carrol and Hoyt (1985) found that these earwigs failed to control aphid population growth on bearing apple trees. Questions also exist as to whether or not earwigs damage apple fruit. Carrol and Hoyt (1985) determined that, where earwigs had alternative food sources, apple damage was minimal.

Populations of less mobile invertebrates did not appear to be affected by insecticide treatments. Slugs and snails were collected in higher quantities in C blocks for both 1996 and 1997. Mites and aphids were also collected in higher quantities in C blocks in 1996. Total collections of these organisms were not calculated for 1997.

One explanation for the decrease in mobile organisms in C blocks is that more mobile organisms contact more poison through their continuous movement. This may result in higher mortality rates. A second explanation is that these more mobile organisms disperse more readily to surrounding habitats after insecticide applications. A possible explanation for the higher presence of less mobile organisms in the C blocks could be the decreased presence of predators.