Pest Management Grants Final Report
Contract No. 98-0265

Contract Title: *Areawide Implementation of Mating Disruption in Pears Using Puffers*

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ABSTRACT

Codling moth (*Cydia pomonella*) (CM) is the primary pest of pears in California. The economic threshold for cannery damage is 5% (including all other defects). FQPA and CalDPR use restrictions on azinphosmethyl and encapsulated methyl parathion have hastened the adoption of alternative CM control programs, mainly using mating disruption (MD). In 1999, 360 acres of pears in Potter Valley, Mendocino County, were treated with the new Paramount Puffer CM®, a method which entails hanging relatively few (1-2 per acre) widely-spaced units around the orchard perimeter, each emitting a large amount of pheromone for a finite period each day, and above a certain ambient temperature threshold. To monitor CM activity, one set of four traps was hung per five acres: 1 mg. low, 1 mg. high, 10 mg. high and oblique-banded leafroller (OBLR) (the major secondary pest of CM MD programs). Egg laying and larval infestation was evaluated for each CM and OBLR generation using tree, ground, and bin samples. Puffer-treated orchards were compared to three upwind orchards: a 22-acre standard block, a 2-acre organic non-puffer block, and a set of untreated apple trees. Harvest data showed virtually no damage in most standard puffer blocks, despite the fact that no organophosphates were applied during the growing season. Minor damage occurred in upwind blocks, small blocks with large "edge effect", edges bordering organic blocks, and along a riparian corridor harboring infested wild apple seedlings. Damage was over 5% in the organic blocks but was 30% in the organic control. Damage in the untreated apples was 20%. OBLR damage was present in almost all blocks at harvest, but most severe in the organic blocks.

EXECUTIVE SUMMARY

Codling moth (*Cydia pomonella*) (CM) is the primary insect pest of pears in California. The maximum threshold for cannery damage is 5% (including all other defects). Food Quality Protection Act (FQPA) and CalDPR use restrictions on azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (i.e. Penncap®) have necessitated the rapid transition to alternative CM control programs, mainly using mating disruption (MD). Resistance of CM to azinphosmethyl is another factor stimulating decreased dependence on that material.

CM MD has been studied in California since 1986. The main commercial strategy employed in California has been to hang 160-400 individual codlemone dispensers per acre twice during the growing season. This is a labor-intensive process during an era of tightening labor availability, increasing costs, and relatively decreasing returns. In addition, users in some locations have also experienced variable pheromone emission during very cool or hot weather, which has led to diminished disruption in some cases. The late Dr. Harry Shorey of UC Riverside developed a new emission strategy to resolve the above issues. His dispenser was designed to emit a very large, uniform amount of pheromone at preset intervals, thus eliminating emission variability. Only one hanging of one or two units per acre was necessary, greatly reducing labor cost. Dr. Shorey named the unit the "puffer", and upon his death in 1998, it was developed commercially by Paramount Farming Co. of Bakersfield, California.

MD research using puffers on the North Coast began in 1996 in cooperation with Dr. Shorey. Initial trials, sponsored by the Pear Pest Management Research Fund, took place on 160 acres of Bartlett pears in Kelseyville, Lake County. In 1999, 360 acres of pears in Potter Valley, Mendocino County, were treated with the Paramount Puffer CM (renamed Paramount Aerosol Pheromone Dispenser® for the 2000 season). The project included every orchard in the valley except one 22-acre block used as a grower control. 75 of the 360 acres were certified organic. Participants included four growers and one licensed pest control adviser (PCA). Standard treated orchards in the area had historically low CM pressure, requiring only two organophosphate treatments most years. The organic orchards had very high CM pressure, despite several years under non-puffer CM MD. Dispensers were hung at a rate of 1.8 per acre. 42 mg. of codlemone was emitted every 15 minutes from 3:00 p.m. to 3:00 a.m. from late March through early October.

CM adult activity was monitored using four traps per five acres: 1 mg. low, 1 mg. high, 10 mg. high, and oblique-banded leafroller (OBLR) (the major secondary pest of CM MD programs). Egg laying and larval infestation was evaluated for each CM and OBLR generation using tree, ground, and bin samples. Puffer-treated orchards were compared to three upwind orchards: the 22-acre standard-treated block, a 2-acre organic non-puffer block, and a set of untreated apple trees. Although supplemental treatment decisions were made by growers and the PCA, standard growers were advised to apply an initial OP since it was the first year using puffers, as well as border sprays adjacent to organic blocks. The organic grower was advised to apply a full complement of oil and BT sprays for every CM hatch and for OBLR. Monthly use reports collated at the end of the year, however, revealed that no OP's were used in any puffer-treated blocks during the 1999 season, indicating very low CM pressure. This was compared to two OP treatments in the 22-acre grower control.

Sampling through the season produced clear differences between the standard and organic orchards. Samples taken prior to, during, and after harvest showed virtually no CM damage in most standard puffer blocks, despite the fact that no OP's were applied during the growing season. Minor damage

occurred in upwind blocks, small blocks with large "edge effect", edges bordering organic blocks and unsprayed backyard trees, and along a riparian corridor harboring infested feral apple seedlings. Puffer-treated organic orchards averaged over 5%; however, damage was 30% in the non-puffer treated organic control and 20% in the untreated apples.

OBLR damage was present in almost all blocks at harvest, but was most severe in the organic blocks. BT applications successfully reduced the amount of damage by the summer brood in the organic blocks, indicating potential for this tactic. A mixed CM/OBLR puffer unit will undergo evaluation during the 2000 season using one Potter Valley organic orchard as a test site.

Total material and monitoring costs using puffers was tabulated for a similar 500-acre project in Kelseyville, Lake County (not including organic). For an individual orchard of 40 acres or less, material costs using two dispensers per acre are $240/acre initially, plus $350 for a programming unit and negligible labor costs. This decreases to $160/acre thereafter. The number of units per acre decreases as treated acreage increases. The 1999 rate was 1.8 in Potter Valley and 1.3 in Kelseyville, offering substantial savings when applied on an areawide basis. Using 1.3 per acre rate, OBLR treatments and additional trapping and damage monitoring costs added $200.00 to a standard OP program, thus making CM MD more expensive than a standard organophosphate program in the first year. Much of the additional monitoring costs have been underwritten by various grant funds, but must eventually be borne by growers. It is hoped that a mixed CM/OBLR puffer, combined with reduced pear psylla and spider mite treatments will offset increased added costs in subsequent years. The intensive trapping rate may also be decreased as confidence in the MD technique increases

Progress and results of the Potter Valley project were presented in both English and Spanish at a July summer field day and at the "Planning for the 2000 Codling Moth Season" meeting held in March 2000. Very poor returns for pears in 1999 have discouraged the standard growers in the Potter Valley project from making the commitment to purchase the puffers for the 2000 season. Puffers will continue to be utilized by the organic grower in 2000, while the standard growers will use one late-season hanging of the traditional form of dispensers in order to save money. A similar 500-acre project in Lake County, however, will expand to 840 acres due to great success of the program. An additional, approximately 180 acres will be treated commercially, for a total of about 1000 puffer-treated acres in Lake County. If results are positive in 2000, it is likely that more North Coast pear growers will seriously consider purchasing puffers for future use.

Introduction

Codling moth (*Cydia pomonella*) is the key pest of pears in California. The economic threshold for damage in cannery loads is 5% (including all other defects). Damage in untreated controls ranges from 10 to 50%, signifying great need for effective control. State and federal actions in 1998 and 1999 have resulted in the restriction or loss of the two key organophosphate insecticides used to control codling moth, azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (e.g. Penncap®). These restrictions have necessitated rapid transition of the pear industry into alternative pest management programs. The most proven and available current alternative is mating disruption, which has been researched in pears since 1987. Mating disruption has been demonstrated to be most effective when utilized on an areawide basis in orchards under low to moderate codling moth pressure. The most widely used strategy is hanging 150-400 pheromone dispensers per acre throughout a treated block. Each dispenser emits a small amount of pheromone over the life of the unit, about 60-120 days.

The demonstration completed in 1999 utilized an alternative, reasonably priced dispenser, the "puffer", developed by the late Dr. Harry Shorey of UC Riverside. The puffer has been further developed and registered by Paramount Farming Co., a large almond and pistachio operation in Bakersfield. It is manufactured in Canada and sold directly by Paramount. The codling moth product is now registered as the Paramount Aerosol Pheromone Dispenser®. Rather than hanging many dispensers that emit small amounts of pheromone each, this method involves hanging two or fewer dispensers per acre, each emitting a large amount of pheromone at preset intervals and above a minimum ambient temperature threshold for 200 days. This dispenser was the focus of three years of pear industry-funded UC research on 160 acres in Lake County (which expanded to 500 acres in 1999 under a USDA Areawide Codling Moth Project (CAMP) grant).

Based on the success in Lake County, in 1999 this project was initiated to apply puffers to control codling moth on 360 acres of Bartlett and Bosc pears in Potter Valley, Mendocino County. This was nearly the total acreage in the valley and included 75 acres of certified organic fruit. Only one 22-acre block of Bartletts and one 2-acre block of organic pears remained untreated which were used as "grower controls". One set of untreated apple trees upwind of the project area served as a completely untreated control.

The 1999 demonstration had four primary objectives:

1) Demonstrate a cost-effective, labor-saving, efficient, commercially-available method of delivering pheromone in a mating disruption program.
2) Verify the minimum level of monitoring needed to commercially use this method.
3) Produce commercial yields of U.S. #1 Bartlett and Bosc pears using greatly reduced amounts of organophosphate insecticides.
4) Control secondary pests as needed.

Materials and Methods

The labeled, recommended commercial application rate using the Paramount puffer is two units per 40 or fewer acres, placed around the perimeter of the block. In this project, 1.8 units per acre were hung in early April every 65 feet around the perimeter of each orchard block. Each unit was programmed to emit 42 mg. of codlemone every 15 minutes from 3:00 p.m. to 3:00 a.m., for a total of 129.6 gms. of codlemone per acre over the season. Emission ceased when the ambient temperature dropped to 50° F. Units were hung in the upper one-third of trees using a hooked, telescoping swimming pool pole. If orchards shared borders, only one side was treated, thus reducing the rate. One set of four monitoring traps was hung per five acres; each set consisted of a 1 mg. low, 1 mg. high, and 10 mg. high codling moth (CM) and an oblique-banded leafroller (OBLR) trap. OBLR is the major secondary pest associated with reduced OP programs. Traps were monitored weekly (Figure 1).

CM and OBLR infestation was evaluated at specific intervals through the growing season. Egg searches were performed in the spring prior to first cover and again in late July prior to the stop-drop spray. This allowed for treatment decisions to be made in case significant numbers of eggs were found. First generation larval damage was evaluated via tree counts in late June and ground fruit counts in early July, again prior to a key treatment opportunity. 1B and second-generation larval damage and worms were evaluated via late July tree and harvest bin counts. To evaluate overwintering potential, a post-harvest sample of fruit remaining on trees was done in early October. Each sample consisted of from 300 to 3,000 fruit per block, depending on block size and sample type.

For trapping and damage evaluations, puffer-treated blocks were compared to the one 22-acre standard-treated orchard, a 2-acre block of organic non-puffer treated Bosc north of the project, and a set of four untreated apple trees upwind of the puffer project.

Results of field activity were reported to participating growers, PCA's and the CalDPR Project Manager via weekly fax (23 issues total). Mid-summer field days in both English and Spanish were organized to present results to date. The project was also summarized at a winter codling moth planning meeting, the September progress report published in the 1999 Pear Research Report produced by the California Pear Advisory Board/Pear Pest Management Research Fund, and in an article published in the December 1999 issue of *California Grower* magazine. A cost study comparing puffer and standard programs was prepared after the entire season was completed. A summary of comparative pesticide use for standard versus puffer mating disruption programs was collated (Appendix IV through VII, Tables 8-9).

Due to severe time and staff constraints, two secondary aspects of the project were unable to be accomplished during the 1999 season: cluster and shoot samples for pear psylla and mites, and the habitat and orchard floor surveys for true bugs. Since this was a first-time effort on such a large scale, the time involved in data collection, preparation, and distribution was greatly underestimated during the grant writing process. However, the summary of pesticide use report information serves to indicate pest pressures that were treated.

Results

a) ***Objective 1:*** *Demonstrate a cost-effective, labor saving, efficient, commercially-available method of delivering pheromone in a mating disruption program.* After one season, CM damage to puffer-treated blocks at harvest was minimal in non-organic orchards (0.34% overall across 11 blocks versus 0.0% in the one standard control block and 20% or more in the untreated apples (based on pre-harvest fruit count only)). Damage occurred only in small blocks with large edge effects, in upwind blocks, and along one relatively upwind riparian border area that harbored wild apple trees infested with CM. Damage to the organic puffer-treated blocks averaged 5.3%, but ranged from 1.5 (north) to 11% (south). This was compared to the organic non-puffer control which had 30.7% damage prior to harvest (no bin data collected). Like CM, OBLR damage was most severe in organic blocks, but present throughout all puffer-treated blocks, while the grower control was free of damage. The puffer units lasted the entire season, showing only one hanging per season is required (Tables 2 to 7).

b) ***Objective 2:*** *Verify the minimum level of monitoring needed to commercially use this method.* The 5-acre trapping unit, though intensive, resulted in being able to pinpoint potential "hotspots". Moths were only caught in 1 mg. low traps in organic blocks or along edges bordering organic blocks, upwind riparian borders, and grower and untreated controls. Catches in 1 mg. high traps mirrored those in 1 mg. low in distribution, but caught more moths, and also caught moths in several blocks that had no 1 mg. low catches. 10 mg. high traps caught moths in every block, regardless of treatment. The best correlation with damage was with 1 mg. low traps. Two key flight periods, July 15 and August 19, were only discernible via 1 and 10 mg. high traps. OBLR traps caught many moths, but numbers showed little correlation to severity of damage. The second major OBLR peak in July was likely garden tortrix rather than OBLR; this peak failed to occur in a similar areawide puffer project in Lake County (Figures 2-12, Table 1).

c) **Objective 3:** *Produce commercial yields of U.S. #1 Bartlett and Bosc pears using greatly reduced amounts of organophosphate insecticides.* Non-organic blocks received no organophosphate treatments during the 1999 season, versus the standard block that received two treatments. Data was compiled from monthly use reports (Table 8).

d) ***Objective 4:*** *Control secondary pests as needed.* No attempt was made to dictate secondary pest control. Leafrollers were controlled by the synthetic pyrethroid used to control pear psylla at petal fall, and by the one OP cover spray used for CM. One subsequent spray was applied for pear psylla and mite control in most orchards. Although not counted, San Jose scale and stink bug damage was noted at harvest, and was only present in the organic blocks. Data on secondary pest treatment was compiled from monthly use reports (Table 9).

Discussion

Data prior to, during, and after harvest indicated several points:

1) Mating disruption, specifically puffers, controls codling moth well even in a first year program, if orchards start the season with relatively low pressure. In Potter Valley, this was achieved despite the total lack of organophosphate treatments. However, an initial OP treatment is still advisable in most years. Multiple years are needed to determine whether damage will remain low or increase. 1999 was a very cool season with unusually low CM pressure.

2) Orchards that begin the season with high pressure will require greater supplementation by insecticides and more years to achieve adequate control. In the case of the organic orchards in this project, there were four key hindrances to acceptable control:

   a. tremendous pressure coming into the 1999 season (despite four previous years using CM MD);
   b. inability to use oil as a CM insecticide through almost the entire first flight due to its incompatibility with lime sulfur used for pear scab;
   c. inability to spray during the final several weeks prior to harvest due to risk of knocking loosened fruit from the trees (NAA is disallowed in organic orchards); and
   d. general ineffectiveness of other organically-available insecticides, i.e. BT, for CM control.

3) Leafrollers, specifically oblique-banded leafrollers, will need to be controlled with chemicals under CM mating disruption because OBLR pheromone is currently ineffective. BT applied in the organic blocks was quite effective in reducing the severity of OBLR damage, and could be useful in mating disruption programs provided weather conditions are conducive to excellent timing and coverage. Other secondary pests, such as stink bugs and San Jose scale, may also eventually be problematic.

As a mating disruption tool, puffers are a good dispenser in that distribution pattern, emission rates, and timing are controllable and flexible, and they are only slightly affected by changes in ambient temperature (due to vapor pressure shifts). However, experience in 1999 brought out several economic and logistical issues:

a. Units must be periodically taken down and checked to make sure they are emitting correctly. They are susceptible to being knocked down by heavy wind and human activity, such as spraying, harvesting, and tree topping. This takes about one minute per unit and can be done at the same time traps are checked. Paramount has made design improvements for 2000 that should eliminate key in-season mechanical problems.

b. The current initial cost to enter the puffer program may be an impediment to adoption, especially in poor market years such as 1998 and 1999. For example, at the maximum two per acre for one 40-acre block, the cost would be $40.00 per unit x 2 = $80.00 plus $80.00 per filled cannister x 2 = $160.00, for a total cost of $240.00 per acre. The accompanying programming unit currently costs $350.00 and must be purchased separately by the user(s). Cost to hang is negligible (about $2.00 per acre). This is compared, for example, to $220.00 for two hangings of 400 Pacific BioControl Isomate® dispensers plus about $25.00 per acre per hanging for application, or about $270.00 per acre per season.

Once the puffers are purchased, they are guaranteed for at least five years, so annual cost is reduced to $160.00 per year plus hanging and checking. As acreage increases, the number of units per acre decreases, making the system most cost effective for areawide programs where growers share up front and ongoing program expenses and benefit from reduced per acre costs. For example, a similar 500-acre project in Kelseyville used 1.3 units per acre, which will decrease to 1.1 units per acre on 840 acres in 2000. Also, as the total number of units purchased increases, the manufacturer will be able to purchase pheromone at a cheaper price, thus reducing the cost of a filled cannister.

c) Costs for intensive monitoring are currently underwritten by grant funds must eventually be borne by users. Sample costs produced in 1999 showed a complete puffer MD program initially adds about $200 per acre to a standard OP program. Besides monitoring costs, treatments for codling moth are replaced by an additional one to three sprays for OBLR. It is expected, however, that treatment costs for pear psylla and mites will decrease as levels of natural predators increase and the orchard system becomes more ecologically balanced. If the mixed CM/OBLR puffer unit proves viable, total program cost should greatly decrease.

Summary and Conclusions

The UC Shorey "puffer", now sold as the Paramount Aerosol Pheromone Dispenser® was utilized to control codling moth in an areawide demonstration project encompassing 360 acres of pears in Potter Valley, Mendocino County. The project was unique in that it included four blocks totaling 75 acres of certified organic pears, half at the north end of the valley and half at the southern end. These orchards harbored a huge incoming population of CM, presenting a great challenge to the program. The area was also at a disadvantage compared to other areawide programs in that many blocks shared no borders and several were much smaller than the 40-acre recommended minimum, thus having a prominent "edge effect". There was also a long upwind riparian corridor harboring seedling apples, from which mated female moths entered puffer-treated blocks.

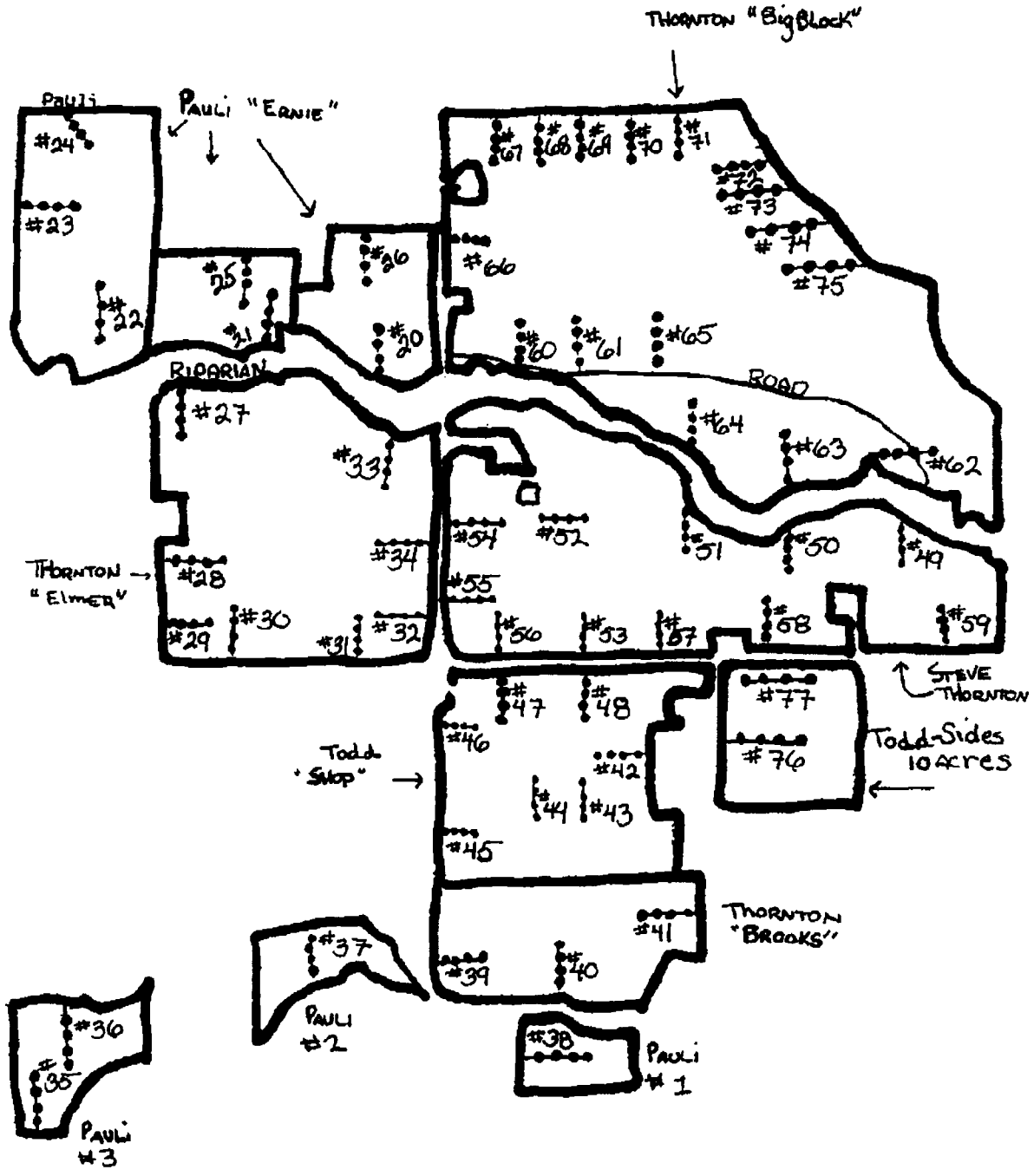
With the above handicaps in mind, puffers were hung at a fairly high average rate of 1.8 per acre around the perimeter of each block (up to two per block in the organic and small blocks), and both codling moth and leafroller populations and damage were monitored throughout the growing season. Trap catch, egg laying, and damage data showed that after one season:

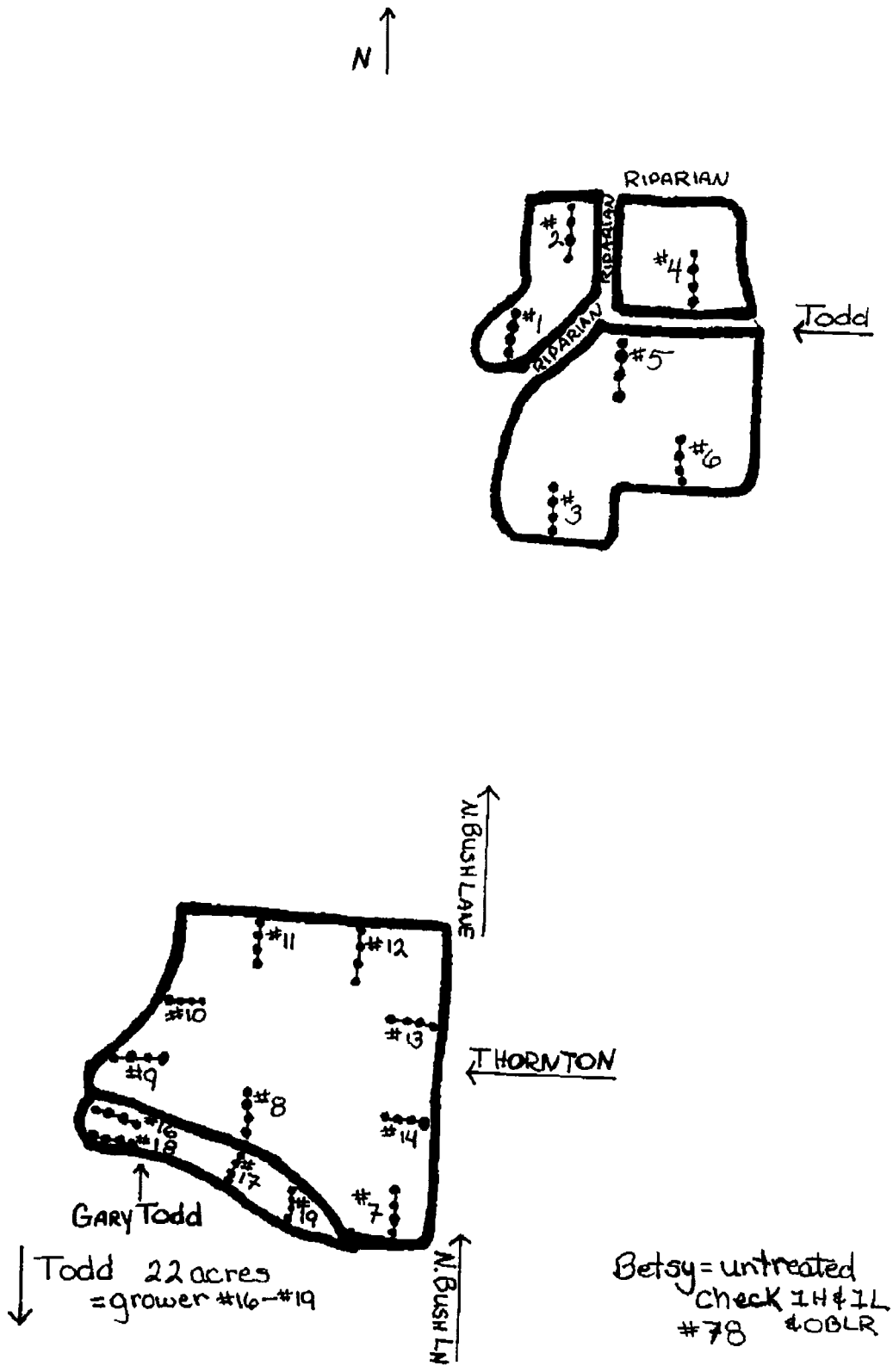
1) control in large orchards under low initial pressure was excellent;
2) control in small blocks under low initial pressure was adequate but poorer than in large blocks;
3) control in non-organic blocks was achieved without the use of organophosphates during the growing season;
4) control in organic blocks under high initial pressure was unacceptable using "mainstream" criteria, but still much better than either the organic or untreated controls;
5) edge effect occurred from neighboring organic blocks, wild apple seedlings, and on upwind borders, and
6) OBLR was a noticeable secondary pest, and could even be considered a primary pest in the organic blocks.

As previous research and other demonstration projects have shown, mating disruption of any type is a multiple-year, multi-tactic strategy. Results after only one year are preliminary. In the case of the neighboring 500-acre Lake County project, one orchard required three years to reduce damage to zero. Growers must thus make a long term commitment to the program, which often includes high initial costs required to reduce flight and subsequent damage. A plan to eliminate pressure from unfarmed apple and pear trees, especially upwind, will also be required.

LIST OF FIGURES AND TABLES

POTTER VALLEY TRAP LOCATIONS




N
RIPARIAN
#2
#4
#1
RIPARIAN
Todd
#5
#6
#3
N. BUSH LANE
#11
#12
#10
#13
THORNTON
#9
#8
#16
#18
#14
#17
#19
#7
GARY Todd
Todd 22 acres
=grower #16–#19
N. BUSH LN
Betsy = untreated
check 1H & 1L
#78 & OBLR

1999 POTTER VALLEY PUFFER PROJECT

Total Codling Moth Trap Catches - All Blocks
April - September 1999

Figure 2a:

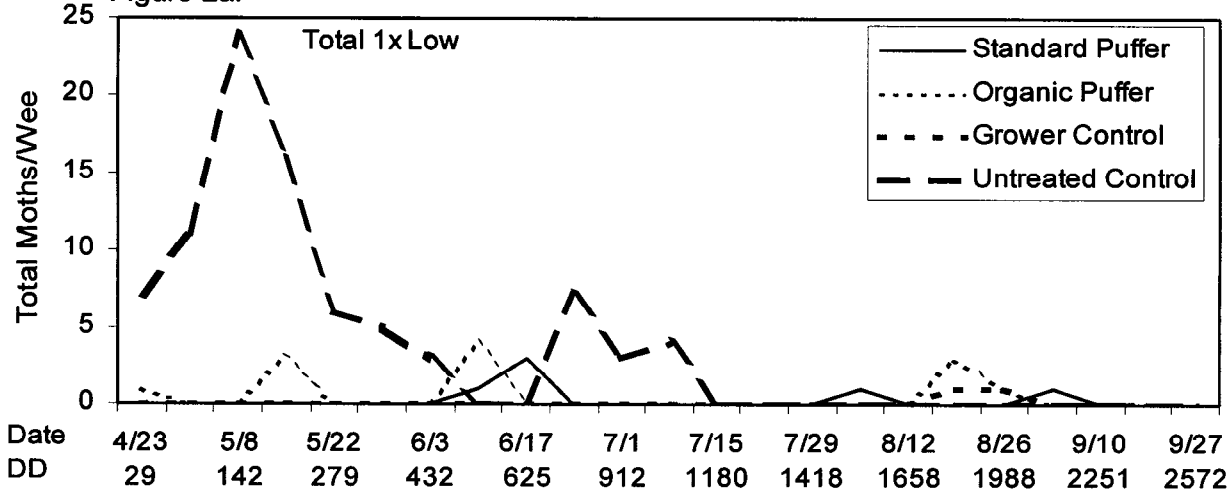


Figure 2b:

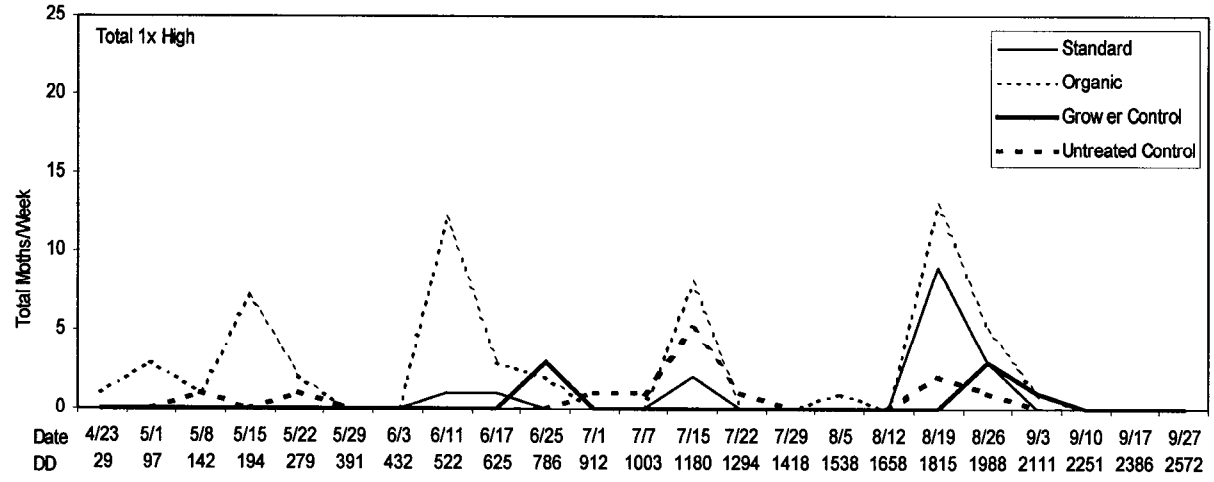
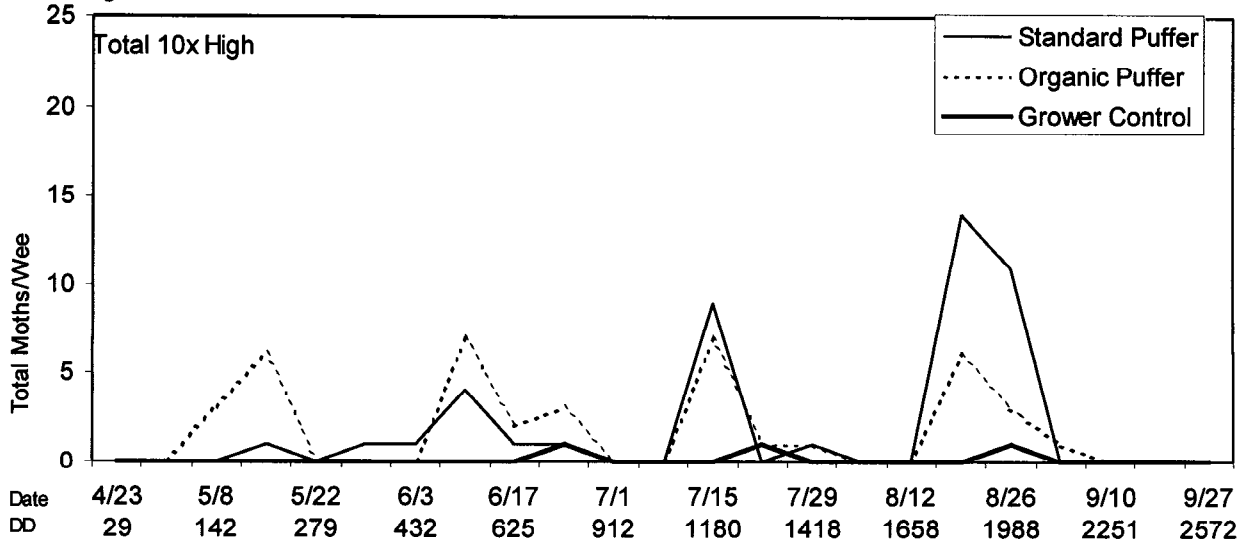


Figure 2c:

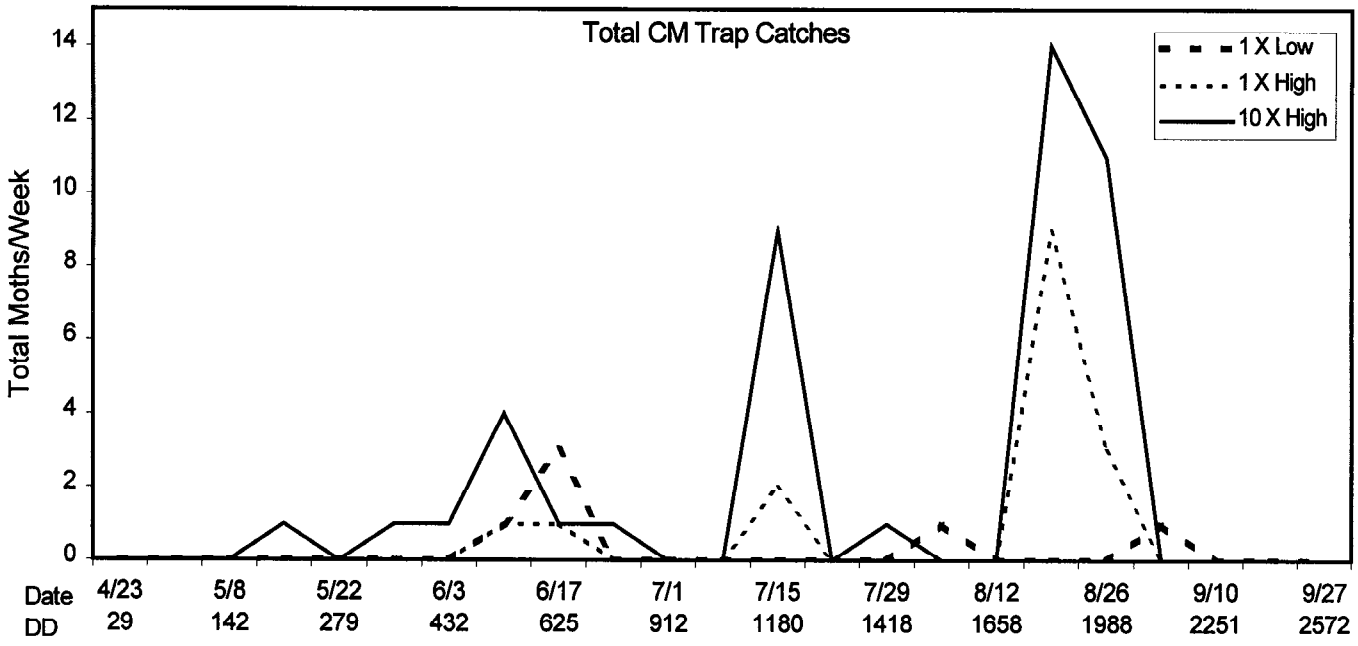


DD = Degree Days Biofix = 4/21/99

1999 POTTER VALLEY PUFFER PROJECT

Codling Moth Trap Catch
Standard Puffer Blocks
April - September 1999

Figure 3:



DD= Degree Days Biofix = 4/21/99

1999 POTTER VALLEY PUFFER PROJECT

Total Codling Moth Trap Catches
In Selected Standard Orchards
April - September 1999

Figure 4a:

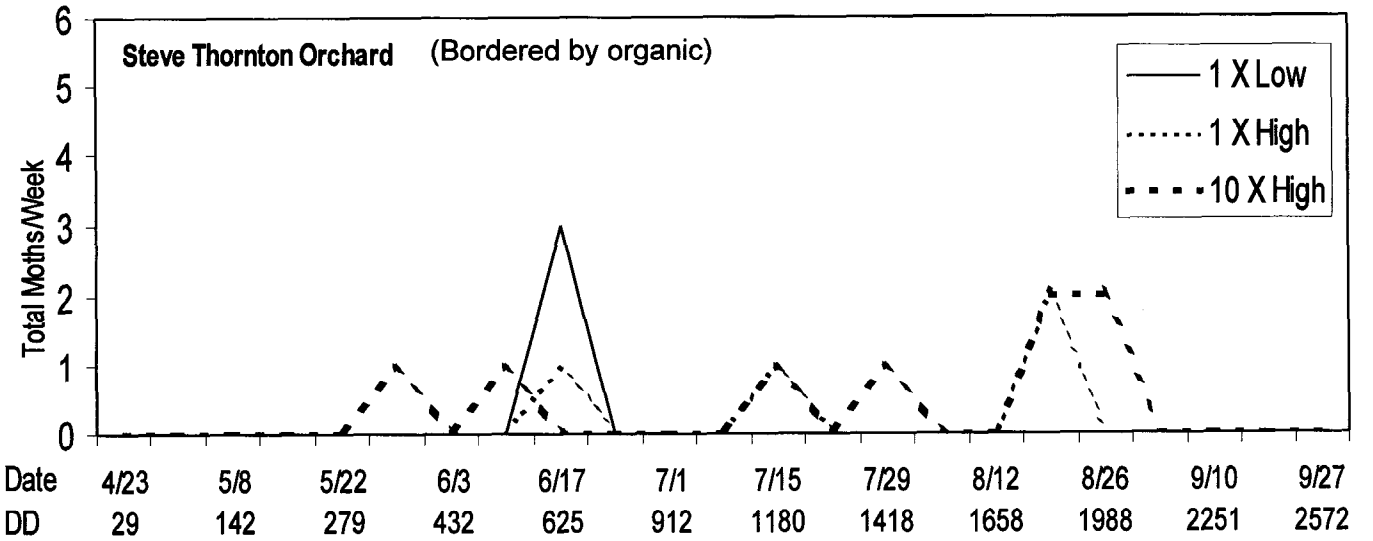
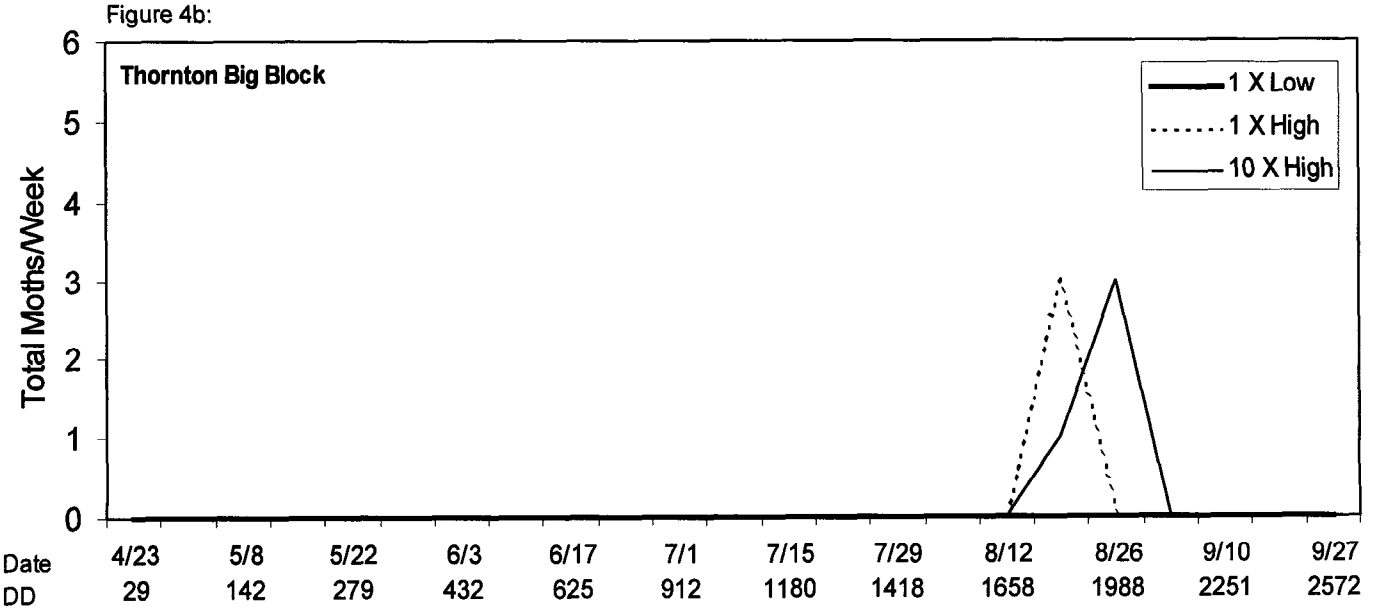


Figure 4b:



No CM catches in 1 X Low traps.

DD = Degree Days Biofix = 4/21/99

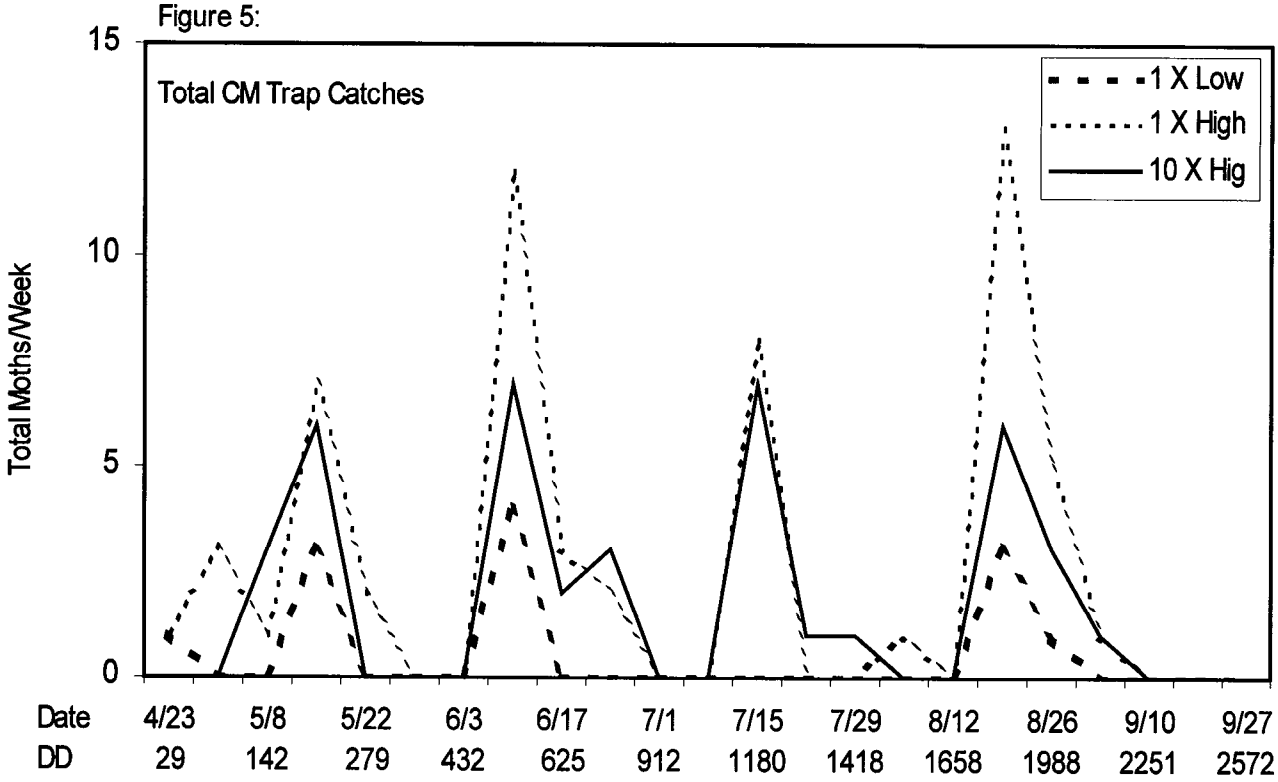
1999 POTTER VALLEY PUFFER PROJECT

Codling Moth Trap Catch

Organic Orchards

April - September 1999

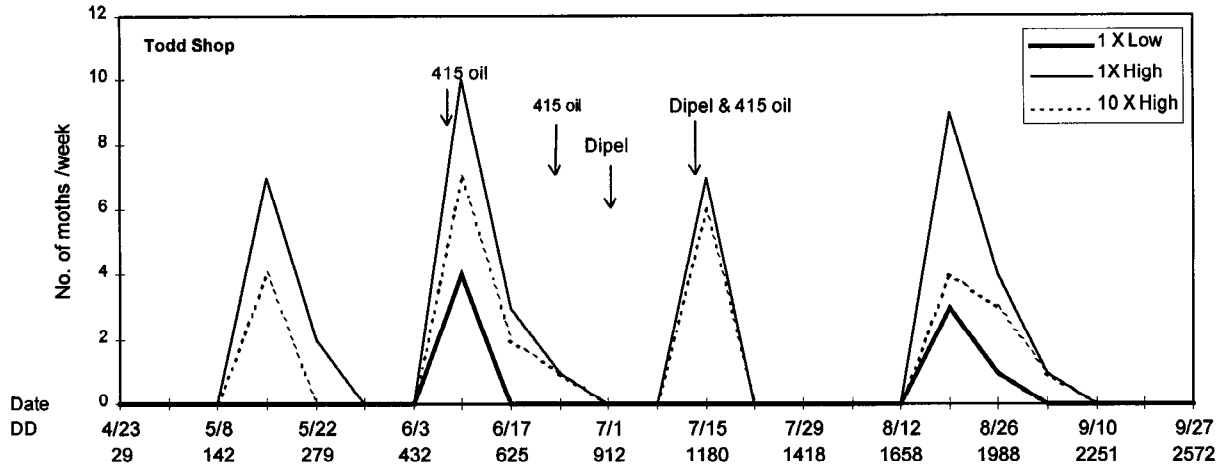
Figure 5:



DD = Degree Days Biofix = 4/21/99

Codling Moth Trap Catches, Organic Orchards
April - September 1999

Figure 6a:



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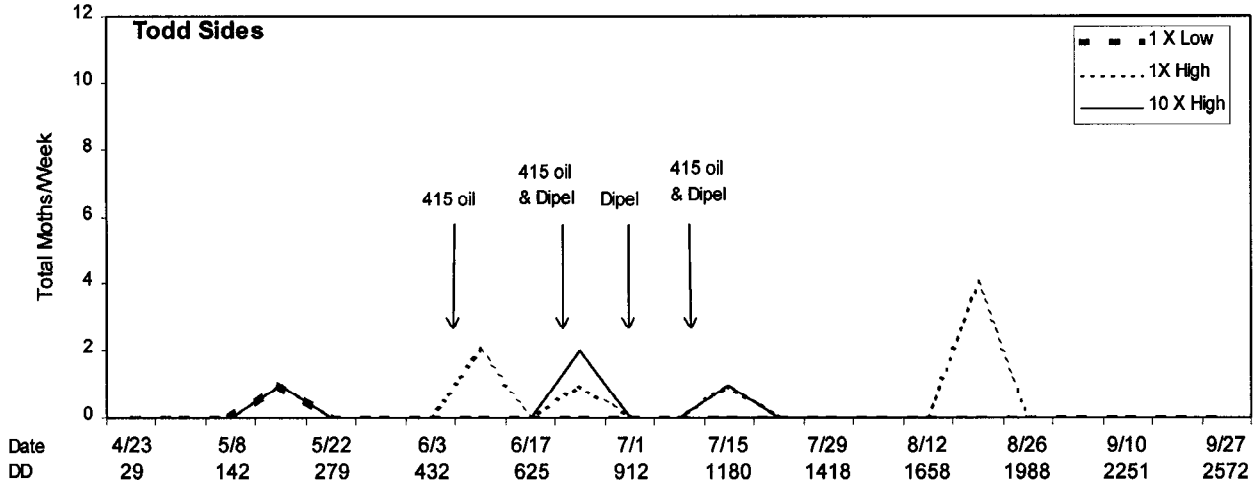
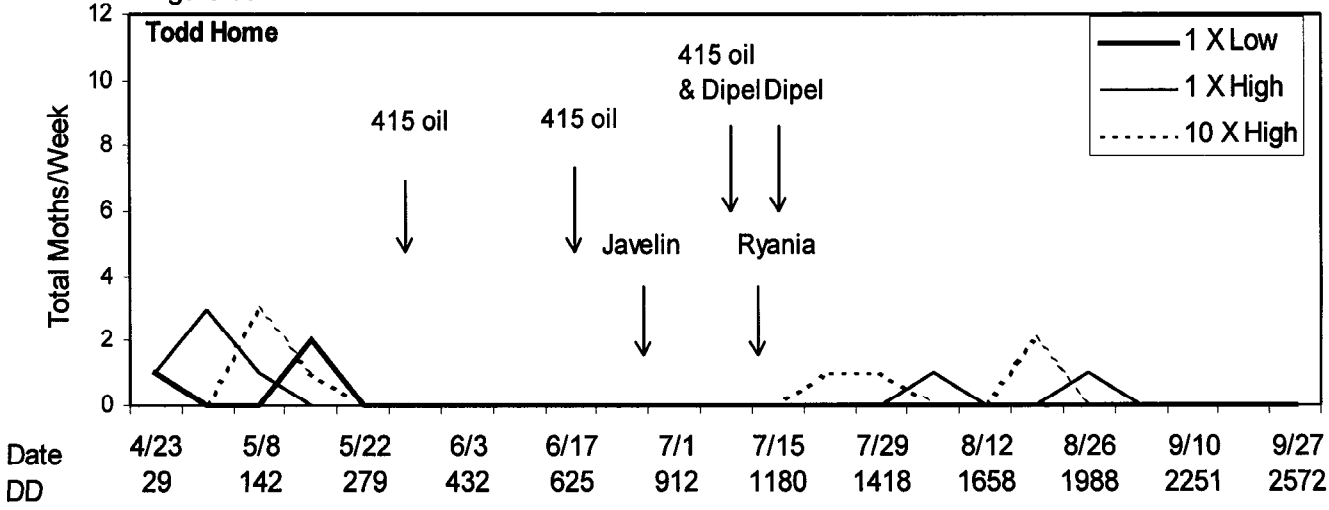


Figure 6c:



DD = Degree Days Biofix = 4/21/99

1999 POTTER VALLEY PUFFER PROJECT

Total Codling Moth Trap Catches

May -September 1999

Figure 7:

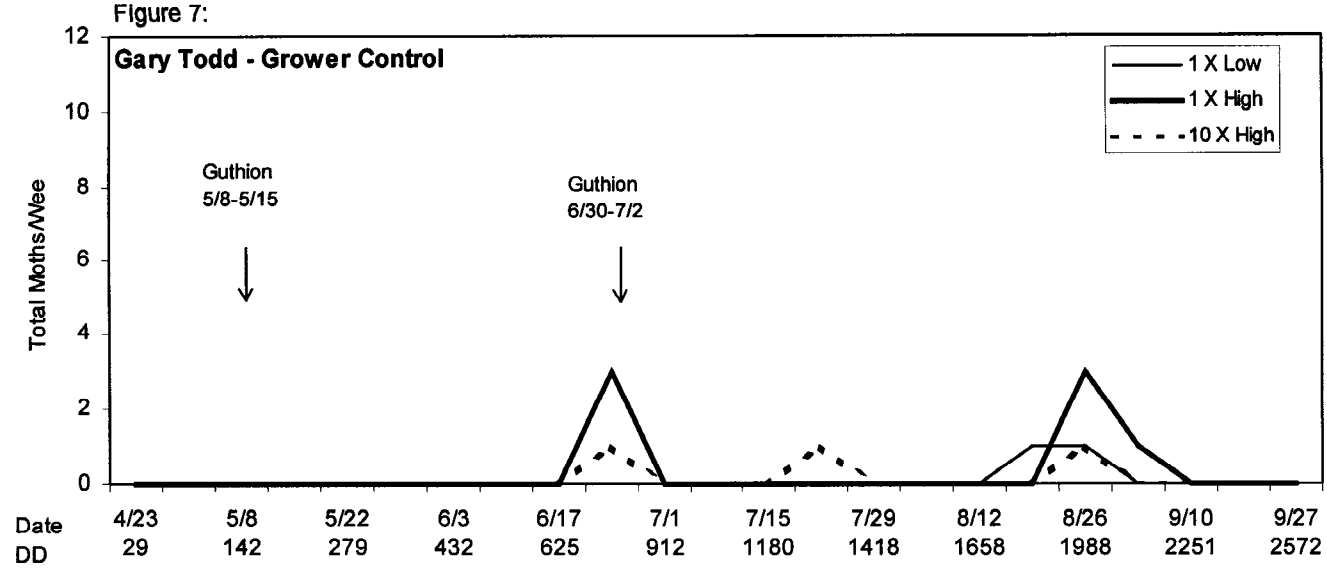
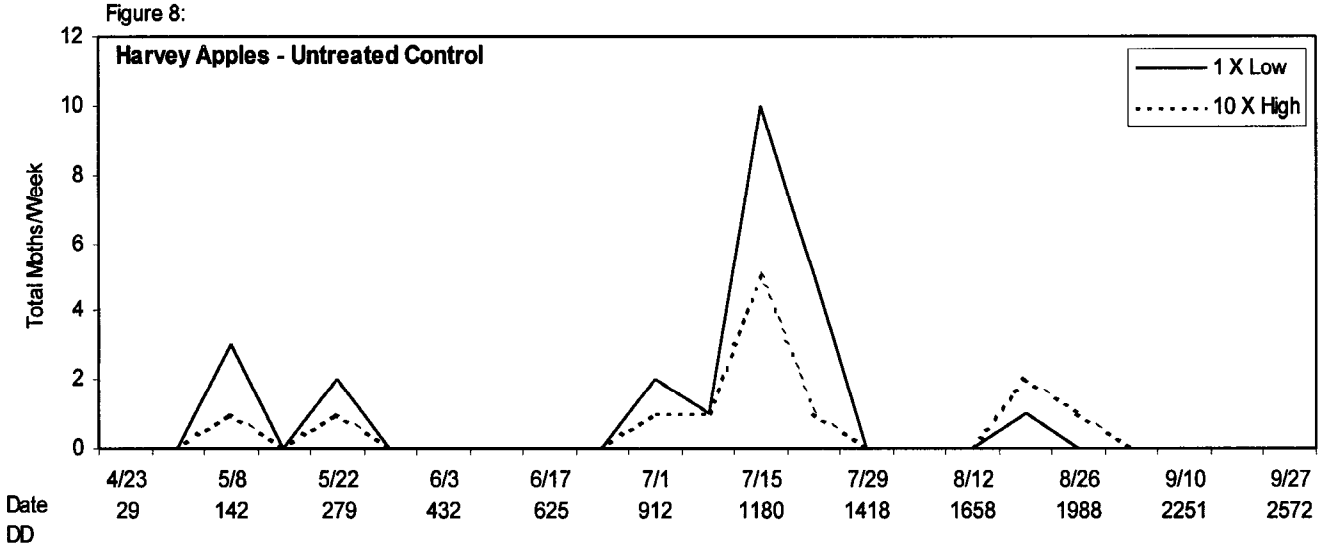
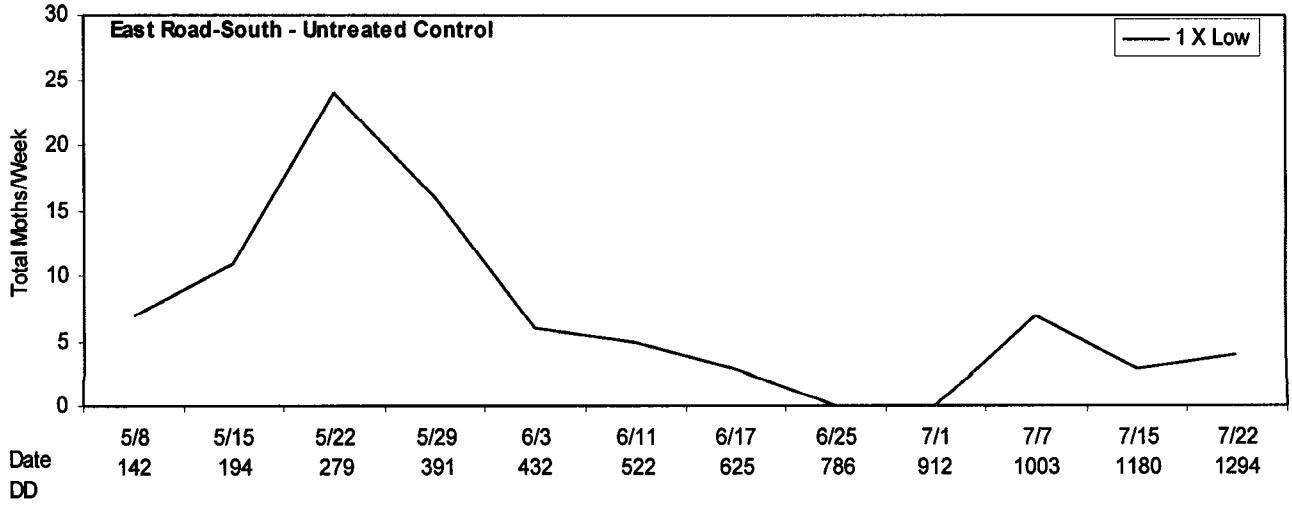


Figure 8:



[1] No CM caught in 1 X High traps

Figure 9:



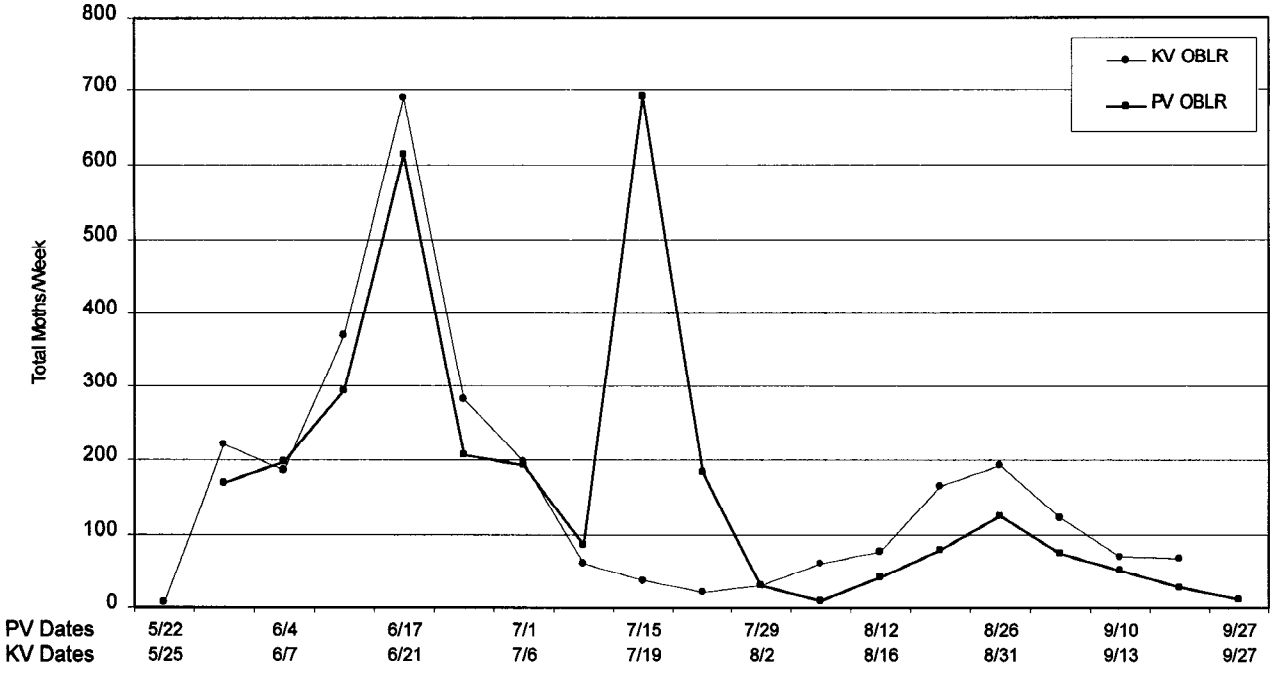
DD = Degree Days Biofix = 4/21/99

KELSEYVILLE OBLR vs. POTTER VALLEY OBLR

Total OBLR Trap Catches

May - September 1999

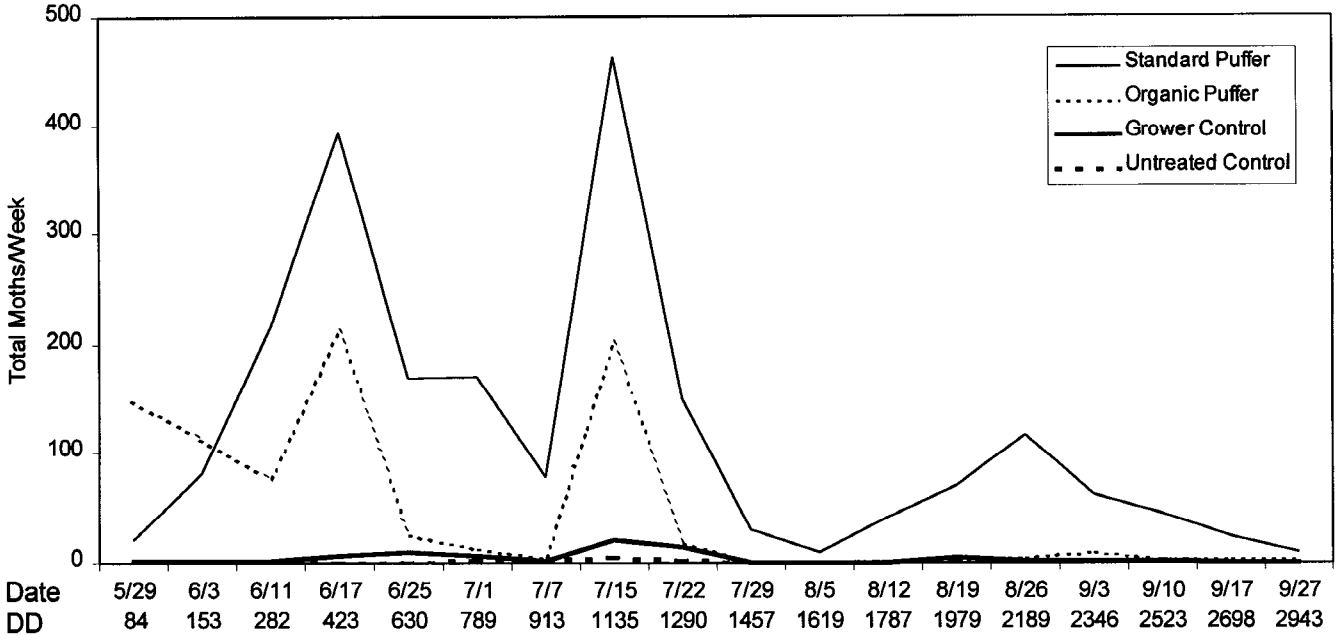
Figure 10:



KV Biofix = 5/25/99 PV Biofix = 5/26/99
The second PV peak could possibly be Garden Tortrix.

1999 POTTER VALLEY PUFFER PROJECT
Total OBLR Catches
May - September 1999

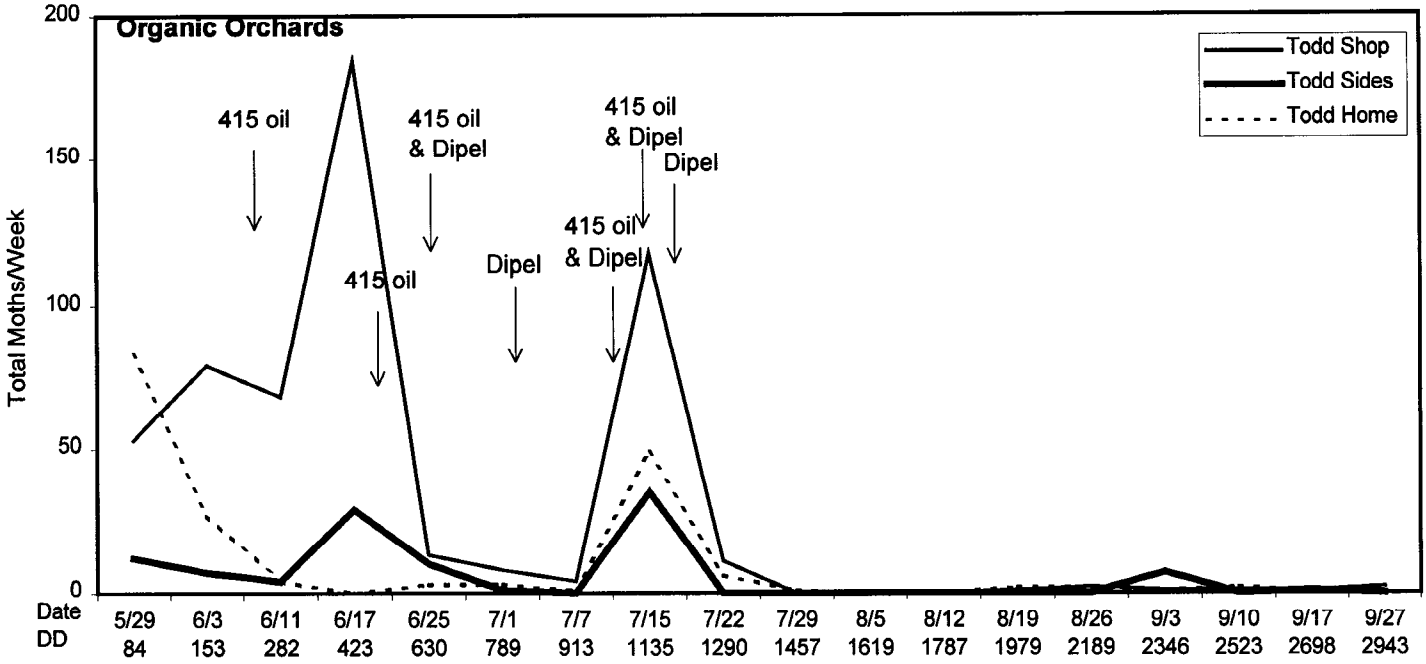
Figure 11:



DD = Degree Days CM Biofix = 4/21/99 OBLR Biofix = 5/26/99

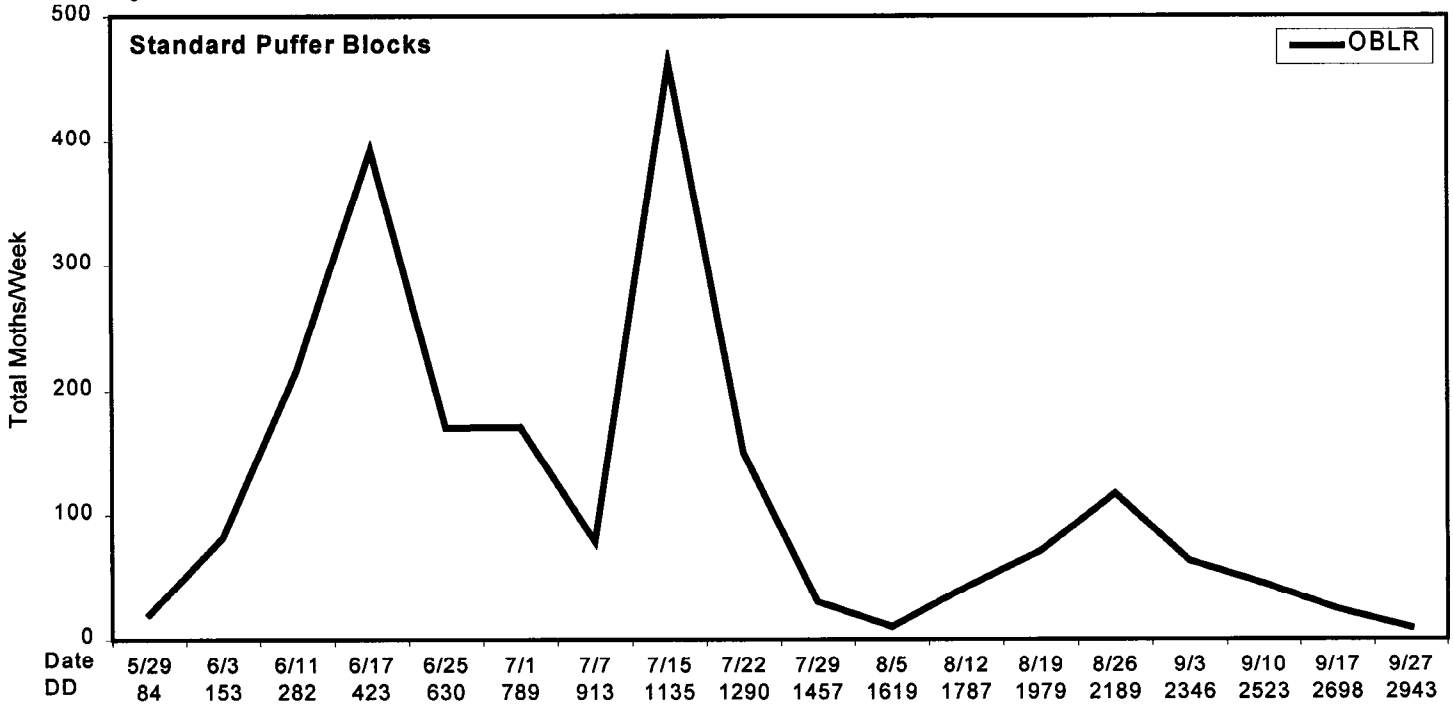
1999 POTTER VALLEY PUFFER PROJECT
Total OBLR Trap Catches
May - September 1999

Figure 12a:



415 oil applied in Todd Home Orchard 5/28/99

Figure 12b:



DD = Degree Days Biofix = 5/26/99 Traps set 5/22/99

1999 POTTER VALLEY PUFFER PROJECT

Total OBLR Catches

May - September 1999

Figure 12c:

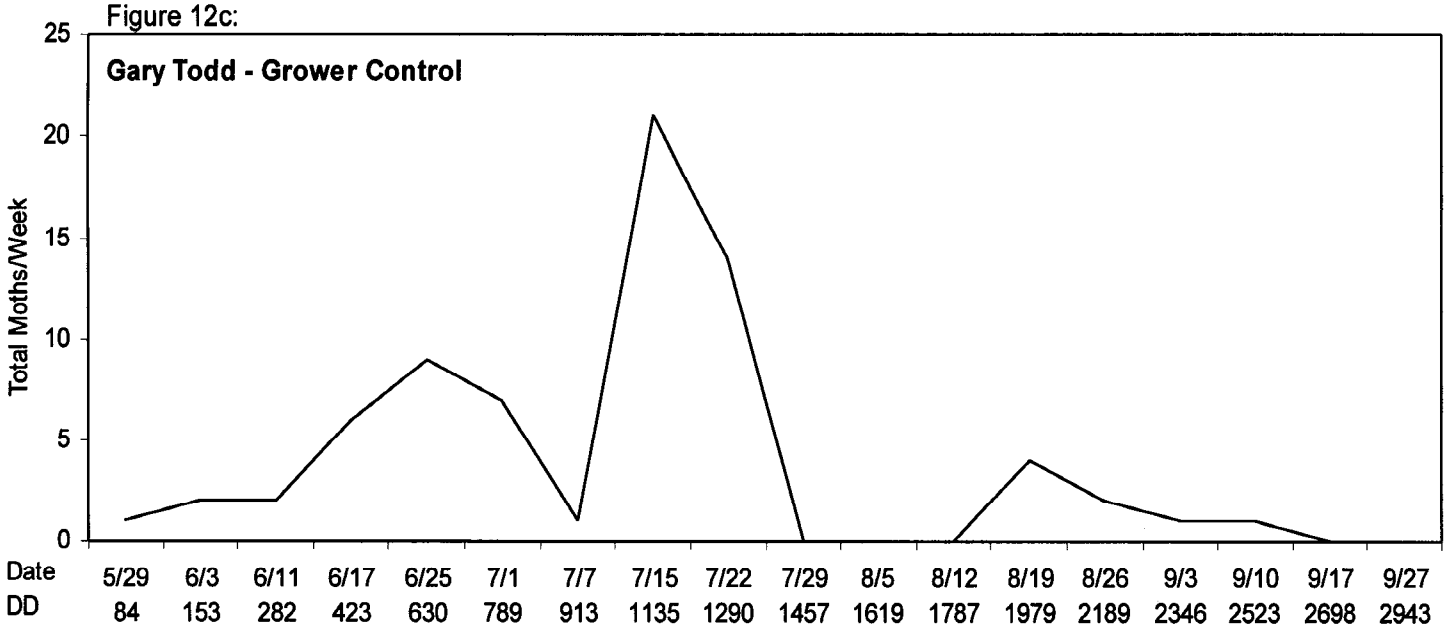
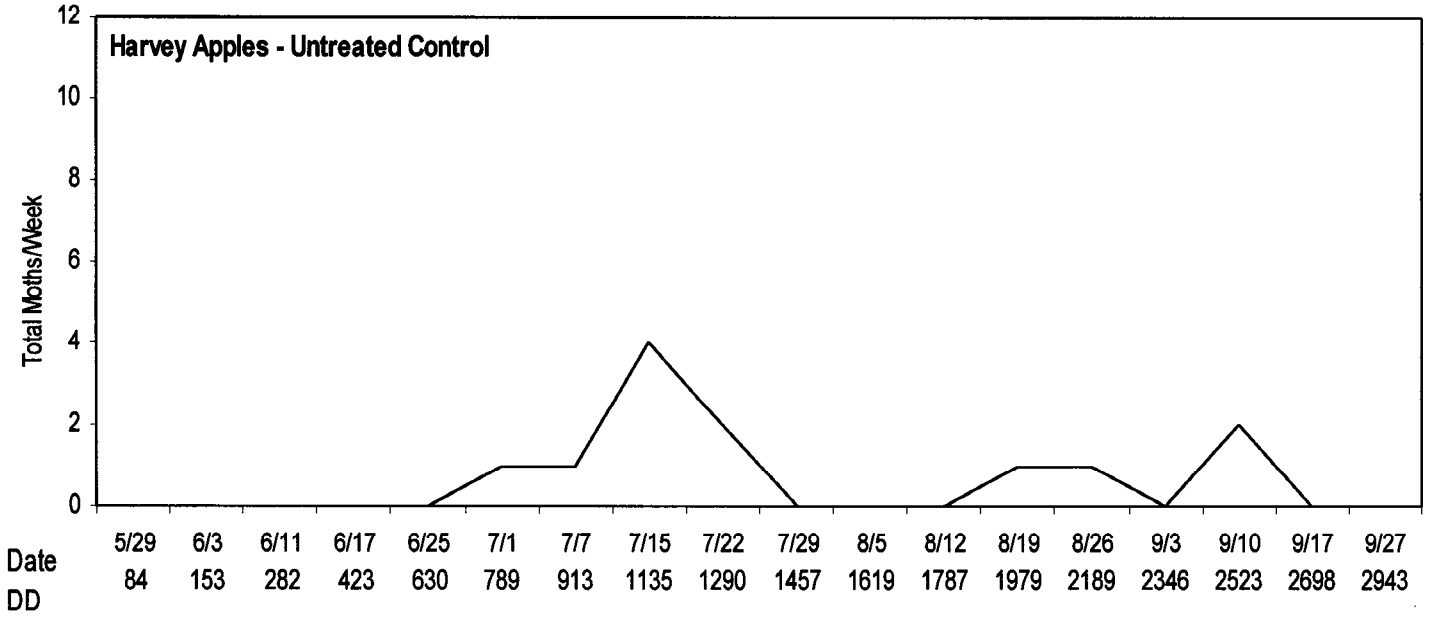


Figure 12d:



DD = Degree Days Biofix = 5/26/99

Table 1

1999 POTTER VALLEY "PUFFER" TRIAL
CM/OBLR TRAP CATCHES[1]
Total catches thru September 18, 1999

TRAP TYPE	BLOCK			
	Standard Puffer (10 plots)	Organic Puffer (5 plots)	Grower (1 plot)	Control (2 plots)
CM 1x LOW	6	12	2	110
CM 1x HIGH	16	59	7	0
CM 10x HIGH	44	40	3	13
OBLR W/H	2147	835	71	12

[1] One trap of each type per 5 acres

Puffers hung week of April 5, 1999

CM biofix April 21, 1999; **OBLR** biofix May 26, 1999

Table 2

1ST GENERATION CODLING MOTH AND OBLR DAMAGE
Potter Valley, Mendocino County
June – July 1999

TREATMENT	TREE June 29 866° D		GROUND July 14-20 1125-1260° D
	CM	OBLR	CM
Puffer			
Non-organic	0.0	0.0	0.0
Organic	0.5	5.5	49.7
Grower Control	0.0	0.0	0.0
Untreated Organic Control[1]	10.0	0	67.6[1]

[1] **no ground fruit in the apples so substituted a 2-acre block of untreated organic Bosc**

Table 3

LATE 1ST AND 2ND GENERATION CODLING MOTH DAMAGE
Potter Valley, Mendocino County
August 6 and 11, 1999
1560 - 1640° D
Pre-harvest Tree Fruit Sample - %

TREATMENT/ BLOCK	Top	Bottom	TOTAL
PUFFER			
Standard			
Thornton Big Block	0.0	0.0	0.0
Thornton Brooks	0.0	0.0	0.0
Thornton Elmer	0.0	0.0	0.0
Thornton Todd	0.0	0.0	0.0
Steve Thornton	0.07	0.1	0.09
Ernie Pauli			
east	0.0	0.0	0.0
middle	0.4	0.1	0.25
west	0.05	0.15	0.1
Pauli Home			
#1 (east)	0.0	0.0	0.0
#2 (middle)	0.3	0.0	0.15
#3 (west)	0.1	0.0	0.05
Average Standard	**0.08**	**0.03**	**0.06**
Organic			
Todd Home	0.05	0.1	0.08
Todd Shop	4.9	3.15	4.03
Todd Sides	5.2	2.1	3.7
Average Organic	**3.4**	**1.8**	**2.6**
STANDARD GROWER CONTROL	**0.0**	**0.0**	**0.0**
ORGANIC GROWER CONTROL	**16.0**	**14.7**	**15.4**
UNTREATED CONTROL (apples)	-	-	**20.0**

Table 4

OBLIQUE-BANDED LEAFROLLER DAMAGE
Potter Valley, Mendocino County
August 6 and 11, 1999
1620 - 1760° D
Pre-harvest Tree Fruit Sample - %

TREATMENT/BLOCK	Top	Bottom	TOTAL
PUFFER			
Standard			
Thornton Big Block	0.0	0.0	0.0
Thornton Brooks	0.0	0.0	0.0
Thornton Elmer	0.05	0.2	0.13
Thornton Todd	0.1	0.0	0.05
Steve Thornton	0.07	0.07	0.07
Ernie Pauli			
east	0.3	0.3	0.3
middle	0.2	0.2	0.2
west	0.7	0.05	0.38
Pauli Home			
#1 (east)	0.7	0.9	0.08
#2 (middle)	3.3	0.9	2.1
#3 (west)	0.2	1.1	0.7
Average Standard	**0.5**	**0.3**	**0.4**
Organic			
Todd Home	3.7	2.8	3.3
Todd Shop	0.5	0.25	0.38
Todd Sides	0.2	0.1	0.15
Average Organic	**1.5**	**1.0**	**1.3**
STANDARD GROWER CONTROL	**0.0**	**0.0**	**0.0**
ORGANIC GROWER CONTROL	**1.9**	**1.4**	**1.7**
UNTREATED CONTROL (apples)	-	-	-

Table 5

LATE 1ST AND 2ND GENERATION CODLING MOTH DAMAGE

Potter Valley, Mendocino County
1680 - 2111° D
August 13 – September 3, 1999
Bin Counts - %/1000 fruit per harvest date

BLOCK	1ST PICK	2ND PICK	TOTAL
PUFFER			
Standard			
Thornton Big Block	-	0.05	0.05
Thornton Brooks (3500 total fruit)	0.0	0.03	0.03
Thornton Elmer	-	0.0	0.0
Thornton Todd	-	0.0	0.0
Steve Thornton	-	0.04	0.04
Ernie Pauli			
east	-	0.0	0.0
middle	-	2.0	2.0
West (2800 total fruit)	0.22	1.90	0.82
Pauli Home			
#1	-	0.03	0.03
#2	-	0.75	0.75
#3	-	0.0	0.0
Average Standard	**0.10**	**0.44**	**0.34**
Organic			
Todd Home West	-	5.4	5.4
Todd Home East	-	1.5	1.5
Todd Shop	-	11.0	11.0
Todd Sides	-	3.2	3.2
Average Organic	-	**5.3**	**5.3**
STANDARD GROWER CONTROL	-	**0.0**	**0.0**
ORGANIC GROWER CONTROL[1]	-	-	-
UNTREATED CONTROL[2]	-	-	-

[1] and [2] – See Table 3

Table 6

OBLIQUE-BANDED LEAFROLLER DAMAGE
Potter Valley, Mendocino County
August 13 – September 3, 1999
1815 - 2346° D
Bin Counts - %/1000 fruit per harvest date

BLOCK	% DAMAGE 1st Gen	2nd Gen	TOTAL
PUFFER			
Non-Organic			
Thornton Big Block	0.05	1.55	1.60
Thornton Brooks	0.06	0.51	0.57
Thornton Elmer	0.03	0.63	0.66
Thornton Todd	0.07	0.47	0.54
Steve Thornton	0.11	0.39	0.50
Ernie Pauli			
east	0.0	0.11	0.11
middle	N/A	3.67	3.67
west	N/A	2.07	2.07
Pauli Home			
#1	0.03	0.63	0.66
#2	0.20	1.90	2.10
#3	N/A	1.50	1.50
Average Non-Organic	**0.07**	**1.22**	**1.29**
Organic			
Todd Home			
west	2.50	4.70	7.2
east	2.54	4.79	7.33
Todd Shop	0.67	6.04	6.71
Todd Sides	N/A	2.55	(2.55)
Average Organic	**1.90**	**4.52**	**6.42**
STANDARD GROWER CONTROL	**0.0**	**0.10**	**0.10**
ORGANIC GROWER CONTROL[1]	-	-	-
UNTREATED CONTROL[2]	-	-	-

[1] and [2] – See Table 4

Table 7

3RD GENERATION CODLING MOTH DAMAGE
Potter Valley, Mendocino county
September 27-28, 1999
Post-harvest Tree Counts (%/300)

BLOCK/TREATMENT	
PUFFER	
Standard	
Thornton Big Block	
southwest	0.0
east	0.0
northwest	0.0
Thornton Brooks	
south	0.0
east (by apples)	1.0
Thornton Elmer	
northwest	0.0
southeast	0.0
Thornton Todd	
northeast	0.0
middle	0.0
southwest	0.0
Thornton Steve	
west	0.0
southeast	0.0
Ernie Pauli	
south (along creek)	0.7
east	0.0
north (Bush Lane)	0.0
Pauli Home	
#1 east	0.0
#2 middle	0.0
#3 Orchard removed	-
Average Standard	**0.1**
Organic	
Todd Home	
west block (%/34)	8.1
east block (%/54)	25.9
Todd Shop	
north to south (%/200)	12.0
Todd Sides	
north to south (%/59)	20.3
Average Organic	**16.6**
STANDARD GROWER CONTROL	**0.0**
ORGANIC GROWER CONTROL	-
UNTREATED CONTROL (apples)	-

Table 8

ORGANOPHOSPHATE SPRAYS APPLIED FOR CODLING MOTH

Spray applications / acre	1998	1999
0	22[2]	100
0.2[1]	0	0
1.0	0	0
>1.0 - <2.0	0	0
2.0	78	0
>2.0 - <3.0	0	0
3.0	0	0
>3.0	0	0
Total acreage	100%	100%

1. Border spray only
2. 22% of acreage is organic
   Grower control used 2 OP sprays both years

Table 9

NUMBER OF INSECTICIDE APPLICATIONS MADE FOR SECONDARY PESTS OF PEARS

Average applications per orchard	Pear Psylla	Leafrollers	True Bugs	Mites
1998				
Agri-mek	1.5	0	0	1.5
Asana XL	1	0	0	0
Dipel	0	0.2	0	0
1999				
Agri-mek	1.6	0	0	1.6
Asana XL	1	0	0	0
Dipel	0	0.7	0	0

Final issue to participating growers, PCA's, and project sponsors.

CODLING MOTH:
9/24 -27 Trap catch status (attached) – Catches were all zeros. Below is the revised catch summary for the 1999 season.

1999 POTTER VALLEY "PUFFER" TRIAL
CM/OBLR TRAP CATCHES[1]
Total catches thru September 27,1999

TRAP TYPE	Block			
	Standard Puffer (10 plots)	Organic Puffer (5 plots)	Grower (1 plot)	Control (2 plots)
CM 1x LOW	6	12	2	110
CM 1x HIGH	16	59	7	0
CM 10x HIGH	44	40	3	13
OBLR W/H	2156	838	71	12

[1] One trap of each type per 5 acres

✳ Puffers hung week April 5, 1999

✳ **CM** biofix April 21 1999; **OBLR** biofix May 26,1999

Degree-day Accumulation and 3rd flight prediction:
As of October 4 there were 2678 °D at the PV Adcon station.

Bin count and post-harvest survey:
To accompany this fax, each grower is being mailed a copy of the progress report submitted to CalDPR. Bin data is reported in Table 4 on page 15. Damage averaged 0.3% in the standard blocks and 5.3% in the organic blocks (range 1.5 – 11.0%).

The post-harvest survey data is below. In standard blocks, the only infested fruit was in close proximity to unsprayed apple trees harboring large amounts of wormy fruit (Brooks southeast corner and Ernie-Pauli along the creek). The organic blocks have significant overwintering potential going into 2000.

OBLR:
9/24-27 trap catch status (attached). Only a few moths lingered; traps were removed at that time.

Degree-day accumulation:
As of October 4 there were 3083 °D at the PV Adcon station. According to the WSU model and adjusted for the North Coast, both flight and hatch should have been complete.

Bin damage and post-harvest survey damage:
As with CM, bin damage data is reported in the progress report in Table 5, page 16. Damage averaged 1.3% in the standard blocks and 6.4% in the organic blocks. Damage in the grower control was 0.1%.

Th post-harvest survey revealed almost no OBLR-infested fruit, so was not counted.

2000 SEASON PLANS
Most, if not all of you have spoken to me about your plans for 2000. Based on discussions thus far, it is clear that an area wide puffer effort is not feasible for 2000. In light of this, we have submitted a proposal to CalDPR to expand the Kelseyville project to 800 acres.

Although there will be no area wide project in Potter Valley, I would be happy to work with growers individually. There will be a special winter meeting focused on codling moth management options. In the meantime, please contact me to discuss your individual situation.

Finally, I wish to thank all of you for supporting the area wide program this season, especially by purchasing the puffers. Both the Potter Valley and Kelseyville programs, though VERY different, showed the enormous potential for managing CM when everybody works together, the challenges of organic production notwithstanding.

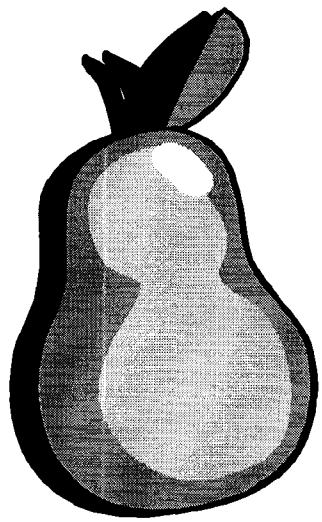
The final DPR report is due early next year. You will all receive copies.

The North Coast industry is facing unprecedented economic challenges, which may or may not be reasonable. In this context, I wish all of you the very best and please let me know how UCCE can best serve you in the coming year.

MENDOCINO COUNTY

PEAR FIELD DAY

1999



Friday – July 23, 1999

Sponsored by:

University of California Cooperative Extension
California Department of Pesticide Regulation
California Pear Advisory Board
Pear Pest Management Research Fund
Ukiah Valley IPM Pear Growers, Inc.

1999 MENDOCINO COUNTY PEAR FIELD DAY
Friday, July 23, 1999

SPONSORS:
U.C. Cooperative Extension
California Department of Pesticide Regulation
California Pear Advisory Board
Pear Pest Management Research Fund
Ukiah Valley IPM Pear Growers, Inc.

3 units PCA Continuing Education Credit applied for

For both sessions meet at Hildreth Ranch, 1520 Ruddick-Cunningham Road, off Talmage Exit, Hwy. 101. Following parking signs.

ENGLISH SESSION: 8:30 a.m. – 12:15 p.m. (Registration at 8:30, program begins at 9:00)

PROGRAM

Registration, refreshments, welcome
Rachel Elkins, U.C. Cooperative Extension, Lake and Mendocino Counties

TOPICS

Pear Pest Management Alliance/Ukiah IPM Growers Areawide Codling Moth Mating Disruption Project
Pete Chevalier, President, Ukiah IPM Growers
Erin Ruddick, Secretary, Ukiah IPM Growers
Participating Growers and PCA's
Mario Moratorio, Acting North Coast IPM Advisor
Bob McClain, CPAB

Kaolin® clay to enhance red pear color and finish
Rachel Elkins
Mike Hildreth, grower
Robin Matson, Engelhard Corp., Yakima, WA

CalDPR Areawide Codling Moth "Puffer" Project
Rachel Elkins and UCCE field staff
Participating growers and PCA's
Bob Elliott, Project Manager, CalDPR

OBLR Trap Comparison and Control Trials
Mario Moratorio

Pear Scab Control
Doug Gubler and Ken Dell, Dept. of Plant Pathology, UCDavis

SPANISH SESSION: 2:30 – 4:30 p.m. (Registration at 2:30, program begins at 3:00)
(This session will be held in Ukiah; if there is interest, the group can travel to Potter Valley as well)

Translation by Mario Moratorio

TOPICS: mating disruption (Isomate, Concep, puffers), pear pest identification, OBLR, pear scab

(Please encourage employees to attend at least one of the Spanish sessions in Lake or Mendocino County–for **your** *benefit as well as theirs!!)*

PLANNING FOR THE 2000 CODLING MOTH SEASON

WHEN: Friday, March 3, 2000
12:30–4:15 p.m.

WHERE: Big Valley Grange #680
1510 Big Valley Road, Finley

PRESENTERS: U.C. Cooperative Extension
California Department of Pesticide Regulation
Lake and Mendocino County PCA's
Mating disruption dispenser producers

AGENDA

(3 hours PCA continuing education credit applied for)

12:30 Registration

1:00 Why are we here? Introduction to issues and concerns
Rachel Elkins, Pomology Farm Advisor, UC Cooperative Extension Lake and Mendocino Counties

1:15 Update on current North Coast areawide mating disruption projects
Rachel Elkins
Bob Elliott, CalDPR
Lucia Varela, UCCE North Coast Area IPM Advisor
Pete Chevalier, Ukiah IPM Growers, Inc.

2:00 Alternative insecticides for codling moth and major secondary pests
Bob Van Steenwyk, Dept. of Insect Biology, UC Berkeley

2:30 BREAK (refreshments by Clear Lake Grange)

2:45 Mating disruption dispensers
Rich Bakke, Concep, Inc.
Roland Gerber, Paramount Farming Co.
Jack Jenkins, Pacific BioControl

3:15 Commercial implementation of mating disruption programs (Panel and round table discussion)
Pete Chevalier, UAP, Ukiah
Bill Knispel, UAP, Finley
Greg McCosker, Harvey Lyman Ag. Services, Lakeport
Bill Oldham, Ag Unlimited, Ukiah
John Sisevich, Harvey Lyman Ag Services, Lakeport
Broc Zoller, Pear Doctor, Inc., Kelseyville

4:15 ADJOURN

Please come prepared with questions, concerns, and your own experiences and observations!

Sample Costs

To produce Bartlett pears
In Lake County, California
Using

PUFFERS

An amendment to the 1997
Lake County cost study

Rachel Elkins
Karen Klonsky
Dustin Blakey

Abstract

Sample costs to produce Bartlett pears in Lake County have been compiled most recently in 1997 using standard production practices of the time. Growers at that time were assumed to make three cover spray applications with organophosphate materials to control codling moth. The advent and recent use of aerosol-released pheromone mating disruption ("puffers") created a need for a cost comparison of the two production systems. Man-hours were recorded for all operations that were considered to be part of a diligent, puffer-based codling moth control program. A model spray program was created that was representative of the sprays applied to puffer acreage according to submitted monthly pesticide use reports. The cultural expenses of the 1997 cost study were amended by adding any additional costs incurred from using puffers and by subtracting any savings. For a 40-acre block, it is recommended to use 2 puffers per acre. As contiguous acreage increases, this rate can be reduced. In this study a rate of 1.3 puffers per acre is used in a 500-acre contiguous block of orchards. One trap set (4 traps) is used every 5 acres to monitor insect development. All other 1997 costs, fees, and interest rates were used when possible so that there could be a valid basis for comparison. To produce pears using standard practices cost $1,847 per acre; using a puffer program cost $2,042 per acre (1997 dollars). A net additional expense of $194 was incurred by using puffers. Use of an improved design puffer cabinet (available in 2000), a reduced number of traps per acre, and elimination of the remaining cover spray would lower costs of production using puffers by reducing material and labor expenses. In subsequent years, the cost of the reusable puffer cabinet would be eliminated.

Table 1. Labor used for operations related to using puffers to produce pears. Amounts given are in man-hours per acre (6 min = 0.1 hours).

Operation	MAR	APR	MAY	JUN	JUL	AUG	SEP
Hang Puffers	0.08	-	-	-	-	-	-
Hang CM Traps	0.07	-	-	-	-	-	-
Change Lures (caps)	-	0.125	0.125	0.125	0.125	0.125	
Check Traps	-	0.144	0.37	0.4	0.28	0.29	0.11
Hang OBLR Traps	-	-	-	0.1	-	-	-
Egg Counts	-	-	0.046	0.046	0.046	-	-
Check Ground Fruit	-	-	-	-	0.064	-	-
Check Tree Fruit	-	-	-	0.172	0.172	-	0.086
Inspect Puffers	0.02	0.02	0.02	0.02	0.02	0.02	-
Compile Weekly Results	-	0.03	0.03	0.03	0.03	0.03	0.03
Bin Counts	-	-	-	-	-	0.24	-
Take Down Traps	-	-	-	-	-	-	0.112
Reprogram Puffers*	-	-	-	-	0.09	-	-

*Not included in cost study.

Table 2. Material costs for puffers and traps. 1999 Prices shown ($US).

Material	Cost	Rate/Acre
Puffer Cabinet	$40.00	1.3
Puffer Canister	$80.00	1.3
Traps*	$32.96**	0.8

* Includes all lures and replacement liners. Average cost of CM and OBLR types.
** Assumes 4% bulk discount over retail, single case price. Discount will vary with quantity purchased.

Cost of traps.

As the cost of one trap used through a season may seem high, the method by which it was calculated is shown in Table 3. These prices reflect full retail prices quoted by Trece in late 1999 less a 4% discount for buying a reasonable quantity. For a quantity of traps to cover 700 acres, the researchers obtained a more sizable discount. A set of traps consists of four traps: 1xCM high, 1xCM low, 10xCM high, and OBLR-W high.

Table 3. Itemized list of costs used to calculate average cost of one trap.

Item	Qty	Price	Price/100	Needed	Cost of 100
1x CM Lures	25	$43.17	$172.68	10	$1,726.80
OBLR-W Lures	25	$43.17	$172.68	5	$863.40
10x CM Lures	25	$27.38	$109.52	3	$328.56
Liners	100	$94.29	$94.29	3	$282.87
Traps	100	$231.34	$231.34	1	$231.34
				Total	$3,432.97
				Less 4% discount	$3,295.65
				Cost per trap	$32.96

Sample Spray Program.

This is the spray program used in conjunction with puffers for pear pests in our cost study. This is a transition orchard and will receive one cover spray with Guthion. This does not include dormant oil, herbicide, or disease sprays. *This is only an example and may not reflect the actual program in every orchard.*

MARCH
- Lorsban, 3 lb / ac
- Asana XL 7.25 oz / ac

APRIL
- Asana XL 7.25 oz / ac

MAY
- Guthion 2 lb / ac
- Agri-mek 15 oz / ac (with oil)

JUNE
- Dipel 2 lb / ac

JULY
- Dipel 2 lb / ac

Table 4. Cultural costs to produce pears using standard practices. Unchanged 1997 cost study amounts.

Beginning JAN 97 Ending DEC 97	JAN 97	FEB 97	MAR 97	APR 97	MAY 97	JUN 97	JUL 97	AUG 97	SEP 97	OCT 97	NOV 97	DEC 97	TOTAL
Cultural:													
Pest Control - Dormant		55											55
Weed Control - Strip Spray 3X		31		10			9						50
Pest Control - Gophers 3X			7										7
Pest Control - Budbreak			16										16
Weed Control - Mow Middles 7X			8	8	8	14	14						50
Pest Control - Scab			35	5									40
Frost Protection				24	24								48
Pest Control - Fungicide Spray				11	59								71
Pest Control - Blight				65	65								131
Pest Control - Blight & Scab				22									22
Prune & Train Trees					792								792
Pest Control - Blight & Cover					38								38
Pest Control - Cover Spray						44	22						66
Irrigate						29	29						58
Fertilize - Nitrogen						34							34
Pest Control - Psylla & Mites						17	155						172
Apply Hormone								28					28
PCA Fees		4	4	4	4	4	4	4	4				33
Leaf Analysis					19								19
Pickup Truck Use	5	5	5	5	5	5	5	5	5	5	5	5	62
ATV Use	5	5	5	5	5	5	5	5	5	5	5	5	57
TOTAL CULTURAL COSTS	10	100	79	159	1019	152	242	42	14	10	10	10	1847

Table 5. Cultural costs to produce pears using puffers. Labor and chemical costs are from 1997. Traps and puffers are 1999 prices. Changes to 1997 study are indicated in *italic* type.

Beginning JAN 99	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Ending DEC 99	99	99	99	99	99	99	99	99	99	99	99	99	
Cultural:													
Pest Control - Dormant		55											55
Weed Control - Strip Spray 3X		31		10			9						50
Pest Control - Gophers 3X			7										7
Pest Control - Budbreak			16										16
Weed Control - Mow Middles 7X			8	8	8	14	14						52
Pest Control - Scab			35	5									40
Frost Protection				24	24								48
Pest Control - Fungicide Spray				11	59								70
Pest Control - Blight				65	65								130
Pest Control - Blight & Scab				22									22
Prune & Train Trees					792								792
Pest Control - Blight & Cover					38								38
Pest Control - Cover Spray													*0*
Irrigate						29	29						58
Fertilize - Nitrogen						34							34
Pest Control - Psylla & Mites			*13*	*13*	*102*								*128*
Change Caps				*1*	*1*	*1*	*1*	*1*	*1*				*6*
Check Traps				*2*	*2*	*2*	*2*	*2*	*2*				*12*
Egg Counts					*0.5*	*0.4*	*0.5*						*1.4*
Check Tree + Ground Fruit & Bins						*0.75*	*0.75*	*0.75*	*0.75*				*3*
Compile Weekly Results				*1*									*1*
Hang Puffers			*157*										*157*
Hang OBLR Traps						*7*							*7*
Inspect Puffers			*1*										*1*
Hang CM Traps			*20*										*20*
Pest Control - OBLR			*36*			*29*	*29*						*94*
Take Down Traps									*1*				*1*
Apply Hormone								28					28
PCA Fees		4	4	4	4	4	4	4	4				32
Leaf Analysis					19								19
Pickup Truck Use	5	5	5	5	5	5	5	5	5	5	5	5	60
ATV Use	5	5	5	5	5	5	5	5	5	5	5	5	60
TOTAL CULTURAL COSTS	10	100	307	176	1125	132	100	45	18	10	10	10	2042

Table 6. Cost comparison of standard and puffer blocks.

Production Type	Cultural Cost
Standard	$1,847
Puffer	$2,041

Table 7. Comparisons of various hypothetical production regimes using puffers at full- and half-rate trap coverage (1 trap per 1.25 acres vs. 1 trap per 2.5 acres) based on 1997 cost study.

Program	*One-half trap rate*	Full trap rate
Year 1 program	$2,019	$2,042
In year 2 with one cover spray	$1,967	$1,990
Same but with no cover sprays	$1,945	$1,968
Year 2 using mixed OBLR-CM canister, 1 Lorsban application & 1 CM cover	$1,909	$1,932
Year 2 mixed OBLR-CM, no CM spray, 1 Lorsban	$1,887	$1,910
Standard production (1997 Study)	$1,848	$1,848

APPLES & PEARS

Codling Moth Mating Disruption

by Rachel Elkins

Codling moth (Cydia pomonella) is the key pest of pears in California. The economic threshold for damage in cannery loads is 5 percent (including all other defects). Damage in untreated controls ranges from 10 to 50 percent, signifying great need for effective control. State and federal actions in 1998 and 1999 have resulted in the restriction or loss of the two key organophosphate insecticides used to control codling moth, azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (e.g. Penncap®). These losses are necessitating rapid transition of the pear industry into alternative pest management programs. The most proven and available current alternative is mating disruption, which has been researched in pears since 1987. Mating disruption has been demonstrated to be most effective when utilized on an areawide basis in orchards under low to moderate codling moth pressure. The most widely used strategy is hanging 150-400 pheromone dispensers per acre throughout a treated block, once to twice per season. Each dispenser emits a small amount of pheromone over the life of the unit, about 60-120 days.

In 1999, USDA and the California Department of Pesticide Regulation sponsored two areawide mating disruption demonstration projects in Lake and Mendocino counties. These projects utilized an alternative, reasonably priced dispenser, the "puffer", developed by the late Dr. Harry Shorey of UC Riverside. The puffer has been further developed and registered by Paramount Farming Co. of Bakersfield, a large almond and pistachio operation. It is manufactured in Canada and sold directly by Paramount. The codling moth product is registered as the Paramount Puffer CM®. Rather than hanging many dispensers which each emit small amounts of pheromone, this method involves hanging two or fewer dispensers per acre, each emitting a large amount of pheromone at preset intervals and above a minimum ambient temperature threshold for 200 days. Prior to initiating this project, this dispenser was the focus of three years of pear industry-funded UC research on 160 acres of Bartlett pears in Kelseyville, Lake County. Based on the success of the Lake County project, in 1999 the puffer was used to control codling moth on a total of nearly 900 acres, or about 10 percent of the total North Coast acreage.

The first site was an expansion of the original 160 acres to 500 acres, under the sponsorship of the USDA Codling Moth Areawide Management Program (CAMP). The second site was 360 acres in Potter Valley, Mendocino County, funded by a California Department of Pesticide Regulation, Pest Management Demonstration grant. This was the entire Potter Valley pear acreage except for one 22-acre block that was used as a grower control and two acres of organic Bosc that was also used as a comparison. The Potter Valley site was unique in that it included 75 acres of certified organic Bartlett and Bosc, almost all of the California organic pear supply.

At each site, puffers were hung with a hooked swimming pool pole every 65 ft. around the perimeter of each 40-acre block. Adjacent blocks or those larger than 40 acres necessitated fewer units per acre. The application rate was 1.3 per acre for Kelseyville and 1.8 for Potter Valley due to its more fragmented configuration and higher initial codling moth pressure. Pheromone was emitted each 15 minutes from 3:00 p.m. to 3:00 a.m. Each site was monitored using 1 mg. and 1 mg. codling moth traps, as well as traps for oblique-banded leafrollers (OBLR). Regular egg and damage sampling was done through the season at harvest, and post-harvest on fruit remaining in the trees.

Results were very encouraging. In the 500 acre Kelseyville site, no codling moth damage was found at harvest, versus 29 percent in untreated controls. This was despite the fact that 70 percent of puffer-treated blocks received no organophosphates. In Potter Valley, the only codling moth damage occurred along an upwind riparian corridor harboring feral apple trees, borders of standard blocks across from organic orchards, and in the organic orchards themselves. The organic orchards entered the program with high initial pressure despite using pheromone ties for the past several years. Early season control was further hindered due to 1) the inability to use oil as an insecticide through almost the entire first flight because it was incompatible with lime sulfur used for pear scab, and 2) general ineffectiveness of other organically-available materials. Harvest damage in organic blocks ranged from 5-12 percent. While this is commercially unacceptable, damage in the untreated block of organic Bosc was 31 percent.

In 2000, the Kelseyville project will expand to 800 acres, indicating support from growers and pest control advisers. The Potter Valley project, for reasons largely unrelated to puffer efficacy, will be discontinued on an areawide basis, though growers may continue individually.

1999 was a late, cool year; consequently codling moth pressure was relatively low. However, most standard blocks still received three OP treatments, and as stated above, damage to completely untreated sites was quite high, indicating high potential if left untreated. The challenge to any pheromone-based system occurs during warm years with three or more full flights, depending on location.

Another challenge to mating disruption programs is increased oblique-banded leafroller damage. Low to moderate (0.1-6 percent) levels were found in over 50 percent of puffer-treated orchards. In 2000, a mixed CM-OBLR unit will be tested that will hopefully prevent OBLR damage levels from increasing.

Previous research and other demonstration projects have shown that mating disruption of any type is a multiple-year, multi-tactic strategy. In the Lake County project, on orchard in the original 160 acres required three years to reduce damage to zero. Growers must thus make a long-term commitment to the program, which often includes high initial costs required to reduce flight and subsequent damage and increased monitoring costs, related to trapping, egg surveillance and damage sampling. A plan to eliminate pressure from unfarmed apple and pear trees, especially upwind, will also be required. CG

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