

Mating Disruption/SIR

Codling moth behavior—our last and best chance to understand MD

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Abstract: The use of sex pheromones to disrupt mating (MD) of codling moth (CM) has been rapidly adopted since 1991, and its use now includes 60% of the tree fruit acreage in WA. A large number of studies have been conducted in my laboratory during the past 10 years to examine how MD works in an effort to improve its effectiveness. Our major findings have included demonstrations that dispensers need to be placed in the tops of trees to be most effective, demonstrating the success of monitoring orchards with high-load pheromone lures placed in the tops of trees away from dispensers and near the borders of orchards, the relative importance of dispenser density and emission rate on the level of disruption, the importance of false-trail following versus habituation as the major mechanism for MD, revealing that most CM females in MD orchards are mated but that multiple mating of females during the second flight are significantly reduced, demonstrating that delay of mating under MD is an important mechanism affecting population growth of CM, showing that the three component pheromone blend is not more effective than using the single major component, codlemone, and that dispensers emitting a blend of codlemone and its three geometrical isomers are more effective than similar dispensers emitting codlemone in shutting down male catch by virgin female-baited traps.

Report

The regional population levels of CM have increased 10-fold in the past few years as the tree fruit industry in WA has undergone a major restructuring. The general perception appears to be that MD will not be able to effectively manage CM as their population densities continue to increase without a concurrent increase in the use of supplemental sprays. Timely improvements in the use of sex pheromones for MD could prevent a reversion back to increased insecticide use. Three research approaches are suggested: further understanding of how sex pheromone treatments impact CM populations, comparative evaluations of different MD approaches, and more extensive field testing of an improved pheromone blend for MD.

Impact of Sex Pheromone Treatments on CM Populations. It was suggested that the mechanism of mass trapping CM tested in the 1970s was due to the extensive removal of a high proportion of male moths by traps that caused significant reductions in the deposition of viable eggs when depleted males mated with females. Multiple-mated males transfer smaller spermatophores and this has been reported to cause a decrease in egg laying and an increase in infertility. However, conflicting studies have disagreed on whether male depletion is an important factor limiting population growth of CM. Greater understanding of the role of male depletion in the use of the pheromone-based attracticide would be useful. Also, this information could be very useful in examining whether the high mating rates of females under current MD

programs could be due to the occurrence of multiple mating by a small proportion of the male population (super males). Conversely, scant data are available on the effect on fecundity and egg fertility of females mating more than once. Preliminary data collected this fall has suggested that females that mate 2-3 times exhibit an increase in fecundity and production of viable eggs. This could be another important mechanism impacting the use of MD because our field data have shown that the proportion of multiple-mated females is significantly lower in MD versus untreated orchards during the second moth flight.

Comparative Evaluations of Different MD Approaches. The development of technologies that utilize CM's sex pheromone to manage populations has followed several paths. Currently, the application of hand-applied dispensers is the most common approach, but other techniques include spray applications of micro-encapsulated sex pheromone, deployment of widely separated grids of aerosol emitters and passive dispenser clusters, and the use of sex pheromone formulated with insecticide to kill male moths has been registered and adopted. Since 1994 my laboratory has shown that nearly all female moths are mated in orchards treated with hand-applied dispensers. However, these data have largely been collected from orchards treated with 200 dispensers per acre. There has not been a strong relationship between the proportion of mated females and the population density of moths across orchards treated with 200 dispensers, e.g., mating has varied from 0 to 100% in orchards where only a few female moths were captured. Data on the mating success of field populations in orchards treated with puffers, sprayables, and attracticide have not been reported or extensively measured. A comparative study of CM mating success under the full range of sex pheromone-based approaches available to growers would be a useful study. The DA lure allows the mating status of female CM to be easily examined.

Field Testing of an Improved Pheromone Blend for MD. Studies funded by WTFRC were conducted in 1994, 1996, 1998, and 1999 to examine in replicated small plots the efficacy of using codlemone + isomers to disrupt sexual communication by CM. Studies in 1994 and 1999 found that codlemone + isomers provided a significantly better disruption of virgin female-baited traps than dispensers emitting codlemone alone. These studies supported the earlier work by McDonough and co-workers that suggested MD could be enhanced with codlemone + isomers. Our studies in 1996 and 1998 reported that no significant difference occurred between these two treatments. Since 1999, five scientific papers have been published from Europe that have re-examined the complete sex pheromone blend of CM and have specifically examined the role of the codlemone isomers. These data have elucidated specific behavioral roles for the isomers and together help to explain how MD could be enhanced with the use of the isomers. The relative weak efficacy of the current dispensers makes expanded testing of a potential improved blend more urgent.

Objectives for 2003.

1. Examine the effect on fecundity and fertility of multiple matings by both females and males.
2. Examine the mating status of CM populations in replicated orchards treated with 200 to 400 Isomate C+ dispensers per acre, 0.25 to 1.0 Suterra Puffers per acre, 1.6 to 4.0 Pheromone Mops per acre, 600 to 1200 drops of Last Call™ per acre, and 2.0 to 10.0 g A.I. sprayable codlemone per acre.

3. Examine the efficacy of dispensers emitting codlemone + isomers versus codlemone in replicated 10-20 acre plots.