Pome Fruits—Pesticide Resistance

Detection and Characterization of Resistance to Pesticides in Codling Moth in Oregon

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No field failure of azinphosmethyl had been noticed in controlling codling moth from Oregon until 1989. However, in a study conducted by Moffitt et al. during 1986 to 1987, a codling moth population from Medford has been reported resistant to diflubenzuron. It was suspected that selection by other commonly used compounds was probably responsible for this resistance. We initiated our work in 1987 to determine the levels of resistance in different populations of codling moth from Oregon to azinphosmethyl and other commonly used insecticides.

Resistance to Azinphosmethyl

A resistance survey conducted to evaluate the susceptibility of azinphosmethyl during 1989 had detected a low levels of resistance (4- to 5-fold) in codling moth from Oregon. The LD_{50} values of most susceptible (Saint Cloud [SC]) and most resistant (Crippens [CR]) populations were 0.038 and 0.163 µg AI/moth, respectively, using the pheromone trap methods described by Riedl. Similarly exposing first instar larvae to the residue in gelatin capsule mounted on apples showed LC_{50} values of 2.85 and 16.37 ppm for SC and CR strains, respectively.

This study was conducted in three geographically different regions of Oregon—Hood River Valley, Rogue River Valley, and Willamette Valley. The orchards included in the study had varied management practices. From each region efforts were made to include an orchard with no or low pesticide pressure and another set of orchards with a high pesticide pressure. From regions where orchards with high pesticide pressure were not available, an orchard bordering with high pesticide pressure site was selected. Because of large variability in the published data (ca. 10-fold for larvae and adults), we felt that it was essential to standardize the bioassay procedures before comparing susceptibility among strains. Some of the important variables considered were posttreatment holding period, posttreatment holding temperature, age of insects, formulations, and selecting a reference strain from an abandoned orchard.

Comparing with susceptible (SC) strain, 4-, 3.75-, and 3.25-fold difference was observed in Crippens (CR), Medford (MD), and Kiger Islands (KI) strains in field bioassays, respectively. These differences were significant at P-value 0.05 and show that codling moth population had developed low levels of resistance to azinphosmethyl in different areas of Oregon. By using larval bioassay with insecticide residue on apples, only CR and MD strains showed significantly higher LC_{50} values than reference strain. MD strain did not differ significantly within region from other population (Hanley strain). In larval topical application bioassay the maximum tolerance was shown by CR strain followed by MD, KI, Hanley, Corvallis and SC strains. In

adult topical bioassay on isolated male and female moths, CR and MD populations responded similarly, showing 4- to 5-fold difference in LD_{50} values over reference (SC) strain. This study showed no regional pattern of resistance in codling moth. The difference in susceptibility of azinphosmethyl was resulting from individual orchards.

Cross Resistance

Significantly higher LD_{50} values (2- to 3-fold) were obtained in CR strain than SC for diazinon and fenvalerate in topical application method on male and female moths. There was no significant difference for carbaryl and endosulfan. Larval topical bioassays showed significant difference only to diazinon. KI strain showed 3- to 4-fold higher LD_{50} values than Corvallis strains in both adult and larval bioassays. Because of few points for correlation analysis, it is difficult to establish a correlation of azinphosmethyl resistance with any of these compounds. However, this study suggests some level of cross resistance exists between azinphosmethyl and diazinon and perhaps fenvalerate. Both LD_{50} and LD_{90} values showed similar patterns.

Resistance To Diflubenzuron

To evaluate the susceptibility of diflubenzuron, methods described by Moffitt et al. (1988) were used with some modifications. Residues of diflubenzuron on immature apples were exposed to ovipositing female moths in order to evaluate subsequent response of egg hatch, larval entries, pupation and adult emergence. There was no significantly different sublethal effect on pupae and adults compared to untreated apples. Egg hatching and first instar larval entries showed a maximum of 2-fold difference among populations compared to the reference strain. This study showed a strong relationship (r=0.8 to 0.9) between the susceptibility of azinphosmethyl and diflubenzuron by codling moth. Continuous selection pressure of diflubenzuron in laboratory at a concentration of 112.3 ppm on six generations of codling moth had decreased the susceptibility by 5-fold.

Pesticides mentioned in this report:

azinphosmethyl	Guthion
carbaryl	Sevin
endosulfan	Thiodan
diazinon	Diazinon
diflubenzuron	Dimilin
fenvalerate	Pydrin