Mating Disruption/SIR

Predicting the success of mating disruption

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Abstract: Examining the many successes and failures of mating disruption reveals that there is a great deal of variability in the susceptibility of species to this control tactic. For some species, such as redbanded leafroller and oriental fruit moth, treatment with pheromone alone is often sufficient to mitigate crop damage. Other pests, such as the codling moth and certain leafrollers, appear to be more "difficult" to control using only mating disruption. Over the past few years we have been conducting studies to determine the factors that may allow the more resilient species to operate in environments permeated with synthetic pheromone. It appears that there are fundamental differences in the capacities of species to become adapted and/or habituated when exposed to high doses of synthetic pheromone. In addition, pheromones vary considerably with respect to rates of evaporation, dispersion in air, and adsorption onto solid surfaces. Collectively, differences in these physico-chemical properties can have profound effects on the longevity and movement of pheromones in the environment. Finally, it is well known that species differ in their dispersal and reproductive capabilities. We propose that it is these basic differences in the properties of moths and their pheromone that make some species highly susceptible to mating disruption, while others are capable of averting the effects of this control technique.

Report

Examining the many successes and failures of mating disruption reveals that there is a great deal of variability in the susceptibility of species to this control tactic. For some species, such as peachtree borer, redbanded leafroller, and oriental fruit moth, treatment with pheromone alone is often sufficient to mitigate crop damage. Complete or nearly complete trap shutdown is consistently achieved, even when fairly low rates of pheromone are used, for these "easy" to disrupt species. In addition, the level of disorientation to traps and suppression of larvae appears to be independent of pest pressure. Other pests, such as the codling moth and certain leafrollers, appear to be more "difficult" to control using only mating disruption. Very high levels of trap shutdown for these species are the exception rather than the rule. Doubling or tripling the rate of deployment does not significantly improve the level of inhibition of moth captures. Also, the level of disorientation to traps and suppression of the larval population appears to be highly related to population density.

If indeed some species are highly amenable to disruption and others are not, what are the factors that allow the more resilient species to operate in environments permeated with synthetic pheromone? It appears that there are fundamental differences in the capacities of species to become adapted and/or habituated when exposed to high doses of synthetic pheromone. Certain lepidopteran species, such as the obliquebanded leafroller (OBLR), are physiologically capable

of decreasing their sensitivity to pheromone for an extended period of time following pheromone exposure, while other species, such as the redbanded leafroller (RBLR), do not exhibit a capacity for this long-lasting form of adaptation (Fig. 1). We speculate that under pheromone mating disruption regimes, long-lasting adaptation may confer an advantage to moth species such as OBLR relative to species such as RBLR. In addition, species differ in their dispersal and reproductive capabilities. Finally, pheromones vary considerably with respect to rates of evaporation, dispersion in air, and adsorption onto solid surfaces. Pheromone evaporation rates from dispensers vary widely with molecular weight. After given molecules do evaporate, the degree to which they partition or stick onto foliage as they are dispersed by wind again depends on their molecular properties, as well as such factors as temperature, wind velocity, and foliage density. The stickiness of pheromones deployed into crops to achieve mating disruption can be expected to vary as a function of compound molecular weight and functional group (Fig. 2). Collectively, differences in these physico-chemical properties can have profound effects on the longevity and movement of pheromones in the environment. We propose that it is these basic differences in the properties of moths and their pheromone that make some species highly susceptible to mating disruption, while others are capable of averting the effects of this control technique (Fig. 3).

Implementing a pheromone-based management program for a pest that has been identified as easy to disrupt improves the chances for success, but it certainly does not ensure that control will be achieved or that it will be economical. The success of mating disruption in the field or orchard depends on cost-effective delivery of the active ingredient. To achieve this requires addressing the many factors or conditions, other than the moth and its pheromone, that impact a mating disruption program. We propose that, in practice, it is this set of conditions that determines the level of difficulty in meeting requirements for successful disruption of a particular pest species (Fig. 3). Operational requirements for successful mating disruption broadly include technical considerations, such as pheromone delivery strategies, crop management considerations, and characteristics of the site, including initial pest density.

References Cited

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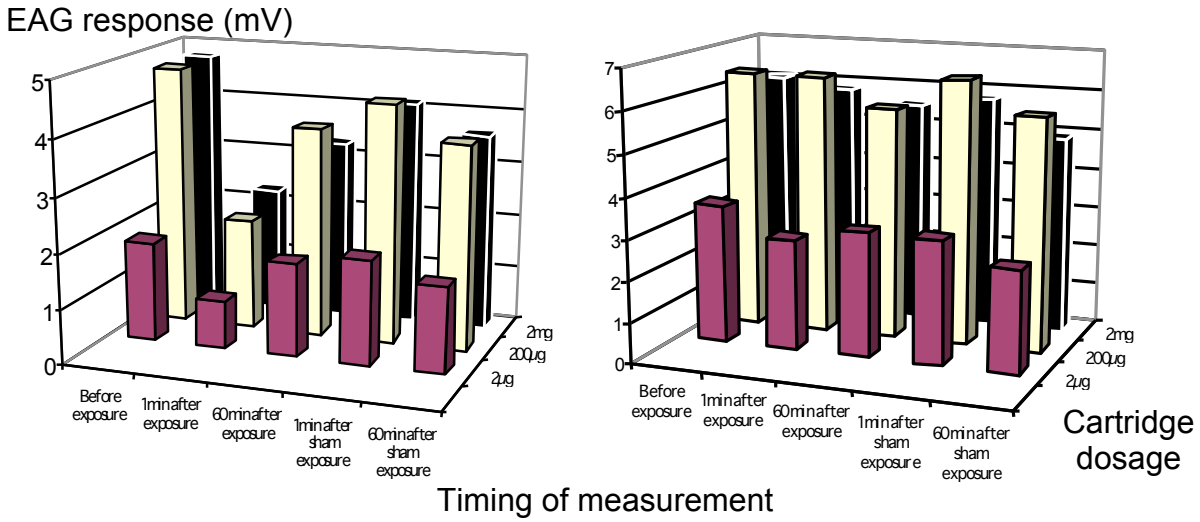

Figure 1. Peripheral response obliquebanded leafroller (left) and redbanded leafroller (lower) to pheromone as measured by EAG following 60 min exposure to high pheromone concentrations (From Stelinski et al., 2003).

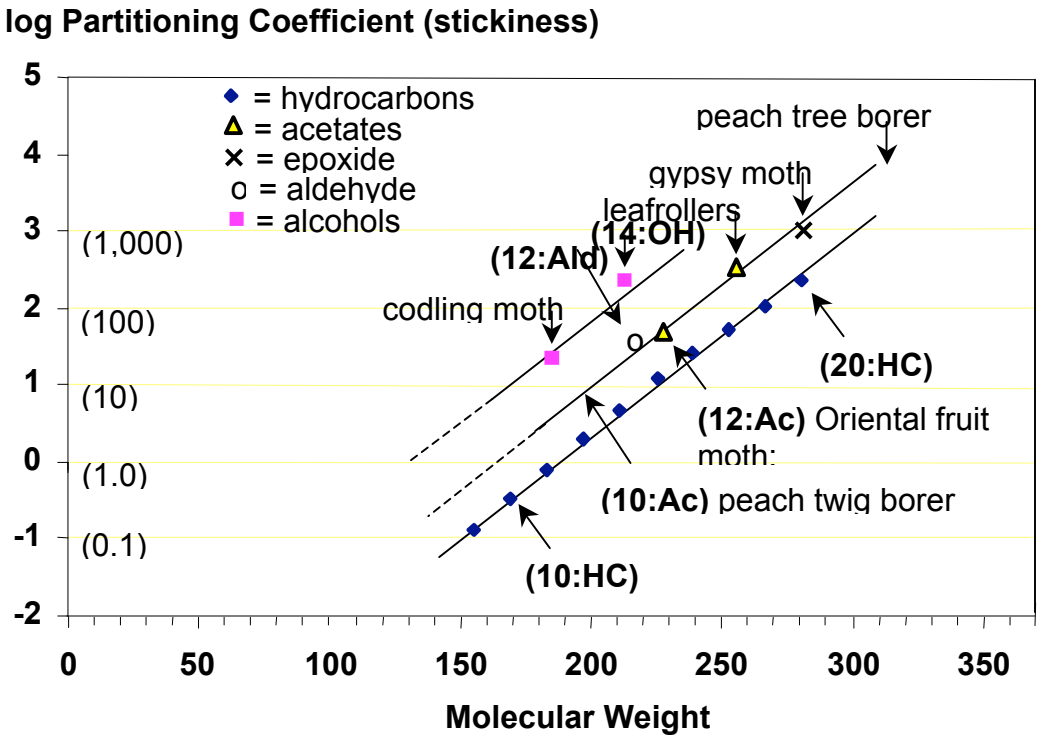

Figure 2. Partitioning coefficients of straight-chain hydrocarbons and selected pheromonal compounds when moving through a narrow-bore glass tube as influenced by functional group. All data points were measured by Miller (2003); those indicated only by an arrow are extrapolated estimates.

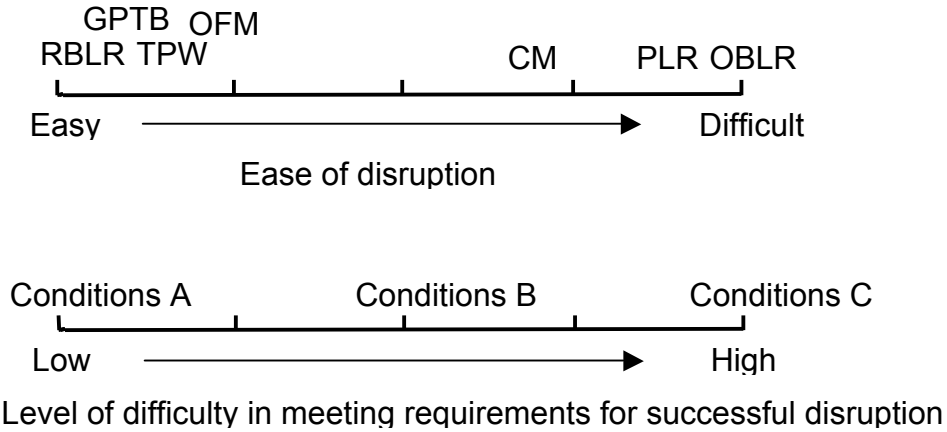

Figure 3. Conceptualization of differences in the susceptibility of various species to mating disruption based on fundamental properties of the moths and their pheromones (upper). Species are redbanded leafroller (RBLR), greater peachtree borer (GPTB), tomato pinworm (TPW), Oriental fruit moth (OFM), codling moth (CM), pandemis leafroller (PLR) and obliquebanded leafroller (OBLR). Conceptualization of differences in the level of difficulty of disrupting a particular species is based on all of the factors other than the moth and its pheromone, such as physical characteristics of the site or starting pest density (lower).