USING AEROSOL PHEROMONE "PUFFERS" FOR AREA-WIDE SUPPRESSION OF CODLING MOTH IN WALNUTS: YEAR TWO
&
DEMONSTRATION OF AERIALLY APPLIED PHEROMONE LAMINATE FLAKES

C. Pickel, J. Grant, S. Welter, R. Buchner, and S. Goldman Smith

ABSTRACT

The Walnut Pest Management Alliance (PMA) continued its efforts to reduce pesticide inputs in California walnuts with an eighth year to demonstrate and move toward implementation of pest management strategies based on pheromone mating disruption. The PMA continued to investigate new application technologies for use of pheromone mating disruption (PMD) in walnuts in an effort to improve efficacy and reduce the cost so that walnut growers have confidence to adopt a pheromone-based mating disruption pest management program. Two application technologies were tested in 2006 using separate methodologies. Two aerosol puffer trials completed their second year and the benefits of using PMD over a large area for several years are already becoming evident in reduced crop damage and reduced codling moth (CM) populations. Both locations had reduced CM damage in 2006 compared to 2005 with 0.6% CM or less on 180 acres in Glenn County and 1.2% CM or less on 564 acres in San Joaquin County, with several blocks having 0% CM damage. A new application technology for applying Hercon laminate flakes was demonstrated at three sites in the Sacramento Valley. Two applications of the flakes broadcast aerially provided codling moth control statistically similar to grower standard treatments which used several insecticide sprays.

INTRODUCTION

In 2006, the PMA tested two different tactics for the application of PMD. The two long-term, area-wide projects using aerosol pheromone puffers were continued for a second year and replicated trials were conducted using aerially applied laminate flakes as dispensers. Puffers were deployed at a rate of one unit per two acres in the same grid pattern used in 2005. A new model Suterra puffer cabinet which is easier to use and more reliable was used at both sites. Supplemental insecticides were applied only as needed, based on field monitoring and damage in individual blocks in 2005. The projects are beginning to see the benefits of area wide long-term PMD with increased harvest quality, fewer conventional insecticide applications, and declining populations of (CM).

New in 2006, a custom applicator was designed to aerially broadcast Hercon micro-flakes and sticker from a bucket suspended below a helicopter. The walnut PMA has previously conducted field tests with the Hercon micro-flakes, but the application methods were unsatisfactory or the flakes did not remain in the trees. Hercon reports that flakes release pheromone for about 65 days under average weather conditions, so two applications are necessary to cover the crop season. These trials include a treatment block using conventional pest management and an untreated control for comparison purposes. Results are measured by in-season damage surveys and assessing codling moth damage at harvest.

OBJECTIVES

1. Validate pheromone application technology required for control of codling moth with an emphasis on "area-wide" control over multiple years. Continue existing trials in San Joaquin and Glenn Counties using aerosol puffers. Monitor codling moth populations 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 or eliminated.
2. Field test new pheromone application technologies that have a high potential for use in walnuts.
3. Assist with and demonstrate the use of monitoring for CM damage for growers who are interested in implementation of pheromone mating disruption.

PROCEDURES

Aerosol Puffers

Both locations chosen to demonstrate the use of Suterra's aerosol pheromone puffers for CM management are large areas of contiguous walnut orchards of several different varieties. Both sites include blocks with historically high CM pressure as well as portions planted with varieties that are more resistant to CM damage. The Glenn County site is 185 acres of walnuts and consists of three blocks, each a different variety and age (Figure 1). The San Joaquin County site is 564 acres comprised of 22 blocks of various tree size, age, and variety (Figure 2).

This project was designed to manage codling moth with pheromones by lowering populations aggressively in the early years with insecticides. After this, the supplemental treatments would be reduced or eliminated, or switched to less effective but more selective insecticides that are more environmentally responsible. As the population is brought down, the supplemental insecticides are withdrawn and decisions are made based on monitoring data. Although the benefits of pheromone puffers will extend equally over the whole trial site, each block is managed separately. In 2005, all pheromone treated blocks 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, an emphasis was placed on managing codling moth population based on combo lure trap catches and not based on potential damage to the nuts. The two trial locations are independent and the results are not meant to be compared to each other.

At both sites, Suterra CM puffers were installed at a rate of one puffer per two acres with a slightly higher concentration along the outside edges. After recording the initial weight of each aerosol pheromone can, the units were assembled and deployed at or before the start of codling moth flight when possible. The units are hung with rope in the upper ¼ of the tree canopy and programmed to emit a 40 mg. "puff" of pheromone at 15 minute intervals for a period of 12 hours each night, beginning at 5 PM. Although they are designed to last 200 days, the trial protocols called for servicing of the units on a regular basis to ensure operational integrity. The aerosol cans were weighed at each servicing, and again at the end of the season when they were removed from the field.

The puffer trials were monitored with Trece Phreocon VI "wing" traps used in sets of two. Each pair included one trap baited with the newer "DA/CM combo" lure and hung high in the tree canopy and one with the traditional 1X pheromone lure 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. The Glenn County trial had 8 pairs of traps, one pair per every 25 acres. The San Joaquin trial used traps at a higher density, with a total of 39 pairs of traps. All traps were checked weekly and the lures changed as recommended by the manufacturer.

In-season "canopy counts" of CM-damaged nuts were performed at least twice during the season, more if time allowed. At the Glenn site, 1000 nuts throughout the tree canopies were examined for CM damage in approximately every 25 acres. At the SJ site, 600 nuts were examined in each block. Independent consulting firms provide Pest Control Advisor service to both of the grower/cooperators involved. Data collected from all monitoring activities was shared with the grower/cooperator and Pest Control Advisor.

Supplemental insecticides were applied as needed using the growers' choice of materials, based on field monitoring and damage in individual blocks in 2005. Tables 1 and 2 list insecticide sprays to the Glenn and San Joaquin sites, and include all those which could affect codling moth, though some sprays target other insect pests such as walnut husk fly or navel orangeworm. Codling moth damage, total trap catches, and the number of sprays were compared to previous years to demonstrate reduction of broad spectrum insecticides and a move to softer insecticides to supplement PMD.

Harvest samples were collected during commercial harvesting operations. Protocols for the collection of harvest samples varied slightly between the two sites due to the difference in plot layout. At the San Joaquin site, twenty 25-nut samples were collected from under trees after shaking in each test block. At the Glenn Co. site, ten 50-nut samples were collected in the general area of each of the 8 monitoring areas discussed above. All nuts were cracked and examined to assess damage from codling moth and navel orangeworm.

Laminate Micro-Flakes

In 2006, aerially applied Hercon laminate micro-flakes were used at three trial locations in the Sacramento Valley. The intentions of these trials were to test efficacy and a method of application and to document whether the flakes remained in the canopy or fell on the ground. The new bucket-type applicator and a reformulated sticker were used, both developed by Hercon Environmental

The Hercon treatment blocks were between 14-20 acres, and each location included a "grower standard" (GS) where the grower used conventional pest control materials of his choosing. Each trial also included an untreated area of 1 to 2 acres. The Hercon flakes were applied at approximately 65 day intervals beginning when overwintering generation female moths began to be consistently caught in the indicator traps and the orchards had leaves mostly expanded. The Hercon treatment blocks at all three sites also received a supplemental Lorsban application to reduce risk to the grower, and because two of the locations had an unknown (to UC researchers) CM population.

To obtain data measuring how well the Hercon flakes stuck on the leaves, both during the applications and for the 65 days afterwards, sheets of black plastic were laid on the ground and pinned down at the edges. The plastic sheets were 10 ft X 25 ft each and were placed in the tree row between two trees, five replicates at each location. The day of application and every week

after that, any flakes that were on the plastic were counted and removed. This was repeated for each of the applications of flakes, with separate totals for the two applications.

Test blocks were monitored with pairs of traps as described above for the aerosol puffers. The traps were checked weekly to follow the CM flights and changes in population. The lures were changed according to the manufacturer's instructions. Canopy counts were also conducted as described previously, surveying 1000 nuts per treatment block near the end of each flight. If, at any time, more than 2% damage was found in the Hercon test block, the grower was advised to apply a supplemental insecticide of their choice. Insecticide sprays listed in Table 3 include those aimed at other insects as well as codling moth. Harvest sampling and processing was performed following the same protocols as the aerosol puffer project, collecting 50 nuts from 10 randomly selected trees in each treatment block, for a total of 500 nuts per block.

RESULTS

Aerosol puffers

The traps baited with the 1X lure caught no moths at either site after puffers were deployed. "Combo" trap catches provided a good picture of CM generations and peaks in flight, shown in Figure 3 Glenn site, and Figure 4 San Joaquin. At the Glenn site, flooding from the Sacramento River caused the Vina orchard to be inaccessible for puffer placement until the first week of May when there was already considerable CM activity. The Northeast section of the Vinas was the last area to have CM control from the pheromone puffers, resulting in increased trap catches for the whole season in this location.

The puffer units performed well all season with very few malfunctions. Calculations based on the weight loss of the aerosol cans showed them to be emitting pheromone within the daily expected range. The 81 aerosol cans at the Glenn site each lost an average of 2.2 grams per day. Details of the puffer units' servicing records are not presented here.

Canopy counts were performed twice during the season, in late June and again at the beginning of August. Very little evidence of damage from CM was found during these surveys, with all blocks at the Glenn site showing less than 1% damage (Table 4). The SJ site also had very little in-season damage, with a couple of exceptions (Table 5). In the first canopy count, Field 2, planted to the Serr variety, was the only block with more than 0.5% damage. Field 2 also had the most CM damage found during the second canopy count with 2.3%, and was one of only four blocks to have more than 1% damage.

Harvest samples reported here include only damage found in "sound" nuts (with intact kernels) and not "unsound" nuts (with shriveled kernels) that would probably be removed and discarded during normal pickup and processing operations. Thus sample damage levels are comparable to growers' harvest grade results. Both trial locations had very little damage from navel orangeworm or codling moth, with several blocks having zero percent damage (Tables 4 and 5). Overall, 2006 damage levels were much lower those observed in the same blocks in 2005. Three-quarters of the blocks at the Glenn site had less damage in 2006 than 2005 (Figure 5). All blocks at the SJ site had less damage in 2006 than 2005 (Figure 6).

Codling moth population reduction can be shown by comparing the total moth capture in combo traps for each year. At the Glenn site (Figure 7), seasonal trap captures were lower in 2006 than

2005 in most blocks. The large trap captures in the Northeast Vinas were attributed to puffers being deployed after the start of the first codling moth flight. At the SJ site there were no consistent differences between 2005 and 2006 in seasonal trap catches (Figure 8).

Laminate Micro-Flakes

In these trials, the traps baited with the combo lure and placed high in the canopy showed CM flight activity in all treatments. The 1X traps, hung low in the tree, show that the treatment is working when they catch zero moths in the pheromone-treated area, but still catch moths in the Grower Standard and Untreated Control. This trap shutdown is measured by comparing total 1X trap catches in the Hercon block to total trap catches in the Untreated Control, both 1X-Low and combo-High (Figure 9). The 1X trap at the Tehama site was shutdown 100%, the Butte and Glenn sites caught a couple of moths in the 1X traps, resulting in slightly less than 100% shutdown. These moths were found in the 1X traps in mid- and late-August when populations were increasing and long periods of very high temperatures may have started to reduce the effectiveness of the pheromone in the Hercon flakes.

In-season damage assessments in the canopy were conducted three times at the Butte and Glenn sites, but only once at the Tehama site because a pruning tower was required to reach the tree canopy. Later season canopy counts can be a good indicator of harvest damage levels. Table 6 shows data from the canopy count in early August, at the end of the second flight, with CM damage well below 2%.

To catch any Hercon flakes that fell from the trees, the plastic sheets were placed on the ground before the first application. The sheets were put between trees of varying canopy size and density to represent the whole orchard. The highest numbers of flakes were found on the plastic sheets just after the application, and for about 2-3 weeks afterwards (Figures 10 & 11). The Tehama county site was the Tehama variety which is a later leafing variety with a larger tree canopy and had less leafing than the other 2 orchards at the 1st application allowing a high number of the flakes to fall on the plastic. At the 2nd application it had the least flakes fall when it was fully leafed out. For the remaining weeks, very few flakes dropped on the plastic indicating that, with good contact between the leaf and the flake, the majority of the flakes remained in the canopy. Some flakes were found still stuck on leaves at the end of the season as the trees began to defoliate.

Harvest samples reported here contained data from only the “sound” nuts, as described in the above section. Damage from both codling moth and navel orangeworm was recorded for each of the treatment blocks (Table 7). Harvest data from the three trials was pooled, with each location as a rep. Average codling moth damage was less than 1% in all treatment blocks (Figure 12), with no statistically significant differences between them. In general, the Hercon-treated blocks were supplemented with one Lorsban spray, and one site received another Lorsban application for walnut husk fly. The Grower Standard blocks all received either two or three insecticide applications. Numerically, the harvest damage in the Hercon-treated blocks was half that of the Grower Standard blocks, showing that Hercon micro-flakes provided codling moth damage suppression better than conventional insecticides. This shows pheromone mating disruption can be integrated into a codling moth management program and can control CM damage as well as conventional methods.

DISCUSSION

The grower/cooperators at both of the puffer trial sites are enthusiastic about integrating aerosol puffers into their pest management program. The PMA plans to continue the aerosol puffer trials for up to three more years to demonstrate the long term population reduction and reduced use of pesticides that have been seen in other crops such as pears. In the next couple of years these trials will rely less on pesticide inputs, with 2005 acting as a baseline for the comparisons of damage and documentation of pesticide use reduction in each block.

The bucket applicator for the Hercon micro-flakes was designed jointly by Russ Stocker of ARENA Pest Management and Hercon Enviromental, and was operated by AvAg aerial applicators. It is one of several methods of applying the Hercon flakes, so far the most successful. The application is quick and faces no obstructions from wet soil, irrigation pipes, or other ground operations and above all, easy for the grower. It also makes the application in the top of the tree canopy which would be difficult to do in the large walnut trees.

An ongoing challenge is the monitoring of CM flights in and close to pheromone-disrupted orchards. 2006 was the third year of using combo lures to overcome this difficulty. In some cases, lures were provided to neighboring growers in case the pheromone treatments (especially the puffers) shut down their conventional pheromone-baited traps. In fact, communication with neighboring growers is becoming more important as pheromones are being more widely used for pest management.

Goals for 2007 include expansion of the puffer treated areas by encouraging the neighboring walnut growers to participate, taking advantage of the benefits of a larger area utilizing PMD to control CM. These successful demonstrations are creating more interest and confidence in integrating pheromone mating disruption into walnut pest management programs.

TABLES AND FIGURES

Table 1. Supplemental Insecticides at Glenn Puffer Trial in 2006

	Apr 21	May 6-8	Mid - May	Mid -Aug	Early – Sept.	Mid – Sept.
VINAS	--	puffers installed	Asana	Lorsban + Onager NORTH ½ ONLY	Ethrel + permethrin	--
TEHAMAS	puffers installed	--	Asana	--	Ethrel + permethrin	--
CHANDLERS	puffers installed	--	--	Lorsban + Onager EOR for tent caterpillars	--	Ethrel + permethrin

* EOR = Every Other Row application

Table 2. Supplemental Insecticides at San Joaquin puffer site in 2006.

Field/Variety	Date	Treatment	Target Pest
1	4-May	Dipel, EOR*	Leaf Roller
Tulare	3-Jun	Warrior, NuFilm P	CM
	26-Jun	Surround	
	8-Aug	Brigade	Aphid, WHF, CM, Mites
	22-Aug	Success + Nulure, EOR*	WHF
2	27-Apr	Dipel, EOR*	Leaf Roller
Serr	18-May	Lorsban	CM
	21-Jun	Surround	
	28-Jul	Success, Nulure EOR*	WHF
	9-Aug	Brigade	Aphid, WHF, CM, Mites
	25-Aug	Success + Nulure, EOR*	WHF
3 & 20	2-May	Dipel, EOR*	Leaf Roller
Chandler	29-May	Warrior, NuFilm P	
	3-Aug	Success + Nulure, EOR*	WHF
	18-Aug	Success + Nulure, EOR*	WHF
4	11-May	Dipel, EOR*	Leaf Roller
Serr	16-May	Lorsban 4E	CM
Chandler	26-Jul	Success + Nulure, EOR*	WHF
	2-Aug	Success + Nulure, EOR*	WHF
	15-Aug	Success + Nulure, EOR*	WHF
5	18-May	Lorsban 4E	CM
Serr/Chandler	15-Aug	Success + Nulure, EOR*	WHF

6 Tulare	1-May 25-May 26-Jun 16-Aug 28-Aug	Dipel, EOR* Warrior, NuFilm P Surround 100lbs/Tank Brigade Success + Nulure, EOR*	Leaf Roller CM Aphid, WHF, CM, Mites WHF
7 Howard	2-May 26-May 26-Jun 16-Aug	Dipel, EOR* Warrior, NuFilm P Surround 100lbs/Tank Success + Nulure, EOR*	Leaf Roller CM WHF
8 Serr Chandler	16-May 26-Jul 12-Aug	Lorsban 4E Success + Nulure, EOR* Brigade	CM WHF Aphid, WHF, CM, Mites
9 Serr Chandler	12-May 17-May 1-Jun 22-Jun 10-Aug 24-Aug	Dipel, EOR* Lorsban 4E Lorsban 4E Surround 100lbs/Tank Brigade Success + Nulure, EOR*	Leaf Roller CM CM Aphid, WHF, CM, Mites WHF
10 Vina Serr	3-May 19-May 1-Jun 19-Jun 30-Jun 28-Jul 11-Aug 24-Aug	Dipel, EOR* Lorsban 4E Lorsban 4E Surround 100lbs/Tank Malathion + NuLure Success + Nulure, EOR* Brigade Success + Nulure, EOR*	Leaf Roller CM CM WHF Aphid, WHF, CM, Mites WHF
12 Serr Chandler	11-May 16-May 27-Jul 11-Aug 14-Aug 14-Aug	Dipel, EOR* Lorsban 4E Success + Nulure, EOR* Brigade Success + Nulure, EOR* Success + Nulure, EOR*	Leaf Roller CM WHF Aphid, WHF, CM, Mites WHF WHF
13 & 22 Chandler	10-May 30-May 28-Aug	Dipel, EOR* Warrior, NuFilm P Success + Nulure, EOR*	Leaf Roller CM WHF
14 & 15 Serr	11-May 17-May 22-Jun 28-Jul 2-Aug 14-Aug 28-Aug	Dipel, EOR* Lorsban 4E Surround 100lbs/Tank Success + Nulure, EOR* Success + Nulure, EOR* Success + Nulure, EOR* Success + Nulure, EOR*	Leaf Roller CM WHF WHF WHF WHF
18 Serr	1-Jun 28-Jul	Lorsban 4E Success + Nulure, EOR*	CM WHF

19 Hartley	27-Apr 30-Jun 11-Aug 18-Aug	Dipel, EOR* Malathion + NuLure Brigade Success + Nulure, EOR*	Leaf Roller Aphid, WHF, CM, Mites WHF
23 Howard	27-May	Warrior, NuFilm P	CM
24 Vina	25-Apr 24-May 20-Jun 29-Jun 27-Jul 4-Aug 9-Aug 22-Aug	Dipel, EOR* Lorsban 4E Surround 100lbs/Tank Malathion + NuLure Success + Nulure, EOR* Success + Nulure, EOR* Brigade Success + Nulure, EOR*	Leaf Roller CM WHF WHF WHF Aphid, WHF, CM, Mites WHF
25 Serr Chandler	12-May 17-May 21-Jun 27-Jul 4-Aug 18-Aug 29-Aug	Dipel, EOR* Lorsban 4E Surround 100lbs/Tank Success + Nulure, EOR* Success + Nulure, EOR* Success + Nulure, EOR* Success + Nulure, EOR*	Leaf Roller CM WHF WHF WHF WHF

* EOR = Every Other Row application

Table 3. 2006 Supplemental Insecticides at Hercon trials

	Hercon PMD	**GS**	**Untreated**
Butte	5/05 Hercon flakes 7/10 Hercon flakes 8/23 Omite 8/23 Lorsban, EOR*	5/16 Asana, EOR* 8/23 Omite 8/23 Lorsban, EOR*	 7/06 Lorsban outside plot
Tehama	5/05 Hercon flakes 7/06 Lorsban 7/10 Hercon flakes 8/17 Omite 8/17 Lorsban, EOR* (WHF)	 7/06 Lorsban 8/17 Omite 8/17 Lorsban, EOR* (WHF)	
Glenn	5/05 Hercon flakes 7/10 Hercon flakes 7/12 Lorsban 8/09 Omite	5/17 Asana 7/12 Lorsban 8/09 Omite 8/09 Asana	

*EOR = Every Other Row

Table 4. Glenn Puffer Trial
2006 Canopy Counts and Damage at Harvest

	Canopy Counts % CM		Damage at Harvest	
	June 19	Aug. 1	% CM	% NOW
Vinas NE	0.0	0.3	0.0	0.2
Vinas NW		0.4	0.4	0.4
Vinas SE		0.2	0.2	0.0
Vinas SW		0.0	0.6	0.8
Tehamas W	0.0	0.0	0.0	0.0
Tehamas E		0.4	0.2	0.0
Chandlers W	0.4	0.2	0.0	0.0
Chandlers E		0.1	0.0	0.0
	1,000-nut sample each		500-nut sample each	

Table 5. San Joaquin Puffer Trial
2006 Canopy Counts and Damage at Harvest

		Canopy Counts % CM		Damage at Harvest	
Block	Variety	6/28 to 7/06	7/31 to 8/11	% CM	% NOW
1	Tulare	-	-	0.00	0.0
2	Serr	1.5	2.3	1.20	0.0
3 & 20	Chandler	-	-	0.00	0.0
4	Chandler Serr	0.3 0.5	0.5 0.3	0.00	0.0
5	Serr/Chandler	0.0	0.3	0.40	0.2
6	Tulare	0.0	0.8	0.00	0.0
7	Howard	0.0	0.3	0.00	0.0
8	Serr Chandler	0.2	0.7	0.35* 0.20	0.0 0.0
9	Serr Chandler	0.0	0.8	0.80 0.20	0.0 0.0
10	Vina, Serr	0.0	0.0	0.00	0.2
12	Serr/Chandler	0.0	1.3	0.00	0.4
13	Chandler	-	-	0.20	0.2
14 & 15	Serr	0.3	1.3	0.40	0.0
18	Serr	0.0	0.0	0.00	0.0
19	Hartley	0.2	1.0	0.00	0.0
22	Chandler	-	-	0.00	0.0
23	Howard	-	-	0.40	0.2
24	Vina	0.0	0.0	0.20	0.0
25	Serr/Chandler	0.0	1.2	0.00	0.6
		600-nut sample each		500-nut sample each * Harvest sample of 283 nuts	

Table 6. Hercon Canopy Counts
% CM DAMAGE Early August 2006

Site	Hercon PMD	Grower Standard	Untreated Control
Butte	1.3	0.5	1.7
Tehama	0.6	0.9	0.9
Glenn	0.9	0.3	1.1
Average	0.93	0.57	1.24

Table 7. 2006 Percent Damage at Harvest from Codling Moth and Naval Orangeworm.

Site	Hercon PMD		Grower Standard		Untreated Control	
	% CM	% NOW	% CM	% NOW	% CM	% NOW
Butte	0.6	4.2	0.4	1.0	1.2	2.2
Tehama	0.4	0.8	1.2	0.8	0.8	0.2
Glenn	0.2	0.8	0.8	0.4	0.0	0.6
Average	0.4	1.9	0.8	0.7	0.7	1.0

Figure 1. Glenn County Puffer Trial

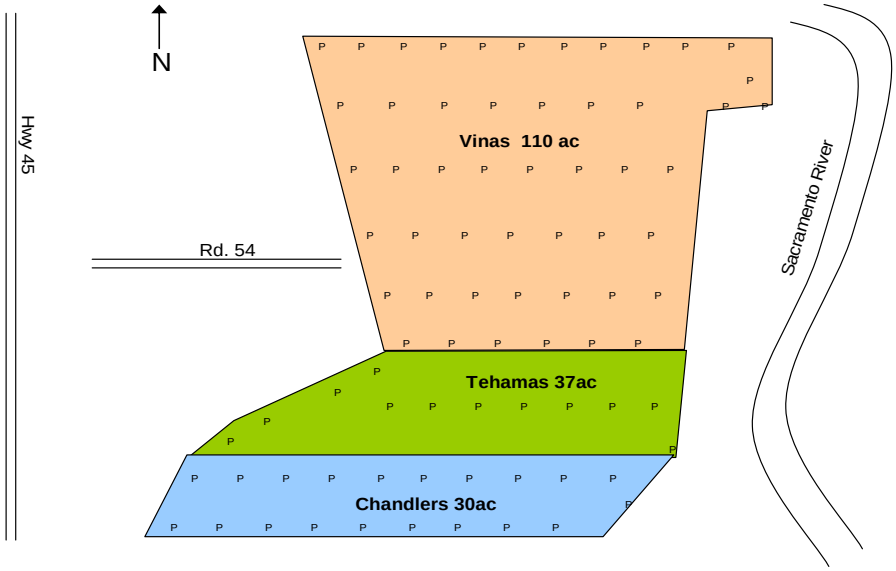
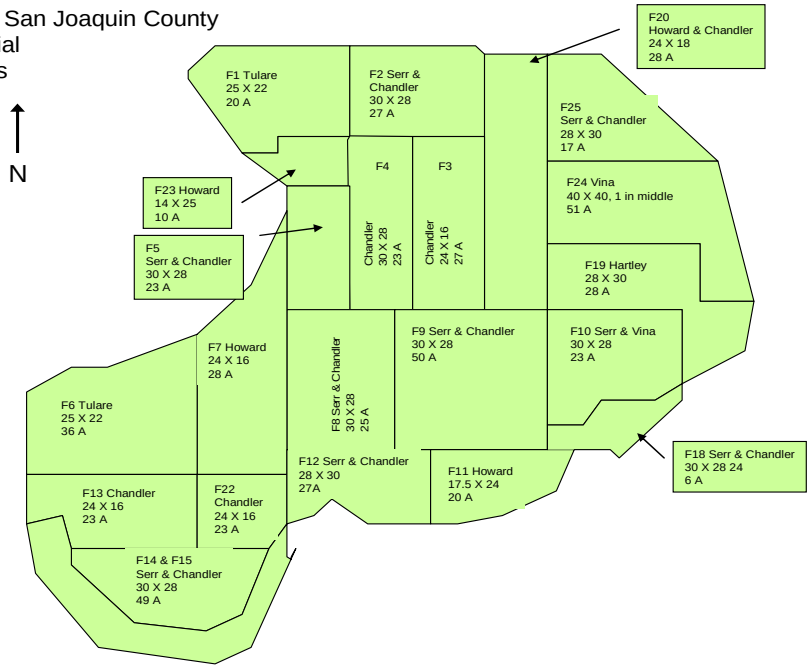


Figure 2. San Joaquin County Puffer Trial
560 acres



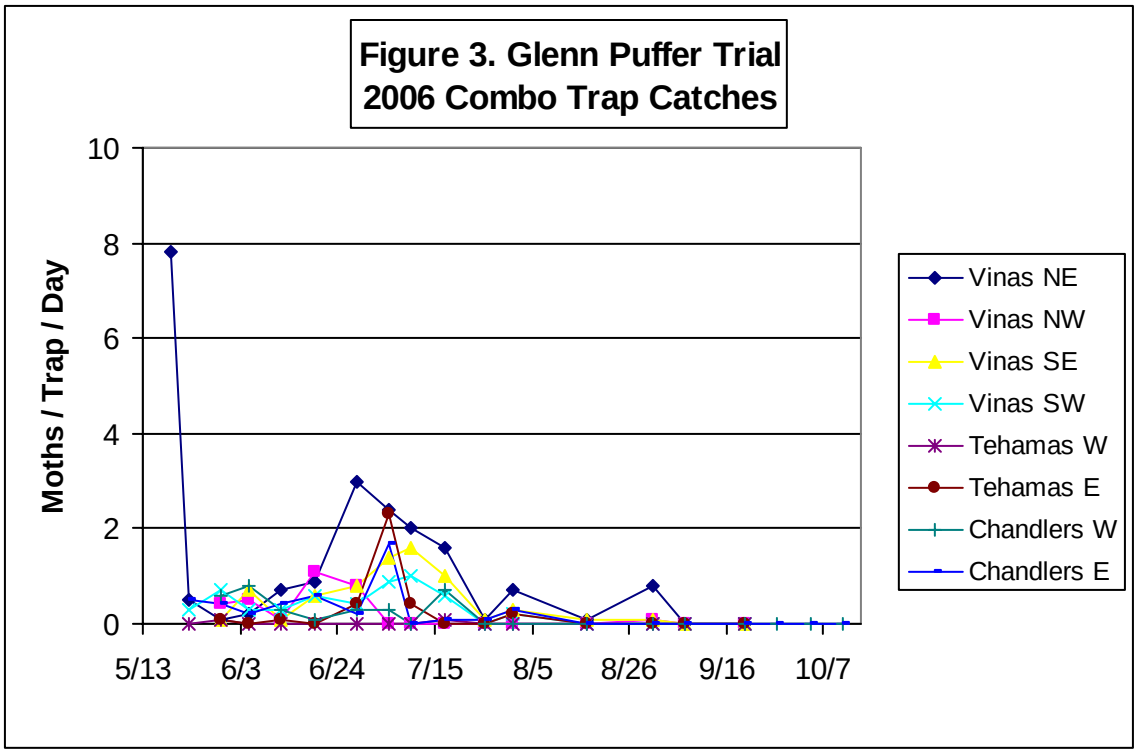


Figure 3. Glenn Puffer Trial
2006 Combo Trap Catches
Moths / Trap / Day
10
8
6
4
2
0
5/13
6/3
6/24
7/15
8/5
8/26
9/16
10/7
Vinas NE
Vinas NW
Vinas SE
Vinas SW
Tehamas W
Tehamas E
Chandlers W
Chandlers E

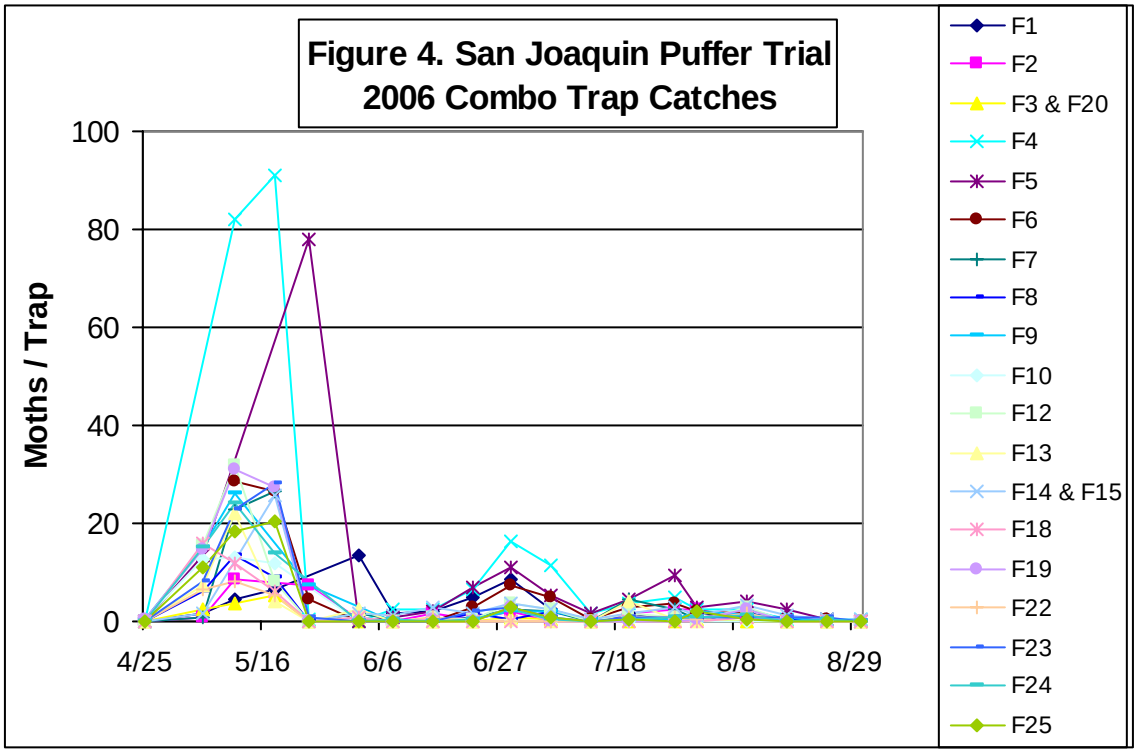


Figure 4. San Joaquin Puffer Trial
2006 Combo Trap Catches
Moths / Trap
100
80
60
40
20
0
4/25
5/16
6/6
6/27
7/18
8/8
8/29
F1
F2
F3 & F20
F4
F5
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F18
F19
F22
F23
F24
F25

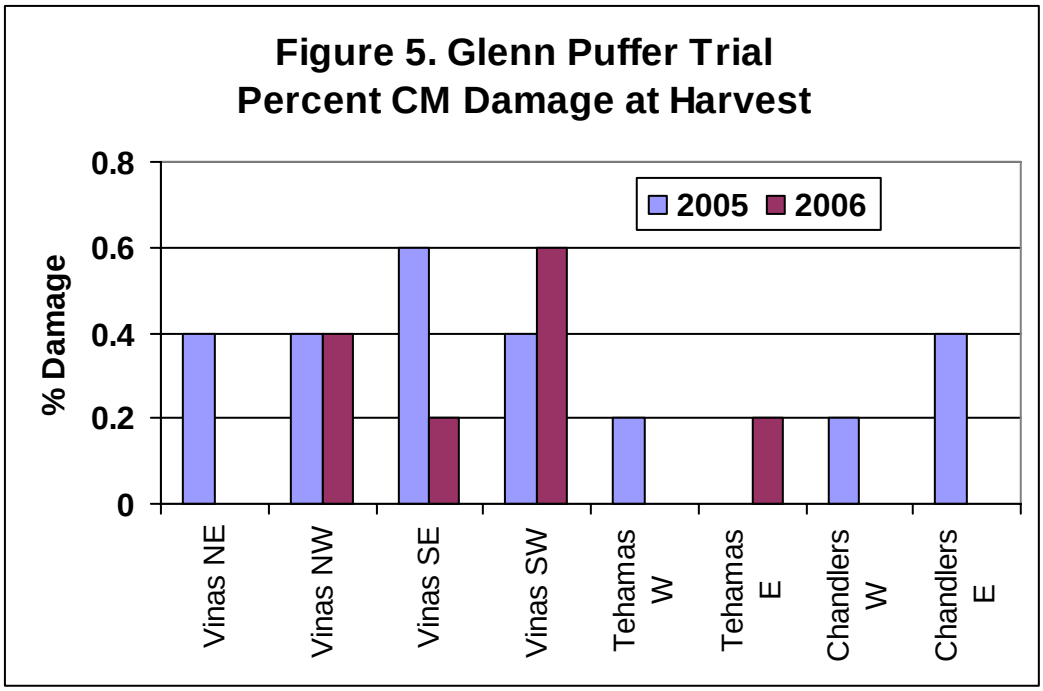
Figure 5. Glenn Puffer Trial
Percent CM Damage at Harvest
% Damage
0.8
0.6
0.4
0.2
0
2005
2006
Vinas NE
Vinas NW
Vinas SE
Vinas SW
Tehamas W
Tehamas E
Chandlers W
Chandlers E

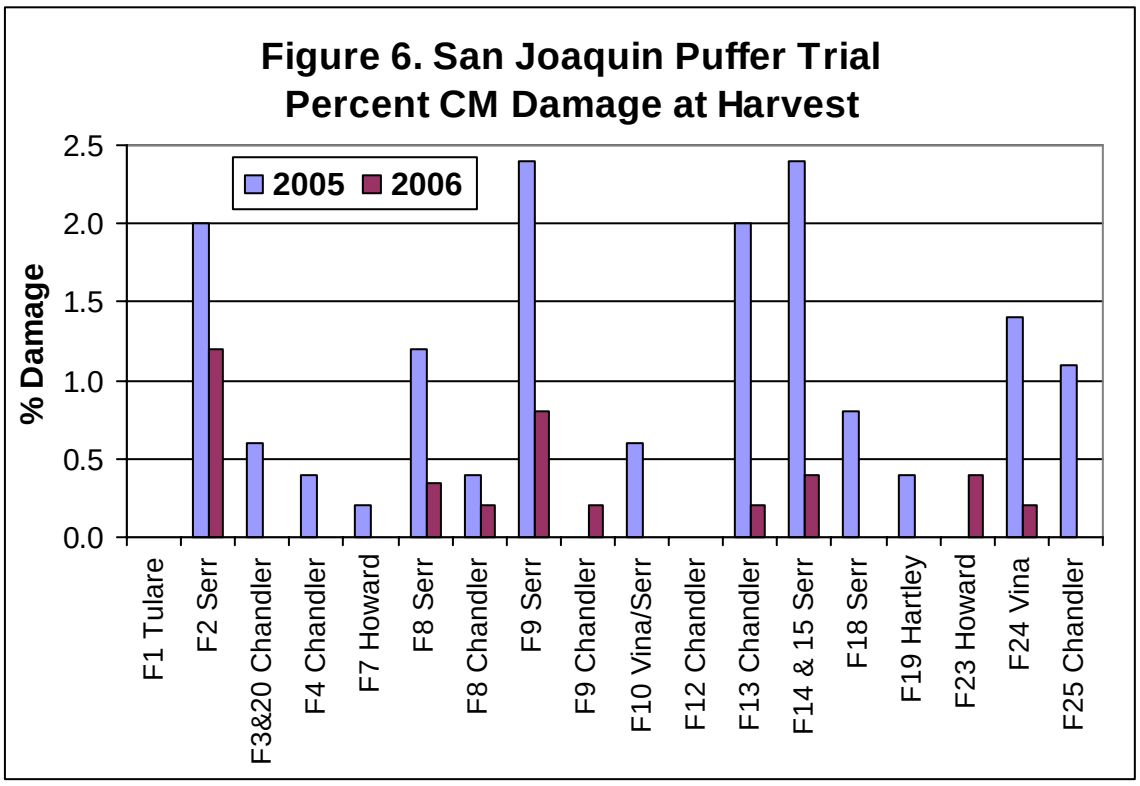
Figure 6. San Joaquin Puffer Trial
Percent CM Damage at Harvest
% Damage
2.5
2.0
1.5
1.0
0.5
0.0
2005
2006
F1 Tulare
F2 Serr
F3&20 Chandler
F4 Chandler
F7 Howard
F8 Serr
F8 Chandler
F9 Serr
F9 Chandler
F10 Vina/Serr
F12 Chandler
F13 Chandler
F14 & 15 Serr
F18 Serr
F19 Hartley
F23 Howard
F24 Vina
F25 Chandler

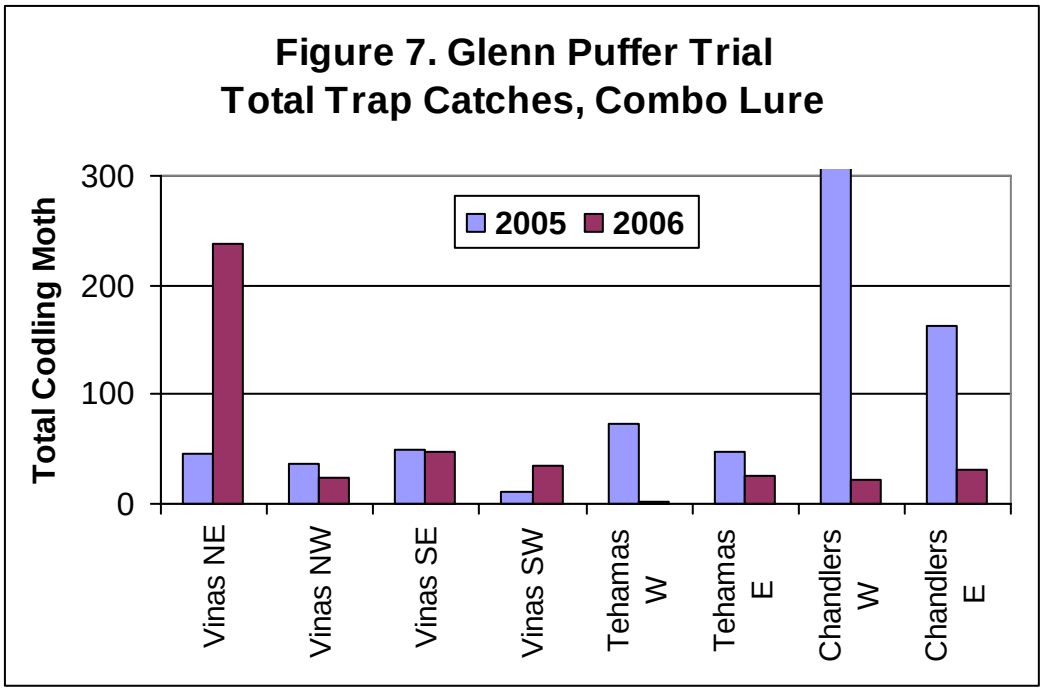
Figure 7. Glenn Puffer Trial
Total Trap Catches, Combo Lure
Total Codling Moth
300
200
100
0
2005
2006
Vinas NE
Vinas NW
Vinas SE
Vinas SW
Tehamas W
Tehamas E
Chandlers W
Chandlers E

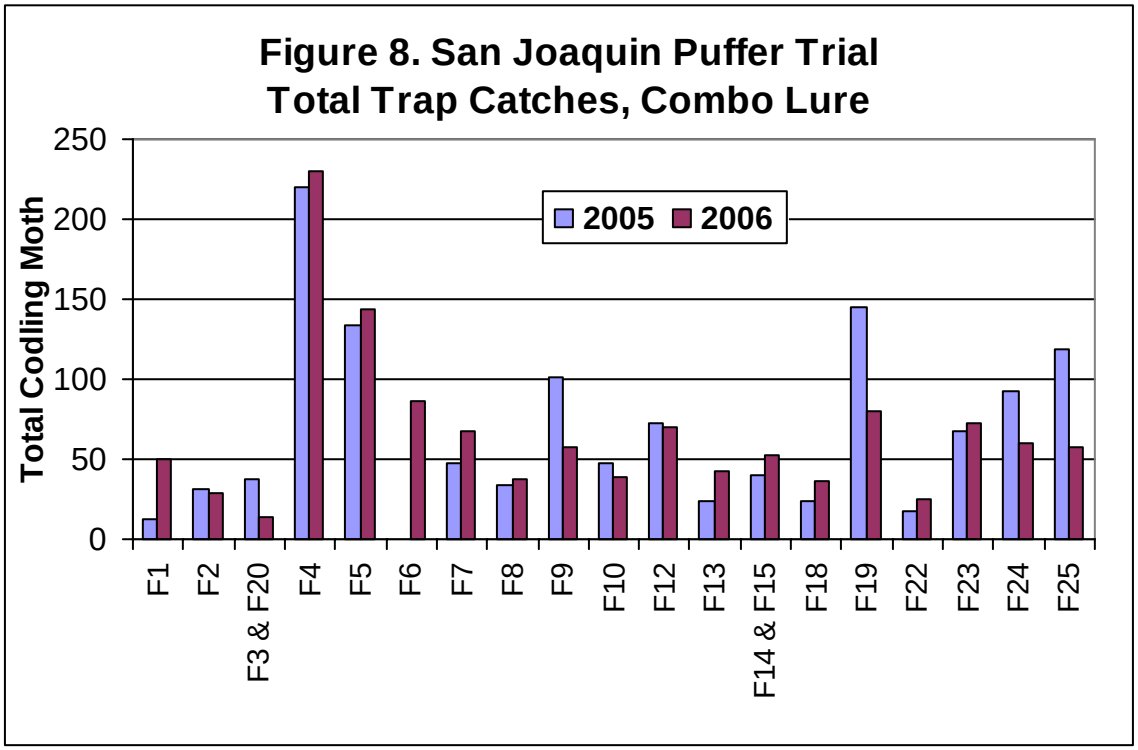
Figure 8. San Joaquin Puffer Trial
Total Trap Catches, Combo Lure
Total Codling Moth
250
200
150
100
50
0
2005
2006
F1
F2
F3 & F20
F4
F5
F6
F7
F8
F9
F10
F12
F13
F14 & F15
F18
F19
F22
F23
F24
F25

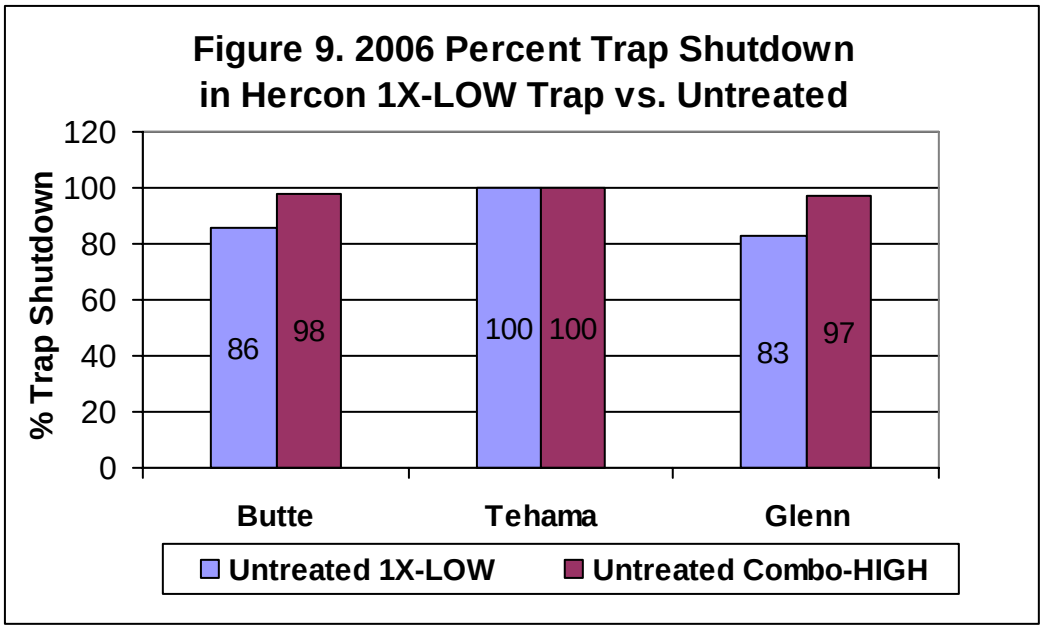
Figure 9. 2006 Percent Trap Shutdown
in Hercon 1X-LOW Trap vs. Untreated
% Trap Shutdown
120
100
80
60
40
20
0
86
98
100
100
83
97
Butte
Tehama
Glenn
Untreated 1X-LOW
Untreated Combo-HIGH

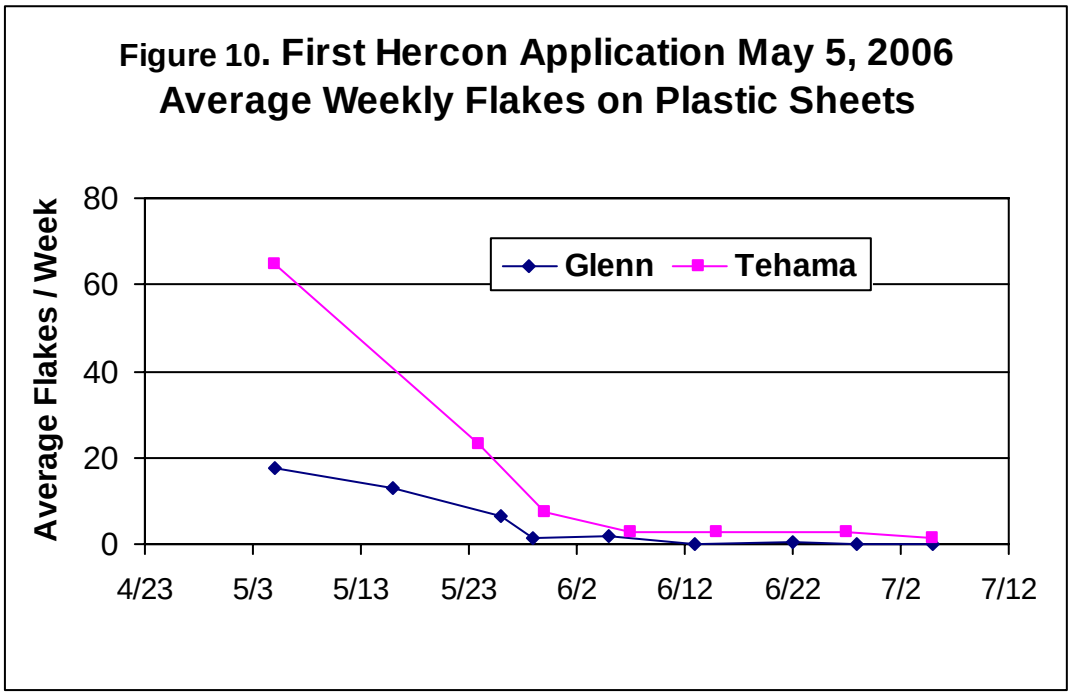
Figure 10. First Hercon Application May 5, 2006
Average Weekly Flakes on Plastic Sheets
Average Flakes / Week
80
60
40
20
0
Glenn
Tehama
4/23
5/3
5/13
5/23
6/2
6/12
6/22
7/2
7/12

Figure 11. Second Hercon Application July 10, 2006
Average Weekly Flakes on Plastic Sheets

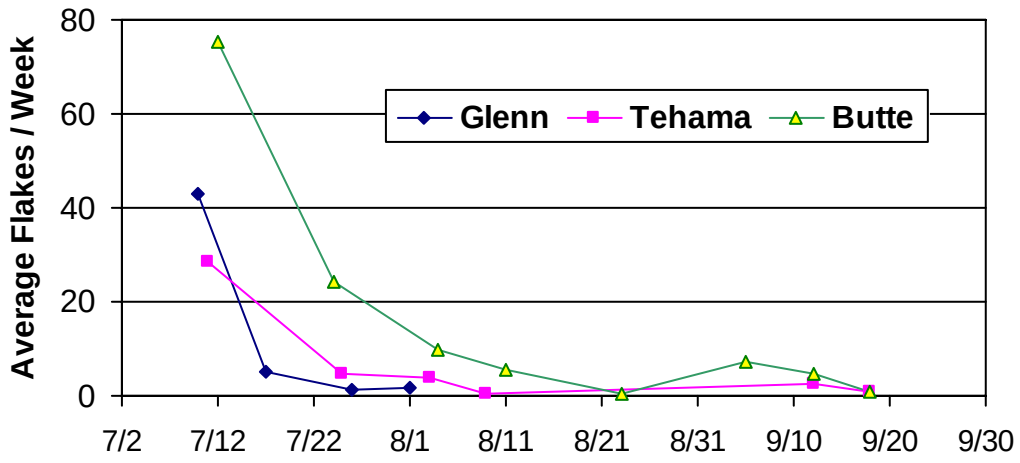

Figure 12. 2006 Percent CM Damage at Harvest (3 Hercon locations)