DESCRIPTION:	**Control of Codling Moth and True Bugs by Reducing Risk Insecticides - Sacramento River**
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Control of Codling Moth, Secondary Pests and True Bugs by Reduced Risk Insecticides

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Abstract: The implementation of the Food Quality Protection Act of 1996 stands to greatly impact established pest management techniques for pears. Changes in the availability and use of current insecticides will require more reduced risk and environmentally benign pest management strategies. Accordingly, trials were conducted in an effort to develop reduced risk control strategies. Field trials were conducted to evaluate new insecticides/miticides for codling moth (CM), twospotted spider mite (TSSM) and European red mite (ERM) control. A single tree crop destruct trial was conducted for CM control. This study showed that Assail, Assail with horticultural oil combined with Dimilin, Calypso preceeding Intrepid and Novaluron are very promising for total insect pest control in pears. These treatment programs provided acceptable CM control that was very similar to the grower standard while at the same time it suppressed TSSM, ERM and pear psylla (PP) populations. It should be noted that only Assail is registered for pears in California. Calypso, Novaluron, Dimilin and Intrepid are not registered in California at this time. Dimilin and Intrepid are registered throughout the U.S. and it is hoped that they will receive California registeration by next season. A large plot speed sprayer trial was conducted for CM control that compared Assail combined with horticultural oil to a grower standard of Imidan preceding Danitol. Assail provided acceptable CM and green fruit worm (GFW) control and was comparable to the grower standard of Imidan and Danitol. Assail provided superior control of San Jose scale (SJS) and lygus bug (LB) compared to the grower standard. The systemic application (soil injections) of Admire or Platinum was not successful in controlling PP populations. The use of Admire or Platinum has not been successful for over three years of study in reducing the PP population despite various methods of application. We have applied these insecticides as a soil drench, a trunk injection and this year as a soil injection. Thus the use of Admire or Platinum as systemic insecticides for control of PP has been very disappointing. The lack of control may be the result of the amount of material applied the size of tree and/or the soil type for soil drench and soil injection. The evaluation of newly registered and unregistered miticides showed that Acramite, Pyramite and Mesa provided excellent control of TSSM but Mesa was less effective against ERM. A continuation study of the effects of caged LB on fruit-bearing limbs showed that any level of LB caged on fruit-bearing limbs for two weeks will cause high amounts of damage. LB feeding significantly affect fruit drop when damage occurs early in the season. Although the LB feeding did not greatly affect fruit drop late in the season, 1 LB per bag caused significant fruit damage throughout the season. There is no selective abortion of the fruit. A study on the effects of adjacent LB host orchards showed that the amount of LB damage appears to be related to the amount of broad leaf weeds within the orchards and not to any outside source. Outside sources of LB can provide large mobile population of LB that invades the pear orchards. But without broad leaf weeds, the LB populations do not stay in the orchard and thus cause little damage.

Introduction: In the summer of 1996, the U.S. Congress unanimously passed, and the President signed, the Food Quality Protection Act. This piece of legislation will have a significant impact on insecticides used in the U.S. and particularly on those used on agricultural crops consumed by infants and children, such as pears. It is anticipated that many of the current organophosphate (OP) insecticides used on pears may have greatly extended pre-harvest intervals and/or greatly extended worker reentry intervals, or the manufacturer may be forced to terminate their registrations by the EPA. Changes in the availability and use of pesticides will require more reduced risk, environmentally benign pest management strategies. The CM pheromone mating disruption program is one such program that has been very successful in reducing OP use. An overall reduction in the use of OP pesticides by 75% or greater has resulted from the CM mating disruption program in pears. However, for pheromone control to be cost effective, only one pheromone application can be used. This often requires one or more supplemental OP insecticide applications for additional CM control. Possible replacements for OP insecticides, that can be used alone or in conjunction with pheromonal control of CM, are: insect growth regulators (IGR), e.g. Confirm, Intrepid and Dimilin; neonicotinoid, e.g. Assail or Calypso; or other reduced risk insecticides, e.g. Avaunt and Success. However, the use of more selective controls for CM has resulted in an increase of secondary pest populations, e.g. true bugs and obliquebanded leafroller (OBLR), which had been indirectly controlled by OP insecticides. Some orchards under mating disruption for CM control have experienced greater economic losses due to secondary pests than from CM. Reported here are the results of our 2002 evaluations of IGRs, neonicotinoids, chitin disrupters and combinations of new insecticides for CM control, large plot evaluation of Assail, evaluation of systemic neonicotinoid insecticides for PP, evaluation of registered and unregistered miticides for TSSM and ERM control, evaluation of seasonal damage of LB in pears, evaluation of LB movement in pear orchards from adjacent alfalfa fields and evaluation of sprayable pheromones for CM control in pears.

1. Evaluation of new insecticides for Codling Moth control

Methods and Materials: This trial was conducted in a commercial ‘Bartlett’ pear orchard in Fairfield, CA. This orchard was planted on a 25 ft. x 25 ft. spacing (70 trees/ac). Fourteen treatments and an untreated control were replicated four times in a randomized complete block (RCB) design. Each replicate was an individual tree. Foliar sprays were applied with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 200 gal/acre (2.87 gal/tree). Applications were scheduled based on degree-days (DD). DD were calculated with a biofix of 28 March for the first generation and a 15 June biofix for the second generation using a single sine horizontal cutoff model with a lower threshold of 50˚F and an upper threshold of 88˚F. Maximum and minimum air temperatures were obtained from the IMPACT weather station at Cordelia, CA. Flight activity of male CM was monitored with a pheromone trap placed high in the canopy of an untreated tree. Target application timings were (Table 1): Imidan 70WP at 250 DD from the 1st biofix and Guthion 50WP at 650 DD from the 1st biofix and 250 DD from the 2nd biofix; Agri-Mek 0.15EC plus 1/4% Omni Supreme oil at 200 DD from the 1st biofix followed by Imidan 70WP at 250 DD from the 1st biofix and Guthion 50WP at 650 DD from the 1st biofix and 250 DD from the 2nd biofix (grower standard); Agri-Mek 0.15EC plus 1/4% Omni Supreme oil at 200 DD from the 1st biofix followed by Assail 70WP at 250 and 650 DD from the 1st biofix and 250 DD from the 2nd biofix; Agri-Mek 0.15EC plus 1/4% Omni

Supreme oil at 200 DD from the 1st biofix followed by Assail 70WP plus Dimilin 2L plus 1% Omni Supreme oil at 250 and 650 DD from the 1st biofix and 250 DD from the 2nd biofix; Agri-Mek 0.15EC plus 1/4% Omni Supreme oil at 200 DD from the 1st biofix followed by Calypso 4SC at 250 and 650 DD from the 1st biofix and Intrepid 2F plus 0.0625% Latron B-1956 at 250 DD from the 2nd biofix; Calypso 4SC at 250 and 650 DD from the 1st biofix and Intrepid 2F plus 0.0625% Latron B-1956 at 250 DD from the 2nd biofix; Calypso 4SC plus Agri-Mycin 17 at 250 and 650 DD from the 1st biofix and Intrepid 2F plus 0.0625% Latron B-1956 at 250 DD from the 2nd biofix; Calypso 4SC plus 1% Omni Supreme oil at 250 and 650 DD from the 1st biofix and Intrepid 2F plus 1% Omni Supreme oil at 250 DD from the 2nd biofix; Novaluron 7.5WG (3.33 lb/ac) at 50 DD from 1st biofix and 2nd biofix followed by two applications at two week intervals per flight; Novaluron 7.5WG (4.44 lb/ac) at 50 DD from 1st biofix and 2nd biofix followed by two applications at two week intervals per flight; Novaluron 7.5WG (4.44 lb/ac) at 50 DD from 1st biofix and 2nd biofix followed by one application at three week intervals per flight; Dimilin 2L at 50 DD from 1st biofix and 2nd biofix followed by one application at three week intervals per flight; Dimilin 2L plus 1% Omni Supreme oil at 50 DD from 1st biofix and 2nd biofix followed by one application at three week intervals per flight; 1% Omni Supreme oil at 250 and 650 DD from the 1st biofix and 250 DD from the 2nd biofix. Control of the CM generations was evaluated at commercial harvest on 23 July by inspecting a maximum of 250 fruit per tree for CM infestation. Control of PP nymphs, TSSM, ERM and SJS crawlers was evaluated by leaf-brushing 10 exterior and 10 interior leaves collected from each tree weekly from 14 May through 16 July. The plates with the contents from the brushed leaves were counted under magnification (20X) in the laboratory.

Table 1. Treatments and Application Timings for Codling Moth Control, Fairfield, CA - 2002

Treatment		Rate lb(AI)/ac	No. Appl.	Application Dates (Degree Days from 1st or 2nd Biofix)
1.	Imidan 70WP[a]	4.2	1	22 April (244 from 1st biofix)
	Guthion 50WP	1.25	2	28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
2.	Agri-Mek 0.15EC[b]	0.0117	1	19 April (214 from 1st biofix)
	Imidan 70WP[a]	4.2	1	22 April (244 from 1st biofix)
	Guthion 50WP	1.25	2	28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
3.	Agri-Mek 0.15EC[b]	0.0117	1	19 April (214 from 1st biofix)
	Assail 70WP	0.147	3	22 April (244 from 1st biofix) and 28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
4.	Agri-Mek 0.15EC[b]	0.0117	1	19 April (214 from 1st biofix)
	Assail 70WP[c]	0.147	3	22 April (244 from 1st biofix) and 28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
	Dimilin 2L	0.25		1st biofix) and 1 July (324 from 2nd biofix)
5.	Agri-Mek 0.15EC[b]	0.0117	1	19 April (214 from 1st biofix)
	Calypso 4SC	0.1875	2	22 April (244 from 1st biofix) and 28 May (632 from 1st biofix)
	Intrepid 2F[d]	0.25	1	26 June (214 from 2nd biofix)
6.	Calypso 4SC	0.1875	2	22 April (244 from 1st biofix) and 28 May (632 from 1st biofix)
	Intrepid 2F[d]	0.25	1	26 June (214 from 2nd biofix)
7.	Calypso 4SC +	0.1875	2	22 April (244 from 1st biofix) and 28 May (632
	Agri-mycin 17	0.306		from 1st biofix)
	Intrepid 2F[d]	0.25	1	26 June (214 from 2nd biofix)
8.	Calypso 4SC[c] +	0.1875	2	22 April (244 from 1st biofix) and 28 May (632 from 1st biofix)
	Intrepid 2F[c]	0.25	1	26 June (214 from 2nd biofix)
9.	Novaluron 7.5WG	0.25	6	4 April (80 from 1st biofix), 19 April (214 from 1st biofix), 1 May (313 from 1st biofix), 17 June (53 from 2nd biofix), 1 July (324 from 2nd biofix) and 15 July 622 from 2nd biofix)
10.	Novaluron 7.5WG	0.333	6	4 April (80 from 1st biofix), 19 April (214 from 1st biofix), 1 May (313 from 1st biofix), 17 June (53 from 2nd biofix), 1 July (324 from 2nd biofix) and 15 July (622 from 2nd biofix)
11.	Dimilin 2L[c]	0.25	4	4 April (80 from 1st biofix), 23 April (260 from 1st biofix), 17 June (53 from 2nd biofix), 8 July (457 from 2nd biofix)
12.	Dimilin 2L	0.25	4	4 April (80 from 1st biofix), 23 April (260 from 1st biofix), 17 June (53 from 2nd biofix), 8 July (457

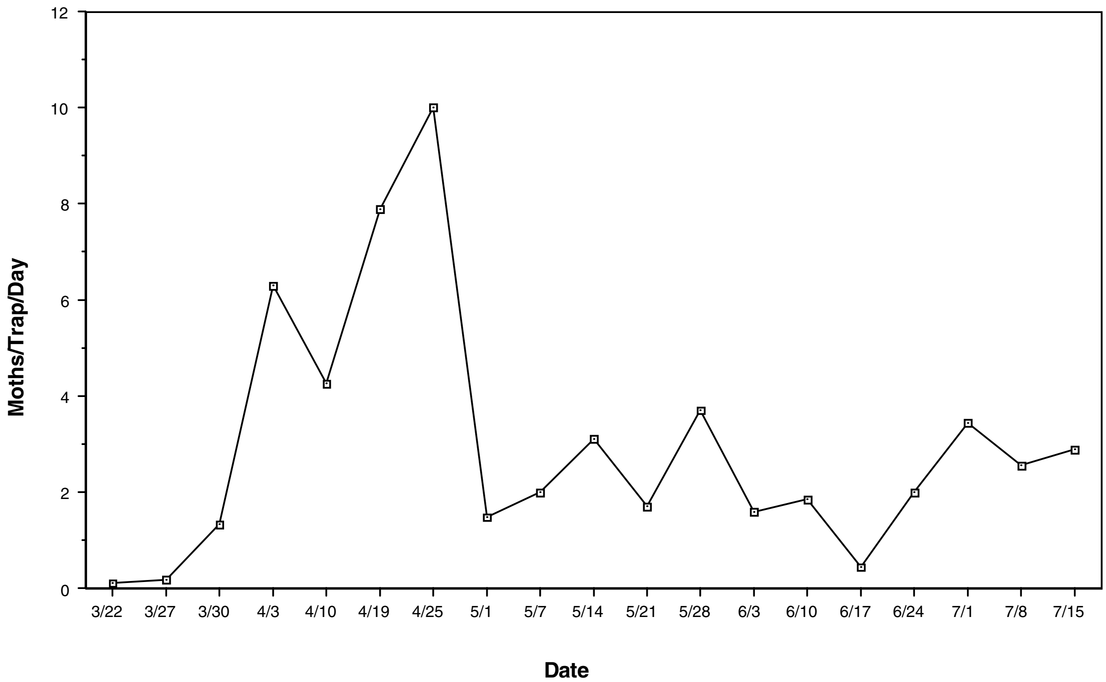
				from 2nd biofix)
13.	Novaluron 7.5WG	0.333	4	4 April (80 from 1st biofix), 23 April (260 from 1st biofix), 17 June (53 from 2nd biofix), 8 July (457 from 2nd biofix)
14.	Omni Supreme oil by volume	1.0%	3	22 April (422 from 1st biofix), 28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
15.	Untreated	—		

[a] Treatment pH was adjusted to < 6.0.
[b] Treatments contained 0.25% Omni Supreme oil by volume.
[c] Treatments contained 1.0% Omni Supreme oil by volume.
[d] Treatments contained 0.0625% Latron B-1956 by volume.

Results and Discussion:

Flight Activity – The overwintering CM flight began 22 March (Fig. 1). The CM biofix is set when sunset air temperatures meet or exceed 62˚F and there is a sustained moth flight. This temperature is the minimum required for CM oviposition. The overwintering flight was not highly bimodal this year. The first peak of the overwintering flight occurred around 25 April at 281 DD. The air temperatures then turned cool and moth flight decreased dramatically. The first peak often occurs at 300 DD after biofix. The second peak of the overwintering flight occurred around 28 May at 633 DD. The second peak often occurs at 650 DD after biofix. The first flight was completed by 14 June at 970 DD. The first flight is usually completed by 1,000 DD. The second biofix was set on 15 June. The peak of the second CM flight occurred approximately on 1 July at 324 DD.

Fig. 1 Seasonal Flight Activity of Codling Moth Captured in a Pheromone Trap Placed High in the Tree Canopy at Fairfield, CA – 2002



<u>CM Evaluation</u> –The CM infestation in the untreated control was over 56% (Table 2). Thus, this trial provided a stringent test of the experimental treatments. The CM infestation in all experimental treatments was significantly lower than in the untreated control. The experimental treatments which had significantly higher CM infestation than the grower standard (Tr. #2) were Dimilin 2L (Tr. #12) and 1% Omni Supreme oil (Tr. #14). Although the Omni Supreme oil treatment had over 13% CM infestation, the oil still provided significantly lower CM infestation than the untreated control. The reason that Dimilin 2L without Omni Supreme oil (Tr. #12) had significantly greater CM infestation compared to Dimilin 2L with Omni Supreme oil (Tr. #11) is unknown but may be related to the synergy of the ovicidal effects of the combination of both Dimilin and oil in conjunction with the CM phenology. In addition, Calypso with or without Omni Supreme oil followed by Intrepid (Trs. #6 and 8) and Calypso with Agri-mycin followed by Intrepid (Tr. #7) had numerically higher levels of CM infestation compared to the grower standard. This higher level, though not significant, is troubling. It appears that Calypso is not as efficacious as Assail. Assail, Assail combined with Dimilin and Novaluron continue to show promise as replacement treatments for the grower standard.

Table 2. Mean Percent Codling Moth-Infested Fruit Inspected at Commercial Harvest in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Percent Infested Fruit at Commercial Harvest
1. Imidan 70WP[b]	4.2	1	1.0 a
Guthion 50WP	1.25	2	
2. Agri-Mek 0.15EC[c]	0.0117	1	0.9 a
Imidan 70WP[b]	4.2	1	
Guthion 50WP	1.25	2	
3. Agri-Mek 0.15EC[c]	0.0117	1	1.0 a
Assail 70WP	0.147	3	
4. Agri-Mek 0.15EC[c]	0.0117	1	0.9 a
Assail 70WP[d] +	0.147	3	
Dimilin 2L	0.25		
5. Agri-Mek 0.15EC[c]	0.0117	1	1.2 a
Calypso 4SC	0.1875	2	
Intrepid 2F[e]	0.25	1	
6. Calypso 4SC	0.1875	2	3.4 a
Intrepid 2F[e]	0.25	1	
7. Calypso 4SC +	0.1875	2	2.0 a
Agri-mycin17	0.306		
Intrepid 2F[e]	0.25	1	
8. Calypso 4SC[d]	0.1875	2	2.8 a
Intrepid 2F[d]	0.25	1	
9. Novaluron 7.5WG	0.25	6	1.0 a
10. Novaluron 7.5WG	0.333	6	1.6 a
11. Dimilin 2L[d]	0.25	4	1.4 a
12. Dimilin 2L	0.25	4	18.0 b
13. Novaluron 7.5WG	0.333	4	1.0 a
14. Omni Supreme oil by vol.	1.0%	3	13.2 b
15. Untreated	——		56.8 c

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsin transformation.
[b] pH was adjusted to < 6.
[c] Treatments contained 0.25% Omni Supreme oil by volume.
[d] Treatments contained 1.0% Omni Supreme oil by volume.
[e] Treatments contained 0.0625% Latron B-1956 by volume.

<u>Secondary Pest Evaluations: Mites</u> – A flare-up in both TSSM and ERM was observed with the grower standard without Agri-Mek (Tr. #1) and Calypso without oil (Trs. #6 & 7) compared to the untreated control (Table 3). Flare-ups of mites have been previously observed in neonicotinoid insecticides. There is also some indication of mite flare-ups with Novaluron. The inclusion of 1% horticultural oil was sufficient in preventing mite flare-ups. Western predatory mite (WPM) and Western Flower Thrip (WFT) were counted along with the other secondary

pests. WPM is an important predator of both TSSM and ERM. WFT is both phytophagus and entomophagus and feeds on mite eggs. There was no significant trend with these predators and their counts were not included in the report.

Secondary Pest Evaluations: Pear Psylla and San Jose Scale – The grower standard without Agri-Mek (Tr. #1) had significantly greater PP than all the other treatments while the grower standard with Agri-Mek (Tr. #2) had numerically greater PP than the other treatments (Table 4). All the other experimental treatments had PP populations similar to or less than the untreated control. The grower standard and all experimental treatments, except for Dimilin without oil (Tr. #12), had significantly lower SJS populations compared to the untreated control (Table 4).

Table 3. Mean Total Number of Motile Twospotted Spider Mites and European Red Mites in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Total per 20 Leaves TSSM	ERM
1. Imidan 70WP[b]	4.2	1	14.2 c	13.5 abc
Guthion 50WP	1.25	2		
2. Agri-Mek 0.15EC[c]	0.0117	1	1.1 ab	1.9 ab
Imidan 70WP[b]	4.2	1		
Guthion 50WP	1.25	2		
3. Agri-Mek 0.15EC[c]	0.0117	1	0.0 a	2.5 ab
Assail 70WP	0.147	3		
4. Agri-Mek 0.15EC[c]	0.0117	1	0.0 a	2.6 ab
Assail 70WP[d] +	0.147	3		
Dimilin 2L	0.25			
5. Agri-Mek 0.15EC[c]	0.0117	1	1.5 ab	0.5 a
Calypso 4SC	0.1875	2		
Intrepid 2F[e]	0.25	1		
6. Calypso 4SC	0.1875	2	8.5 abc	16.5 c
Intrepid 2F[e]	0.25	1		
7. Calypso 4SC +	0.1875	2	8.9 bc	14.1 bc
Agri-mycin17	0.306			
Intrepid 2F[e]	0.25	1		
8. Calypso 4SC[d]	0.1875	2	0.8 ab	1.3 ab
Intrepid 2F[d]	0.25	1		
9. Novaluron 7.5WG	0.25	6	5.9 abc	8.5 abc
10. Novaluron 7.5WG	0.333	6	1.4 ab	5.6 abc
11. Dimilin 2L[d]	0.25	4	0.0 a	0.8 a
12. Dimilin 2L	0.25	4	2.2 ab	3.8 abc
13. Novaluron 7.5WG	0.333	4	2.3 ab	6.9 abc
14. Omni Supreme oil by vol.	1.0%	3	0.8 ab	0.3 a
15. Untreated	———		1.7 ab	1.7 ab

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsin transformation.
[b] pH was adjusted to < 6.
[c] Treatments contained 0.25% Omni Supreme oil by volume.
[d] Treatments contained 1.0% Omni Supreme oil by volume.
[e] Treatments contained 0.0625% Latron B-1956 by volume.

Table 4. Mean Total Number of Pear Psylla Nymphs and San Jose Scale in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Total per 20 Leaves PP	SJS
1. Imidan 70WP[b]	4.2	1	297.0 d	2.9 a
Guthion 50WP	1.25	2		
2. Agri-Mek 0.15EC[c]	0.0117	1	114.0 c	6.3 a
Imidan 70WP[b]	4.2	1		
Guthion 50WP	1.25	2		
3. Agri-Mek 0.15EC[c]	0.0117	1	60.2 ab	8.6 a
Assail 70WP	0.147	3		
4. Agri-Mek 0.15EC[c]	0.0117	1	57.2 ab	13.5 a
Assail 70WP[d] +	0.147	3		
Dimilin 2L	0.25			
5. Agri-Mek 0.15EC[c]	0.0117	1	43.7 a	10.4 a
Calypso 4SC	0.1875	2		
Intrepid 2F[e]	0.25	1		
6. Calypso 4SC	0.1875	2	70.5 abc	7.7 a
Intrepid 2F[e]	0.25	1		
7. Calypso 4SC +	0.1875	2	59.3 ab	9.9 a
Agri-mycin17	0.306			
Intrepid 2F[e]	0.25	1		
8. Calypso 4SC[d]	0.1875	2	65.2 ab	11.9 a
Intrepid 2F[d]	0.25	1		
9. Novaluron 7.5WG	0.25	6	48.4 ab	11.0 a
10. Novaluron 7.5WG	0.333	6	67.7 abc	10.4 a
11. Dimilin 2L[d]	0.25	4	77.6 abc	19.2 a
12. Dimilin 2L	0.25	4	73.0 abc	117.5 b
13. Novaluron 7.5WG	0.333	4	91.7 bc	22.8 a
14. Omni Supreme oil by vol.	1.0%	3	61.8 ab	19.5 a
15. Untreated	——		75.3 abc	144.1 b

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). Data analyzed using an arcsin transformation.
[b] pH was adjusted to < 6.
[c] Treatments contained 0.25% Omni Supreme oil by volume.
[d] Treatments contained 1.0% Omni Supreme oil by volume.
[e] Treatments contained 0.0625% Latron B-1956 by volume.

Conclusions: This trial was conducted against a very high CM population with over 56% of the fruit infested at harvest in the untreated control and with 0.9% CM infested fruit in the grower standard. This trial should be considered a rigorous test of the experimental materials. However, this year the CM population was not as high as in previous years. Assail and Assail combined with horticultural oil and Dimilin provided acceptable CM control that was very similar to the grower standard while at the same time suppressing TSSM, ERM and PP populations. Multiple applications of Novaluron were effective in suppressing CM but there is some indication of ERM flare-up. Two applications of Calypso followed by one application of Intrepid had increased levels of CM infestation compared to the grower standard.

2. Evaluation of Assail for control of Codling Moth

Methods and Materials: This trial was conducted in a commercial 'Bartlett' pear orchard in Hood, CA. This orchard was planted on a 16 ft. x 16 ft. off-set spacing (170 trees/ac). Three treatments were replicated three times in a completely randomized design. Each replicate was 1.3 acres in size. There was an adjacent 1/2 acre plot used as an unreplicated control. Treatments were applied between 6:30 a.m. and 8:30 a.m. on 24 May and 20 June using a Turbo-Mist PTO operating at about 2.5 mph with a finished spray volume of 100 gal/acre. Harvest evaluation was conducted on 9 July by inspecting 1000 fruit per replicate (3,000 fruit per treatment) for CM, GFW, SJS and LB damage or infestation.

Results and Discussion: There was no significant difference in the percent CM or GFW infested fruit between Assail and the grower standard of Imidan followed by Danitol (Table 5). Although the grower standard had significantly more SJS and LB damage than the Assail treatment, the SJS and LB damage were well within grower acceptable levels for both treatments. The untreated control, which was adjacent to the test plot, had unacceptable CM damage. However, since the untreated control was not replicated within the test plot, statistical analysis using the untreated control was not possible.

Table 5. Mean Percent Fruit Infestation at Harvest at Hood, CA – 2002

Treatment/	Rate	Mean[a] Percent Damage at Harvest			
Formulation	lb(AI)/ac	CM	GFW	SJS	LB
Assail 70WP[b]	0.15	0.40 a	0.37 a	0.00 a	0.07 a
Imidan 70WP[cd]	3.5	0.77 a	0.23 a	0.17 b	0.27 b
Danitol 2.4EC	0.4				
Untreated	——	1.6	0.3	0.1	0.6

[a] Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.1$).
[b]Treatment contains 1.0% Gavicide Super–90 by volume for the first application and 1.5% Gavicide Super–90 by volume for second application.
[c]Treatment pH was adjusted to < 6.
[d]Treatment contain 1.0% Gavicide Super–90 by volume.

Conclusions: Assail provided acceptable CM and GFW control and was comparable to the grower standard of Imidan and Danitol. Assail provided superior control of SJS and LB compared to the grower standard.

3. Evaluation of systemic insecticides for Pear Psylla control

Methods and Materials: This trial was conducted in a commercial 'Bartlett' pear orchard in Fairfield, CA. This orchard was planted on a 25 ft. x 25 ft. spacing (70 trees/ac). Four treatments and an untreated control were replicated four times in a RCB design. Each replicate was an individual tree. Foliar sprays were applied with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 200 gal/acre (2.87 gal/tree). Applications were scheduled based on degree-days (DD). DD were calculated with a biofix of 28 March for the first generation and a 15 June biofix for the second generation using a single sine horizontal cutoff model with a lower threshold of 50˚F and an upper threshold of 88˚F. Maximum and minimum air temperatures were obtained from the IMPACT weather station at Cordelia, CA. Flight activity of male CM was monitored with a pheromone trap placed high in the canopy of an untreated tree. Target application timings were: Admire 2F and Platinum 2SC at delayed dormant; Agri-Mek 0.15EC plus 0.25% Omni Supreme oil at 200 day-degrees (DD) from the 1st biofix; Imidan 70WP at 250 DD from the 1st biofix and Guthion 50WP at 650 DD from the 1st biofix and 250 DD from the 2nd biofix (Table 6). Control of the CM generations was evaluated at commercial harvest on 23 July by inspecting a maximum of 250 fruit per tree for CM infestation. Control of PP nymphs, TSSM and ERM was evaluated by leaf-brushing 10 exterior and 10 interior leaves collected from each tree weekly from 14 May through 16 July. The plates with the contents from the brushed leaves were counted under magnification (20X) in the laboratory.

Table 6. Treatments and Application Timings for Pear Psylla Control, Fairfield, CA - 2002

Treatment		Rate lb(AI)/ac	No. Appl.	Application Dates (Degree Days from 1st or 2nd Biofix)
1.	Admire 2F	0.5	1	12 February (Delayed Dormant)
	Imidan 70WP[a]	4.2	1	22 April (244 from 1st biofix)
	Guthion 50WP	1.25	2	28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
2.	Platinum 2SC	0.172	1	12 February (Delayed Dormant)
	Imidan 70WP[a]	4.2	1	22 April (244 from 1st biofix)
	Guthion 50WP	1.25	2	28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
3.	Imidan 70WP[a]	4.2	1	22 April (244 from 1st biofix)
	Guthion 50WP	1.25	2	28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
4.	Agri-Mek 0.15EC[b]	0.0117	1	19 April (214 from 1st biofix)
	Imidan 70WP[a]	4.2	1	22 April (244 from 1st biofix)
	Guthion 50WP	1.25	2	28 May (632 from 1st biofix) and 1 July (324 from 2nd biofix)
5.	Untreated	——	——	

[a] Treatment pH was adjusted to < 6.
[b] Treatment contained 0.25% Omni Supreme oil by volume.

Results and Discussion:

CM Evaluation - The CM infestation in all experimental treatments was significantly lower than in the untreated control (Table 7). This result is to be expected since the experimental treatments were identical except for the addition of Admire and Platinum at the delayed dormant timing.

Secondary Pest Evaluation: Mites - There were significantly more motile TSSM and ERM in Platinum preceding Imidan and Guthion (Tr. #2) compared to the other treatments (Table 8). Also there were numerically more TSSM and ERM in Admire preceding Imidan and Guthion (Tr. #1) and Imidan and Guthion (Tr. #3) compared to Agri-Mek preceding Imidan and Guthion (Tr. #4) and the untreated control (Tr. #5). It is not known why Platinum preceding Imidan and Guthion (Tr. #2) had significantly more mites than Admire preceding Imidan and Guthion (Tr. #1) and Imidan and Guthion (Tr. #3). These treatments should all have similar mite populations.

Secondary Pest Evaluation: Pear Psylla - Admire preceding Imidan and Guthion (Tr. #1), Platinum preceding Imidan and Guthion (Tr. #2) and Imidan and Guthion (Tr. #3) had significantly more PP compared to Agri-Mek preceding Imidan and Guthion (Tr. #4) and the untreated control (Tr. #5) (Table 8). Again, Platinum preceding Imidan and Guthion (Tr. #2) had numerically elevated numbers compared to Admire preceding Imidan and Guthion (Tr. #1) and Imidan and Guthion (Tr. #3). Therefore, the delayed dormant application of Admire or Platinum did not reduce the PP population.

Table 7. Mean Percent Codling Moth-Infested Fruit Inspected at Commercial Harvest in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Percent Infested Fruit at Commercial Harvest
1. Admire 2F	0.5	1	0.7 a
Imidan 70WP[b]	4.2	1	
Guthion 50WP	1.25	2	
2. Platinum 2SC	0.172	1	0.4 a
Imidan 70WP[b]	4.2	1	
Guthion 50WP	1.25	2	
3. Imidan 70WP[b]	4.2	1	1.0 a
Guthion 50WP	1.25	2	
4. Agri-Mek 0.15EC[c]	0.0117	1	0.9 a
Imidan 70WP[b]	4.2	1	
Guthion 50WP	1.25	2	
5. Untreated	——		56.8 b

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$).
[b] pH was adjusted to < 6.
[c] Treatment contained 0.25% Omni Supreme oil by volume.

Table 8. Mean Total Number of Secondary Pests per 20 Leaves in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Total No. / 20 leaves		
			TSSM	ERM	PP
1. Admire 2F	0.5	1	16.0 a	14.3 a	286.3 b
Imidan 70WP[b]	4.2	1			
Guthion 50WP	1.25	2			
2. Platinum 2SC	0.172	1	68.5 b	88.0 b	432.5 b
Imidan 70WP[b]	4.2	1			
Guthion 50WP	1.25	2			
3. Imidan 70WP[b]	4.2	1	14.0 a	13.3 a	296.8 b
Guthion 50WP	1.25	2			
4. Agri-Mek 0.15EC[c]	0.0117	1	1.0 a	1.8 a	113.8 a
Imidan 70WP[b]	4.2	1			
Guthion 50WP	1.25	2			
5. Untreated	——		1.5 a	1.5 a	75.0 a

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$).
[b] pH was adjusted to < 6.
[c] Treatment contained 0.25% Omni Supreme oil by volume.

Conclusions: The use of Admire or Platinum has not been successful for over three years of study in reducing the PP population despite various methods of application. We have applied these insecticides as a soil drench, a trunk injection and this year as a soil injection. Thus the use of Admire or Platinum as systemic insecticides for control of PP has been very disappointing. The lack of control may be the result of the amount of material applied, the size of tree and/or the soil type for soil drench and soil injection.

4. Control of European Red Mite and Twospotted Spider Mite in Pears – Orchard I

Methods and Materials: This trial was conducted in a commercial 'Bartlett' pear orchard in Fairfield, CA. This orchard was planted on a 21 ft. x 21 ft. spacing (99 trees/ac). Six treatments were replicated four times in a RCB design. Each replicate was an individual tree. Foliar sprays were applied with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 250 gal/acre (2.53 gal/tree). All of the trees, except for the untreated control (Season), were treated with 0.072 lb (AI)/ac of Asana on 1 May and 29 May and 0.0155 lb (AI)/ac of Asana on 26 June to simulate a typical grower program and to flare mite and pear psylla populations. The miticides were applied on 21 August. Control of motile TSSM and ERM was evaluated by leaf-brushing 10 exterior and 10 interior leaves collected from each tree weekly from 15 August (pre-treatment count) through 23 September. The plates with the contents from the brushed leaves were counted under magnification (20X) in the laboratory.

Results and Discussion: There was no significant difference in the number of TSSM or ERM among the experimental miticides and the post-harvest untreated control for the pre-treatment sample. After the application, all experimental miticides caused a significant reduction in the TSSM and ERM population compared to the post-harvest untreated control (Tables 9 & 10). However, there was no difference among the experimental miticides and the untreated control (Season). Thus the repeated in-season applications of Asana resulted in a secondary flare-up of TSSM and ERM. Although there was no significant difference among the experimental miticides, it appears that Mesa was slightly less effective than Acramite and Pyramite. There was a slight rate response with Acramite for ERM but not for TSSM. Few WPM were observed among the treatments and their numbers are not reported.

Table 9. Mean Number of Twospotted Spider Mites per 20 Leaves in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	Mean[a] No. Twospotted Spider Mites per 20 Leaves					
		8/15[b]	8/26	9/3	9/9	9/16	9/22
Acramite 50W	0.375	13.3 ab	2.8 a	0.3 a	0.0 a	0.0 a	2.3 a
Acramite 50W	0.500	24.8 b	0.3 a	0.3 a	0.0 a	0.0 a	0.0 a
Pyramite 60W	0.495	1.3 a	0.3 a	0.0 a	0.0 a	0.0 a	0.5 a
Mesa 0.078EC	0.015	8.8 ab	0.8 a	3.0 ab	0.5 a	10.0 ab	6.5 a
Post-harvest Control	—	9.3 ab	12.8 b	18.8 b	3.0 b	26.8 b	20.8 b
Untreated (Season)	—	1.8 a	0.5 a	1.5 a	0.0 a	1.3 a	1.5 a

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).
[b]Pre-treatment sample.

Table 10. Mean Number of European Red Mites per 20 Leaves in Fairfield, CA - 2002

	Rate lb	Mean[a] No. European Red Mites per 20 Leaves					
Treatment	(AI)/ac	8/15[b]	8/26	9/3	9/9	9/16	9/22
Acramite 50W	0.375	39.3 ab	11.3 a	1.0 a	5.5 a	2.5 ab	8.0 a
Acramite 50W	0.500	83.3 b	3.8 a	1.8 a	1.8 a	1.3 a	3.3 a
Pyramite 60W	0.495	20.3 ab	1.3 a	0.5 a	0.0 a	1.0 a	1.5 a
Mesa 0.078EC	0.015	45.3 ab	9.8 a	14.5 a	7.8 a	12.5 c	13.0 a
Post-harvest Control	——	34.3 ab	46.8 b	34.5 b	20.5 b	45.0 d	33.5 b
Untreated (Season)	——	4.3 a	15.0 a	8.0 a	4.5 a	11.3 bc	13.0 a

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).
[b]Pre-treatment sample.

Conclusions: Acramite, Pyramite and Mesa provided excellent control of TSSM but Mesa was less effective against ERM.

5. Control of European Red Mite in Pears – Orchard II

Methods and Materials: This trial was conducted in a commercial 'Bartlett' pear orchard in Fairfield, CA. This orchard was planted on a 25 ft. x 25 ft. spacing (70 trees/ac). Six treatments were replicated four times in a randomized complete block (RCB) design. Each replicate was an individual tree. Foliar sprays were applied with a hand-held orchard sprayer operating at 250 psi with a finished spray volume of 200 gal/acre (2.87 gal/tree). All of the trees, except for the untreated control (Season), were treated with 4.2 lb (AI)/ac of Imidan on 23 April and 1.25 lb (AI)/ac of Guthion on 28 May and 1 July to simulate a typical grower program and to flare mite and pear psylla populations. The miticides were applied on 15 August. Control of motile TSSM and ERM was evaluated by leaf-brushing 10 exterior and 10 interior leaves collected from each tree weekly from 12 August (pre-treatment count) through 23 September. The plates with the contents from the brushed leaves were counted under magnification (20X) in the laboratory.

Results and Discussion: There was no significant difference in the number of ERM among the experimental miticides and the post-harvest untreated control for the pre-treatment sample (Table 11). After the application, all experimental miticides caused a significant reduction in the ERM population compared to the post-harvest untreated control. However, there was no difference among the experimental miticides and the untreated control (season). Thus the repeated in-season applications of Imidan and Guthion resulted in a flare-up of ERM. Although there was no significant difference among the experimental miticides, it appears that Mesa was slower-acting and slightly less effective than Acramite and Pyramite. There was a slight rate response with Acramite. Few TSSM or WPM was observed among the treatments and their numbers are not reported.

Table 11. Mean Number of European Red Mites per 20 Leaves in Fairfield, CA - 2002

Treatment	Rate lb (AI)/ac	Mean[a] No. European Red Mites per 20 Leaves					
		8/12[b]	8/19	8/26	9/3	9/9	9/16
Acramite 50 W	0.375	28.3 b	2.8 a	1.0 a	0.8 a	0.3 a	0.3 a
Acramite 50 W	0.500	14.5 ab	3.5 a	0.5 a	0.5 a	0.0 a	0.0 a
Pyramite 60W	0.495	12.5 ab	0.8 a	0.0 a	2.0 a	0.0 a	0.0 a
Mesa 0.078	0.015	21.8 ab	13.0 a	0.5 a	8.0 a	1.8 a	1.8 a
Untreated Post-Harvest	—	13.5 ab	76.0 b	11.0 b	43.0 b	17.5 b	10.5 b
Untreated Season	—	1.3 a	6.0 a	2.0 a	5.8 a	0.7 a	0.3 a

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).
[b] Pre-treatment sample.

Conclusions: Acramite, Pyramite and Mesa provided excellent control of ERM.

6. Seasonal Damage of Lygus Bugs in Pears

Methods and Materials: Laboratory-cultured adult LB were caged on fruit bearing limbs for two week intervals from 10 April to 9 July. There were seven replicates of five treatments. The treatments were: 1, 3 and 5 bagged LB, limbs caged without LB to act as a bagged control and limbs without bags or LB were used as an untreated control. The cages were 24 in. long by 15 in. wide and made of nylon mesh. Each treatment used limbs that were chosen based upon the maximum number of fruit available at that time during the season. Every 7 days, all dead LB were replaced with new LB. Every 14 days, all the cages were removed and then placed on another seven replicates of fruit-bearing limbs. Fruit drop on all previously treated limbs was counted weekly from 16 April through 9 July. Just prior to commercial harvest on 9 July, all previously caged fruit were removed and the number of stings per fruit was counted in the laboratory. The study was conducted in an organically grown pear orchard and no true bug insecticides were applied during the season.

Results and Discussion: For the first week of this experiment in early April, there was over 70% fruit drop in every treatment. The high early season fruit drop in the untreated control was due to natural fruit abortion. Because of the natural fruit drop, the total number of fruit within each cage decreased as the season progressed (Table 12). However, because of rapid fruit growth, the fruit surface area remained fairly constant throughout the experiment. The 1 LB treatment never caused significantly greater fruit drop than the controls (Table 13). The limbs bagged with 3 LB had significantly greater fruit drop than the bagged control only on 25 April. The 5 LB treatment had significantly greater fruit drop than the 1 LB treatment and the bagged and unbagged controls only on 25 April and 21 May. It appears that LB have the greatest effect on fruit drop early in the season when the pears are more prone to natural fruit drop.

The few LB stings found on the controls throughout the study were attributed to a native lygus population. The lower number of stings per fruit that occurred early in the season was the result of fruit abortion. The maximum number of stings counted per fruit was 10. Heavily stung fruit in the 3 and 5 LB treatments often exceeded 10 stings per fruit. Throughout the season, the 5 LB treatment had significantly greater number of LB stings per fruit than the 1 LB treatment and the controls. The 3 LB treatment also had significantly greater number of LB stings per fruit than the controls on every evaluation after 10 April (Table 14). The 1 LB treatment had significantly greater number of LB stings per fruit than the controls from 25 April to 18 June.

The mean percent fruit with stings closely mirror the results from the mean number of stings per fruit, as one would expect. After the first week, the 3 LB treatment had a significantly greater percentage of fruit with stings than the controls (Table 15). The 5 LB treatment also had a significantly greater percentage of fruit with stings than the controls on every. The average number of stings per fruit and fruit with stings in the 1, 3 and 5 LB treatments was reduced on the last reading on 2 July. It is likely that the lower number of stings observed on 2 July was a result of the stings not having a chance to visibly develop before they were examined on 9 July.

Conclusions: Any amount of LB bagged on fruit-bearing limbs for two weeks will cause unnaturally high amounts of damage. LB stings significantly affect fruit drop when damage occurs early in the season. Although the LB stings did not greatly affect fruit drop for the rest of the season, all of the LB treatments caused significantly greater fruit damage for the majority of the season. Since LB do not cause selective abortion of the fruit, LB damaged fruit will have greatly reduced or no market value.

Table 12. Mean Fruit per Bag by week at Sacramento, CA - 2002

Week	No. Limbs Bagged	Mean Fruit per Bag
1	7	15.5
3	7	7.5
5	7	5.8
7	7	6.1
9	7	4.3
11	7	4.7
13	7	3.9

Table 13. Mean Total Percent Fruit Drop at Harvest at Sacramento, CA - 2002

	Date When Fruit was First Bagged						
Treatment	10-Apr	25-Apr	7-May	21-May	4-Jun	18-Jun	2-Jul
0 Bugs	72.7 a	44.6 a	40.0 a	4.4 a	2.9 ab	0.0 a	3.6 a
1 Bug	77.3 a	58.9 ab	18.3 a	2.4 a	0.0 a	6.4 a	0.0 a
3 Bugs	83.0 a	80.9 bc	28.6 a	10.9 ab	0.0 a	3.6 a	0.0 a
5 Bugs	88.0 a	84.0 c	27.9 a	18.9 b	0.0 a	7.7 a	0.0 a
Untreated	82.1 a	59.1 ab	28.3 a	8.9 ab	11.3 b	11.4 a	5.7 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).

Table 14. Mean Number of Stings per Fruit at Harvest at Sacramento, CA - 2002

	Date When Fruit was First Bagged						
Treatment	10-Apr	25-Apr	7-May	21-May	4-Jun	18-Jun	2-Jul
0 Bugs	1.0 a	0.2 a	0.3 a	0.6 a	0.4 a	0.2 a	0.3 a
1 Bug	2.4 a	6.6 b	3.9 b	3.9 b	5.8 b	4.9 b	1.6 ab
3 Bugs	1.9 a	8.7 c	8.3 c	8.6 c	9.0 c	7.8 c	2.4 b
5 Bugs	5.9 b	9.8 c	9.0 c	8.4 c	9.9 c	8.4 c	4.8 c
Untreated	0.9 a	0.2 a	0.1 a	0.4 a	0.2 a	0.2 a	0.5 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).

Table 15. Mean Percentage of Fruit with Stings at Harvest at Sacramento, CA - 2002

	Date When Fruit was First Bagged						
Treatment	10-Apr	25-Apr	7-May	21-May	4-Jun	18-Jun	2-Jul
0 Bugs	1.0 a	0.2 a	0.3 a	0.6 a	0.4 a	0.2 a	0.3 a
1 Bug	2.4 a	6.6 b	3.9 b	3.9 b	5.8 b	4.9 b	1.6 ab
3 Bugs	1.9 a	8.7 c	8.3 c	8.6 c	9.0 c	7.8 c	2.4 b
5 Bugs	5.9 b	9.8 c	9.0 c	8.4 c	9.9 c	8.4 c	4.8 c
Untreated	0.9 a	0.2 a	0.1 a	0.4 a	0.2 a	0.2 a	0.5 a

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).

7. Evaluation of Lygus Bugs movement in Pear orchards from adjacent alfalfa fields

Methods and Materials: This trial was conducted in 10 commercial pear orchards in the Sacramento Delta. The trial was initiated on 16 May 2002 and was terminated on 19 July 2002. All orchards but one had an adjacent LB host field. Seven of the adjacent LB host fields were alfalfa; one adjacent field was safflower and one adjacent field was weedy abandon sugar beets. Each orchard had three sampling transects running perpendicular from the LB host field. Along each transect, there were four sampling locations at 0, 4, 8 and 16 trees from the LB host field. At each sampling location, there was a one square foot plastic sticky panel trap. Also, fifty sweep net samples were taken at each sampling location and 100 fruit were visually inspected for LB damage. In addition, LB were sampled in the adjacent LB host field by taking fifty sweep net samples opposite each of the three transects. All samples were taken weekly. The type of vegetation in the sampling area was also noted, taking into account LB host plants (broad leaf weeds).

Results and Discussion: The orchards that had broad leaf weeds had somewhat larger, but not significantly different, LB populations both inside and outside the orchards compared to orchards that had no broad leaf weeds (Table 16). However, there was a significant increase in the percent damage in the orchards that had broad leaf weeds. Thus it appears LB damage is associated with broad leaf weeds in the orchard. There is also a trend for higher damage in those orchards that did not use herbicides to suppress the broad leaf weeds (Table 17). About half of the herbicide applications were specific broad leaf herbicides (2-4-D type) while the other half were general herbicides (Round-up type). Orchards that used three or more herbicides had less then 0.33% damaged fruit while those orchards using 0 to 1 herbicides had damage greater than 0.33%. This reinforces the observation that orchards with a greater density of broad leaf weeds resulted in greater LB damage compared to orchards with less broad leaf weeds. It should also be noted that during the study, only one orchard (No. 6) applied insecticides (Guthion and Imidan) for CM control that would have suppressed the LB population. Thus insecticides were not responsible for the suppression of the LB damage in orchards. There was a moderately strong relationship (r^2=0.57) between damage and the number of LB caught on the front of the sticky panel traps in orchards without broad leaf weeds (Fig. 2). However, there was not a strong relationship between damage and the number of LB caught on the back of the sticky panel traps in orchards without broad leaf weeds or on either side of the sticky panel traps in LB orchards with broad leaf weeds. This indicates that there is movement of LB from the host field into the pear orchard. Thus in orchards without broad leaf weeds, LB were moving into and through the orchard and, presumably, out of the orchard without causing a great deal of damage. While in orchards with broad leaf weeds, there is no directionality to the movement and LB move into the orchard from adjacent host fields and appear to stop at the host weeds. This resulted in a resident LB population that fed over time on the pears causing considerable damage.

Conclusions: The amount of LB damage appears to be related more to the amount of broad leaf weeds. Outside sources can provide large populations of LB into the orchards, but without broad leaf weeds, the LB population do not stay in the orchard and do not cause great amounts of damage.

Table 16. Mean No. LB / 50 Sweeps Inside and Outside of Orchards with and without LB Hosts, Sacramento, CA – 2002

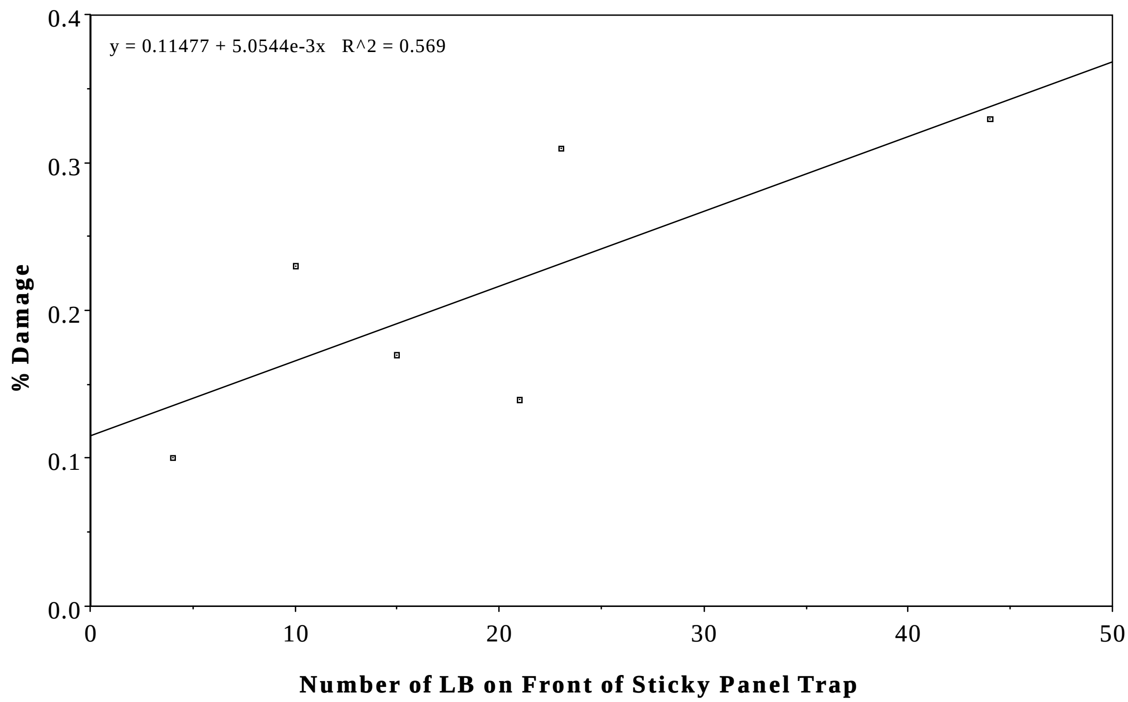
	Mean No. LB/ 50 Sweeps			
	Inside	Outside	Combined	% Damage
Orchard w/ Host	1.0 a	13.0 a	3.5 a	0.77 b
Orchard w/ Non-Host	0.5 a	9.5 a	2.5 a	0.21 a

Means followed by the same letter within a column are not significantly different (Student's T-Test , $P < 0.05$).

Table 17. Number of Herbicide Applications and % Damage in orchards, Sacramento, CA-2002

Orchard No.	No. of Herbicide Applications	% Damage
1	1	1.16
2	0	1.03
3	0	0.52
4	0	0.38
5	5	0.33
6	7	0.31
7	3	0.23
8	5	0.17
9	5.2	0.14
10	5	0.10

Figure 2. Relationship Between the Number of LB on Front of Sticky Panel Trap and Percent Fruit Damage



8. Evaluation of Sprayable Pheromones for Codling Moth control in Pears
Please see report by Lucia Varela on page 115.