Control of Secondary Pests in Codling Moth Mating Disrupted Orchards

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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, environmentally benign pest management strategies. Accordingly, various trials were conducted in an effort to develop alternate control to methods. Trials conducted were evaluate new insecticides for CM control, sprayer volume and speed on the efficacy of Confirm for obliquebanded leafrollers (OBLR) control, pear psylla (PP) management with Esteem and seasonal damage of lygus bugs (LB) and stink bugs (SB). A single tree crop destruct trial was conducted for CM control. This study showed that Avaunt with horticultural oil, Calypso and Assail are promising experimental materials for CM control. The addition of Actara early in the season to the grower standard provides excellent PP control and was similar to the Agri-Mek standard. However, Actara did not provide mite control. A trial was conducted on the efficacy of different sprayer volumes and speeds for control of OBLR with Confirm. Unfortunately, this trial was unsuccessful because of the low OBLR population in this orchard. A trial was conducted on timing and efficacy of Esteem to control PP. This trial showed that petal fall applications of Esteem were more efficacious than delayed dormant applications. A trial of the seasonal fruit damage of LB and SB showed that the greatest damage occurs from mid-season to harvest. However, high bug populations early in the season can cause increased fruit drop but low bug populations cause little damage.

Introduction: In the summer of 1996 the U.S. Congress unanimously passed, and the President signed, the Food Quality Protection Act (FQPA). 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 insecticides (OP) used on pears may have greatly extended pre-harvest intervals or the manufacturer may be forced to terminate their registrations. Changes in the availability and use of pesticides will require more reduced risk, environmentally benign pest management strategies. Codling moth (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 approximately 75% has resulted from the CM mating disruption program. However, for pheromonal control to be cost effective only one pheromone application can be used. This often requires application of a subsequent OP insecticide for additional CM and/or leafroller control. Possible replacements for OP insecticides, which can be used alone or in conjunction with pheromonal control of CM, are insect growth regulators [(IGRs) e.g. Confirm, Dimilin and Esteem] and 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)] that 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 2000 evaluations for new insecticides for CM control, sprayer volume and speed on the efficacy of

Confirm for OBLR control, pear psylla (PP) management with Esteem and seasonal fruit damage by lygus bugs (LB) and stink bugs (SB).

1. Evaluation of new insecticides for CM control

Methods and Materials: The trial was conducted in a commercial 'Bartlett' pear orchard in Fairfield, CA. The orchard was planted on a 25 ft. x 25 ft. spacing (70 tree/ac). Fourteen treatments and an untreated control were replicated four times in a randomized complete block 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/ac (2.87 gal/tree). Applications were scheduled based on degree-days (DD). DD were calculated with a biofix of 31 March for the first generation and a 13 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. Minimum and maximum 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 tree canopy starting on 16 March and monitored at weekly intervals through 24 July. The target application timings were (Table 1): Avaunt with and without Omni Supreme oil, the high rate of Calypso and both rates of Assail at 200 and 600 DD from the 1st biofix and 200 DD from the 2nd biofix; Avaunt, Baythroid 2EC, Baythroid 20WP, Danitol, Guthion and Omni Supreme oil at 250 and 650 DD from the 1st biofix and 250 DD from the 2nd biofix; the low rate of Calypso at 100 DD and at two weeks and four weeks after 100 DD from the 1st biofix and 100 DD after the 2nd biofix. The grower standard was Imidan at 250 DD from the 1st biofix and Guthion at 650 DD from the 1st biofix and 250 DD from the 2nd biofix. Actara and Agri-Mek combined with Omni Supreme oil were applied at 200 DD from the 1st biofix and then followed by the grower standard. Control of the first CM generation (overwintering flight) was evaluated on 7 June and control of the second generation (summer flight) was evaluated at commercial harvest on 31 July by inspecting a maximum of 250 fruit per replicate for CM infestation. Control of PP nymphs, motile twospotted spider mites (TSSM) and European red mites (ERM) were evaluated by sampling 10 exterior and 10 interior leaves per replicate weekly from 8 May through 24 July. The 20 leaf samples were brushed and the secondary pests were counted under magnification (20X) in the laboratory.

Table 1. Treatments and Application Timings for Codling Moth Control, Fairfield, CA – 2000

Treatment	Rate lb (AI)/ac	No. Appl.	Application Dates (Degree-Days from 1st or 2nd Biofix)
1. Avaunt 30WG[a]	0.11	3	18 Apr (206 from 1st biofix), 23 May (627 from 1st biofix) and 19 Jun (168 from 2nd biofix)
2. Avaunt 30WG	0.011	3	18 Apr (206 from 1st biofix), 23 May (627 from 1st biofix) and 19 Jun (168 2nd biofix)
3. Avaunt 30WG	0.011	3	24 Apr (258 from 1st biofix), 24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
4. Calypso 4SC	0.096	4	7 Apr (110 from 1st biofix), 24 Apr (258 from 1st biofix), 5 May (382 from 1st biofix) and 19 Jun (168 from 2nd biofix)
5. Calypso 4SC	0.125	3	18 Apr (206 from 1st biofix), 23 May (627 from 1st biofix) and 19 Jun (168 from 2nd biofix)
6. Assail 70WP	0.1	3	18 Apr (206 from 1st biofix), 23 May (627 from 1st biofix) and 19 Jun (168 from 2nd biofix)
7. Assail 70WP	0.15	3	18 Apr (206 from 1st biofix), 23 May (627 from 1st biofix) and 19 Jun (168 from 2nd biofix)
8. Baythroid 2EC	0.022	3	24 Apr (258 from 1st biofix), 24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
9. Baythroid 20WP	0.022	3	24 Apr (258 from 1st biofix), 24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
10. Danitol 2.4EC	0.4	3	24 Apr (258 from 1st biofix), 24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
11. Actara 25WG[b]	0.086	1	18 Apr (206 from 1st biofix)
Imidan 70WP[c]	4.2	1	24 Apr (258 from 1st biofix)
Guthion 50WP	1.5	2	24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
12. Agri-Mek 0.15EC[b]	0.012	1	18 Apr (206 from 1st biofix)
Imidan 70WP[c]	4.2	1	24 Apr (258 from 1st biofix)
Guthion 50WP	1.5	2	24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
13. Omni Supreme oil by volume	1.0%	3	24 Apr (258 from 1st biofix), 24 May (644 from 1st biofix) and 22 Jun (229 from 2nd biofix)
14. Imidan 70WP[c]	4.2	1	24 Apr (258 from 1st biofix),
Guthion 50WP	1.5	2	24 May (644 from 1st biofix) and 22 Jun

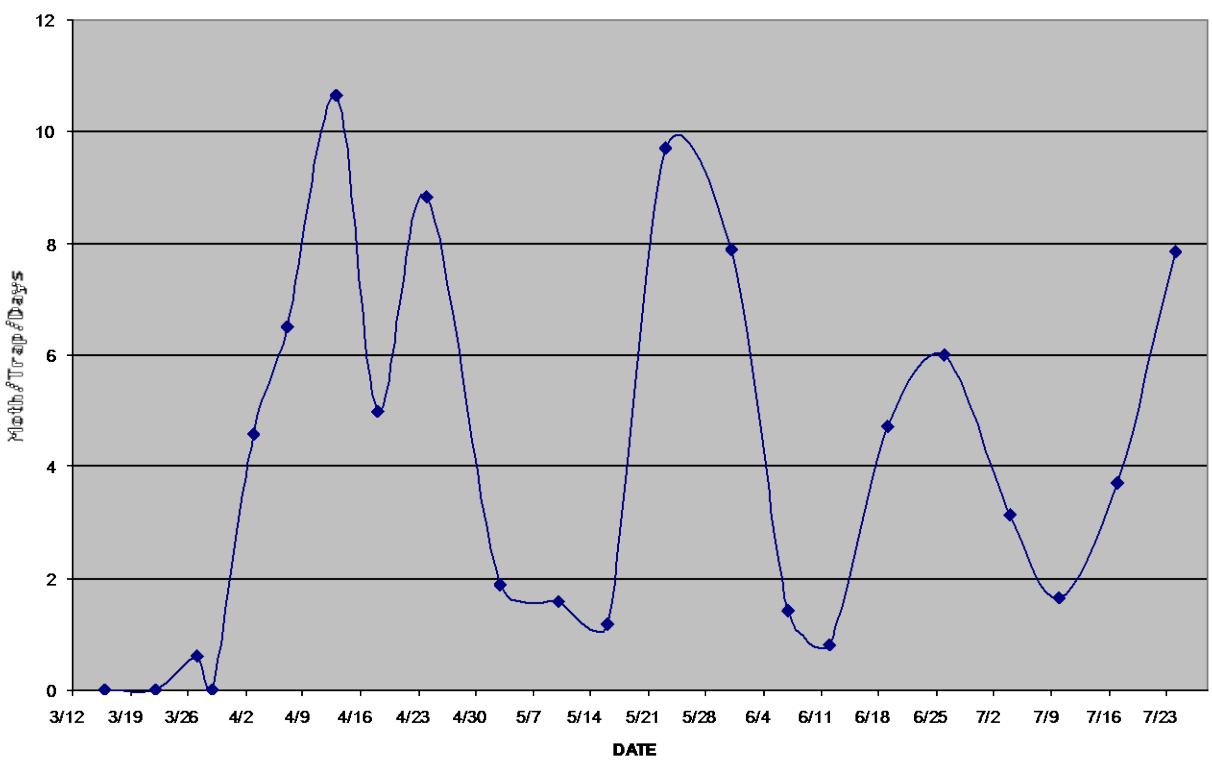
			(229 from 2nd biofix)
15. Untreated	——	——	

[a] Treatments contained 1.0% Omni Supreme oil by volume.
[b] Treatments contained 0.25% Omni Supreme oil by volume.
[c] pH was adjusted to < 6.0.

Results and Discussion:

Flight Activity - The first CM flight, as measured by a pheromone trap placed high in the tree canopy, indicated that CM flight began between 29 March and 3 April (Fig. 1). The first peak usually occurs between 200 and 300 DD after biofix while the second peak often occurs between 600 and 700 DD after biofix. The first and second flights were bimodal. The first peak of the first flight occurred around 24 April at 258 DD. The first flight was completed about 12 June at 928 DD. The first flight is usually completed between 1000 to 1100 DD in pears. The second biofix was set on 13 June. The first peak of the second CM flight occurred at approximately 301 DD on 26 June.

Figure 1 Seasonal Flight Activity of Codling Moth Captured in Pheromone Trap Fairfield, CA 2000



First Generation Evaluation - All experimental treatments had significantly lower CM infestation compared to the untreated control (Tr. #15) (Table 2). There was no significant difference among the experimental treatments and the grower standard (Tr. #14) except for Avaunt 30WG without Omni Supreme oil (Tr. #3) which had significantly higher CM infestation compared to the grower standard.

Table 2. Mean Percent Codling Moth Infested Fruit Inspected at Fairfield, CA – 2000

Treatment		Rate lb (AI)/ac	No. Appl.	Mean[a] Percent CM Infested Fruit Mid-season	Harvest
1.	Avaunt 30WG[b]	0.11	3	0.5 abc	8.8 abc
2.	Avaunt 30WG	0.11	3	0.7 bc	13.8 c
3.	Avaunt 30WG	0.11	3	1.0 c	14.2 c
4.	Calypso 4SC	0.096	4	0.0 a	6.7 abc
5.	Calypso 4SC	0.125	3	0.7 bc	7.9 abc
6.	Assail 70WP	0.1	3	0.2 ab	5.7 ab
7.	Assail 70WP	0.15	3	0.0 a	3.7 ab
8.	Baythroid 2EC	0.022	3	0.3 abc	14.1 c
9.	Baythroid 20WP	0.022	3	0.8 bc	13.5 c
10.	Danitol 2.4EC	0.4	3	0.2 ab	11.1 bc
11.	Actara 25WG[c]	0.086	1	0.1 ab	2.4 a
	Imidan 70WP[d]	4.2	1		
	Guthion 50WP	1.5	2		
12.	Agri-Mek 0.15EC[c]	0.012	1	0.0 a	3.2 a
	Imidan 70WP[d]	4.2	1		
	Guthion 50WP	1.5	2		
13.	Omni Supreme oil by vol.	1.0%	3	0.8 bc	41.8 d
14.	Imidan 70WP[d]	4.2	1	0.1 ab	4.9 ab
	Guthion 50WP	1.5	2		
15.	Untreated			10.8 d	80.5 e

[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 arcsine transformation.
[b] Treatments contained 1.0% Omni Supreme oil by volume.
[c] Treatments contained 0.25% Omni Supreme oil by volume.
[d] pH was adjusted to < 6.0.

Harvest Evaluation - The CM infestation in the untreated control was over 80% (Table 2). Thus, this trial provided a stringent test of the experimental treatments. The CM infestation rates in all experimental treatments were significantly lower than the untreated control. The experimental treatments with significantly higher CM infestation than the grower standard were: both the Avaunt treatments without oil (Trs. #2 & 3), both Baythroid treatments (Trs. #8 & 9) and Omni Supreme oil (Tr. #13). Although the Omni Supreme oil treatment had over 40% CM infestation, the oil still provided significantly lower CM infestation than the untreated control. Combining Omni Supreme oil with Avaunt improved its effectiveness more than changing the timing of the applications using Avaunt alone. Thus, the inclusion of oil with Avaunt appears to be necessary for improved efficacy through improved coverage and/or penetration of the insecticide. Both rates of Calypso and Assail (Trs. #4, 5, 6, & 7) were efficacious, particularly the high rate of Assail (Tr. #7) which had a lower infestation rate than the grower standard treatment (Tr. #14). CM control with Danitol or the two formulations of Baythroid were disappointing this year compared to previous years' studies and there was no difference between Baythroid 2EC and Baythroid 20WP. The higher CM infestation rates in the Baythroid treatments this year were likely caused by the reduced rate of application (0.022 versus 0.044 lb (AI)/ac last year) and the exclusion of Omni Supreme oil. The high infestation rate in the Danitol treatment was likely caused by the exclusion of Omni Supreme oil. This indicates that the inclusion of horticultural spray oil to Baythroid or Danitol may result in improved CM control.

Secondary Pest Evaluations: Mites – There were significantly more TSSM and ERM in both Baythroid treatments (Trs. #8 & 9), Actara followed with the grower standard (Tr. #11), and the grower standard alone (Tr. #14) compared to the untreated control (Tr. #15) (Table 3). The other treatments did not differ significantly from the untreated control. The Agri-Mek followed by the grower standard (Tr. #12) had very low TSSM and ERM populations while the grower standard caused a significant flare-up of both TSSM and ERM populations. Danitol appears to be a very effective miticide (Tr. #10). The Danitol treatment had numerically fewer TSSM and ERM than the untreated control. The early Avaunt applications (Trs. #1 & 2) had lower TSSM and ERM populations than did the late Avaunt application (Tr. #3).

Secondary Pest Evaluations: Pear Psylla - PP were significantly suppressed by all experimental treatments compared to the grower standard (Tr. #14) (Table 3). The grower standard and both Baythroid treatments (Trs. #8 & 9) had significantly greater PP than the untreated control. The addition of Actara or Agri-Mek, early in the season, to the grower standard (Trs. #11 & 12) provided excellent control of PP. This suggests that Actara and Agri-Mek were adequate to suppress the PP flare-ups that are often associated with treatments such as Guthion. Actara did not suppress these TSSM or ERM flare-ups while Agri-Mek adequately suppressed mite flare-ups.

Table 3. Mean Total Number of Mobile Two Spotted Spider mites, European Red Mites and Pear Psylla Nymphs per 20 Leaves in Fairfield, CA – 2000

Treatment	Rate lb (AI)/ac	No. App.	Mean[a] Total. per 20 Leaves TSSM	ERM	PP
1. Avaunt 30WG[b]	0.11	3	3.6 a	8.8 a	14.5 ab
2. Avaunt 30WG	0.11	3	3.6 a	6.4 a	16.1 ab
3. Avaunt 30WG	0.11	3	15.4 abc	15.4 ab	30.8 cd
4. Calypso 4SC	0.096	4	7.0 a	7.4 a	11.4 ab
5. Calypso 4SC	0.125	3	12.2 ab	8.7 a	10.4 ab
6. Assail 70WP	0.1	3	19.6 abcd	12.7 ab	5.7 a
7. Assail 70WP	0.15	3	28.4 abcde	18.5 ab	8.2 a
8. Baythroid 2EC	0.0	3	54.2 cde	35.1 c	35.3 d
9. Baythroid 20WP	0.022	3	51.0 bcde	32.0 bc	35.5 d
10. Danitol 2.4EC	0.4	3	0.3 a	3.8 a	16.5 ab
11. Actara 25WG[c]	0.086	1	59.0 de	29.8 bc	23.2 bcd
Imidan 70WP[d]	4.2	1			
Guthion 50WP	1.5	2			
12. Agri-Mek 0.15EC[c]	0.012	1	1.4 a	3.4 a	17.0 ab
Imidan 70WP[d]	4.2	1			
Guthion 50WP	1.5	2			
13. Omni Supreme oil by vol.	1.0%	3	3.6 a	7.7 a	21.4 bc
14. Imidan 70WP[d]	4.2	1	67.0 e	38.6 c	63.8 e
Guthion 50WP	1.5	2			
15. Untreated		0	3.6 a	4.8 a	17.8 abc

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

[b] Treatments contained 1.0% Omni Supreme oil by volume.

[c] Treatments contained 0.25% Omni Supreme oil by volume.

[d] pH was adjusted to < 6.0.

Conclusions: This trial was conducted against a high CM population with over 80% of the fruit infested at harvest in the untreated control and with 4.9% of the fruit infested in the grower standard. Given the elevated CM population, this should be considered a rigorous test of the experimental materials. Avaunt with horticultural oil, Calypso and Assail are promising experimental materials. The addition of Actara early in the season to the grower standard provides excellent PP control. However, Actara does not provide suitable TSSM or ERM control. Areas of future research are the inclusion of horticultural oil with Calypso, Assail, Danitol and Baythroid to improve their efficacy against CM and secondary pests.

2. Sprayer Volume and Speed on the Efficacy of the IGR - Confirm

Methods and Materials: This study was conducted in a commercial 'Bartlett' pear orchard near Courtland, CA. Four treatments were replicated three times in a randomized complete block design. Each replicate consisted of approximately 0.376 acres for a total of 1.13 acres per treatment. Applications were applied using a PTO rig operating at 1.3 or 2.6 mph and applying 65 or 130 gallons of finished spray per acre. The four treatments were: Confirm 2F at 18 oz/ac applied at 2.6 mph in 65 gal of finished spray per acre, Confirm 2F at 18 oz/ac applied at 1.3 mph in 65 gal of finished spray per acre, Confirm 2F at 18 oz/ac applied at 1.3 mph in 130 gal of finished spray per acre and an untreated control. All Confirm treatments contained 0.0625% Latron B-1956 by volume. Applications were scheduled based on DD. DD were calculated with a biofix of 1 May using a single sine horizontal cutoff model with a lower threshold of 43˚F and an upper threshold of 85˚F. Maximum and minimum air temperatures were obtained from the IMPACT weather station at Lodi, CA. The summer generation DD timing was targeted at 600 DD and was applied on 30 May at 665 DD. The treatments were evaluated weekly from 2 June through 15 June by examining 333 fruit pairs per replicate (1000 fruit pairs per treatment) for OBLR larvae and/or associated fruit damage. Each sample comprised of examining two adjacent and touching pears or a fruit and a leaf or leaves that touched the fruit.

Results and Discussion: This experiment was designed to determine the effect of sprayer speed and spray volume on OBLR control by the IGR, Confirm. Unfortunately, due to a very low OBLR population in this orchard, there were no significant differences among the treatments (Tables 4 and 5). However, through the first two weeks of evaluation, more OBLR larvae and associated fruit damage occurred in the untreated control than in the other treatments.

Table 4. Mean Percent OBLR Damaged Fruit when Treated with an Orchard Sprayer Operating at Various Speeds and Spray Volumes at Courtland, CA – 2000

Application		Mean* Percent Damaged Fruit			
Speed	Volume	2-Jun	8-Jun	15-Jun	Total
2.6 mph	65 gal/ac	0.0	0.0	1.33	1.33
1.3 mph	65 gal/ac	0.67	0.0	3.33	4.0
1.3 mph	130 gal/ac	0.33	0.67	0.67	1.67
Untreated Control		2.0	1.0	0.67	3.67

* There was no significant difference (Fisher's protected LSD, $P \leq 0.05$).

Table 5. Mean Percent of Fruit with One or More OBLR Larvae Present when Treated with an Orchard Sprayer Operating at Various Speeds and Spray Volumes at Courtland, CA – 2000

Application		Mean* Percent Infested Fruit			
Speed	Volume	2-Jun	8-Jun	15-Jun	Total
2.6 mph	65 gal/ac	0.0	0.0	0.33	0.33
1.3 mph	65 gal/ac	0.0	0.0	1.33	1.33
1.3 mph	130 gal/ac	0.0	0.33	0.33	1.72
Untreated Control		0.33	0.67	0.33	3.87

* There was no significant difference (Fisher's protected LSD, $P \leq 0.05$).

Conclusion: Since Confirm must be consumed to be effective, thorough spray coverage is required to achieve desirable results. Unfortunately, as a result of the low OBLR population in this orchard, no meaningful conclusion can be made on the effects of sprayer speed and spray volume on OBLR control with Confirm. This experiment will be repeated next year in an orchard with a higher OBLR population.

3. Pear Psylla Management with Esteem

Methods and Materials: This study was conducted in eight commercial orchards. Six orchards (A – F) received four treatments (Table 6): The four treatments were: 1) Esteem 0.86EC at 1 pt/ac applied to 5 acres at delayed dormant, 2) Esteem 0.86EC at 1 pt/ac applied to 5 acres at petal fall which overlapped half of the delayed dormant application, 3) Esteem 0.86EC at 1 pt/ac applied at delayed dormant and petal fall (the overlapping 5 acre area of treatments No. 1 and 2) and 4) untreated control. Orchards G and H applied Esteem 0.86EC at delayed dormant but not at petal fall. In orchards C, D, E, G & H, the portion of the orchards not treated with Esteem at delayed dormant was treated with Asana XL or Lorsban 4EC. In orchards A, B and F, the portion of the orchards not treated with Esteem at delayed dormant remained untreated. All orchards, except F and G, received a dormant oil treatment. Treatments were applied using an air-blast speed sprayer operating at about 2.0 mph and applying 100 gal. of finished spray per acre, except orchards F & H which applied Esteem at 250 gal. of finished spray per acre.

<u>Evaluation Procedures</u>: Adult PP were evaluated with 50 to 250 beating tray samples (three limb taps per sample) per orchard from mid-February through early March which was after the dormant oil applications but before the delayed dormant applications. After the delayed dormant application, 100 spurs (15 spurs in the untreated portions of the Lake and Mendocino County orchards) were collected from 10 to 29 March from each treatment and orchard. The spurs were examined in the laboratory under magnification (20X) for PP eggs and nymphs. After the petal fall application, 50 high shoots and 50 low shoots were examined from each treatment and orchard from 7 to 26 April for PP eggs and nymphs.

Results and Discussion: Adult PP were found in high numbers in the Suisun Valley orchards (A & B), moderate numbers in one of the Sacramento Delta orchards (C), in the two Lake County orchards (G & H) and in the Mendocino County orchard (F) while few PP adults were found in two Sacramento Delta orchards (C & E) (Table 7). The Sacramento Delta historically has had low PP pressure compared to the Suisun Valley, Lake or Mendocino County orchards.

For analytical purposes the orchards were divided into two groups. One group consisting of orchards A, B and F applied Esteem at delayed dormant, petal fall and at both the delayed dormant and petal fall timing, but did not apply a grower standard. A second group consisting of orchards C, G and H applied Esteem and a grower standard at the delayed dormant timing but did not apply Esteem at petal fall or the data was not considered at the petal fall timing (orchard C). The PP population did not develop in orchards D and E. Thus, they were not considered in the analysis.

There was no significant difference in the number of PP eggs and nymphs per spur in the Esteem treatment compared to the untreated control (Table 8) or the Esteem treatment compared to the untreated control or grower standard following the delayed dormant applications (Table 9). Although the difference was not significant, there were a larger number of eggs and nymphs per spur in the untreated control than in the Esteem treatment (Table 8). It appears that Esteem is an ovipositional deterrent. However, further study is needed to verify the ovipositional deterrence of Esteem. There was significantly lower percent spurs infested with PP eggs in the Esteem treatment compared to the untreated control (Table 8) or between the control and grower standard (Table 9). The percent spurs infested with PP nymphs was suppressed by the Esteem or grower standard treatment but was not significantly lower. The percent of spurs infested with PP eggs or nymphs compared to the number of eggs or nymphs from the spurs indicates a very clumped distribution. Although numerous eggs were found, the eggs had not begun to hatch and very few nymphs were observed in the spur samples.

The PP populations had increased substantially at the petal fall timing evaluation (Table 10). Although there was no significant difference in the number of eggs per shoot or the percent of shoots infested, there were less eggs and percent of infested shoots in the Esteem treatments, particularly at the petal fall timing. However, there were significantly fewer nymphs per shoot in the combination of delayed dormant and petal fall applications and the single petal fall application compared to the untreated control. There were also significantly fewer shoots infested with nymphs in the single petal fall Esteem treatment compared to the untreated control.

Table 6. Treatments and Application Timings for Pear Psylla Control with Esteem – 2000

Orchards/Grower		Application Dates & Material: Delayed Dormant	Petal fall
A	Experimental	3/3 – Esteem 0.86EC, 1 pt/ac +1% Volck oil	4/3 – Esteem 0.86EC, 1 pt/ac
	Grower Standard	------	------
B	Experimental	3/3 – Esteem 0.86EC, 1 pt/ac +1% Volck oil	4/3 – Esteem 0.86EC, 1 pt/ac
	Grower Standard	------	------
C	Experimental	3/10 – Esteem 0.86EC, 1 pt/ac + Nu-Film-17, 8 oz/ac	4/3 – Esteem 0.86EC, 1 pt/ac + Nu-Film 17, 6.4 oz/ac
	Grower Standard	3/10 – Asana XL, 8 oz/ac + Nu-Film 17, 8 oz/ac	------
D	Experimental	2/25 – Esteem 0.86EC, 1 pt/ac + 4% Volck Oil by Vol.	3/29 – Esteem 0.86EC, 1 pt/ac
	Grower Standard	2/25 – Asana XL, 6 oz/ac + 4% Volck Oil by Vol.	------
E	Experimental	2/28 – Esteem 0.86EC, 1 pt/ac + Nu-Film-P, 6.9 oz/ac	3/29 – Esteem 0.86EC, 1 pt/ac + Nu-Film-P, 3.8 oz/ac
	Grower Standard	2/28 – Asana XL, 8 oz/ac + Nu-Film-17, 11.9 oz/ac	------
F	Experimental	3/13 – Esteem 0.86EC, 1 pt/ac	4/3 – Esteem 0.86EC, 1 pt/ac
	Grower Standard	------	------
G	Experimental	3/8 – Esteem 0.86EC, 1 pt/ac	------
	Grower Standard	3/13 – Lorsban 4EC, 4 pts/ac + 0.8% 415 spray oil by vol. (whole orchard)	------
		3/25 – Asana XL, 1 pt/ac	------
H	Experimental	3/6 – Esteem 0.86EC, 1 pt/ac + 1.6% 415 spray oil by vol.	------
	Grower Standard	3/6 – Lorsban 4EC, 4 pts/ac + 1.6% 415 spray oil by vol.	------
		4/4 – Asana XL, 7.25 oz/ac (whole orchard)	------

Table 7. Mean Number of Pear Psylla Adults per Beat Sample (Three Limb Taps) Between the Dormant and Delayed Dormant Treatments

Orchards – Region	Mean Number of Pear Psylla Adults/Beat Sample
A – Suisun Valley	0.94
B – Suisun Valley	0.44
C – Sacramento Delta	0.12
D – Sacramento Delta	0.04
E – Sacramento Delta	0.04
F – Mendocino County	0.14
G – Lake County	0.26
H – Lake County	0.15

Table 8. Mean Number and Percent Infested Spurs with Pear Psylla Eggs and Nymphs after Delayed Dormant Application in Orchards A, B and F

	Mean Number of Pear Psylla		Mean Percent Spurs Infested	
Treatments	Eggs	Nymphs	Eggs	Nymphs
Esteem 0.86EC	0.29 a	0.02 a	7.33 a	1.67 a
Control	5.68 a	0.42 a	27.67 b	11.00 a

Means followed by the same letter within a column are not significantly different. Fisher's protected LSD, P<0.10. Data analyzed using SQRT(X + 1) transformation.

Table 9. Mean Number and Percent Infested Spurs with Pear Psylla Eggs and Nymphs after Delayed Dormant Application in Orchards C, G and H

	Mean Number of Pear Psylla		Mean Percent Spurs Infested	
Treatments	Eggs	Nymphs	Eggs	Nymphs
Esteem 0.86EC	0.49 a	0.03 a	3.00 ab	2.67 a
Grower Standard	1.01 a	0.00 a	1.33 a	0.33 a
Control	0.36 a	0.03 a	10.00 b	3.33 a

Means followed by the same letter within a column are not significantly different. Fisher's protected LSD, P<0.10. Data analyzed using SQRT(X + 1) transformation.

Table 10. Mean Number and Percent Infested Shoots with Pear Psylla Eggs and Nymphs after Petal Fall Application in Orchards A, B and F

	Mean Number of Pear Psylla		Mean Percent Shoots Infested	
Treatments	Eggs	Nymphs	Eggs	Nymphs
Esteem 0.86EC DD	3.02 a	0.81 ab	32.0 a	21.0 ab
Esteem 0.86EC DD & PF	2.14 a	0.56 b	31.0 a	19.7 ab
Esteem 0.86EC PF	1.62 a	0.31 b	22.7 a	10.3 b
Control	5.39 a	1.77 a	47.0 a	42.0 a

Means followed by the same letter within a column are not significantly different. Fisher's protected LSD, $P<0.10$. Data analyzed using SQRT(X + 1) transformation.

Conclusion: It appears that the most efficacious timing of Esteem is at petal fall and that Esteem is an ovipositional deterrent when applied at either petal fall or delayed dormant timing.

4. Seasonal Damage of Lygus and Stink Bug on Pears

Methods and Materials: Laboratory-cultured adult LB (*Lygus hesperus*) and SB (*Acrosternum hilare*) were caged on four to seven fruit bearing limbs for two week intervals from 14 April to 5 July. The cages were about 24 in. long by 15 in. wide and made of nylon mesh. The number of bugs caged were: 5 and 15 LB and 3 and 9 SB. After 7 days, any dead bugs were replaced and the percent bug mortality was measured at 7 and 14 days. Bugs and cages were removed after 14 days and the cages with another set of bugs were placed on other fruit limbs. Fruit drop was counted weekly from 21 April through 5 July. Bagged, fruit bearing limbs without bugs were used as untreated controls. Just prior to commercial harvest, all previously caged fruit were removed and the numbers of stings per fruit were counted in the laboratory. Fruit diameter was measured weekly from 14 April through 5 July on 25 random fruit. The study was conducted in an organically grown pear orchard and no true bug insecticides were applied during the season.

Results and Discussion:

<u>Lygus Evaluation</u> – The five LB treatments did not cause substantially greater fruit drop than the untreated control (Fig 2). However, fruit with 15 LB consistently had a greater percent fruit dropped than either the five LB treatment or the untreated control. 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 11). However, because of rapid fruit growth, the fruit surface area remained fairly constant throughout the experiment. The greatest difference in percent fruit drop between the untreated control and 15 LB treatment was observed on 26 May when there was 19% fruit drop in the untreated control and 78% fruit drop in the 15 LB treatment (Table 12). It is speculated that the fruit in the 15 LB treatment was inadvertently knocked off the tree by spray equipment.

The number of LB stings per fruit show a bell shaped pattern for both the 5 and 15 LB treatments with the greatest number of LB stings per fruit occurring on 26 May (Fig. 3). The untreated control had very few stings throughout the study and the stings were attributed to a native lygus population. The lower number of stings per fruit that occurred early in the season were the result of fruit abortion. A large number of the fruit with stings aborted, leaving on the tree a greater percent of fruit without stings. Thus it is likely that fruit with lygus stings will abort more readily than fruit that is not stung. There is no data for the 15 LB treatment on 14 April because all the fruit had aborted. Maximum number of stings counted per fruit was 10. Heavily stung fruit in the 15 LB treatment often exceed 10 stings per fruit. While there was less fruit drop in the 5 LB treatment as the season progressed, the average number of stings per fruit tended to increase. This is significant since these fruit will have greatly reduced or no market value. The average number of stings per fruit in the 15 LB treatment were greater than 10 from mid-May to early June. It is likely that the lower number of stings observed on 23 June was a result of the stings not having a chance to visibly develop.

Stink Bug Evaluation – As seen with the 5 LB treatment, there was no difference in fruit drop between the 3 SB treatment and the untreated control until mid-May (Fig 4). From the third evaluation on, the 3 SB treatment had much greater fruit drop than the untreated control. From the second evaluation on, the percent fruit drop from the 9 SB treatment was much greater than the untreated control. The 9 SB treatment had a similar percent fruit drop to the 3 SB treatment at midseason and much greater fruit drop for the last two evaluation dates.

The 9 SB treatment consistently had a greater average number of stings per fruit than the untreated control while the 3 SB treatment had a larger number of stings per fruit from the second evaluation period (Fig 5). Like the LB evaluation, a maximum of 10 SB stings per fruit were counted. The 9 SB treatment consistently averaged about 3 stings per fruit more than the 3 SB treatment. Nevertheless, both SB treatments caused more than enough stings to cause the fruit to have little or no market value.

Conclusion: The number of LB and SB used in this study was maintained at unnaturally high levels. These extreme populations allowed for more easily measurable results and increased likelihood that a significant number of bugs would be alive by the end of the week at which point any dead bugs were replaced. It is highly improbable that such a high population would be found naturally in the field. The 9 SB and 15 LB treatment caused a greater amount of fruit drop than the 3 SB or 5 LB treatment, respectively. However, all treatments caused very high sting damage that would reduce or eliminate the market value of the fruit. Because of the large natural fruit abortion early in the season, it appears that low populations of either pest will cause minimal fruit damage. These pests appear to cause the greatest damage from mid-season to harvest.

Table 11. Mean Fruit Diameter and Fruit per Bag by week at Sacramento, CA - 2000

Week	Mean Fruit Diameter (in)	No. Limbs Bagged	Mean Fruit per Bag
1	0.49	5	15.85
2	0.73	5	10.80
3	1.06	7	7.00
4	1.33	7	5.57
5	1.63	7	6.18
6	2.00	7	5.71

Table 12. Mean Total Percent Fruit Drop at Harvest at Sacramento, CA - 2000

	Date When Fruit were First Bagged					
Treatment	14-Apr	28-Apr	12-May	26-May	8-Jun	22-Jun
5 LB	0.91	0.59	0.27	0.21	0.14	0.00
15 LB	1.00	0.79	0.54	0.78	0.39	0.26
3 SB	0.83	0.60	0.47	0.39	0.27	0.28
9 SB	0.85	0.75	0.41	0.44	0.56	0.58
Bagged control	0.82	0.59	0.22	0.19	0.14	0.02

Fig 2. Mean Total Percent Fruit Drop by Lygus Bugs.

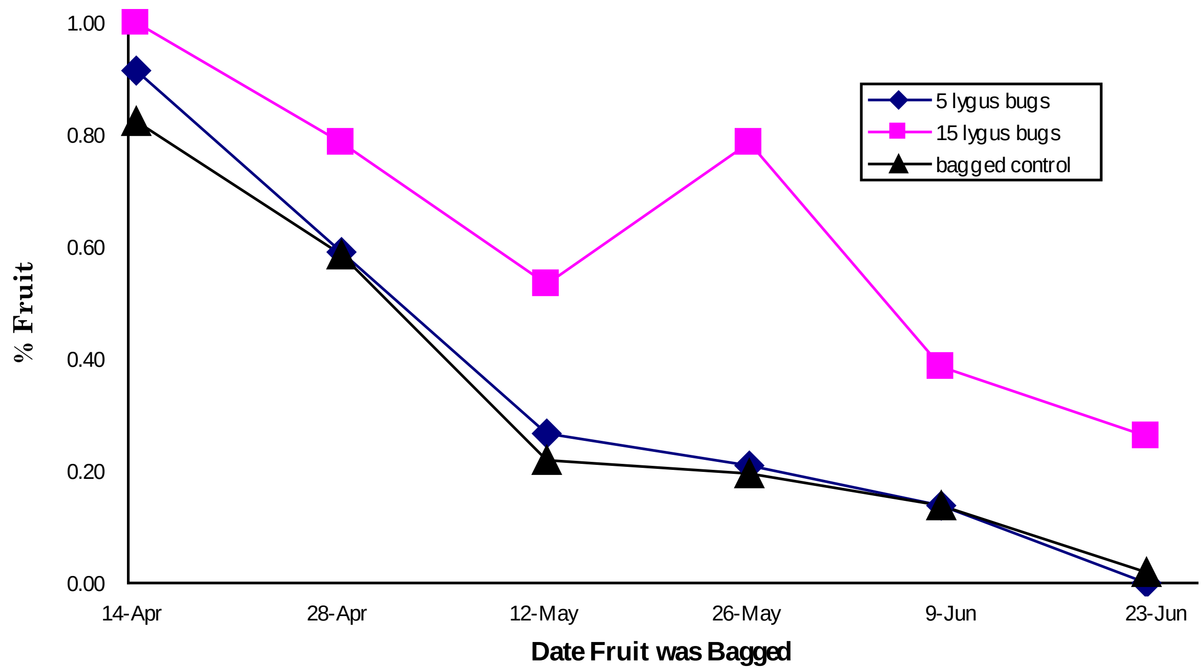


Fig 3. Mean Number of Lygus Bug Stings per Fruit at Harvest.

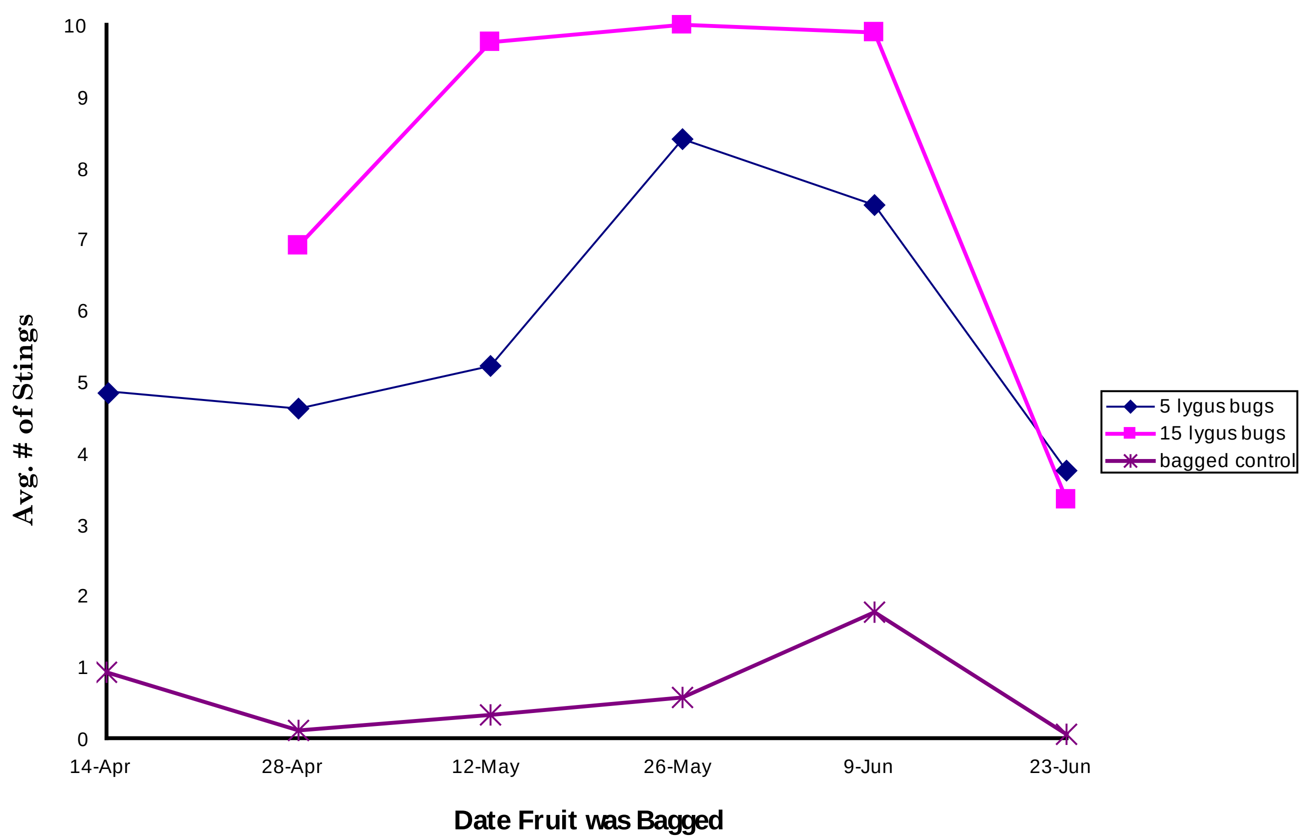


Fig 4. Mean Total Percent Fruit Drop by Stink Bugs.

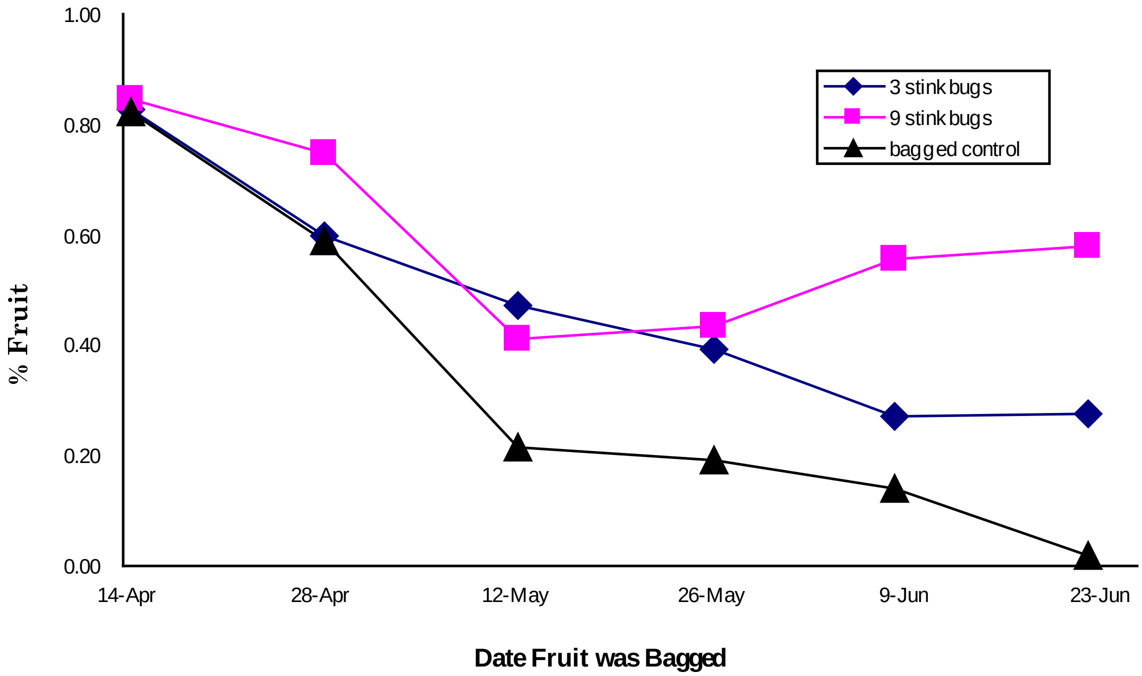
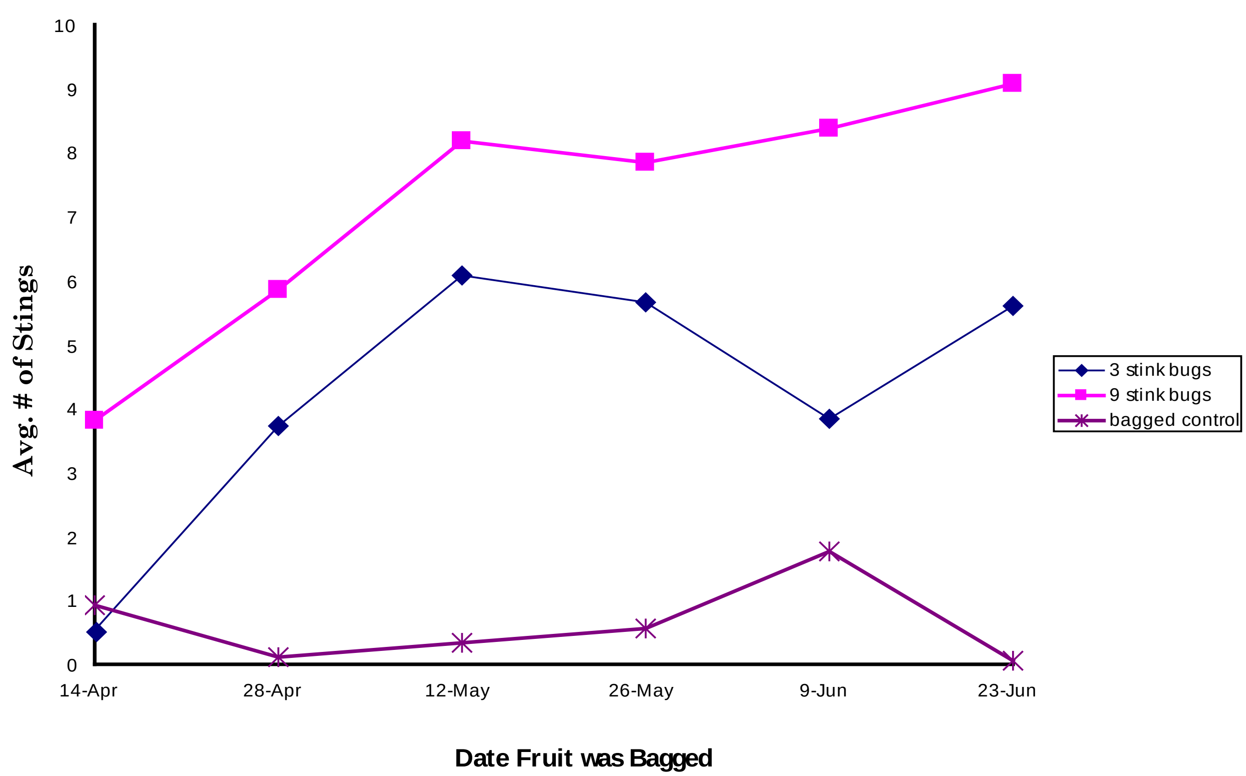


Fig 5. Mean Number of Stink Bug Stings per Fruit at Harvest.



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