Pome Fruits—Biological Control

Mating Disruption as a Control for Codling Moth

Larry J. Gut[1], Jay F. Brunner[1] and Alan Knight[2]
[1]Washington State University Tree Fruit Research and Extension Center, Wenatchee, WA
[2]USDA-ARS, Yakima, WA

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Mating disruption (MD) as a control for codling moth (CM) in Washington was evaluated at 13 study sites. Test sites were comprised of one to three pheromone treated orchards plus an orchard treated with either conventional or organic insecticides. Eleven apple and two pear orchards in the Wenatchee area (75.8 acres) and eight apple orchards in the Yakima area (147 acres) were treated with Isomate-C (Biocontrol Ltd.) dispensers. Application rates of 400 dispensers per acre (d/a), and 800 d/a were evaluated. In some orchards dispensers were applied two times, effectively doubling the treatment rate. Dispensers were applied by ladder, trailer or ground and in all cases were hung in the upper third of the canopy prior to CM biofix. Application of the pheromone required 1.7 to 5.3 person hours per acre.

Pheromone trap catch. Pherocon 1CP traps baited with 1 mg of codlemone in a grey septa were used to monitor the effectiveness of mating disruption through the season. Four traps, one per quadrant, were placed in each of the main test orchards and two were placed in the smaller blocks left as untreated controls. The number of male CM captured was recorded twice a week.

Septa were changed at four week intervals and trap bottoms were replaced every four weeks, more often if dirty. Trap catch was significantly greater in the non-pheromone treated orchards as compared to the pheromone treated blocks (Figure 1), indicating that the Isomate-C dispenser successfully disrupted male orientation to codlemone and, thus, to calling females.

A potentially unfavorable effect of treating an orchard with pheromone is that the inhibition of trap catch interferes with our ability to monitor the seasonal development of CM populations. Thus, we examined the potential for increasing moth capture in MD orchards by loading septa with 10 mg or 20 mg of codlemone and by placing traps high in the tree canopy. To compare load rates, orchards were divided into quadrants and either a 1 mg and 10 mg baited trap (at 12 sites) or a 1, 10 and 20 mg baited trap (at 1 site) were placed in each quadrant. To minimize position effects, within a quadrant traps were rotated twice a week or three times a week depending on the number tested.

Capture of males in MD orchards in traps baited with 10 mg or 20 mg of codlemone was consistently greater than in traps baited with the standard amount of the sex pheromone (Figure 2 and Table 1). There was about a 3- to 4-fold increase in moth capture in traps loaded with 10 mg. Increasing the dosage of codlemone from 10 mg to 20 mg did not significantly improve trap catch in pheromone treated orchards. Trap catch in 1 mg, 10 mg or 20 mg baited traps placed in non-pheromone treated orchards was not significantly different (Figure 2 and Table 1).

Placing traps in the upper third of the canopy also had a dramatic effect on trap catch in pheromone treated orchards. Capture of males in traps hung in this optimum position was 7- to 8-fold greater than in traps placed lower in the canopy (middle third). Trap catch in the upper third of the canopy in the pheromone treated orchard was equivalent to that in the same location in the non-pheromone treated orchard. The increase in sensitivity of traps placed high in the canopy was recorded when traps were baited with either a 1 mg or 10 mg septa. Next year we will continue efforts to develop guidelines for monitoring CM in pheromone treated orchards with the long-term goals of being able to 1) follow the seasonal development of CM and 2) predict the potential for CM damage.

Fruit damage. The most critical measure of MD success is the amount of CM injury to fruit at harvest. Control in 12 of 13 orchards treated with pheromone at the rate of 400 d/a was at least equivalent to that in the non-pheromone treated orchards (Figure 3). Only one of the 12 orchards had fruit injury greater than 0.5%. Moreover, two of the orchards were at organically managed sites where high CM pressure resulted in 10.5% and 36.2% fruit injury in adjacent non-pheromone (organically) treated orchards. An unacceptable level of CM injury (7.4%) occurred in one MD orchard in Yakima. At least three factors contributed to the glaring failure of MD in this orchard. First the pheromone was applied to a large portion of the orchard at only half the recommended rate. Second, dispensers were not applied in areas with missing trees or where trees were heavily grafted. Third, the orchard had a history of high CM injury suggesting that supplemental controls against first generation should have been used. Excluding this orchard, fruit injury in MD orchards occurred primarily along the borders. Where border infestations were heavy, a source of CM could easily be located nearby. This was especially apparent in a Wenatchee orchard that was treated with 800 dispensers per acre. A gradient from high to low CM injury extended from the border adjacent to the organically treated orchard (10.5% damage) into the interior of the pheromone treated orchard. Although the average level of fruit injury for the entire orchard was 2%, the average fruit injury in the interior was less than 0.4%.

Levels of control were similar in orchards treated with a single (400 d/a) or double (800 d/a) rate and with one or two applications of Isomate-C. However, greater than 10% injury to fruit has been reported from some commercial orchards in Washington that received a single application of pheromone and had high CM pressure. At one test site in Wenatchee, with a known history of CM problems, two applications of pheromone were made to MD orchards. In addition, a partial organic insecticide program was applied against first generation CM. As a result, good control of CM was achieved. Currently, we believe that one application of 400 d/a is sufficient where CM levels at the end of the first generation are low. Supplemental chemical controls may be required in some pheromone treated orchards. If satisfactory control of the first generation is not achieved, a second application of pheromone and/or supplemental chemical controls during the second generation may be required.

Impact on nontarget species. Population densities of leafrollers, aphids, mites, white apple leafhopper (WALH), western tentiform leafminer (WTLM), and the natural enemies of each were determined. In the first year of MD, similar densities of most species were recorded in pheromone treated and non-pheromone treated orchards. Mite and WTLM populations were maintained at low densities by natural enemies, while high numbers of aphids and WALH were detected at most sites. Leafrollers were absent or at low abundances in all pheromone treated and conventionally or organically treated orchards at Wenatchee test sites. However, they were detected in fairly high densities in several of the test sites in Yakima. Levels of fruit injury from pandemis leafroller were high in 4 pheromone treated orchards in Yakima, and failure to control this pest accounted for the majority of crop loss for these growers. Growers used a variety of chemical controls for pandemis, including Lorsban and Penncap-M. Both materials are highly toxic to the major parasite of western tentiform leafminer, *Pnigalio flavipes.* Thus, insecticide control of pandemis in MD orchards may disrupt the biological control of leafminer. Leafminers did not occur in high densities in the Yakima test sites, but there was some indication of the potential for this to occur. The lowest levels of parasitism were recorded in orchards receiving multiple insecticide treatments for pandemis leafroller and these orchards also had higher densities of western tentiform leafminer.

Table 1. Capture of male codling moth in orchards treated with pheromone and in traps baited with 1 mg, 10 mg and 20 mg of codlemone.

		Codling moth catch per trap per season[1]								
		400 + 400 d/a			800 + 800 d/a			No pheromone		
Site	CM generation	1 mg	10 mg	20 mg	1 mg	10 mg	20 mg	1 mg	10 mg	20 mg
W5	1st	4.50a	13.25ab	21.00b	4.50a	18.25ab	32.25b	47.25a	68.25a	65.25a
	2nd	0.25a	0.50a	1.50a	0.00a	0.75a	0.50a	2.50a	7.00a	15.50b

[1]Mean pairs followed by the same letter are not significantly different (Student-Newman, P<0.05), d/a=dispensers per acre.

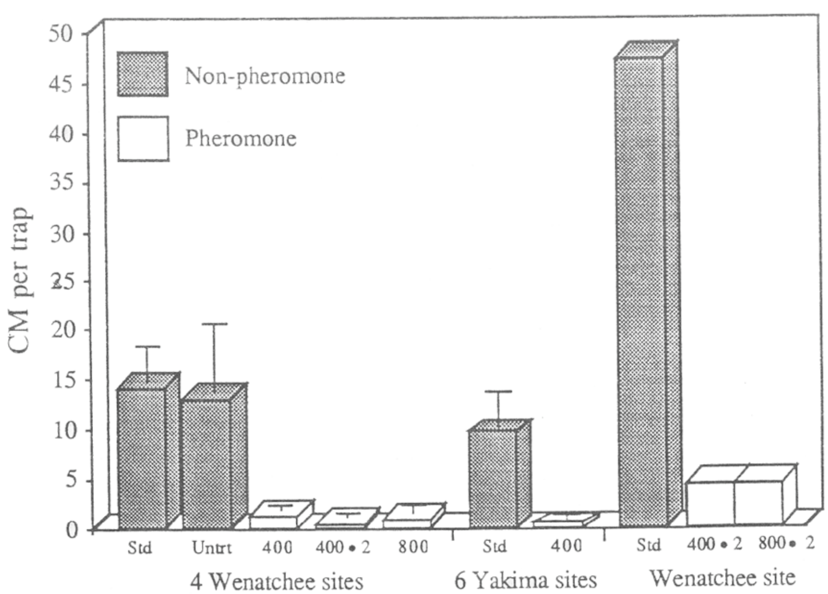

Figure 1. Average total capture of CM males in pheromone traps placed in MD test sites in Wenatchee and Yakima in 1991.

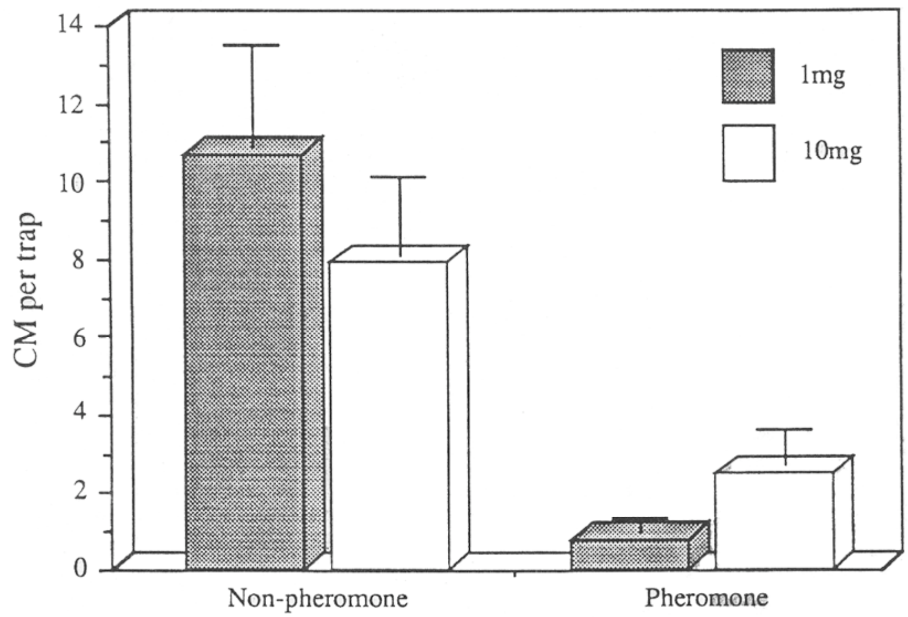

Figure 2. Capture of male codling moth in traps baited with 1 mg or 10 mg of codlemone.

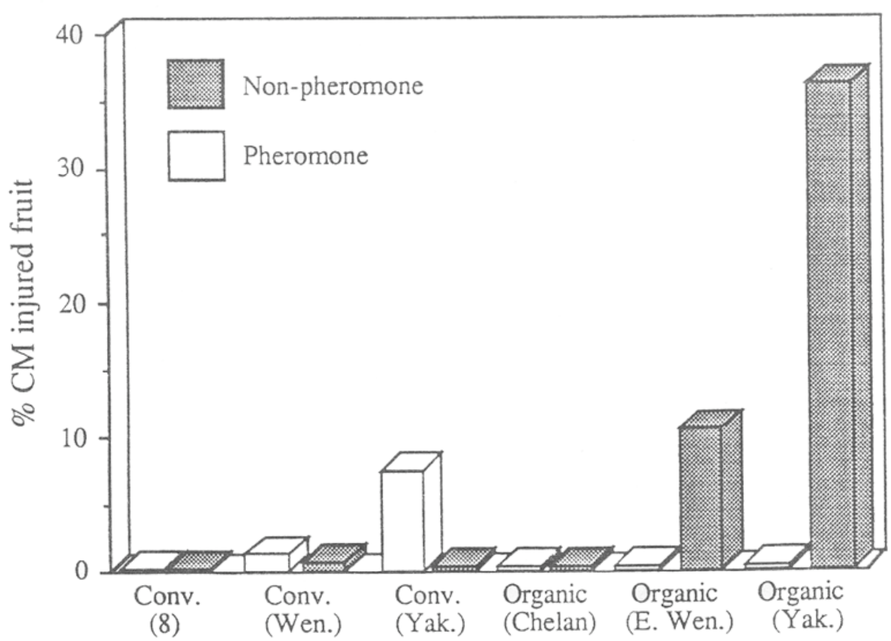

Figure 3. Codling moth injury to fruit in pheromone and non-pheromone treated orchards at MD test sites in Wenatchee and Yakima in 1991.