

Biological Control

Biological Control of Codling Moth: Parasitoid Releases in Walnuts, Apples, Pears

Janet Caprile¹ and Nick Mills²

¹University of California Cooperative Extension, Contra Costa County, CA

²Department of Insect Biology, University of California, Berkeley, CA

Keywords: codling moth, biological control, *Cydia pomonella*, parasitoids, *Mastrus ridibundus*, apple, pear, walnut

Abstract: *Mastrus ridibundus*, a codling moth parasitoid from central Asia which attacks the overwinter stage of codling moth, were released in 16 apple, pear, or walnut orchards over a 6-year period (1998-2003). Both tree band and pheromone trap counts indicate a suppression of the overwintering codling moth population for 2 or more years following releases into walnut orchards. Parasitism rates varied from 0-34% over the 6-year study and were higher in orchards with higher codling moth populations and when the band traps were left out longer in the fall. The overwintering codling moth flight was suppressed in walnuts for two or three seasons after the initial release. Codling moth damage in walnuts was reduced in the two seasons following releases and increased again following seasons with no or very small releases; the degree of damage varied by variety. This work suggests that *Mastrus* may be able to “naturalize” and provide satisfactory codling moth control in some of the less susceptible walnut varieties but may require annual or bi-annual augmentation in more susceptible varieties. *Mastrus* was not able to provide an acceptable level of control in apple or pear orchard.

Introduction

CM is the most important pest of apples, pears and walnuts in California. It is not native to the state and our naturally occurring biological control agents are not effective in providing any appreciable control. In a classical biological control effort, Dr. Nick Mills collected CM parasitoids from the wild apple forests of central Asia where CM is thought to originate. He imported them to California and reared them in his quarantine insectary at UCB. *Mastrus ridibundus* is one of these parasitoids. It attacks the cocoon stage of the CM lifecycle. If it can be established in California orchards, it may provide significant suppression of codling moth in unsprayed orchards. This poster describes the effort to establish and monitor the establishment of *Mastrus ridibundus* in orchards in eastern Contra Costa County.

Materials & Methods

Mastrus ridibundus were released in a total of 16 apple, pear or walnut orchards over a 6-year period from 1998-2003. Most orchards selected for release were unsprayed in order to be able to track future establishment, although management changed in several orchards over the course of this study. Either single or multiple releases were made in individual orchards each fall with the exception of the fall of 2001. Release dates varied from 8/26 to 11/20. Release rates varied from 400 to 8000 wasps per orchard or 83 to 1000 wasps if calculated on a per acre basis. All releases are summarized in Table 1.

Corrugated cardboard bands were used to recover *Mastrus* from the orchards and to evaluate the rate of establishment and parasitization. In each orchard, fifty 2-3 inch wide cardboard bands with A-flute corrugation were wrapped around tree trunks for several weeks from August through October or November to capture overwintering codling moth. Bands were placed in selected orchards before the first release, the first year following a release, the second year following a release and/or the third year following a release. Bands were then collected and brought back to the Mills lab to determine the number of codling moth captured, the *Mastrus* recovery and the rate of parasitization.

Codling moth populations were monitored with standard pheromone traps in 3-4 unsprayed walnut orchards and compared to those in 3 conventional, sprayed walnut orchards over a 5-year period (1999-2003). Insect damage data from the processor grade sheets reports were available from one unsprayed walnut release site the Palma orchard for the season before and 4 seasons after the releases began.

Results

Band traps placed in orchards just prior to the first release of *Mastrus* caught high numbers of overwintering codling moth (Table 2: Orchards 6-10, 1999). The release of laboratory reared *Mastrus* into those orchards resulted in 6-12% parasitization the year of the release. In the first and frequently the second and third season following a release, comparatively few codling moth could be caught in the bands, indicating that *Mastrus* had survived in the orchard and was having a significant impact in reducing the overwintering codling moth population. (Table 2: Orchards 1-5, 1999; Orchards 6, 7, 13, 2000; Orchards 3-5, 12, 2001). Curiously, the few CM that were caught in the bands had none or a very low rate of parasitism evident at the time the bands were collected in October. In 2003, releases were again made in orchards that were expected to be relatively free of *Mastrus* – they had not had a previous release, had been sprayed after a previous release, or had not had a significant release for 3 years. These orchards were successful in capturing significant numbers of CM and the parasitization rate from the 2003 release ranged between 0 (in a very low pressure walnut orchard) to 34% in a high pressure apple orchard.

The pheromone traps showed a suppressed overwintering flight in the unsprayed walnut release sites when compared to conventionally sprayed walnut orchards with no parasitoid releases (Figure 1). This suppression of the overwintering generation was evident for at least two to three seasons after the release, again indicating *Mastrus* survival. The 2nd and 3rd flights in the unsprayed release sites were similar to or higher than in the conventional comparison orchards. There was little difference in the cumulative seasonal trap counts in the unsprayed release sites and the conventionally sprayed orchards (Figure 2).

The grade sheets from Orchard 7 show moderate “insect” damage the season prior to the first *Mastrus* release. Damage was reduced in the seasons following releases (2000 and 2001) and increased again following seasons with no (2001) or very small (2002) releases (Table 3).

Discussion

Both the band and pheromone trap counts indicate a suppression of the overwintering codling moth populations for 2 or more years following the release of *Mastrus* into an orchard. We were unable to determine the actual parasitism rate in years following the release due, in part, to the difficulty in recovering enough overwintering codling moth in the band traps for evaluation. The low parasitism rate in the few larva that were caught may have been due, in retrospect, to a premature removal of the bands. Other (unpublished) work indicates that “naturalized” *Mastrus* goes through more than one winter generation in California and can continue to attack the overwintering codling moth through the winter and into the spring. This corresponds to the higher rates of parasitism evident in bands left in orchards later in the season (Table 2: Orchards 6-10 in 1999 and all orchards in 2003).

The unsprayed walnut orchards with *Mastrus* releases were able to maintain pheromone trap counts that were similar to the conventional, sprayed comparison orchards. Orchard 7 was also able to achieve acceptable levels of codling moth control during the years following large *Mastrus* releases even in the very susceptible Serr variety. The damage levels following years without significant releases were acceptable in Chandler but not in Serr. This suggests that *Mastrus* may be able to “naturalize” and provide satisfactory codling moth control in some of the less susceptible walnut varieties but may require annual augmentation in more susceptible varieties. *Mastrus* was not able to provide an acceptable level of control in apple orchards.

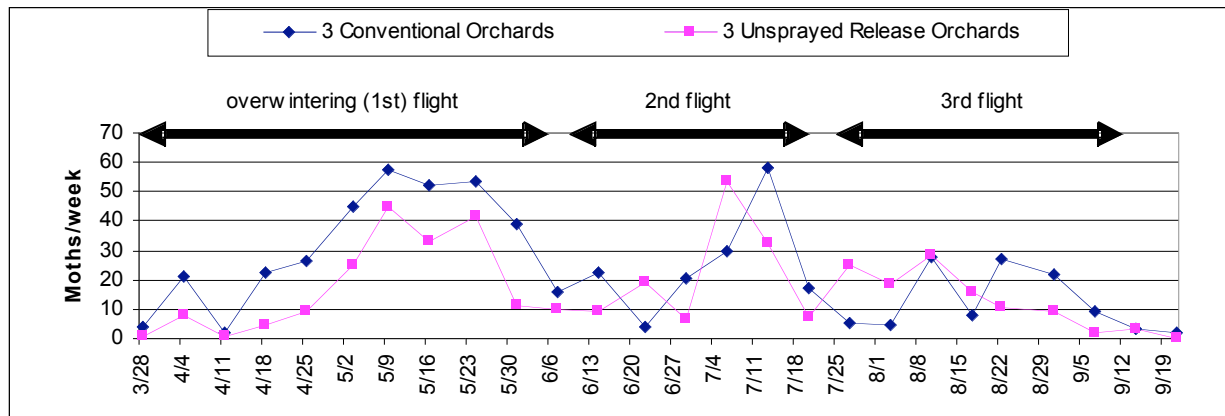


Figure 1. 2001 pheromone trap counts in unsprayed walnut release sites, 2-3 years after initial release, compared with conventionally sprayed walnuts with no parasite releases.

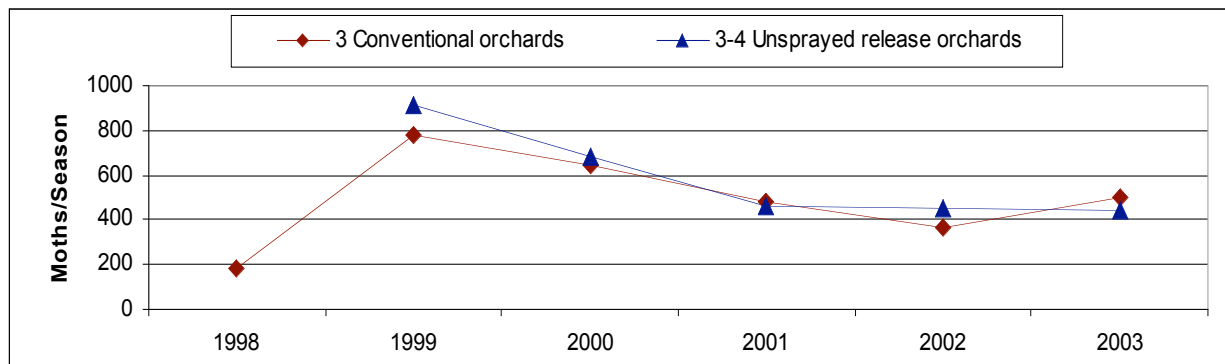


Figure 2. Seasonal pheromone trap comparisons in unsprayed walnut release sites compared with conventionally sprayed walnuts with no parasite releases.

Reports of the 79th Annual Western Orchard Pest & Disease Management Conference

Table 1. *Mastrus* release summary

Orchard	Crop	Acres	Management	1998		1999		2000		2002		2003	
				Date	Number/ orchard	Date	Number/ orchard	Date	Number/ orchard	Date	Number/ orchard	Date	Number/ orchard
1 Christ	apple	3	unsprayed	11/4	1500	10/22	2000					10/17	400
2 Courchesne	pears	6	organic	11/4	1500	10/22	2000			9/30	500		
3 Bix	walnut	6	unsprayed	11/17	1200	10/22	2000						
4 Black	walnut	2	unsprayed	11/20	1200	10/22	2000						
5 Grey	walnut	5	unsprayed	10/22	1500	10/22	2000			9/30	500		
6 Mena	walnut	5	unsprayed/Conv			8/26, 9/2, 9/15	2700	11/7	1700	9/30	500	10/1,10/13	500
7 Palma	walnut	10	unsprayed			8/26, 9/2, 9/15	2700	9/1,9/28	6000	9/30	500	10/1,10/13	500
8 Tennant	walnut	30	conventional			8/26, 9/2, 9/15	2700						
9 Johnson	walnut	9	unsprayed			8/26, 9/2, 9/15	2700						
10 Coehlo	walnut	18	conventional Mating			9/15	2700						
11 Delta	apples	16	Disruption Mating			10/22	2000						
12 Rosie Hills	apples	35	Disruption			10/22	2000						
13 Faria	apples	60	organic					10/4, 10/12	8000				
15 Massoni	walnut	50	conventional									10/13	500
16 Nielson	apple	10	unsprayed									10/17	400

Reports of the 79th Annual Western Orchard Pest & Disease Management Conference

Table 2. *Mastrus* recovery summary

Orchard	Crop	Acres	Management	1999		2001		2002		2003	
				CM cocoons	% Parasitization	CM cocoons	% Parasitization	CM cocoons	% Parasitization	CM cocoons	% Parasitization
1 Christ	apple	3	unsprayed	517	0.0					64	34%
2 Courchesne	pears	6	organic	12	0.0			14	0%		
3 Birx	walnut	6	unsprayed	20	0.0	3	0%				
4 Black	walnut	2	unsprayed	149	0.0	4	0%				
5 Grey	walnut	5	unsprayed	19	0.0	2	0%	0	0%		
6 Mena	walnut	5	unsprayed/Conv	636	5.7	1	0%	216	0%	69	14%
7 Palma	walnut	10	unsprayed	380	8.3	4	0%	79	4%	200	15%
8 Tennant	walnut	30	conventional	162	10.0						
9 Johnson	walnut	9	unsprayed	22	12.5						
10 Coehlo	walnut	18	conventional	305	10.9						
11 Delta	apples	16	Mating Disruption								
12 Rosie Hills	apples	35	Mating Disruption			59	0%				
13 Faria	apples	60	organic			19	0%				
15 Massoni	walnut	50	conventional							5	0%
16 Nielson	apple	10	unsprayed							384	9%
Banding dates				Orch. 1-5 8/31-10/22		all 8/31-10/11		all 8/23-10/25		all 8/15-11/18	
				Orch.6-10 8/31-11/27							

Table 3. Insect damage from processor's grade sheet for one unsprayed walnut release site

Year	Variety	"Insect" damage*	Notes
1999	Chandler	3%	Prior to any releases
	Serr	7%	
2000	Chandler	0%	2700 released previous fall
	Serr	6%	
2001	Chandler	1%	6000 released previous fall
	Serr	3%	
2002	Chandler	0	No releases previous fall
	Serr	14%	
2003	Chandler		500 released previous fall
	Serr	10%	

*Insect damage may include navel orangeworm as well as codling moth.