PROJECT NO: 3093 Termination Report

TITLE: Mating Disruption of Codling Moth in Pear

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ACCOMPLISHMENTS:

A three-year study of the transition of pear from a conventional to a pheromone-based pest management program demonstrated the potential value of such programs as well as problems and future concerns. We demonstrated that mating disruption is a highly effective codling moth (CM) control in pear. At sites where initial CM densities were low, CM control was achieved using 250 to 400 Isomate-C dispensers per acre (d/a). Where CM densities were higher, especially in organic blocks, higher densities of MD dispensers were required, 650 to 800 per acre, as well as augmentation by organically approved insecticides.

Population densities of pear psylla (PP) were variable during the three years. Good PP control was achieved in most sites and in most years through a combination of biological control and "soft" insecticides. In 1993 a single late application of abamectin was necessary to prevent excessive pear russet from PP honeydew. Where colonization by predators occurred in early summer, one or two supplemental treatments with soap or diatomaceous earth were sufficient for control of PP. Pear blocks with the highest levels of predator activity were adjacent to native vegetation, particularly woodlands, that appeared to be good sources of colonists. In contrast, colonization by predators was reduced at sites surrounded by conventionally treated apple and pear orchards. *Deraeocoris brevis*, *Campylomma verbasci* and *Chrysopa nigricornis* were the most abundant predators of PP.

Densities of most potential pests, including grape mealybug and mites, were low in pheromone mediated "soft" blocks over three years. However, in 1993 high densities of the leafroller, *Pandemis pyrusana*, were recorded in three blocks where larval feeding resulted in 3 to 12% crop loss. *Bacillus thuringiensis* (Bt) products used in 1994 suppressed LR below economic injury levels.

A pheromone trap baited with 10 mg of codlemone was determined to be an effective system for monitoring CM in pheromone treated orchards. Leafrollers were detected as a serious pest of pear in the second year of transition to a pheromone-based pest management program.

RESULTS:

Twelve pear blocks (45 acres) were treated with the pheromone product Isomate-C for control of codling moth from 1992 through 1994. Pheromone applications of 400 or 250 d/a in 9 low pressure blocks provided control of CM equivalent to that obtained in adjacent, conventionally treated blocks (less than 0.1% injury, Table 1). In two blocks that had 1.6 % and 3.6 % fruit injury in 1992, treatment with high rates of pheromone in 1993 (650 or 800 d/a) provided significantly better control of codling moth (< 0.5 % fruit injury).

Table 1. Capture of codling moth in pheromone and insecticide treated pear blocks and percent fruit injury at harvest..

	1992			1993			1994		
Site-Treat.	Rate (d/acre)	Moths per trap[1]	% fruit injury	Rate (d/acre)	Moths per trap[1]	% fruit injury	Rate[3] (d/acre)	Moths per trap[1]	% fruit injury
W3-									
Pher	400	0.0	0.0	400	4.0	<0.1	400	2.0	0.0
Pher	400	0.5	0.0	400	5.5	0.2	250	5.0	0.3
Conv	0	5.0	0.0	0	3.5	0.0	0	7.0	0.0
W5-									
Pher	400	4.0	0.0	400	9.0	0.1	800[2]	3.0	0.0
Pher	—	—	—	—	—	—	400	0.0	0.0
Conv	0	0.0	0.0	0	0.5	0.0	0	0.5	0.0
W8-									
Pher	400	0.0	0.0	400	0.0	0.0	400	0.0	0.0
Conv	0	18.0	0.0		30.5	0.0	0	19.0	<0.1
W11-									
Pher	400	9.0	1.6	650	6.0	0.3	—	—	—
W13-									
Pher	400	0.0	0.0	400	0.0	0.0	400	1.0	0.2
Conv	0	0.0	0.0	0	5.0	0.0	0	3.0	0.0
W14-									
Pher	400	0.5	<0.1	400	1.0	0.0	400	2.0	<0.1
Pher	250	4.0	<0.1	250	2.0	0.2	250	1.0	0.0
Conv	0	11.0	0	0	8.5	0.0	0	7.0	0.0
W15-									
Pher	400	0.0	0.1	400	1.0	0.0	400	1.0	<0.1
Pher	250	0.5	<0.1	250	1.0	0.1	250	1.0	0.0
Conv	0	1.5	0.1	0	6.5	0.0	0	3.5	0.0
W16-									
Pher	400	2.0*	3.6	800	9.5	0.4	—	—	—
Conv	0	66.0	1.7	0	71.0	0.0	—	—	—

[1] Seasonal capture of moths in Pherocon 1CP traps baited with codlemone at a dosage of 10 mg (pheromone treated orchards) or 1 mg (non-pheromone treated orchards) and placed within the fruiting canopy of the tree, 1.5-2 meters. Asterisks indicate that trap catches were only recorded during the first generation.

[2] Dispensers applied at a rate of 400 per acre first CM flight and 400 per acres against the second flight.

[3] Isomate-C+ was used in all plots in 1994.

Management of pear psylla with "soft" materials was less effective in 1993 than in 1992 or 1994. In 1992 in four of the pheromone mediated "soft" blocks, substantial colonization by predators occurred early in the summer, and one or two treatments with soap or diatomaceous earth were sufficient for control of pear psylla. In 1993 high initial psylla densities and a lack of predator activity early in the season at five sites necessitated a summer application of abamectin to reduce psylla populations to levels that would not cause high levels of fruit damage at harvest. Management of PP with "soft" materials was substantially more effective in 1994 than in 1993. Downgrading of fruit due to honeydew marking occurred in only two of eleven MD orchards in 1994, while eight of twelve MD orchards incurred this kind of damage in 1993. A portion of the improved PP control was probably due to the effectiveness of fenoxycarb, a new "soft" control for this pest. Good control of PP was achieved without summer applications of soap or supplemental insecticides in most of these orchards. Abamectin was applied in the summer in one of the pheromone treated orchards at site W3, but PP control may have been achieved without this treatment. Densities of PP predators were consistently higher in orchards treated with pheromone and other "soft" controls than in orchards treated at least once with conventional insecticides. For the third consecutive year, PP predators most effectively colonized "soft" orchards at sites adjacent to native vegetation, including the four orchards in the Entiat river valley (W14 and W15). The only orchards sustaining significant levels of PP fruit downgrading were the two organic orchards at site W5.

Leafrollers appear to have the greatest potential to be pests in pheromone treated orchards. Leafrollers were absent or in low abundances in all pheromone and conventionally treated pear blocks in 1992. However, in 1993 high densities of the leafroller, *Pandemis pyrusana*, were recorded in three blocks. Failure to apply supplemental controls for leafrollers in these orchards resulted in 3 to 12% crop loss (Table 2). Similar levels of injury have been reported in the first or second year following implementation of a pheromone-based pest management program for apples in Washington (Brunner and Gut 1992). It is evident that successful pheromone-based management programs in pear in central Washington will sometimes require the use of selective insecticides, such as *Bacillus thuringiensis*, to control leafrollers.

Table 2. Fruit injury from pests in pheromone-based (soft) and conventional pear blocks, 1993.

		% PP downgrading			% Other pest damage			
Site	Prog.	US1	US2	Cull	LR	GMB	RM	SJS
W3	Pher	0.7	0	0	0	0	0	0
	Pher	13.0	7.0	3.0	3.0	0	0	0
	Conv	0	0	0	0	3.3	0	0.7
W5	Pher	17.0	20.0	33.0	12.0	0	0	0
	Conv	0	0	0	0	0	0	0
W8	Pher	0	0	0	3.0	0	0	0
	Pher	3.0	0	0	11.0	0	0	0
	Conv	0	0	0	0	6.0	0	0
W13	Pher	2.3	0	0	0	2.3	0	0
	Conv	0.7	0	0	0	0	0	0
W14	Pher	0	0	0	0	0.7	0	0
	Conv	0	0	0	0	0	0	0
W15	Pher	1.5	0	0	0.5	0	0	0
	Conv	1.0	0	0	0.5	0	0	0
W16	Pher	10.0	0.7	0	0	0	0	0
	Conv	0	0	0	0	0	0	0

Densities of most potential pests, including grape mealybug and mites, were low in all pheromone mediated "soft" blocks in 1992 and 1993. However, in 1994 densities of some other pests were higher in MD "soft" orchards compared to the previous two years. Spiders mite populations at site W5 caused severe damage to foliage before they were suppressed by two summer oil applications (Table 3). Rust mites were a pest problem at sites W3 W13, W14 and W15. Close to 5% fruit russetting occurred at sites W3 and W14. Rust mites were prevented from reaching damaging levels at site W15 with an early miticide treatment. The highest levels of fruit injury at harvest were caused by grape mealybug (36%, site W13) and boxelder bug (12.7%, site W14). Boxelder bug damage was especially severe along the orchard edge adjacent to native vegetation and an insecticide application along this border probably prevented higher levels of damage. Lower densities of boxelder bugs and stinkbugs caused detectable levels of fruit damage at three other sites as well (W3, W8 and W15). It appears that populations of several pests will need to be carefully monitored in pear orchards where pheromone-based "soft" pest management programs are implemented.

Table 3. Comparison of pest and predator mite densities in pheromone and conventionally treated orchards in 1994.

		Ave. mites / leaf (mid-June)				Ave.mites / leaf (mid-July)			
Site	Treat	Rust	2-spot[1]	ERM[1]	Typh[1]	Rust	2-spot[1]	ERM[1]	Typh[1]
W3	Pher	0.0	6.3	0.5	0.0	0.0	0.0	0.0	0.0
	Pher	82.5	0.3	1.3	0.5	40.0	0.3	0.3	0.0
	Conv	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
W5	Pher	0.0	7.3	0.0	0.3	0.0	105.3	0.0	2.0
	Pher	0.0	12.5	0.0	0.3	0.0	24.3	2.5	1.8
	Conv	0.0	0.3	0.8	0.0	0.0	1.3	2.8	0.0
W8	Pher	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.3
	Conv	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W13	Pher	8.2	0.3	0.0	0.0	86.5	5.0	1.0	0.0
	Conv	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W14	Pher	0.0	0.0	0.5	0.0	22.5	0.5	1.0	1.5
	Pher	0.0	0.0	0.0	0.0	117.5	0.5	0.0	1.5
	Conv	0.0	0.0	0.0	0.0	0.0	23.5	0.0	0.3
W15	Pher	0.0	1.5	0.0	0.0	2.0	0.0	0.0	0.0
	Pher	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
	Conv	0.0	0.0	5.0	0.0	2.0	0.5	0.0	0.0

[1] Eggs and post-embryonic individuals included in calculating averages for two-spotted (2-spot), European red (ERM), and Typhlodromid (Typh) mites.

SUMMARY:

The availability of MD as a non-disruptive control for CM and the ability to control other major pests in a "soft" manner are important steps in the move toward more stable pest management programs in pear in north central Washington. The transition to this era of pheromone-based pest management will require the patience to allow for the build-up of predators and parasitoids and the continued development of selective controls for non-target pests. The potential for natural control of some pests, such as PP, is encouraging but variable depending on orchard setting and yearly differences in environmental conditions that affect psylla and predator abundances early in the season. Other pests, such as leafrollers, are less likely to be controlled naturally and will require the intervention with "soft" insecticides like *Bacillus thuringiensis*. The goal of our research was to provide an understanding of how a transition from conventional pest management programs to a pheromone-based IPM system would occur and to develop the management tools that will be required along the way. This goal has been achieved and pear growers throughout Washington now consider this approach a viable option for managing their pear orchards.

DISSEMINATION OF INFORMATION:

1. Proceedings:

Gut, L. J., J. F. Brunner. 1993. Implementation of pheromone-based pest management programs in pear in Washington, U.S.A. Proc. International Colloquium of Integrated Pest Management in Pear Orchards, Cesena, Italy. Bulletin SROP, 1994 (in press).

Brunner, J. F., L. J. Gut, and A. Knight. 1993. Transition of apple and pear orchards to a pheromone-based pest management system Proc. Wash. St. Hort. Assoc. 88: 169-175.

Gut, L. J., J. F. Brunner. 1993. Mating disruption of codling moth and leafrollers. Proc. Wash. St. Hort. Assoc. 88: 281-284.

Gut, L. J., J. F. Brunner. 1993. Mating disruption 1992: revenge of the worm. Proc. Oregon St. Hort. Soc. 88: 94-102.

2. Technical reports:

Gut, L., J. Brunner, and T. Unruh. 1993. Pheromone-based pest management programs in pear. Advances in pear psylla management workshop. National meeting ESA, Indianapolis, Indiana.

Gut, L., J. Brunner, A. Knight and T. Unruh. 1993. Pheromone-based pest management programs in apple and pear. Advances in pheromone-based management of insect pests symposium, Pacific Branch ESA, Portland.

Gut, L., J. Brunner, and T. Unruh. 1993. Pheromone-based pest management programs in pear. 67th Annual Western Orchard Pest and Disease Management Conference, Portland, Oregon.

3. Talks at grower meetings:

North Central Washington Annual Pear Day, Wenatchee - December, 1991
Oregon Horticulture Society, Portland, Oregon - January, 1992.
North Central Washington Fieldman's Assoc. meeting, Wenatchee - April, 1992.
Washington Horticulture Association, Yakima - December, 1992.
Oregon Horticulture Society, Portland - January, 1993.
Dovex growers meeting, Wenatchee - March, 1993
Fieldman's meeting, Yakima - April, 1993.