DESCRIPTION:	**Control of Codling Moth in Organic Pear Orchards**
PROJECT LEADER:	**Rachel Elkins, UCCE Lake County**
2002 FUNDING:	**Funding from UCCE Lake County**

Control of Codling Moth in Organic Pear Orchards

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ABSTRACT

Two replicated trials were carried out in mature Bartlett pear orchards in the third year of transition to becoming certified organic. In the first, treatments were each applied to single trees using a handgun at dilute (about 300 gpa) rates to five trees in a randomized complete block design down the most upwind row in the orchard, bordered by walnuts. Codling moth (CM) pressure was high in 2001, thus likely assuring measurable results. The entire orchard was treated with the Suterra CM Puffer for CM mating disruption (MD). Chemical treatments were: 1) Surround® WP (kaolin clay), 2) Surround® WP to June 19 followed by 415 oil, 3) 415 oil, 4 and 5) two rates of Pyganic® 1.4 EC plus Nufilm P (pyrethrin), 6 and 7) two rates of GF-773 (spinosad) plus 1% 415 oil, and 8) untreated control (MD only). Treatments were applied 6-9 times and timed for each CM flight through July 12. CM eggs and damage were sampled through the season and percent control vs. untreated calculated. 10 leaves per tree were sampled biweekly for the presence of other arthropods. Results were significant. Untreated controls averaged 5.6% CM damage just prior to harvest on July 29. Both Surround® WP treatment regimes and the oil program had 0% damage (100% control). GF-773-treated trees averaged 95% control, Pyganic® 1.4 EC averaged 57% (2 pints) and 82% (4 pints) respectively. Damage on August 20, after the 2B flight, increased to 16% in untreated controls, but control remained at 100% in Surround® WP, oil, and GF773 (73 gms.) treatments, and 94% for GF773 (109 gms.), indicating the longevity of these treatments. Damage in the Pyganic® 1.4 EC (2 pint)-treated trees was higher than in untreated controls, and the 4 pint rate gave only 44% control, indicating the very short residual of this material. These results indicate that integrated programs of CM MD, combined with various combinations of Surround® WP, oil, and spinosad can potentially effectively control CM in organic pear orchards, but wider scale testing using grower equipment must be done to confirm this. In the second trial, treatments applied by the grower were: 1) MD plus Surround® WP applied 4 times through June 18; 2) MD plus 415 oil applied 5 times; and 3) MD alone. CM pressure was very low and no moths or damage occurred. European red mites were higher in the Surround® WP plots, as was the case in the single tree trial.

INTRODUCTION

Codling moth mating disruption (CM MD) has become the standard practice in the California pear industry. It must however, be supplemented by insecticides in at least some locations and years in order to maintain overall efficacy. The lack of effective supplements will likely render the technique ineffective over time due to CM population buildup in warm years or where sources of infestation exist.

Effective, environmentally acceptable alternative insecticides are desperately needed to replace or supplement currently available materials in MD programs. Current materials are mainly broad-spectrum organophosphates that are being increasingly restricted and are becoming less effective due to resistance. Potential alternatives include certain insect growth regulators (e.g. Confirm®, Success® WP) and biopesticides. The problem is particularly acute for organic growers or those interested in transitioning to organic practices. Besides limiting their own ability to control CM, the lack of effective options for organic growers increases pressure in neighboring non-organic orchards, thereby jeopardizing established and areawide control programs.

The most widely utilized organically approved insecticide currently used for CM control are oils of various types. Ryania was used until it was withdrawn by the manufacturer. Dr. Louis Falcon of UC Berkeley isolated and developed a codling moth granulosis virus (GV) for use as a biopesticide. His work was partially funded by the pear industry during the late 1970's and early 1980's. The product was used by a few organic growers, but was never fully developed commercially and eventually faded from use some years ago. A new GV product, Virosoft $^{CP4®}$ (Biotepp, Quebec, Canada), was tested in 2001, but failed due to inadequate formulation. (Two new GV products will be tested in 2003 if funding is received).

Several potentially useful materials have recently become available for testing in organic pear orchards. Kaolin clay (Surround®, Engelhard Corp., New Jersey) is widely used in the Pacific Northwest for pear psylla control, as well as to enhance fruit finish and reduce sunburn. Evidence of some level of CM control has also been documented but there is still only limited published data on this use (Unruh 2000). A non-organic formulation of spinosad (Success®, Dow Agrosciences, Indiana) is registered in non-organic pome fruit orchards. An organic formulation recently received a federal Section 3 registration and is called Entrust® 80WP (Organic Material Research Institute (OMRI) approval is pending). Finally, a relatively new pyrethrum formulation (PyGanic 1.4 EC, McLaughlin Gormley King Co., Minnesota) has been used to control many different outdoor and indoor pests both commercially and non-commercially.

Increasing interest in organic production has led to over 400 acres of pear orchards (both Asian and European) to be certified through California Certified Organic Farmers (CCOF) and approximately 200 acres in transition in California.

In order to increase the number of effective materials, a one-year trial was established and carried out in two orchards in the final year of transition to becoming certified organic by California Certified Organic Growers (CCOF). The purpose was to gain preliminary efficacy data on selected available materials in order to provide an objective evaluation to supplement grower experience.

The project was supported by Gerber Products Company due to their great interest in ensuring the viability of organic pear production to supply their organic baby food line, as well as their commitment to support expanded use of reduced-risk materials and areawide IPM programs nationwide.

PROCEDURES AND RESULTS

Two replicated trials were carried out in Lake County. The first was a single tree trial comparing different rates of several materials. The second was a grower-treated trial comparing several regimes of Surround® and/or oil.

I. Single tree trial

Site description: Murphy Hellsbound, Finley, Lake County
Mature trees, 25' x 25' spacing, 70 trees per acre
Entire orchard treated with the Suterra CM Puffer

Trial Design: RCBD, 5 single tree replications per treatment; interplanted buffer tree between each treatment tree.

CM Pressure: Heavy

All timings were applied at dilute rate (about 300 gpa) by hand-gun (Mitchell Sprayers, Wilsonville, OR).

Treatments and timings were (Figure 1):

1) Surround® WP, 50 lbs. per acre, applied April 22, May 1, May 13, May 21, June 5, June 11, June 19, June 25 and July 12 (9 applications).
2) Surround® WP, 50 lbs. per acre, applied as in 1) through June 11 (6 applications), then 415 oil, 4 gallons per acre, applied June 19, June 25, July 9, July 12 (4 applications).
3) 415 oil, 4 gallons per acre, applied May 1, May 13, May 21, June 5, June 11, June 19, June 25, July 9, July 12 (9 applications).
4) Pyganic® 1.4 EC, 2 pints per acre plus Nufilm P, applied May 13, May 21, June 11, June 19, June 25 and July 12 (6 applications).
5) Pyganic® 1.4 EC, 4 pints per acre plus Nufilm P, applied as in 4).
6) GF773 (spinosad), 73 gms. per acre (0.16 lb.) plus 1% 415 oil, applied May 13, May 21, June 11, June 19, June 25, and July 12 (6 applications);
7) GF773 (spinosad), 109 gms. per acre (0.24 lb.) plus 1% 415 oil, applied as above.
8) Mating disruption alone (control)
9) One standard treated orchard, located about one mile upwind from the trial site was used to obtain comparative trap and damage data for reference purposes only.
10) Untreated controls – two sets of 25-50 upwind trees were used to obtain information as in 9).

Evaluation

Degree-days and trap catches (reference only):

CM degree-days (base 50° F/88° F, single sine horizontal cut off) were calculated from a UCIPM PestCast Network Campbell Scientific weather station located less than 1 mile from the test

orchard. Trece 1x high and low and 10x high CM traps were hung in the orchard prior to biofix to track CM flight.

CM infestation:

1) 20 fruit after growth began (10 top and 10 bottom) were sampled for CM eggs on May 5 and May 22. 10 top and 10 bottom fruit from each tree were sampled for eggs, worms, and damage on June 26 (980°D, 1st generation); 144 ground fruit on July 10-16 (1262-1413 °D, 1st generation); 50 top and 50 bottom fruit per tree on July 29 (1688°D, 2a and 2b generation); 10 top and 10 bottom fruit per tree on August 20 (2119 °D, late 2nd generation). A post-harvest fruit sample of fruit remaining on the trees (varying number) was taken on October 14 (2936 ° D, 3rd generation).
2) 10 shoots (5 top and 5 bottom) per replicate were collected biweekly from May 22 through September 6, run through a mite brushing machine, and the number of pear psylla, thrips, web spinning and predator mites, true bugs, aphids, lacewing eggs and adults, ladybird larvae and wasps counted.

Results

Degree-day and trap catches: Data shows there were two and a partial third generations of CM (the third showed up in only one set of traps in one of the untreated controls). Biofix was set on April 1 based on data from surrounding orchards, but moths were first caught in UCCE traps in the trial orchard on April 30 (208°D) (one PCA trap, however, caught moths prior to this date in the same orchard). Moths were caught through August 26 (2225°D) in the closest untreated control, but only through July 29 (1688°D) in the trial block (Figures 1).

Egg and larval infestation: Damage was statistically equal in all treatments through the 1st generation sample (biofix to June 26). Significant treatment differences occurred in both the pre-harvest and harvest samples (July 29 and August 20, respectively). The best results were obtained with the full season Surround® WP, early-season Surround® WP followed by 415 oil, full-season 415 oil, and GF-778 (interestingly, the 2 pint per acre rate fared better than the higher rate). The most damage occurred in both Pyganic® 1.4 EC treatments (even statistically exceeding untreated controls in the final harvest sample). For comparison purposes only, there was no damage in the standard grower orchard and the two completely untreated control sites averaged 21.4% damage at harvest (July 30-August 27, 1712-2251°D) (data not shown). The late post-harvest sample in the trial orchard (October 14) revealed no significant damage in any replication except for one untreated control tree (5.9%), one Pyganic® 1.4 EC tree (5.0%), and one 4 pt. GF773 tree (1.8%), all in one rep, indicating that no significant CM activity occurred after harvest (data not shown). This was likely due to the significant block differences in the final harvest sample (Table 2).

Biweekly shoot samples: The only significant differences found were in European red mite populations. These began to appear in the August 7 sample and were highest through the season in the Surround® WP only treatment through August 20, and highest in the Surround® WP/415 oil treatment on September 6 (Figure 2).

II. Large scale trial

Site description: Yoxagoi Cookson Orchard, Finley, Lake County
17 x 10 ft. spacing, 256 trees per acre
Entire orchard treated per acre with Suterra CM puffers

Trial design: RCBD, 4 replications, 307 trees per plot = 1.2 acres per plot (7-8 rows x 38 trees per row).
All treatments applied by the grower using a commercial engine-driven air blast sprayer.
Data was taken from the center rows of each plot.

CM pressure: Low

Treatments and timings were:

1) MD plus Surround® WP at 50 lbs. per acre, applied April 20, May 1, May 21, and June 21 (4 applications) **
2) MD plus 415 oil, 2.5 gallons per acre, applied May 7, May 16, May 21, June 13, and June 21 (5 applications)
3) MD alone
4) grower control as in single tree trial
5) untreated controls as in single tree trial

** The grower chose to forgo oil applications after the Surround® WP treatments ended as there was no CM pressure.

Evaluation

Degree-days and trap catches: Same as in the single-tree trial

CM infestation

1) 1000 fruit per replicate (500 top and 500 bottom) were sampled on June 24 – July 1 (935-1080 °D, 1st generation larvae); 250 ground fruit on July 10-16 (1262-1413 °D, 1st generation larvae); 1000 fruit (500 top and 500 bottom) on July 30 (1712 °D, late 1st and 2nd generation larvae); 600 fruit from bins (200 fruit x 3 bins) on August 27 (2236 °D, 2nd and early 3rd generation larvae).

2) A post-harvest sample of fruit remaining on trees (varying number per replicate depending on availability) was taken on September 30 (2789°D) to determine late 2nd and 3rd generation overwintering potential.

3) 10 shoots (5 top and 5 bottom) were collected and 30 leaves (3 per shoot, top, mid, and bottom leaf) run through a mite brushing machine. The numbers of all arthropods present were recorded, as in single-tree trial.

Results

Degree-day and trap catches: No CM were caught in this orchard.

Egg and larval infestation: There were no eggs, larvae, or damage found in any sample during the entire growing season or post-harvest in the MD plots. 1st generation damage was 0.8% in the grower control and averaged 10.5% in the two untreated controls. 2nd generation damage was 0% in the grower control and averaged 21.4% in the two untreated controls (data not shown).

Shoot samples: The only significant differences among treatments was in the number of European red mites, which were higher in the Surround WP® plots through most of the season, as was the case in the single tree Surround WP® plots (Figure 3).

CONCLUSIONS

Codling moth presence and damage was restricted to the single tree trial. Results indicate that CM MD will benefit from being supplemented with Surround WP®, oil, and GF773 (Spinosad, now known as Entrust®) used in varying combinations in an integrated program, while Pyganic 1.4EC appears to have too short a residual to be effective unless applied excessively frequently.

The number of treatments in the single tree trial ranged from 6 to 9. While biofix was set at April 1 based on catches in the vicinity of the trial, moths were first caught in UCCE traps in the single tree trial orchard on April 30, with no subsequent catch until June 17. Eggs were found on May 6, and hatched larvae on May 30, indicating the Surround WP® treatments made on April 22 may have been premature and hence unnecessary. GF773 applied on May 13 may also have been premature, as egg and larval development appeared delayed. Surround WP®, however, is applied pre-bloom in the Northwest to control pear psylla, so the early timing may have a combined purpose. The single tree trial was carried out to provide maximum opportunity for each treatment to reduce CM damage. Larger scale trials using grower equipment, as well as varying numbers of application will be needed to confirm the efficacy of the materials.

Due to virtually nil CM pressure in the large-scale trial, the grower chose to forgo two of the Surround WP® treatments and all of the subsequent oil treatments in Treatment 1. This thus resulted in comparison of secondary pest and beneficial populations only. Surround WP® caused a significant increase in the number of European red mites in both the single tree and large-scale trial. Hot weather in July likely exacerbated this problem, but users should be aware of the potential for increases in mites and plan accordingly, for example, by avoiding water stress, utilizing oil to suppress populations, and possibly reducing the number of Surround WP® applications. The other potential drawback to using Surround® WP is the perceived difficulty of removing residue prior to packing. This had been observed on Red Sensation Bartlett in 1999, but failed to materialize as a problem on green Bartlett fruit in 2002.

DISCUSSION

There are several relatively new possibilities for supplemental CM control in organic pear orchards. Future testing should look at various combinations in combination with MD to develop

a true integrated pest management that manages CM while ensuring a good overall pest/predator balance.

ACKNOWLEDGEMENTS

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We greatly thank Gerber Products Company, particularly John Aselage and Todd DeKryger, for their support of local UCCE pear pest management programs, as well as their interest in pest management issues facing all pear growers.

We also thank Dr. Barat Bisabri of Dow AgroSciences (GF773), Mitchell King of Engelhard Corp. (Surround® WP), and Don Sundquist of McGlaughlin Gormley King Co. (PyGanic 1.4 EC) for providing materials used in this trial.

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Figure 1

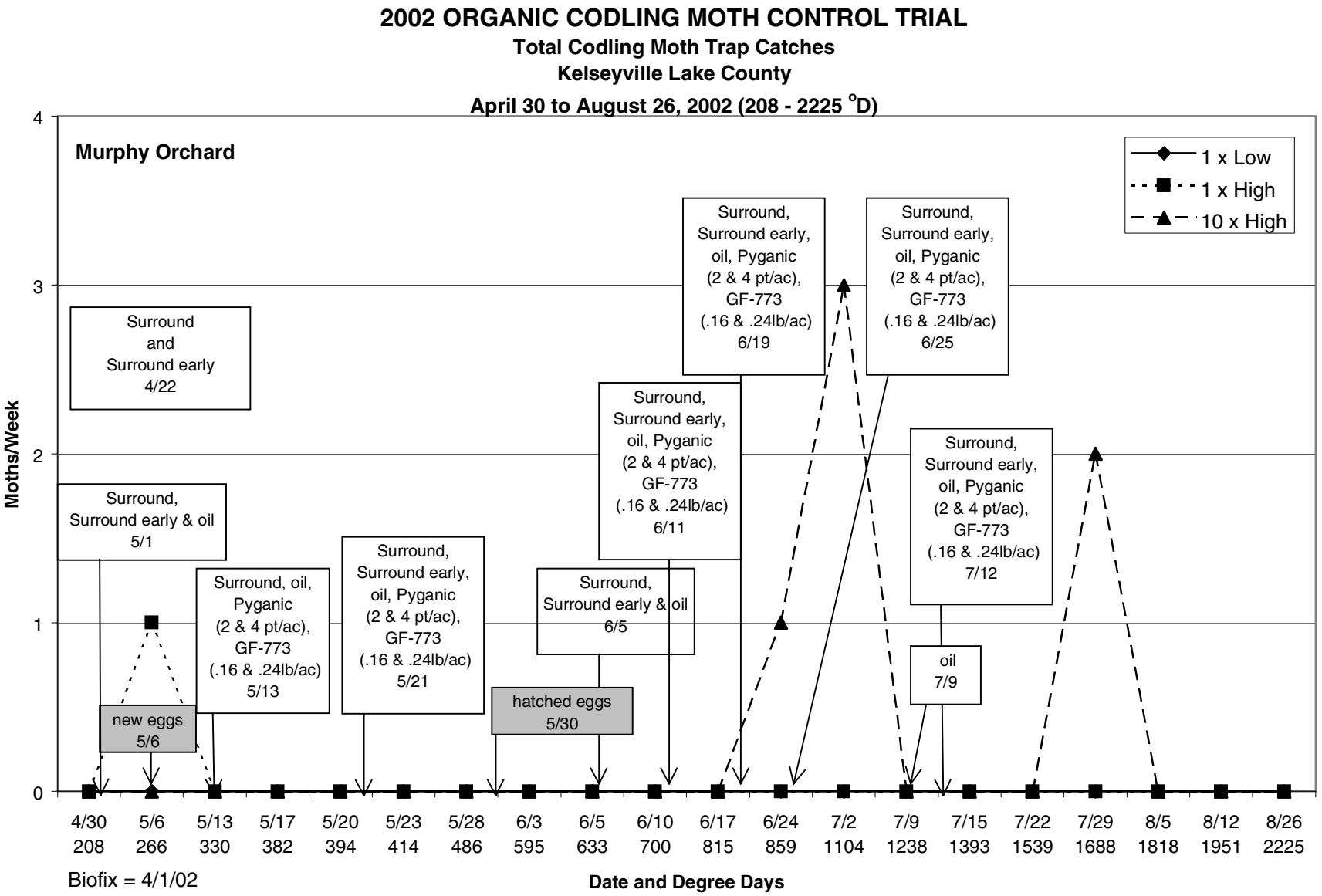

2002 ORGANIC CODLING MOTH CONTROL TRIAL
Total Codling Moth Trap Catches
Kelseyville Lake County
April 30 to August 26, 2002 (208 - 2225 °D)
Murphy Orchard
1 x Low
1 x High
10 x High
Moths/Week
Surround and Surround early 4/22
Surround, Surround early & oil 5/1
new eggs 5/6
Surround, oil, Pyganic (2 & 4 pt/ac), GF-773 (.16 & .24lb/ac) 5/13
Surround, Surround early, oil, Pyganic (2 & 4 pt/ac), GF-773 (.16 & .24lb/ac) 5/21
hatched eggs 5/30
Surround, Surround early & oil 6/5
Surround, Surround early, oil, Pyganic (2 & 4 pt/ac), GF-773 (.16 & .24lb/ac) 6/11
Surround, Surround early, oil, Pyganic (2 & 4 pt/ac), GF-773 (.16 & .24lb/ac) 6/19
Surround, Surround early, oil, Pyganic (2 & 4 pt/ac), GF-773 (.16 & .24lb/ac) 6/25
oil 7/9
Surround, Surround early, oil, Pyganic (2 & 4 pt/ac), GF-773 (.16 & .24lb/ac) 7/12
0
1
2
3
4
4/30 208
5/6 266
5/13 330
5/17 382
5/20 394
5/23 414
5/28 486
6/3 595
6/5 633
6/10 700
6/17 815
6/24 859
7/2 1104
7/9 1238
7/15 1393
7/22 1539
7/29 1688
8/5 1818
8/12 1951
8/26 2225
Biofix = 4/1/02
Date and Degree Days

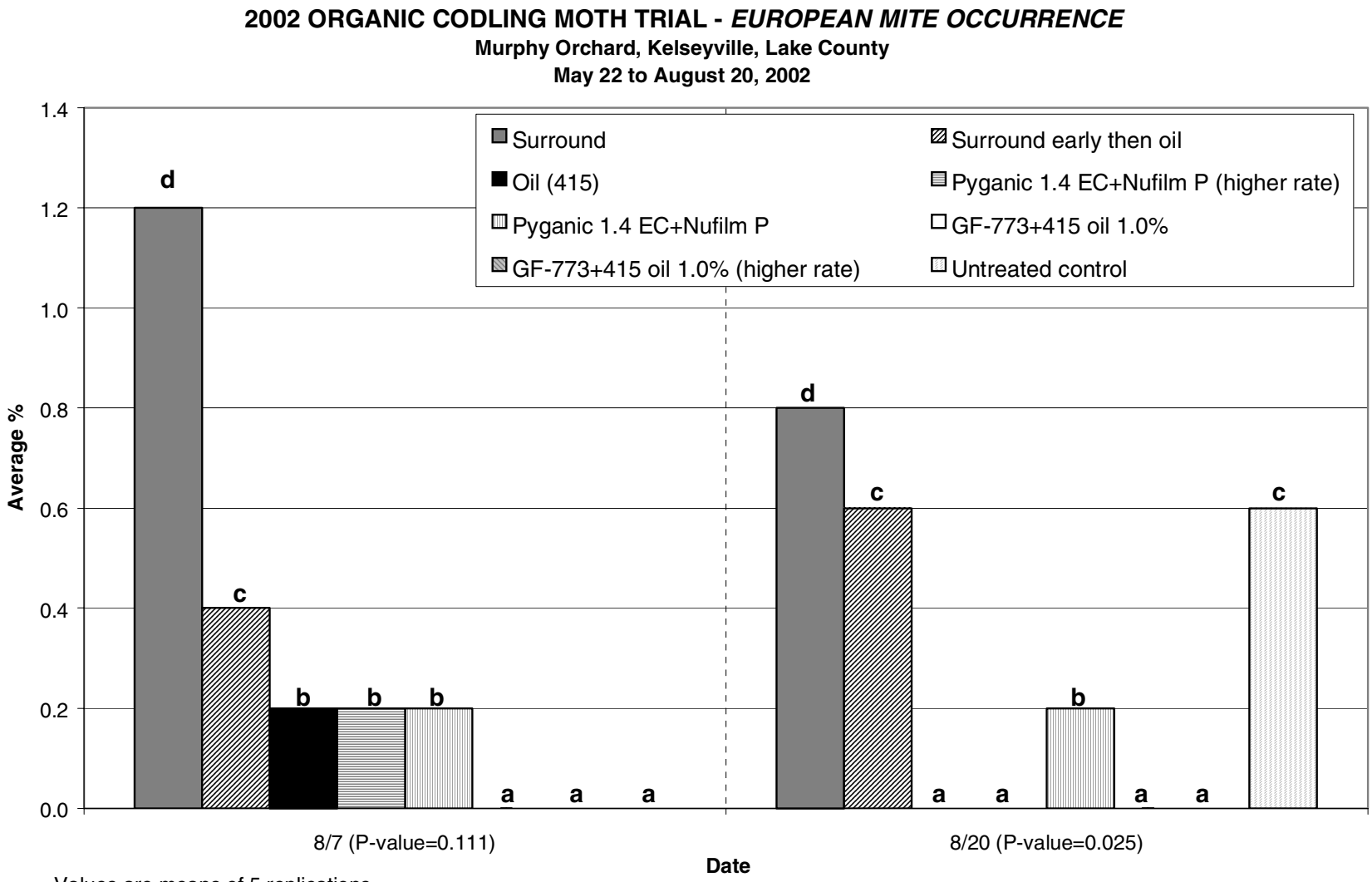
Table 1:

2002 ORGANIC CODLING MOTH CONTROL TRIAL
Treatments, Applications, Average % Damage and Control
Murphy Orchard, Kelseyville, Lake County
April 22 - August 20, 2002

			1st Gen Sample [1]					Pre-harvest Sample [2]					Harvest Sample [3]				
				Eggs				Worms/Damage					Worms/Damage				
Treatment	Rate/ Acre	No.[4] Appl.	Worms/ Damage Total	Top	Bottom	Total	% Control	Top	Bottom	Total	% Control	Eggs Total	Top	Bottom	Total	% Control	Eggs Total
Surround	50 lb	9	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0a	0.0a	**0.0a**	**100.0**	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0
Surround early (>6/19), then oil	50 lb	6, 3	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0a	0.0a	**0.0a**	**100.0**	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0
Oil (415)	4 gal	9	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0a	0.0a	**0.0a**	**100.0**	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0
Pyganic 1.4 E.C. + Nufilm P	4 pt	6	0.0	0.0a	2.0b	**1.0b**	**66.7**	3.2d	1.6d	**2.4d**	**57.1**	0.0	18.0d	20.0d	**19.0e**	**no control**	0.0
Pyganic 1.4 E.C. + Nufilm P	2 pt	6	0.0	0.0a	0.0a	**0.0a**	**100.0**	1.2c	0.8c	**1.0c**	**82.1**	0.0	10.0c	8.0b	**9.0c**	**43.8**	0.0
GF-773 + 415 oil 1.0%	73 gm + 4 gal	6	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0a	0.4b	**0.2b**	**96.4**	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.0
GF-773 + 415 oil 1.0%	109 gm + 4 gal	6	0.0	0.0a	0.0a	**0.0a**	**100.0**	0.4b	0.4b	**0.4b**	**92.9**	0.0	2.0b	0.0a	**1.0b**	**93.8**	0.0
Untreated Control	-	-	0.0	6.0b	0.0a	**3.0c**	**-**	6.0e	5.2e	**5.6e**	**-**	0.0	22.0e	10.0c	**16.0d**	**-**	0.0
ANOVA (p-value)																	
Treatment			-	0.452	0.452	**0.541**		0.054	0.025	**0.015**		-	0.002	<0.001	**<0.001**		-
Block*			-	0.424	0.424	**0.540**		0.185	0.508	**0.708**		-	0.058	0.026	**0.031**		-

[1] 1st gen sample = 10 top, 10 bottom (6/26/
[2] Pre-harvest sample = 50 top, 50 bottom (7
[3] Harvest sample = 10 top, 10 bottom (8/20/
[4] Applications began 4/22/02
[5] Within columns treatments significantly different (Tukey-Kramer multiple range test, P< 0.05), data transformed, [SQRT(X+0.5)].
* Rep = single tree, 5 reps/treatment

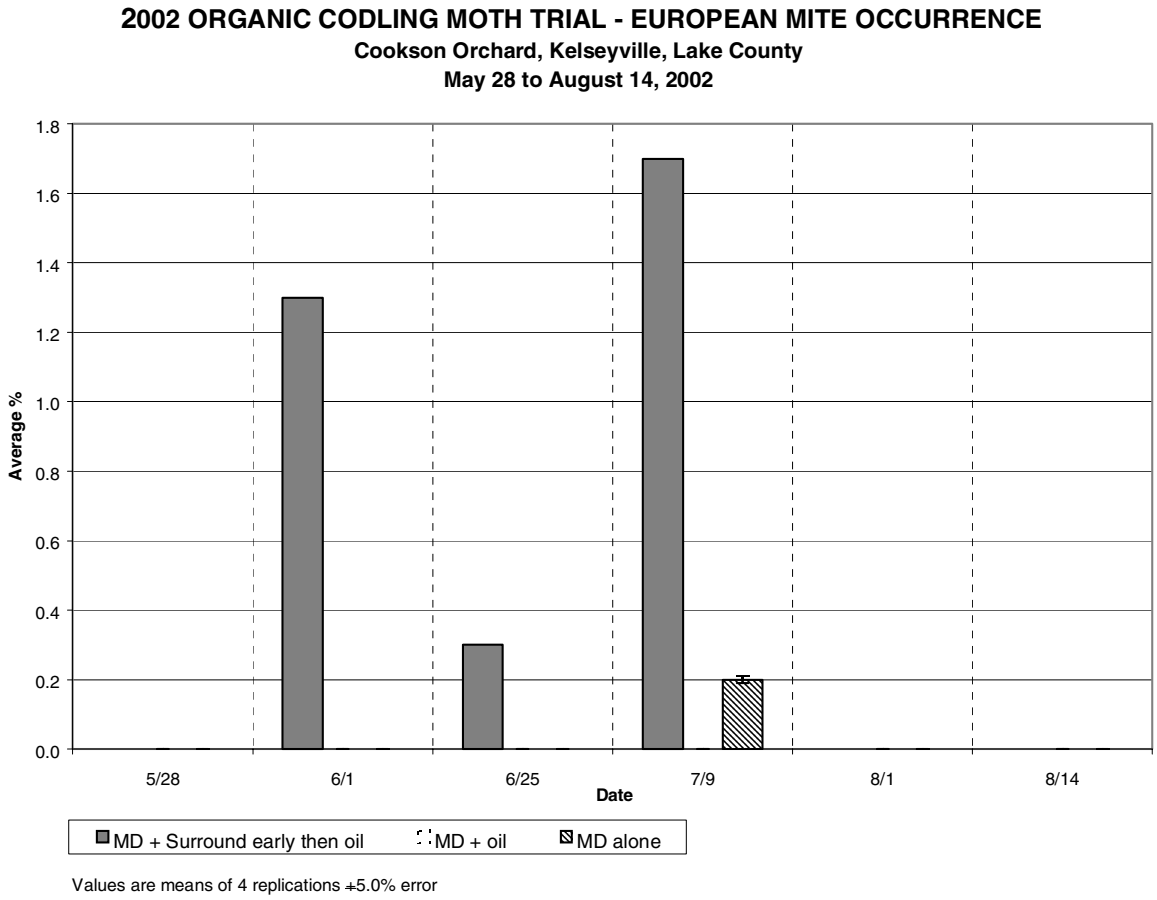
Figure 2:



Values are means of 5 replications.

Zero ERM found at other sample dates: 5/22, 6/3, 6/17, 7/2 and 7/23.

Figure 3:


2002 ORGANIC CODLING MOTH TRIAL - EUROPEAN MITE OCCURRENCE
Cookson Orchard, Kelseyville, Lake County
May 28 to August 14, 2002
Average %
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
5/28
6/1
6/25
7/9
8/1
8/14
Date
MD + Surround early then oil
MD + oil
MD alone
Values are means of 4 replications ±5.0% error