Building a Pheromone-based Multi-tactic Pest Management System for Western Orchards

2003 Areawide II Demonstration Project
Mid-Year Report
Washington State

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Areawide II Demonstration – 2003 Mid-year Report

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A primary goal of the IFAFS/RAMP funded project is to stabilize and extend codling moth mating disruption (CMMD) to 75% of the pome fruit and 25% of the walnut acreage in WA, OR and CA. Washington State University has implemented a demonstration project, Areawide II (AWII), which is evaluating CMMD programs that replace supplemental organophosphate controls with selective insecticides (e.g. oils, IGRs, particle film, microbials, neo-neurotoxins). Grower experience in using these pest control tools has been limited either by perceptions that the approaches are too risky or because they are new (recently registered). AWII compares a “novel” pest control program using only selective (“SOFT”) insecticides with a conventional (“CONV”) program that allows for the use of organophosphate (OP) or carbamate insecticides. AWII contrasts the relative efficacy and economic value of the novel programs.

The initial step to implementing the AWII demonstration project was to establish apple and pear study sites covering at least 400 acres of apple and 100 acres of pear in Washington State. The corner stone of the management program has been to have CMMD applied to the entire area at each site as part of the grower’s normal practice. Two supplemental treatment regimes have been standardized for each study site, a CONV regime using broad-spectrum insecticides plus CMMD and a SOFT regime using selective insecticides plus CMMD (Appendix 1-Apple, Appendix 2-Pear). The SOFT treatment regime specifically eliminates the use of all OPs while striving for the elimination of carbamates (including carbaryl traditionally used as a thinning agent for apples), chlorinated hydrocarbons and synthetic pyrethroid insecticides. Products available include but are not be limited to Bts (e.g. Dipel WDG, Javelin), methoxyfenozide (Intrepid), spinosad (Success), horticultural mineral oil, imidacloprid (Provado), indoxacarb (Avaunt), pyriproxyfen (Esteem), and particle films (Surround). The SOFT treatment regime is flexible and can change from year to year as newly registered products become available or as pest densities are lowered to the point that the softest alternative will replace more disruptive insecticides.

The experimental design is a series of side-by-side comparisons (CONV vs. SOFT) of at least 10 acres/treatment, replicated across several sites. The acreage and cultivar at each site is shown in Table 1. General pest monitoring is conducted at each study site using protocols developed in the CAMP study. Pests to be monitored include CM, leafrollers (LR), *Lacanobia subjuncta* (LAC), white apple leafhoppers (WALH), western tentiform leafminer (WTLM), spider mites, aphids, pear psylla (PP), and grape mealybug (GMB).

These pests represent key components or representatives of key pest groups that will reflect the efficacy of different treatment regimes and the impact of these regimes on natural enemy and secondary pest populations. A pest control advisor was selected to work with growers at each study site to manage pest control programs, collect treatment records and assist a state coordinator, USDA-Wapato and WSU-TFREC personnel in collecting pest and beneficial insect data. Pest densities are monitored using traps, foliage samples and visual examinations following established protocols. Impact of pests will be evaluated by examining fruit at the end of the first CM generation and again at harvest for damage in each treatment regime. Study sites can be compared for trends in data over time. Data on cost of programs and crop damage will be analyzed by an economist to determine the overall impact of the treatment regimes on grower profitability.

APPLE

A wide array of tools is used to monitor lepidopteran pests. Adult CM are monitored with large delta-style sticky traps baited with a high-load pheromone lure (SuperLure, Phero Tech, Inc.) and similar traps baited with a kairomone attractant (DA lure, Trécé, Inc.). CM traps are used at a density of one pheromone and one DA baited trap per 2-2.5 acres. Both pandemis (PLR) (*Pandemis pyrusana*) and obliquebanded (OBLR) (*Choristoneura rosaceana*) leafrollers are monitored using delta-style sticky traps baited with a standard (1X) and low load (0.1X for PLR, 0.05X for OBLR) pheromone lures, with one lure of each type being placed in a trap in each treatment-block. LAC are monitored with a general purpose, plastic bucket style trap (Phero Tech, Inc.) baited with a standard-load pheromone lure (Suterra, Inc.) at a density of one per treatment-block. All traps are checked weekly and the number of moths recorded. CM adults in the DA Lure baited traps are collected and returned to WSU-TFREC for identification, counting and determination of sex and mating status. The SuperLures, LR pheromone lures, and LAC pheromone lures are changed every 6 weeks. The DA lures are changed every 8 weeks.

Field monitoring for fruit and foliage damage is done at key times throughout the season in each orchard. Surveys are made in each block for the amount and location of damage by each of the lepidopteran pests. Leafroller damage is surveyed in late May and early August. Damage by CM and LAC is evaluated in early to mid July, and CM damage is evaluated again prior to harvest. Further, fruit are inspected in bins during harvest for damage from lepidopteran pests and other insects.

Specific secondary pest and natural enemy density samples are made using protocols developed in the CAMP study. The following samples are made: overwintering WALH eggs for egg density and parasitism; *Campylomma verbasci* nymphs during bloom; leafhopper nymphs (1^{st} and 2^{nd} generation); green aphid complex and associated natural enemies (once each in June, July, and August); mites (tetranychid, rust, and predatory) once each in June, July, and August; WTLM (mine density during the latter part of the 1^{st}, 2^{nd} and 3^{rd} generation mines), and parasitism estimates on those blocks with sufficient mines present; fruit damage/presence of secondary pests before harvest (adult mite and egg calyx infestation, aphid honeydew and leafhopper tarspotting); and campylomma adults in pheromone-baited traps.

PEAR

Leptidopteran pests are monitored essentially the same in the pear test sites as in the apple. The kairomone used in the DA Lure is a pear ester and was shown to have reduced attractiveness to CM in pear orchards. Therefore, DA lure use was discontinued in pears during 2003. LAC is not a major pest in pear and thus is not monitored in this project. Every two weeks, the pear orchards are monitored separately for pear pests and natural enemies by limb-tap sampling. Spur (prebloom) and leaf samples (mid-May through August) are also collected at two-week intervals. These leaf samples are brushed using a standard mite-brushing machine and counted at WSU-TFREC. All key pest and beneficial arthropods are counted during the limb-tap and leaf-brush sampling periods. Fruit and foliage damage assessments are made using the same methods as the apple orchards.

2003 MID-YEAR RESULTS (Apple)

Codling moth:

CM densities are generally low at all sites as measured by damage assessments (Table 2) and pheromone trap captures (Table 3). Trap captures in Table 2 are reported as total moths caught/treatment. Most sites have at least 8 CM pheromone traps/treatment. There is virtually no difference among treatment regimes on average. However, this may be an oversimplification of data analysis. It will be necessary to analyze spray records at the end of the season to understand the effects of the different treatment regimes. Fruit damage from CM was detected in 4 of the CONV blocks and two of the SOFT blocks after the first larval generation. The SOFT block in orchard A5 had the highest level of fruit injury, but it should be noted that the damage was on two trees relatively close together on an outside border. Orchard A5 has correspondingly high trap captures. Orchard A3 has had high CM pressure through the entire project and along with orchards A1 and A4 continues to record the highest trap captures. After the first generation only one CM damaged fruit was found in orchards A3 and A4, and no CM damage was noted in A1.

Leafroller:

Leafroller larval densities were very low or nonexistent at a majority of the apple sites during the first larval sample (Table 2). Two of SOFT treatment blocks (A8, A9) and only one of the CONV blocks (A13) had measurable larval populations. Only the SOFT treatment at Orchard A8 had a troublesome population of live larvae. It should be noted that the SOFT treatment of A8 received two Esteem applications targeting this population. Larval mortality after an Esteem application can be significantly delayed due to its juvenile hormone mode of action. A significant reduction in the size of the second larval generation was noted during a modified sample conducted in early July. Trap captures in low-load pheromone baited traps were low in most blocks during the first adult flight (Table 3). However, there were 2 CONV apple blocks (A1, A3) and three SOFT apple blocks (A3, A8, A11) that had elevated trap captures (>20 cumulative moths/trap) indicating a higher risk potential for the second larval generation.

***Lacanobia subjuncta*/Cutworms:**

It can be difficult to measure LAC populations with a foliage sample as the feeding damage is similar to other noctuids, and can resemble that of grasshoppers or other foliage feeders. A low level of foliage feeding is typical in every orchard. Only if feeding damage reaches levels of >10% infested shoots, especially with no corresponding fruit injury, does an accurate species ID become important. None of the apple or pear blocks had generalized foliage feeding levels that would indicate LAC or any other noctuid posed a threat to cause significant fruit injury (Table 2). Unpublished data (Doerr and Brunner) suggested that LAC captures that peak at greater than 100/week indicate an elevated risk level. Only orchards A9, A10 and A11 had captures that reached this level (Table 3). There was no difference among treatment protocols noted in these orchards. These three orchards have each had historically elevated LAC pressure but little fruit damage has ever been noted.

Overwintering WALH egg sample: Ten cm. sections were cut from one-yr wood before the commencement of shoot growth. Twenty shoots per block were sampled. Shoots were brought back to the lab, trimmed to 10 cm, and examined for leafhopper eggs using 10X magnification. If eggs were found, they were dissected and examined for the presence of a 'fat body', which represents the developing larvae of the egg parasitoid, *Anagrus epos*. This sample was designed to evaluated relative differences among treatments and not to used to predict summer densities. Overwintering WALH densities were generally low with no difference between treatments noted with either density or parasitism rates (Table 4).

Petal Fall Campylomma Samples:
This sample was taken during the late bloom-petal fall time period. Twenty samples/block were taken by holding a 45 x 45 cm beating tray covered with black cloth underneath a section of branch with a high density of blossoms. The branch was struck sharply three times to dislodge the nymphs onto the tray surface, where they were counted.

This sample was not conducted as a measure to assist consultants with treatment decisions, rather as a means to assess the effectiveness of the Campylomma control programs. Of specific interest was whether there was any increased risk from Campylomma in the AWII SOFT blocks from leaving Lorsban out of the delayed dormant applications. AWII orchards have had very low Campylomma densities throughout the evaluation periods. However, it is clear that Campylomma numbers have not increased in the SOFT blocks after three years with no OP insecticides used (Table 5). It should be noted that orchard A5 had relatively high adult captures in fall of 2002 (100-120 adults/trap in both blocks) suggesting A5 had elevated risk potential in 2003. This did not correspond to damaging Campylomma densities during the petal fall period of 2003.

Western Tentiform Leafminer density estimate:
Ten leaves from each of 20 trees were examined for the presence of mines. Cluster leaves were sampled for mines of the 1st generation, and mid-shoot leaves were sampled

for the 2nd and 3rd generations. Samples were taken during mid-May, mid-July, and mid-August.

WTLM densities of the first generation were very low in all plots (Table 6). Orchard A14 had the highest density noted during the third generation sample of 2002 in both the CONV and SOFT blocks. The moderate density noted in 2002 did not result in an elevated population relative to the other blocks in 2003. An evaluation of the petal fall spray program may shed light on the low density noted in 2003.

White Apple Leafhopper, nymph sample:
Ten fully expanded leaves were examined for WALH nymphs from each of 20 trees in each test block (200 lvs/block). The number of nymphs present on both the upper and lower surfaces was recorded. Sample timing targeted the peaks of the first (mid-May) and second (mid-August) generations.

WALH densities were very low at all blocks at the first generation sample in mid-late May (Table 7). Only A7 and A11 had moderate populations develop during the second generation of 2002. These populations did not correspond to elevated densities in those blocks during the spring of 2003.

Tetranychid, eriophyid, and predatory mites, leaf brushing sample:
Ten leaves from each of 20 different trees per block (200-leaf composite sample) were gathered in mid-June (will be collected in mid-July and mid-August) and brought back to the lab. Leaves sampled were distributed among both spur and shoot leaves, as well as from the inner and outer canopy. The mites were brushed from the leaves onto a circular glass plate coated with a thin film of sticky material using a mite-brushing machine. Both eggs and motile stages were counted of tetranychid mite species and predatory mites. Only motile stages of apple rust mite were counted.

Mite densities were low at each site in the mid-June sample (Table 8). Of all the blocks samples, only A3 had tetranychid densities greater than 1 per leaf. This corresponded with an elevated late season density in 2002. However, other orchards with elevated counts during late 2002 (A1, A7, A9, A11, and A14) did not have corresponding elevated counts in mid-June 2003. Overall, predatory mite counts were low in all orchards. This is not unexpected given the low tetranychid and apple rust mite densities present.

Apple aphid and natural enemies:
Twenty upright vegetative shoots were sampled from each block. Three samples were taken, with the first taken during mid-June (the others will be taken mid-July and mid-August). The number of aphid-infested leaves on the top 10 leaves/shoot were counted. Aphid natural enemies, if present were also counted on the sampled shoots. The included coccinellids, lacewings, *Deraeocoris*, *Campylomma* and syrphid flies.

Aphid populations were generally low during the mid-June 2003 samples (Table 9). Natural enemy populations were correspondingly low.

2003 MID-YEAR RESULTS (Pear)

Pear Psylla:

The success of any pear pest management program is judged by its ability to manage PP. Overwintering and first summer generation adult PP densities were low at each of the pear sites as measured by limb-tap samples with little or no difference among treatment programs (Table 3). The data reported in table 3 are total PP adults counted in at least 200 total limb-tap samples.

Codling moth:

No damage was noted from CM in any of the pear plots after the first larval generation (Table 2). CM adult captures in pheromone-baited traps were low at each of the pear sites with the exception of P3. This continues a trend in which P3 had the highest captures in 2002 and with a further increase in 2003; close attention to CM will be required during the second generation. There did not appear to be any consistent difference between treatment protocols.

Leafroller:

There were no live LR detected at any of the pear sites during the first larval sample (Table 2). Subsequently, low LR captures were noted in all pheromone-baited traps (Table 3).

Table 1. Areawide II growers, acreage & varieties

APPLES		Main	
Orchard	**Region**	**Cultivar**	**Acres**
A1	West Richland	Gala	18
A2	Vantage	Early Fuji	28
A3	Mattawa	Spur Red	30
A4	Wapato	Granny Smith	40
A5	Moxee	Spur Red	40
A6	West Yakima	Spur Red/Jonagold/others	17
A7	Quincy	Gala	16
A8	Quincy	Red Delicious	25
A9	Quincy	Golden Delicious	28
A10	Chelan	Red Delicious	30
A11	Orondo	Fuji	20
A12	Orondo	Golden	20
A13	Brewster	Granny Smith	40
A14	Brewster	Fuji	25
A15	Bridgeport	Granny Smith	25

PEARS		Main	
Orchard	**Region**	**Cultivar**	**Acres**
P1	Moxee	Bosc/Anjou	15
P2	Moxee	Red Anjou	20
P3	Naches	Bartlett	16
P4	Monitor	Bosc	17
P5	Dryden	Anjou	20
P6	Entiat	Anjou	16

Table 2. Mid-year damage assessments, 2003.

	% shoots w/ live LR			% LAC inf. shoots			% CM damage	
Orchard	CONV	SOFT		CONV	SOFT		CONV	SOFT
A1	0.0	0.0		4.7	2.4		0.0	0.0
A2	0.0	0.0		0.2	0.1		0.0	0.0
A3	0.0	0.0		3.4	3.9		0.1	0.0
A4	0.0	0.0		0.2	1.3		0.0	0.1
A5	0.0	0.0		0.0	0.0		0.0	0.3
A6	0.0	0.0		0.0	0.0		0.0	0.0
A7	0.0	0.0		0.0	0.0		0.1	0.0
A8	0.0	2.7		0.2	0.0		0.0	0.0
A9	0.0	0.2		0.0	0.0		0.0	0.0
A10	0.0	0.0		1.9	1.2		0.1	0.0
A11	0.0	0.0		2.0	3.4		0.0	0.0
A12	0.0	0.0		0.1	0.1		0.0	0.0
A13	0.1	0.0		0.3	0.8		0.0	0.0
A14	0.0	0.0		0.6	0.1		0.1	0.0
A15	0.0	0.0		0.4	0.4		0.0	0.0
Avg (SE)	0.007 (0.007)	0.193 (0.180)		0.933 (0.371)	0.913 (0.338)		0.027 (0.012)	0.027 (0.021)
P1	0.0	0.0		0.0	0.0		0.0	0.0
P2	0.0	0.0		0.0	0.0		0.0	0.0
P3	0.0	0.0		0.0	0.0		0.0	0.0
P4	0.0	0.0		0.0	0.0		0.0	0.0
P5	0.0	0.0		0.1	0.0		0.0	0.0
P6	0.0	0.0		0.2	0.5		0.0	0.0
Avg (SE)	0.000 (0.000)	0.000 (0.000)		0.050 (0.034)	0.083 (0.083)		0.000 (0.000)	0.000 (0.000)

Table 3. Year to date trap catch totals, through 7/1/03.

	Total LR-Low load			LAC			CM-Pheromone	
Orchard	CONV	SOFT		CONV	SOFT		CONV	SOFT
A1	29	7		49	28		25	9
A2	1	0		81	97		5	0
A3	58	47		211	129		30	17
A4	6	6		397	241		52	10
A5	0	0		111	193		38	116
A6	1	0		209	200		7	20
A7	4	11		88	346		2	9
A8	12	28		166	375		1	2
A9	5	8		341	251		3	2
A10	3	1		411	270		7	14
A11	7	25		944	716		1	4
A12	14	8		313	340		1	3
A13	2	1		274	353		14	2
A14	0	0		104	74		12	1
A15	0	0		78	99		3	0
Avg (SE)	9.5 (4.0)	9.5 (3.5)		251.8 (58.5)	247.5 (44.1)		13.4 (4.1)	13.9 (7.5)
	Total LR-Low load			PP adults (b. tray)			CM-Pheromone	
Orchard	CONV	SOFT		CONV	SOFT		CONV	SOFT
P1	5	0		104	54		17	0
P2	1	1		64	46		2	0
P3	0	5		106	124		100	76
P4	14	11		446	203		37	25
P5	0	0		244	288		8	7
P6	5	10		609	296		4	8
Avg (SE)	4.2 (2.2)	4.5 (2.0)		262.2 (90.0)	168.5 (45.4)		28.0 (15.3)	19.3 (11.9)

Table 4. Overwintering white apple leafhopper egg samples, 2003.

		Total Eg/20 shoots (10 cm)		% Parasitized	
Block	Date	SOFT	CONV	SOFT	CONV
A1	1-Apr	1	0	100.0	
A2	1-Apr	0	0		
A3	1-Apr	65	38	40.0	52.6
A4	24-Mar	0	0		
A5	24-Mar	74	21	56.8	38.1
A6	24-Mar	9	18	44.4	61.1
A7	1-Apr	16	24	68.8	58.3
A8	1-Apr	61	9	41.0	44.4
A9	1-Apr	10	158	50.0	52.5
A10	31-Mar	19	42	42.1	45.2
A11	31-Mar	128	226	53.9	41.6
A12	31-Mar	0	0		
A13	31-Mar	5	3	40.0	33.3
A14	31-Mar	10	4	20.0	0.0
A15	31-Mar	3	0	66.7	
Avg (SE)		26.7 (9.8)	36.2 (17.0)	52.0 (5.5)	42.7 (6.0)

Table 5. Campylomma nymph sampling using limb-tap and beating tray technique during the bloom period, 2003.

		Campy nymps/tray	
Block	Date	SOFT	CONV
A1	4/22	0.00	0.00
A2	4/22	0.00	0.00
A3	4/22	0.00	0.00
A4	4/23	0.05	0.10
A5	4/23	0.20	0.10
A6	4/23	0.00	0.00
A7	4/29	0.00	0.00
A8	4/29	0.00	0.00
A9	4/29	0.00	0.00
A10	5/8	0.00	0.00
A11	5/1	0.10	0.15
A12	5/1	0.00	0.00
A13	5/8	0.00	0.00
A14	5/8	0.00	0.00
A15	5/8	0.00	0.00
Avg (SE)		0.02 (0.002)	0.02 (0.013)

Table 6. Western tentiform leafminer sampling during the first larval generation, 2003.

First gen.		WTLM mines/leaf	
Block	Date	SOFT	CONV
A1	28-May	0.000	0.000
A2	29-May	0.000	0.000
A3	29-May	0.000	0.000
A4	28-May	0.000	0.000
A5	28-May	0.000	0.000
A6	28-May	0.000	0.000
A7	29-May	0.005	0.000
A8	29-May	0.000	0.000
A9	29-May	0.000	0.005
A10	23-May	0.000	0.000
A11	23-May	0.000	0.000
A12	23-May	0.000	0.000
A13	21-May	0.000	0.000
A14	21-May	0.005	0.000
A15	21-May	0.005	0.045
Avg (SE)		0.001 (0.0005)	0.003 (0.003)

Table 7. White apple leafhopper nymph samples during the first generation, 2003.

		WALH nymps/leaf	
Block	Date	SOFT	CONV
A1	28-May	0.000	0.000
A2	29-May	0.000	0.000
A3	29-May	0.000	0.000
A4	28-May	0.000	0.000
A5	28-May	0.000	0.000
A6	28-May	0.000	0.000
A7	29-May	0.005	0.000
A8	29-May	0.000	0.000
A9	29-May	0.000	0.005
A10	23-May	0.000	0.000
A11	23-May	0.000	0.000
A12	23-May	0.000	0.000
A13	21-May	0.000	0.000
A14	21-May	0.000	0.000
A15	21-May	0.000	0.000
Avg (SE)		0.0003 (0.0003)	0.0003 (0.0003)

Table 8. Mite samples using leaf brushing technique, 2003 (motile mites only reported).

		Tetranychid Mites		Predatory Mites		Apple Rust Mites	
Block	Date	SOFT	CONV	SOFT	CONV	SOFT	CONV
A1	10-Jun-03	0.04	0.61	0.00	0.00	0.00	0.00
A2	10-Jun-03	0.00	0.00	0.32	0.56	0.00	0.14
A3	10-Jun-03	1.20	4.22	0.04	0.03	0.04	0.01
A4	10-Jun-03	0.00	0.01	0.00	0.00	0.00	0.00
A5	10-Jun-03	0.22	0.59	0.46	0.09	0.00	0.03
A6	10-Jun-03	0.03	0.00	0.01	0.10	0.00	0.01
A7	10-Jun-03	0.04	0.12	0.00	0.01	0.00	0.00
A8	10-Jun-03	0.00	0.00	0.04	0.02	0.00	0.03
A9	10-Jun-03	0.15	0.11	0.01	0.00	0.00	0.00
A10	12-Jun-03	0.03	0.09	0.01	0.00	0.00	0.00
A11	12-Jun-03	0.01	0.00	0.00	0.00	0.00	0.00
A12	11-Jun-03	0.80	0.30	0.00	0.00	0.00	0.00
A13	12-Jun-03	0.00	0.00	0.00	0.00	0.00	0.00
A14	12-Jun-03	0.00	0.00	0.00	0.00	0.00	0.00
A15	12-Jun-03	0.00	0.00	0.00	0.02	0.00	0.00
Average		0.17	0.40	0.06	0.06	0.00	0.01

Table 9. Aphid and predator complex, 2003.

Type	Block	Date	n	Prop. infested shoots	Lady Beetles/ shoot	Campy/ shoot	Lacewings/ shoot	Syrphids/ shoot	Total motile predators/ shoot
SOFT	A1	10-Jun-03	20	0.05	0	0	0	0	0
SOFT	A2	10-Jun-03	20	0.00	0	0	0	0	0
SOFT	A3	10-Jun-03	20	0.05	0	0	0	0	0
SOFT	A4	10-Jun-03	20	0.35	0	0	0	0	0
SOFT	A5	10-Jun-03	20	0.00	0	0	0	0	0
SOFT	A6	10-Jun-03	20	0.10	0	0	0	0	0
SOFT	A7	10-Jun-03	20	0.00	0	0	0	0	0
SOFT	A8	10-Jun-03	20	0.05	0	0	0	0	0
SOFT	A9	10-Jun-03	20	0.10	0	0	0	0	0
SOFT	A10	12-Jun-03	20	0.00	0	0	0	0	0
SOFT	A11	12-Jun-03	20	0.00	0	0	0	0	0
SOFT	A12	11-Jun-03	20	0.15	0	0	0	0	0
SOFT	A13	12-Jun-03	20	0.00	0	0	0	0	0
SOFT	A14	12-Jun-03	20	0.00	0	0	0	0	0
SOFT	A15	12-Jun-03	20	0.00	0	0	0	0	0
	Average		**15**	**0.057**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Table 9 (cont). Aphid and predator complex, 2003.

Type	Block	Date	n	Prop. Infested Shoots/ Block	Lady Beetles/ shoot	Campy/s hoot	Lacewings/ shoot	Syrphids/ shoot	Total motile predators/ shoot
CONV	A1	10-Jun-03	20	0.50	0	0	0	0	0
CONV	A2	10-Jun-03	20	0.00	0	0	0	0	0
CONV	A3	10-Jun-03	20	0.10	0	0	0	0	0
CONV	A4	10-Jun-03	20	0.35	0	0	0.05	0.10	0
CONV	A5	10-Jun-03	20	0.00	0.05	0	0	0	0.05
CONV	A6	10-Jun-03	20	0.00	0	0	0	0	0
CONV	A7	10-Jun-03	20	0.00	0	0	0	0	0
CONV	A8	10-Jun-03	20	0.25	0	0	0	0	0
CONV	A9	10-Jun-03	20	0.00	0	0	0	0	0
CONV	A10	12-Jun-03	20	0.05	0	0	0	0	0
CONV	A11	12-Jun-03	20	0.00	0	0	0	0	0
CONV	A12	11-Jun-03	20	0.35	0	0	0	0	0
CONV	A13	12-Jun-03	20	0.00	0	0	0	0	0
CONV	A14	12-Jun-03	20	0.00	0	0	0	0	0
CONV	A15	12-Jun-03	20	0.00	0	0	0	0	0
	Average		**15**	**0.106**	**0.003**	**0.000**	**0.003**	**0.006**	**0.003**

Appendix 1. Recommended pesticide options for CONV and SOFT treatments in apple, 2003.

Time of control	Pests targeted for control	Traditional Program (includes OPs if needed)	Selective Program (NO-OP insecticides)
Dormant	Scale, aphids, spider mites	Oil	Oil
	Cutworms	Lorsban, Thiodan	Avaunt, Intrepid
Delayed-dormant	Leafrollers, scale, aphids, spider mites	Oil+Lorsban	Oil[1]
Pre-bloom	Aphids, lygus	Dimethoate	Low rate Provado (RAA)
	Leafminer	Vydate, Oil	Oil
Bloom	Thrips, campylomma	Carzol	Carzol
	Leafroller	Success	Bt, Intrepid
	Codling moth	Pheromone	Pheromone
Petal fall	Leafroller	Success	Intrepid, Esteem, Bt
	Codling moth	NONE	Esteem, Oil
	Scale	Assail	Esteem
	Leafhopper	Sevin, Provado	Oil, Avaunt
Petal fall + 14 days	Leafroller	Success	Esteem, Bt, Intrepid
	Codling moth	NONE	Esteem, Oil
	Leafhopper	Sevin, Provado	Avaunt
Early summer	Codling moth	Guthion, Imidan, Assail	Virus, Intrepid, oil
	Leafroller		LR Pheromone
mid-late summer	Codling moth	Guthion, Imidan, Assail	Intrepid, virus, Oil
	Leafroller	Success	Bt, Intrepid
	Lacanobia fruitworm	Thiodan	Avaunt
	Aphids	Provado	Biocontrol, soap, oil
	Leafminer	Provado, Vydate	Biocontrol, oil, Intrepid
	Mites	AgriMek, Pyramite	Biocontrol, Oil, Savey, Apollo
Pre-harvest	Codling moth	Imidan, Sevin	Intrepid
	Stink bugs	Carzol, Thiodan, Danitol	Carzol, Thiodan
	Leafhoppers	Provado, Sevin	Provado
	Aphids	Provado	Soap
Post-harvest	Woolly Apple Aphid	Diazinon, Thiodan	Thiodan

[1] Use oil here if not used earlier because of availability of water.

Appendix 2. Recommended pesticide options for CONV and SOFT treatments in pear, 2003.

Standard

Dormant	Delayed Dormant	Clusterbud	Petalfall	Post Petalfall	Summer
Oil	Oil	Actara	Agri-Mek	Agri-Mek	Agri-Mek
Surround	Surround	Assail	Actara	Actara	Actara
	Sulfurs	Pyramite	Provado	Provado	Provado
	Thiodan	Surround	Assail	Assail	Assail
		Oil	Pyramite	Pyramite	Pyramite
			MD	MD	MD
				Ops	Ops
				Savey / Apollo	Vendex
					Savey / Apollo
No pyrethroids all year					

IGR

Dormant	Delayed Dormant	Clusterbud	Petalfall	Post Petalfall	Summer
Oil	Oil	Esteem	Esteem	Esteem	Esteem
Surround	Surround	Dimilin	Dimilin	Dimilin	Dimilin
	Sulfurs	Oil	Neemix / Aza-Direct	Neemix / Aza-Direct	Neemix / Aza-Direct
	Thiodan	Surround	MD	MD	MD
		Neemix / Aza-Direct	Acramite	Intrepid	Intrepid
				Apollo/Savey	Apollo/Savey
				Acramite	Acramite
		No pyrethroids, chloronicotinyls or OPs			