

Resistance Management

The OP-MD connection in effectively managing codling moth

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Abstract: The organophosphate insecticide azinphosmethyl (Guthion) has been the backbone of our management program for codling moth (CM) for more than 40 years. Despite documentation of elevated tolerance to this insecticide in the early 1990s in WA and other western states, this insecticide continues to be widely used. Concurrent with the rapid adoption of sex pheromones for mating disruption (MD) the use of Guthion remained an important supplemental tool to manage CM. More recently as the population density of CM in many of our orchards has dramatically increased, the use of Guthion has remained strong. Use of Guthion has recently increased in Europe following the development of high levels of resistance to synthetic pyrethroids (SP) and some insect growth regulators (IGR). Cross-resistance in CM populations exposed to long-term use of Guthion has been reported to a range of other new and old insecticides that are its possible replacements. Certainly, the legacy of 40 years of Guthion use in WA orchards will be significant in the development of future pest management programs.

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Genetic selection for resistance to Guthion has been reported to include a range of pleiotropic effects that can reduce the fitness of the resistant individuals. These costs can impact fecundity, developmental rates, longevity, pupal and adult weight, and the pheromone communication system. These potential impacts may significantly interact with the successful use of MD and our ability to further reduce the use of insecticides to manage CM.

Fecundity for insecticide-resistant CM populations has been reported to be 35-50% lower compared with susceptible populations. Similar data are also published for the oriental fruit moth and several tortricid leafrollers. This reduced fecundity may have been the cause of the fairly rapid decline in resistance detected in our field-collected population when removed from Guthion exposure (population reverted to susceptible after 5 generations; similar data reported from CA). The relative success of MD against CM populations that vary 2-fold in fecundity could be significant. Rapid adoption of MD in WA following the detection of resistance in 1992-93 and the gradual decline in the use of Guthion during the next five years may have impacted levels of resistance and the fecundity of field populations. Hypothetically, the anecdotal assessment that the effectiveness of MD has recently declined could have been impacted by a gradual increase in the fecundity of more Guthion-susceptible moths.

The developmental rates for IGR- and SP-resistant CM have been shown in France to be slower relative to susceptible moths. Resistant moths begin post-diapause development later and develop more slowly than susceptible moths. Reports of the Washington CM model failing to predict the occurrence of late peaks in the first flight and the second flight have increased in

recent years. The flight curves for CM populations monitored at the USDA and WSU experimental research farms appear to fit the current model. These populations are susceptible to Guthion. In contrast, many field populations are mixtures of susceptible and resistant individuals, and this mixture could contribute to greater variation in the timing of emergence and the shape of the flight curves.

Studies with the IGR- and SP-resistant CM in France have shown that the pheromone communication system of these populations is identical to the pheromone communication systems of susceptible populations. In contrast, several studies have found that the obliquebanded leafroller pheromone communicational system has been influenced by the selection for Guthion resistance. Resistant moths had decreased pheromone production and a delayed periodicity of pheromone release.

Another potential interaction of Guthion use and management of CM with MD may involve hormoligosis, stimulation of moths by exposure to low chemical residues. In a Swiss study, CM exposed to a 1/10th field rate of Guthion exhibited increased mating and egg laying during the subsequent 48 h compared with untreated moths. We have duplicated these findings in our lab this winter. In addition, the Swiss found that exposure of CM to low residue levels of Guthion increased moth movement in restricted containers. We have found that Guthion is a repellent for CM neonates, and it is possible that the observed increase in adult movement could lead to greater emigration rates of moths out of Guthion-treated orchards. Hypothetically, orchards adjacent to MD-treated orchards supplemented with one to two Guthion covers during the season could be exporting moths with enhanced levels of egg laying. Our studies this winter have shown that hormoligosis is enhanced following a brief exposure to Guthion and then transfer of the moths to a residue-free container.

Objectives for 2003.

1. Re-survey CM populations within WA for resistance to Guthion.
2. Examine patterns of potential cross-resistance to Intrepid and Assail.
3. Correlate the fecundity of field-collected CM populations with their response to Guthion.
4. Examine the timing of spring emergence and larval development for CM populations with variable levels of Guthion resistance.
5. Examine the pheromone titer, blend ratio, and sexual behavior of populations with variable levels of resistance to Guthion.
6. Examine the influence of hormoligosis on CM fecundity and dispersal capability.