USING AEROSOL PHEROMONE "PUFFERS" FOR AREA-WIDE SUPPRESSION OF CODLING MOTH IN WALNUTS: YEAR FIVE

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ABSTRACT

The Walnut Pest Management Alliance (PMA) for an eleventh year continued work to reduce pesticide inputs in California walnuts and demonstrate and increase implementation of pest management strategies based on various formulations of pheromone mating disruption (PMD).

Six long-term, area-wide projects continued in 2009 with aerosol pheromone 'puffers' for codling moth (CM) control and one additional site was created. Two of these sites, San Joaquin and Glenn, have successfully used puffers for five years as the primary CM management tool. The majority of the PMD acreage in this project did not need supplemental CM insecticide treatments in 2008 or 2009. Several years of using PMD over a large area demonstrate the benefits of this system including reduced crop damage, reduced CM populations which can be managed using fewer insecticide sprays, reduced broad spectrum insecticide applications, and a move to softer insecticides as supplements for PMD. The success of this program is the result of input from many collaborators including growers, pest control advisors (PCAs), UCCE Farm Advisors, Suterra LLC, Trece Inc, USDA-ARS, Ca. Dept. of Pesticide Regulation, the UC Integrated Pest Management Program, and the California Walnut Board.

OBJECTIVES

1. Validate pheromone application technology required for control of codling moth with an emphasis on "area-wide" control over multiple years. Continue using aerosol puffers at sites in San Joaquin, Glenn, and Butte Counties and expand acreage of SJ site to take advantage of area-wide CM suppression.
2. Create new sites where growers have shown interest in Yolo, and Tehama Counties to increase local visibility and experience with the pheromone puffers.
3. Demonstrate the use of monitoring CM to watch for population increases and to determine spray timings. Monitor damage to the crop with in-season surveys of nuts in the canopy. Over time, the need for supplemental sprays should be decreased and eliminated with CM population reductions.

PROCEDURES

To demonstrate area-wide control of CM, large areas of contiguous walnut orchards of several different varieties are treated with aerosol pheromone puffers. Sites include blocks with historically high CM pressure as well as portions with varieties with both high and low CM susceptibility to CM. Varieties include Ashley, Chandler, Hartley, Howard, Serr, Tehama, Tulare, and Vina (Table 1). The San Joaquin site is in its fifth season of puffer deployment and monitoring in 2009 and a 540-acre "Expansion" area, is in its second season in 2009. The San Joaquin site is 600 acres contiguous acres of walnuts divided into 22 blocks of varying age, varieties, and pest pressure. It is owned and managed by a single farming entity. The "Expansion" area consists of eleven contiguous walnut blocks, farmed by five owner/operators. The 180 acre Glenn site, consisting of a large block of Vinas and two small blocks with Tehamas and Chandlers, has also had five years with puffers. The Butte site is 205 acres of Vinas in two blocks. The Butte and Glenn sites both have areas within the blocks that have greater CM pressure and must be monitored very closely. The two sites in Tehama County have each used the puffers for two years and the Yolo site is in its first year.

This project was designed to manage codling moth with pheromones by lowering populations aggressively in the early years with supplemental insecticide treatments. After this, the treatments are reduced, eliminated, or switched to selective insecticides that are more environmentally friendly. In 2005, all first-year pheromone treated blocks at Glenn and San Joaquin (SJ) were supplemented with at least one insecticide treatment to ensure high quality nuts at harvest and reduce population levels at the start of the 2006 season. In 2006 and beyond, an emphasis was placed on managing codling moth population based on combo lure trap catches and in-season CM damage assessments. The sites established in 2007 and later have received very few applications of insecticide to control CM, a decision ultimately left to the grower.

Suterra CM puffers are deployed at or before the start of codling moth flight and are automatically programmed to emit a "puff" of pheromone at 15 minute intervals for a period of 12 hours each night. The puffers are arranged in a grid pattern at a rate of one puffer per two acres within the orchard and a slightly higher concentration along the outside edges. Each unit consists of a re-usable hard plastic cabinet which holds a 200-day supply can of aerosol pheromone and is powered by 4 D-cell batteries. Field workers at each site are trained to assemble them in the field and hang in the upper 1/3 of the tree canopy. The trial protocols originally called for servicing of the units at least once during the growing season to ensure operational integrity, even though they are designed to last 200 days without any maintenance. The puffers have been found to malfunction very rarely and servicing has been reduced to occasional spot checks.

Trial blocks were monitored with Pherocon VI Delta traps (Trece, Inc.) baited with the newer CM-DA "Combo" lure and hung high in the tree canopy at varying rates according to CM pressure and the needs of the grower. Very large orchards were divided into smaller blocks for monitoring purposes. Monitoring blocks ranged in size from 10 to 25 acres, each with a Combo lure trap placed high in the canopy. For assurance that mating is being disrupted, additional traps with "1X" lures (Trece Standard Lure) were hung low in the canopy. The 1X traps act as an "early warning system": they should not catch any moths in a pheromone-treated orchard. Traps were checked weekly and the lures changed as recommended by the manufacturer. Data from Combo lure traps provide a picture of CM generations and peaks in flight, useful for timing of sprays. Seasonal total catches from these traps are also used as an indicator of CM population size.

Crop damage from the second flight and subsequent generations was monitored with "canopy counts" performed from ground level or at mid-canopy height with a pruning tower. In each block, 500 to 1,000 nuts at random locations in the canopy were examined and percent CM damage was recorded. In-season damage surveys followed protocols available at http://www.ipm.ucdavis.edu/index.html. Data collected from all monitoring activities were shared with the grower/cooperator and the independent consulting firms providing Pest Control Advisor service to the grower.

Supplemental insecticides were applied as needed using the growers' choice of materials, based on field monitoring and damage in individual blocks. Supplemental insecticides for CM control were unnecessary at many of the project locations in 2009, although sprays to control walnut husk fly (WHF) and navel orangeworm (NOW) were applied at some sites (Table 2). The majority of the project acreage did not receive supplemental CM control with insecticides in 2009.

Harvest samples were collected during commercial harvesting operations. Protocols for the collection of harvest samples varied slightly between sites due to differences in plot layout and to additional shaking and harvesting activities. At the San Joaquin sites, twenty to twenty-five 25-nut samples were collected from the ground after shaking in each test block. At the Yolo, Glenn and Butte sites, ten 50-nut samples were collected in each of the monitoring blocks/areas. At the Tehama sites, 1,000 nuts were collected from each monitoring area. At the Butte site, samples were collected again during a second shake which occurred 2-3 weeks later, because the majority of the crop remained on the trees after the first harvest. All nuts were cracked and examined to assess damage from codling moth and navel orangeworm. Harvest samples reported here include total damage found in "sound" nuts (with intact kernels) and "unsound" nuts (with shriveled kernels) that would probably be removed and discarded during normal pickup and processing operations. Thus sample damage levels are sometimes higher than growers' harvest grade results.

RESULTS

Puffers were deployed in a timely manner in all test blocks, before any first flight significant CM activity. Assembly and installation was done by each grower's field staff after receiving training from UC and Suterra personnel. The puffer units performed well all season, even continuing to function after falling from the tree. Installed at an overall density of slightly more than one puffer per 2 acres, the project sites described here use more than 1,000 puffer units, many of which have been in the field for several years. In previous years, calculations based on the weight loss of the aerosol cans showed them to be emitting pheromone within the daily expected range; the average weight loss was 2.2 grams per day.

In 2008 and 2009, some blocks were surveyed with the use of a pruning tower due to concerns that ground-based searches may underestimate CM damage. Very little CM damage was found during any of these surveys, with less than 1% damage to nuts in the canopy in pheromone treated blocks at all Sacramento Valley sites in 2009.

At the San Joaquin site where puffers have been used since 2006, codling moth populations, as indicated by total seasonal CM-DA trap captures in each block, have steadily declined (Figure 2). Trap captures were so low in 2009 that canopy damage assessments were deemed unnecessary in all but a a few blocks near the periphery of the site, and the results of these assessments (data not shown) indicated that supplemental insecticide treatments were not warranted in any block. As such, no codling moth treatments were applied at this site in 2009 (or 2008). Some of these "edge" blocks sustained minor codling moth damage at harvest. In all cases, this damage occurred in trees very near to the outside edge of these blocks (Figure 3). The grower cooperator at this site considers this level of codling moth damage acceptable and has elected not to address these residual "edge" populations and damage with insecticide treatments.

Codling moth populations also declined in 2009 compared to 2008 in all San Joaquin "Expansion" area sites (Table 3). In general, supplemental codling moth insecticide applications were made when deemed necessary by canopy damage assessments, and fewer treatments were made in 2009 than 2008. These favorable results and trends are generally consistent with those observed in other second-year puffer deployment sites. Three of the blocks with codling moth damage at harvest (Hartley 45a, Chandler 45a and Vina 44a) are "edge" blocks with a codling moth population assumed to be residual from an apple orchard formerly located to the west and north of these blocks. Greater harvest damage occurred in the Serr 30a block than was anticipated by early season canopy damage assessments or CM trap captures. Unlike other "edge" blocks with CM damage, CM-infested nuts were randomly distributed through the block at harvest and not concentrated near the edge of the block. This block will be closely monitored – and treated if necessary – in 2010.

In the Sacramento Valley, overall harvest damage from CM, averaged over the entire site, was very low (Table 2). The Glenn site, with 1.2% was the only location with more than 1% CM damage. Some of the samples did include a small amount of damage from NOW, but all were less than 1% NOW damage.

Codling moth population reduction over time can be shown by comparing the total moth capture in combo traps for each year. However, total trap catches are not always a reliable indicator of damage at harvest. Comparing crop damage from the same blocks over time is more useful for tracking progress and identifying field areas that may need more attention. At the Glenn County site, for example, although the number of supplemental CM treatments has been reduced since 2005, and the 2009 season only required CM treatment on about 10% of the site, harvest damage has remained low while insecticide inputs have been reduced. The Butte County site has not received any supplemental CM treatments for 3 years and the two Tehama sites have also received no supplemental CM sprays in the 2 years with puffers. The Yolo site received one application of Lorsban for CM, a reduction from 2008 when that site did not have pheromone mating disruption and received three insecticide sprays.

DISCUSSION

Codling moth damage, total trap catches, and the number of sprays can be compared to previous years to demonstrate reduction of broad spectrum insecticides and a move to softer insecticides to supplement PMD.

The grower/cooperators at the trial sites are enthusiastic about integrating aerosol puffers into their pest management program. Most of the sites began with grower-initiated implementation and all the growers now purchase their own puffer units and aerosol cans without monetary support from this project. The PMA plans to continue aerosol puffer implementation assistance, if funding allows, several more years at the more recently created sites to demonstrate the long term successes that have been seen in other crops such as pears. Several of the cooperating growers have expressed a desire to eliminate supplemental insecticides for CM and rely solely on the puffers for control from the first year on. Monitoring insect populations and in-season damage in pheromone-treated blocks will always be necessary and is especially important as insecticides are reduced or eliminated. Efforts to develop treatment thresholds if/when supplemental sprays are needed are ongoing so walnut growers have confidence in pheromone-based pest management programs. The puffer units have been very reliable as well as cost effective at approximately $70.00 per acre, a cost which is competitive with conventional insecticide programs used by many growers.

These successful demonstrations are creating more interest and confidence in integrating pheromone mating disruption into walnut pest management programs.

Table 1. 2009 CM Puffer Project Sites.

LOCATION	# YEARS	ACRES	# BLOCKS	VARIETIES
San Joaquin	5	600	22	Chandler, Hartley, Howard, Serr, Tulare, Vina
SJ expansion	2	540	10	Chandler, Hartley, Serr, Vina
Glenn	5	180	3	Chandler, Tehama, Vina
Butte	3	205	2	Vina
Yolo2	1	180	4	Chandler, Hartley, Tehama, Vina
Tehama-S	2	120	2	Ashley, Tehama
Tehama-N	2	160	2	Vina

Table 2. Sacramento Valley Sites. Number. of codling moth sprays applied, season total trap catches, and percent damage at harvest 2009. Sprays to control pests other than CM are not included.

LOCATION	# OF CM SPRAYS	COMBO TRAP TOTALS Moths/trap	Harvest Damage % CM	Harvest Damage % NOW
Tehama-N	0	5.5	0.0	0.1
Tehama-S	0	38.2	0.1	0.7
Butte	0	154.3	0.7*	0.2*
Glenn	spot treat only	54.75	1.2	0.4
Yolo	1	131	0.5	0.1

*Butte data from 1st shake only

Table 3. In-season and harvest codling moth damage, number of CM insecticide treatments applied, and seasonal CM-DA 'Combo'total trap captures for eleven walnut blocks in San Joaquin "Expansion" area-wide pheromone puffer site.

	Year	Canopy damage assessment% CM damage		% CM damage at harvest	No. CM sprays applied	Total seasonal 'Combo' trap capture, moths/trap
		End 1st generation	End 2nd generation			
Hartley 45a	2008	0	0	1.0	0	9
	2009	0.3	0.3	0.6	0	2
Chandler 45 a	2008	1.1	0.2	0.0	2@west half	61
	2009	5.4	1.9	0.4	0	39
Vina 44 a	2008	0.8	0.0	0.0	2	80
	2009	1.8	2.1	1.0	1	26
Chandler 20 a	2008	0.8	0.2	0.0	0	80
	2009	0.2	0.0	0.0	0	22
Serr 30 a	2008	0.0	0.0	0.0	1	63
	2009	0.2	0.3	1.8	0	14
Chandler 60 a	2008	0.0	0.0	0.0	1	41
	2009	0.0	0.3	0.0	0	10
Hartley 55 a	2008	0.0	0.0	0.0	0	46
	2009	0.0	0.0	0.0	0	14
Vina 65 a	2008	0.0	0.2	0.0	0	28
	2009	0.5	0.5	0.2	0	20
Chandler 68 a	2008	0.0	0.0	0.0	0	25
	2009	Not included in 2009				
Chandler 40a	2008	0.0	0.2	0.0	1	12
	2009	0.2	0.0	0.0	0	7
Serr 40 a	2008	0.2	Not done	0.4	2	101
	2009	1.3	1.0	0.3	0	26

Table 4. Glenn puffer site five years data

		2009	2008	2007	2006	2005
VINA	% CM @ harvest	1.9	0.2	2.1	0.3	0.5
	Trap totals, moth/trap	79	194	150	86	36
	# of CM sprays	spot treat	2	1	2	3
TEHAMA	% CM @ harvest	0.8	0.0	1.6	0.1	0.1
	Trap totals, moth/trap	37	103	52	14	61
	# of CM sprays	0	2	1	1	3
CHANDLER	% CM @ harvest	0.0	0.0	0.3	0.0	0.3
	Trap totals, moth/trap	25	115	142	27	247
	# of CM sprays	0	1	1	0	1

Figure 1. Codling Moth Trap Catches at Selected Puffer Sites 2009

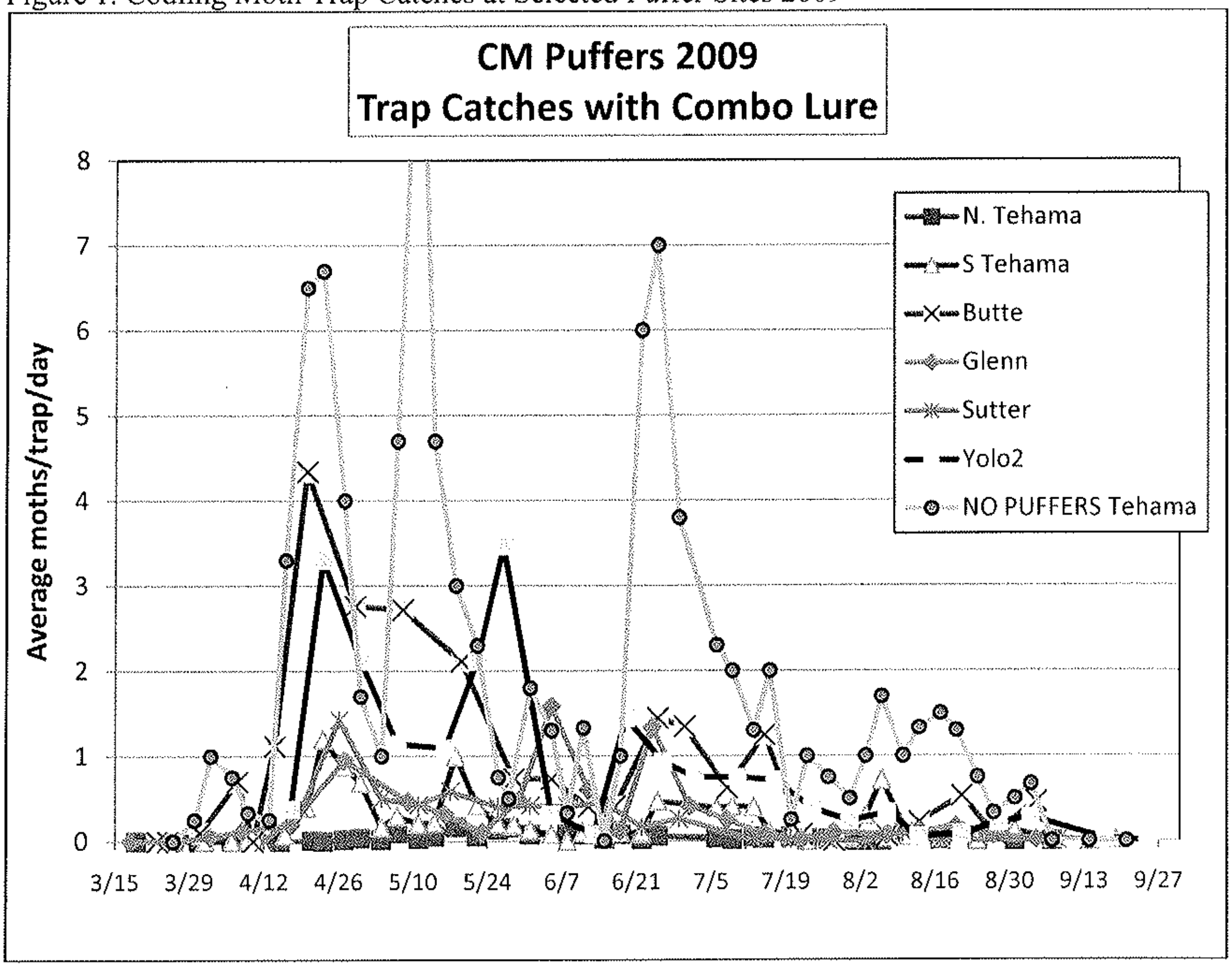

Figure 2. Total CM-DA 'Combo' lure-baited trap capture, all blocks, San Joaquin puffer demonstration site. Average (1 to 4 traps/block) trap capture per block, summed across all blocks.

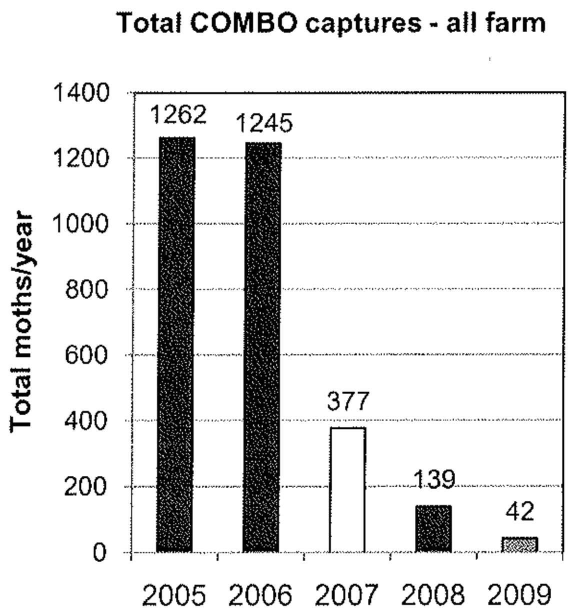

Figure 3. Percent codling moth damage at harvest, 2008 and 2009, at Locke Ranch pheromone puffer demonstration site. Blocks with no values shown had no CM damage in 2008 and 2009.