Control of Oriental fruit moth by mating disruption

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Confusing the male Oriental fruit moth by flooding peach orchards with the female's pheromone provided excellent control of the insect and may be an alternative to conventional insecticide use.

Oriental fruit moth has been an important pest in California peach and nectarine orchards since the mid-1950s, and commercial control depends on annual insecticide use. In the mid-1970s, this insect, *Grapholitha molesta* (Busck), was successfully controlled in Australia by an alternative method called mating disruption. In 1985 we initiated field studies to evaluate the effectiveness of this control technique in California.

Mating disruption uses the insect's own communication system to its detriment. Female Oriental fruit moths release a specific chemical, a pheromone, into the air to attract males for mating. Males detect the pheromone and follow it upwind to locate the female. The mating disruption technique floods the air in an orchard with Oriental fruit moth pheromone, preventing males from finding and mating with females. Prevention of mating protects the crop from damage by Oriental fruit moth larvae and has the potential for long-term reduction of Oriental fruit moth populations.

1985 field trials

The success of mating disruption depends on having a pheromone dispenser that is practical for use in the field. Such a dispenser (Isomate-M) became available in 1985, and during that season we conducted five field trials in California peach and nectarine orchards. Four of the trials were in commercial orchards in Marysville (Yuba County), Rio Oso (Sutter County), Sanger (Fresno County) and Arvin (Kern County), and the fifth was at the University of California Kearney Agricultural Center in Parlier (Fresno County).

Because the synthetic Oriental fruit moth pheromone used for mating disruption is dispensed into the orchard atmosphere and cannot be confined to individual plots within an orchard, we could not use a traditional experimental design. At each trial location, a treated orchard was paired with another orchard in the same locality that was conventionally treated with insecticide for Oriental fruit moth control (table 1). We determined the effectiveness of the mating disruption technique by comparing the two orchards at each location.

The five pheromone-treated orchards received an application of pheromone dispensers during the fourth week of February and a second application during the fourth week of May (the Sanger orchard did not receive the second pheromone application). Four dispensers per tree (about 400 per acre), spaced evenly around the tree canopy at about 10 feet above the ground, were applied by hand from a tractor-drawn trailer. The five insecticide-treated orchards received sprays for Oriental fruit moth timed by using pheromone traps and degree-day accumulations.

We monitored Oriental fruit moth activity in all orchards by using pheromone traps and terpinyl acetate/sucrose bait traps (table 1). Pheromone traps were installed in mid-February at Kearney Agricultural Center and in early March at the other locations. Bait traps were installed in early April at Sutter and in early May at the other locations (Kern orchards did not have bait traps). Traps were cleaned about every four days. Pheromone caps and trap bottoms were replaced about every four weeks. Bait traps were refilled with bait as necessary.

To assess mating disruption, we compared male moth catch in pheromone traps, mating status of female moths caught in bait traps, and fruit damage at harvest. The mating status of female moths caught in bait traps was determined by dissection of the internal genitalia; the presence of a spermatophore was used to indicate mating. Oriental fruit moth damage at harvest was evaluated by inspection of at least 2,000 randomly selected fruit per orchard. Fruit damage caused by other lepidopterous pests, such as peach twig borer (*Anarsia lineatella*), omnivorous leaf roller (*Platynota stultana*), and codling moth (*Laspeyresia pomonella*), was also recorded.

Results

The pheromone treatment virtually eliminated male Oriental fruit moth catch (table 2). This result indicates that the pheromone treatment successfully disrupted mating because, if males could not locate pheromone traps, they should have been less able to locate female moths.

The pheromone-treated orchards had a much higher percentage of unmated females than the insecticide-treated orchards (table 2). This result is a very good indication that the pheromone treatment was successful in mating disruption.

The most important measure of any control technique is the insect damage at harvest (table 3). The pheromone treatment resulted in excellent control of Oriental fruit moth damage to fruit and performed as well as or better than the insecticide treatments. We did not include harvest data from the Kern orchards, because the pheromone-treatment orchard

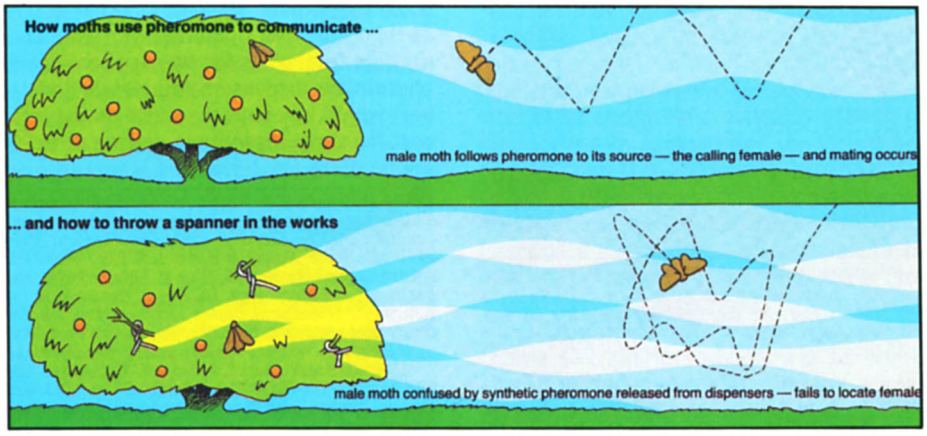

Diagram courtesy C.S.I.R.O., Australia

A plastic pheromone dispenser that became available in 1985 made mating disruption a practical control technique for Oriental fruit moth in peach and nectarine orchards. The dispensers, twisted around twigs, virtually eliminated male OFM catches in test orchards.

TABLE 1. Trial location, variety, size, treatment, and number of traps, 1985

Location	Variety	Size (ha)	Treatment	No. applications	No. pheromone traps	No. bait traps
Sutter	Klamt	3.6	Pheromone	2	4	4
Sutter	Andross	3.6	Insecticide	3	4	4
Yuba	Carolyn	5.2	Pheromone	2	4	4
Yuba	Carolyn	5.2	Insecticide	3	4	4
Sanger	Royal Giant	8.0	Pheromone	1	6	5
Sanger	Royal Giant	8.0	Insecticide	2	6	5
KAC	Fay Elberta	0.7	Pheromone	2	2	2
KAC	Fay Elberta	1.6	Insecticide	2	2	2
Kern	Autumn Gem	4.1	Pheromone + Insecticide	2 + 2	4	-
Kern	Autumn Gem	4.8	Insecticide	3	4	-

TABLE 2. Results of trap catches of Oriental fruit moths in pheromone- and insecticide-treated orchards

Orchard	Trap catches by treatment: Pheromone	Insecticide
Sutter		
Total males	1	1,176
% unmated females	53.0	0.0
Yuba		
Total males	0	2,124
% unmated females	59.9	3.1
Sanger		
Total males	0	1,104
% unmated females	23.0	3.8
KAC		
Total males	0	2,500
% unmated females	16.3	3.2
Kern		
Total males	2	1,184
% unmated females*	—	—
Mean		
Total males†	0.6	1,617.6
% unmated females‡	38.1	2.5

* Mating status data unavailable, because bait traps were not used in Kern orchards.
† Treatments significantly different at the 0.01 level.
‡ Treatments significantly different at the 0.051 level.

TABLE 3. Fruit damage from Oriental fruit moth (OFM) and from other species

Orchard	Damage in treatments: Pheromone	Insecticide
	%	%
Sutter		
OFM	0.10	0.33
Other*	0.85	0.17
Yuba		
OFM	0.00	0.00
Other	2.65	0.00
Sanger		
OFM	0.10	0.15
Other	0.30	0.25
KAC		
OFM	0.10	4.00
Other	2.40	0.85
Mean†		
OFM	0.08	1.12
Other	1.55	0.32

* Includes peach twig borer, omnivorous leaf roller, and codling moth.
† Treatments not significantly different at the 0.05 level.

was over-sprayed with insecticide for peach twig borer.

Although the differences in fruit damage at harvest caused by peach twig borer, omnivorous leaf roller, and codling moth were not significant, damage from these other lepidopterous pests was higher in the pheromone than in the insecticide orchards (table 3). Because the pheromone treatment does not control insects other than Oriental fruit moth, fruit in these orchards are subject to a higher risk of damage from other lepidopterous pests. An insecticide treatment may sometimes be necessary to prevent one of them from causing economic damage. Orchards treated with Oriental fruit moth pheromone should be closely monitored for potential fruit damage from peach twig borer, omnivorous leaf roller, and codling moth, especially orchards near outside sources of these other pests, such as almonds and prunes.

Conclusion

The use of Oriental fruit moth pheromone dispensers for mating disruption resulted in excellent control of this insect in 1985 field trials. This alternative to conventional insecticide use offers several advantages: (1) the pheromone dispensers are nontoxic to applicators, field workers, fish, and other wildlife; (2) the pheromone treatment does not kill beneficial insects or mites; and (3) pheromone use avoids the difficult management decisions associated with scheduling insecticide sprays for Oriental fruit moth around inclement weather or irrigation, thinning, and harvest operations.

A potential drawback of using pheromone for mating disruption is that it is specific for Oriental fruit moth, so treated orchards must be monitored for potential damage from other lepidopterous pests. The significance of this damage potential from other pests will become more apparent as more experience is gained with this new control method.

The actual cost of the Oriental fruit moth pheromone dispensers is not known at this time. The manufacturer estimates that the total costs for two applications of pheromone dispensers (materials and labor) would be about the same as the total cost for three insecticide and/or miticide applications (material and labor).

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