The Wenatchee Valley Pear IPM Project, 1999-2001: Lessons from Soft Pest Management Programs

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The Wenatchee Valley Pear IPM Project (WVPP) was created to investigate whether more cost-effective pear pest management programs could be implemented by increased use of biological control. Several factors encouraged the development of this project at that time. Pest control costs were rising steeply, and Wenatchee Valley growers were spending more than most of their western North American counterparts. Pest populations and damage were as serious as ever. Regulations were limiting or eliminating the use of many pesticides. At the same time, several new pesticides and pest control methods were becoming available but were almost untested in the area. Biological control was an important, and cost-saving, part of pest management programs in other western pear districts but was little used in the more pesticide-intensive programs of the Wenatchee Valley.

Fifteen growers originally provided pear blocks for the project; one grower (#10) sold the orchard after Year 2, and three new blocks were added in 2001. Anjou pear was the cultivar sampled in each orchard. This variety is quite susceptible to pear psylla and spider mites, two of the main pests in the Valley, and provided a good test for soft programs. The blocks were located throughout the Wenatchee Valley, from the western edge of Wenatchee to just east of Leavenworth. They varied considerably in their surroundings (native vegetation vs. orchard, narrow canyon vs. extensive farmed area). Details on the WVPP pear blocks, as well as spray records and extensive monitoring data summaries, are found in the WVPP annual reports produced each year. Table 1 at the end of this report presents three-year summaries of key data from the project.

Every block was sampled weekly beginning in mid March, before the first sprays were applied, until after harvest. The sample methods varied with the stage of development of the pests and crop, and were based upon the methods outlined in Orchard Pest Monitoring Guide for Pears (published by the Good Fruit Grower, 1999). The sample data from each visit was sent the same day to the grower and associated fieldmen. This prompt turnaround time allowed the grower to closely monitor the development of pests and natural enemies and use the information in making pest control decisions. A monthly newsletter was sent to all participants, presenting information on pests, natural enemies, pest control options and WVPP developments. Regular lunch meetings were held with consultants to discuss findings and control options.

No pest control recommendations were provided by the WVPP. Information was provided on less-disruptive pest control options that could conserve natural enemies. The growers managed their pest control programs using the information provided by the WVPP and the advice of their consultant(s). All growers were interested in encouraging the development of more biological control in their orchards and balanced this with the risk of pest-caused fruit damage. Consequently, no two blocks followed the same spray program. The fifteen blocks were essentially in two categories:

1. "Conventional" blocks used broad-spectrum insecticides before and after bloom for pear psylla and grape mealybug control. These insecticides included AgriMek, Pyramite, pyrethroids (Asana, Baythroid), neonicotinyls (Provado, Actara) and organophosphates (Lorsban, Diazinon, Guthion, Imidan).
2. "Soft" blocks used none of the above materials (with a few exceptions). For psylla control sprays, these growers mostly relied upon pre-bloom Surround, Esteem, azadirachtin and foliar oil.

Over the three years of the project the distinction between programs became blurred as the growers and consultants adapted to what was learned and sought the most economical approach. Conventional growers increasingly used both Surround and foliar oil sprays, and some soft growers used post bloom OP sprays. There was a pest management transition among the fifteen original pear blocks. By Year 3, two of the original seven conventional blocks became soft and two of the original eight soft blocks became organic, increasing the total under organic management to four.

Pests

Wenatchee Valley pear growers regularly contend with pear psylla and twospotted spider mites, and grape mealybug is a serious and increasing problem for many. Codling moth, leafrollers, pear rust mite, stink bugs and boxelder bugs can and do cause problems as well. The status of most of these pests changes with soft pest management programs.

Pear psylla causes more overall losses each year, through downgraded and culled fruit, weakened trees and discouraged pickers, than any other pest in the Valley. The WVPP soft programs dropped the main psyllicides used by most area growers and relied instead upon oil, tree washing and natural enemies for post bloom control of psylla. In Year 1, almost all soft blocks had high summer psylla populations and suffered extensive fruit marking. Psylla predators and parasites increased their numbers and, together with the use of selective insecticides, generally provided good psylla control in Years 2 and 3, equal to the conventional blocks. Biological control alone will not control psylla adequately; supplemental sprays are needed each year, with the extent of sprays determined by psylla and natural enemy populations each year.

Prebloom control of psylla is important in any management program, and even more so in soft programs in which the summer options for selective sprays are essentially limited to foliar oils and tree washing. Beating tray counts of psylla adults should be below 1.0/tray by popcorn timing, even in soft blocks with a good bio control history; we've not yet been concerned about a lack of food for predators! Adult numbers can be reduced to very low levels without disrupting bio control by use of just Surround, oil and sulfur, with Thiodan a safe option for additional control.

Psylla nymphs appear on shoot leaves beginning in mid to late June; summer controls must focus on keeping this and subsequent generations below critical levels. Fruit marking was acceptably low in WVPP blocks in which psylla nymphs on top shoot leaves did not exceed 1.0/leaf for more than one week in the late June to early August period, and in blocks where the average count of psylla nymphs per top shoot leaf in July was 0.5 or less. We also found that higher nymph populations and honeydew amounts could develop in mid August or later with little risk of fruit marking on Anjous (although at a risk of driving off pickers!) A late season psylla population can maintain natural enemies, with a carryover benefit to the next spring. Once psylla natural enemies were established, good control was achieved in the soft blocks; the least psylla marking each year came from two organic blocks as well as two conventional blocks. Psylla problems in soft blocks after the transition year (Year 1) were related to poor prebloom control, ineffective sprays (fish oil) or disruptive sprays (summer Surround and possibly azadirachtin).

Grape mealybug has increased its range and severity in the Wenatchee Valley over the past ten years. It is found in other western pear regions but is rarely a pest. Repeated and expensive sprays of disruptive materials are used for control in the Valley. In the WVPP soft blocks, mealybug populations either declined or remained low, and no sprays were applied for mealybug control. In contrast, the conventional neighbors to many of the soft blocks regularly sprayed for mealybug control. This pest may be induced by the use of broad-spectrum insecticides, so growers with a new or low mealybug population may be best off to not begin treatments for it. Orchards with high mealybug populations may not be able to transition to a soft program without extensive damage for one or more years. In only one of the two WVPP soft blocks with high populations in 1999 have mealybugs ceased to be a problem; disruptive summer sprays (Surround and azadirachtin) in the other have harmed natural enemy populations and limited bio control.

Twospotted spider mites can cause extensive leaf damage and drop on Anjou pear trees. Treatment thresholds as low as 1.0/leaf have been suggested. In the WVPP soft blocks very few miticides were applied, and none other than oil after Year 1. Spider mites failed to build up, even in the absence of any sprays, in most soft blocks. Where control was needed, one or two sprays of foliar oil were effective. This was in contrast to the higher populations that were often found in the conventional blocks and required miticide applications. Use of the pesticide Provado was shown in the WVPP and elsewhere to lead to higher mite populations. It should not be used in soft programs and other neonicotinyls, such as Actara, must be evaluated for their potential to cause the same problem. Biological control undoubtedly contributed to spider mite control. Mite predators were found infrequently on leaf or tray samples, not surprising considering the low mite populations; much of the mite bio control may occur before they reach the tree canopy, on the trunk or in the cover crop.

Pear rust mite is usually well controlled by miticides in conventional programs and rarely causes fruit damage. Rust mites increased in the WVPP soft blocks and caused fruit marking in several blocks by the third year. Pear growers in British Columbia who moved into soft programs experienced the same problem over the same time period. Additional miticides are needed in many soft blocks to reduce rust mite numbers. Prebloom sulfur and oil are not enough. Prebloom Thiodan has suppressed rust mites well and soft growers will need to consider other options, including post harvest sulfur and low rates of Carzol and AgriMek.

Codling moth is usually not a serious pest for Wenatchee Valley pear growers, but regional populations have grown with an increase in neglected orchards and reduced control programs. Most WVPP growers used only mating disruption for codling moth control. The common sprays for codling moth control (OPs) are harmful to many natural enemies and disrupt biological control. New insect growth regulators (Esteem and Intrepid) provide codling moth control with little or no disruption. Intrepid looks particularly good for codling moth and leafroller control, and can be used alone or with mating disruption. Codling moth can be controlled with soft materials but only if consistently kept under control. Two soft growers developed serious codling moth problems. Grower #4 had a moderate population of CM that became much worse when a spring frost almost, but not quite, eliminated his crop and he abandoned CM sprays. Grower #6 had a dirty neighbor that infested his block. In each case, the grower

responded by increasing the rate of mating disruption dispensers to close to 400/acre and applied two Guthion sprays. Codling moth was brought under control and, although some natural enemies were reduced, bio control of psylla was not seriously disrupted.

Leafrollers were trapped in all blocks. Obliquebanded leafroller came to be the dominant species in most WVPP blocks, and pandemis leafroller was widespread. European leafroller (*Archips rosanus*) was found in a number of orchards, particularly in side canyons. Like codling moth, leafrollers can be kept below damaging levels in soft programs if consistent attention is paid to control. Leafroller damage tended to increase in a number of soft blocks in the second year. Well-timed Bt sprays reduced populations and damage the next year. Esteem and Intrepid are effective, non-disruptive leafroller insecticides. The soft blocks that applied petal fall Esteem for psylla had lower leafroller catches and lower fruit damage each year, with no other sprays applied for leafrollers.

Stink bugs and boxelder bugs caused increased damage in many WVPP orchards in Years 2 and 3. This problem was associated with the nearby native vegetation and not with the spray program, and occurred mostly in the outer rows of the block. The extent of damage by stink bugs and boxelder bugs probably reflects the size of their populations in the nearby wild lands, determined by factors beyond the control of the orchardist.

Natural Enemies

A diverse complex of predators and parasites developed in the WVPP soft blocks, with most of those identified feeding on pear psylla. The conventional blocks had far fewer types of natural enemies, and much lower numbers of those that were found. Over 20 different types of natural enemies were found. The five identified as being most effective and/or most abundant were deraeocoris (*Deraeocoris brevis*), campylomma (*Campylomma verbasci*), lacewings, earwigs and *Trechnites sp.*, a parasitic wasp.

A diverse complex of natural enemies is needed for the most effective biological control. The diversity better allows the various natural enemies to "cover for each other"; when one species is absent or at low numbers during a particular season or time of year, the others may fill the gap. Some species are active early in the year (deraeocoris, snakeflies), while others don't appear until after bloom (campylomma, earwigs), or build to significant numbers until later in the summer (lacewings). Some are particularly sensitive to many pesticides (Trechnites) while others show greater tolerance (campylomma). Each soft block differed in the types, numbers and proportions of natural enemies found. Natural enemy populations are influenced by many factors including food available (e.g. psylla, mealybugs), sprays applied, weather, overwintering hosts and sites, and more.

The vegetation in the habitats outside the orchard plays an important part in establishing bio control in soft blocks. Wild lands serve as refugia for many natural enemies and may have plants bearing alternate hosts for important predators or parasites. Ponderosa pine often is infested with a scale insect that deraeocoris will feed on in the winter. Bitterbrush has a psyllid that several predators will feed on until June when the psyllid matures, forcing the predators to move on (and into the orchard, we hope!) Pear blocks that are isolated from native habitat may be slower to establish an effective complex of natural enemies. The geography of the Wenatchee Valley puts many orchards close to wild lands and provides a potential advantage for many blocks.

Chief among the psylla predators were two hemipterans (true bugs): deraeocoris and campylomma. "Derries" overwinter in or near orchards and were among the first to be found each year. They reached their highest levels in the soft blocks in August of the first year. "Campies" were the more abundant of the two in most blocks in Years 2 and 3. They overwinter as eggs under the bark of young wood in fruit trees, and emerge each spring during or soon after bloom. High campy populations in a block in late summer are strongly associated with high numbers the next spring. Campies were present in very high numbers in several soft blocks (>2 per tray) but fruit marking by campy was never seen, although a characteristic feeding damage to shoot tips was easily found.

Our observations and those of pear IPM consultants in the Okanagan of British Columbia suggest that significant bio control of psylla is taking place if counts of these predators, alone or in combination, reach 0.5/tray. When significant numbers of predators are present, psylla populations increase more slowly, if at all; the grower in these cases can continue to monitor without fear of a population explosion and still respond in a timely manner if needed. We often saw rapid growth in psylla numbers in conventional blocks with few natural enemies, requiring the grower to respond rapidly to prevent damage.

Lacewings are predators of many insects, including psylla and mealybugs. Brown lacewings were the most common types found in WVPP pear blocks, although green lacewing adults were found in high numbers in some blocks in late summer. Lacewings tended to build up in late July and August, when the larvae were most common on trays.

Trechnites is a parasitic wasp that exclusively attacks psylla. They are quite sensitive to many pesticides, and in 1999 were not identified in the soft blocks until August. They have many generations each year, first appearing close to bloom when they emerge from the parasitized psylla nymphs they overwintered in. Trechnites were counted in all soft blocks by August 2000 and again in 2001. Counts of 0.5-1.0 adults/tray were common. One blocks had over 20/tray at petal fall, and a sample of 12 psylla nymphs showed 100% to be parasitized.

Earwigs are very active predators of many insects, and investigations have shown them to be among the best predators of psylla in the summer. They are primarily active at night and pass the day in protected locations on the tree trunk and ground. Beating tray samples do not accurately reflect earwig population size so we monitored them with earwig "condos", rolls of corrugated cardboard placed inside PVC pipe. Summer counts in the soft blocks were consistently three to six times higher than those in conventional blocks.

Pesticides

Pesticide use determines whether a pear block is "soft", that is, natural enemies are conserved and biological control contributes significantly to pest control. Most pesticides are not inherently "soft" or "hard". The impact of pesticides on natural enemies, or "selectivity", is determined by several factors, among them the rate used and the application timing relative to natural enemy and pest presence. For example, Thiodan is harmful to many psylla predators but its use at delayed dormant timing, to reduce psylla adult numbers, occurs before most of the key predators are active in the orchard. A well-established natural enemy complex has some resiliency and may withstand limited use of some broad-spectrum insecticides, as shown by the use of Guthion sprays in two soft blocks. Pesticides are developed for their effect on pests and information on their impact on natural enemies usually comes later, if at all. The many new pesticides that are now or becoming available (insect growth regulators, neonicotinyls, botanicals, particle films and more) need to be evaluated for their impact on predators and parasites. Based on WVPP experiences, comments can be made on a number of pesticides used in soft pear pest control programs.

Surround- this material is quite effective before bloom at reducing psylla adult counts and egg lay. Coverage is very important, with multiple applications best as buds develop. No advantage was seen with rates above 50#/acre. Post bloom use reduced counts of many natural enemies, provided little control of psylla and led to high spider mite populations.

Horticultural mineral oil- the use of oil applied in the post bloom period has increased dramatically in the Wenatchee Valley over the past three to five years. Soft and organic growers now rely more than ever on oil for post bloom psylla and mite control. Many conventional growers apply oil, often at a 1% rate, with other foliar insecticides. An average of over six gallons per acre of oil, in at least five sprays, was applied to the WVPP soft blocks from popcorn on in 2001. No fruit or leaf marking was observed in these blocks in 2001. To minimize risk, precautions were followed with oil use including: a) don't exceed a 1-1.25% mix, b) adjust volume to spray to wet, not to drip, c) maintain a two week interval between sprays, d) don't apply at temperatures above 85F. Concerns remain with the possible weakening of fruit spurs and reduction of tree vigor with multiple oil applications over several years.

Esteem- this insect growth regulator was used by most of the non-organic soft growers, applied at popcorn and petal fall. No effect on the key natural enemies was noted. Applied for psylla control, it also controlled San Jose scale and can provide some control of leafrollers and codling moth.

Mating disruption- this pest control method can provide or at least help with control of codling moth. Its use has allowed pear growers with low codling moth populations to reduce or eliminate using organophosphate cover sprays that disrupt bio control. The cost of mating disruption may not be justified in blocks where two or less covers are needed unless a soft program is the objective. New, selective and more effective insecticides, like Intrepid, can supplement or replace mating disruption.

Azadirachtin- this botanical insecticide was used in several formulations by WVPP growers. Trials in WVPP blocks showed it may have as much impact on several key natural enemies as psylla. Organically approved materials, such as azadirachtin, also need to be evaluated for selectivity for predators and parasites as well as efficacy on pests.

Tree washes- these materials were applied to wash small psylla nymphs and honeydew from the leaves. The most common material used was inexpensive laundry detergent without bleach, applied at 0.75-1.0 #/100gallons. Psylla numbers were not reduced much, if at all, by these sprays but the rate of increase was slowed. No reduction of spider mites or psylla predators was observed. High water volume is critical to the success of this approach; 500 to 600 gpa is probably a minimum for summer applications on full sized pear trees.

There is no one soft spray program that can be recommended for soft growers in the Wenatchee Valley, but based on WVPP observations several pesticide options can be suggested. The following list is not all-inclusive, but many WVPP growers have used only these materials, or less, with good results.

Delayed dormant to finger bud: Surround (multiple applications), sulfur, oil, Thiodan
Popcorn: Esteem, oil, mating disruption
Petal fall: Esteem, oil
Summer: oil, Bt, Intrepid, tree washes

'Costs
Pesticide costs in most Wenatchee Valley pear orchards in recent years were at least $600 to $800/acre. Pesticide costs in the WVPP soft blocks averaged $435/acre in 1999, $395 in 2000 and $390 in 2001. The three least expensive pest control programs each year, all soft and all with good pest control, averaged $420 in 1999, $295 in 2000 and only $235 in 2001. Costs fell in many soft blocks as biological control provided more help and growers adopted the more cost-effective pest control practices. Costs for the WVPP conventional blocks also dropped ($595-1999, $635-2000, and $470-2001) as these growers implemented more economical practices.

Limitations of Soft Programs
Not all Wenatchee Valley pear growers will adopt soft pest management programs, nor should they. Several key limitations to further adoption persist.

- Pear psylla populations can build up to high levels and cause fruit marking in at least the first year that most blocks transition to a soft program. Of the ten soft blocks followed in the WVPP, seven had over 10% of the fruit with psylla marking (a cumulative area of russet the size of a nickel or greater) in Year 1.
- Proximity to native habitat is important as a source of natural enemies. Blocks that are isolated from wild lands may need two or more years until biological control is well established.
- Soft programs tend to be more information and management intensive. They may require more regular monitoring of pests and natural enemies, and more assistance in determining how to use this information.

Why go soft? For many Wenatchee Valley growers the reason is economics, as they can potentially save considerable money per acre. Growers must consider their interest in and ability to manage a more information intensive pest management program. Soft programs accept and even need higher numbers of some pests than most growers are accustomed to; the grower's tolerance of risk, and ability to sleep well at night, may be challenged!

Taking a longer term perspective, pear growers need to move away from the almost sole reliance upon pesticides that has characterized pear pest management over the past five decades. Pear psylla have encountered, and become resistant to, a long list of insecticides and there is no reason to think the future will be any different. We have been in a 50-year long race to keep one pesticide ahead of our number one pear pest. Some new insecticides are more selective (good for bio control) and have novel modes of action, but eventually we can expect the same result. Encouraging and conserving natural enemies will lead to more economical and more stable pear pest management programs, in which resistance develops slowly or not at all and pest control costs are kept relatively low.

The WVPP encouraged the development of soft programs at a time when they were needed as never before. Many of the pest control practices that were investigated and adopted have utility for all Wenatchee Valley pear growers, whether biological control is a factor in their orchards or not. Further research studies and implementation projects are needed to help growers adapt and compete in this time of rapid change.

Table 1. Summary tables of WVPP monitoring data, 1999-2001 (original 15 blocks only)

Psylla adults/tray - High count, March (pre-treatment)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	16.0	24.7	38.0	42.0	44.0	28.0	43.0	15.0	14.0	22.0	15.0	23.0	17.0	12.0	10.0	22.2	26.0
2000	32.9	16.0	5.4	29.8	24.8	12.6	29.1	11.6	10.7	43.6	9.5	9.4	14.8	24.0	17.3	23.8	15.6
2001	6.8	30.6	19.1	22.4	12.2	22.0	32.7	22.2	15.9		13.6	10.5	24.6	13.0	14.6	21.1	17.2

Pear psylla nymphs - per top shoot leaf, July average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.02	1.28	7.50	11.63	1.75	5.08	2.47	0.06	2.73	1.70	4.05	0.88	6.50	2.00	2.93	1.20	5.27
2000	0.38	0.94	3.14	0.36	0.54	0.44	0.88	0.28	0.31	0.70	0.28	0.46	1.28	0.72	0.40	0.62	0.84
2001	0.02	0.46	0.51	0.67	1.15	1.16	0.58	0.33	0.27		0.14	0.03	0.30	0.51	0.25	0.38	0.50

Grape mealybug - % infested shoots, August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0%	22%	0%	62%	43%	6%	49%	2%	0%	2%	0%	0%	0%	0%	0%	11%	14%
2000	0%	0%	0%	15%	30%	0%	73%	0%	0%	0%	0%	0%	0%	0%	11%	10%	7%
2001	4%	13%	0%	8%	64%	10%	53%	5%	0%		0%	13%	3%	3%	0%	15%	11%

Grape mealybug - per tray, August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.00	0.08	0.00	0.75	0.90	0.18	2.90	0.00	0.05	0.18	0.00	0.02	0.05	0.00	0.15	0.45	0.26
2000	0.00	0.03	0.00	0.11	1.88	0.00	4.44	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.21	0.64	0.28
2001	0.01	0.04	0.00	0.06	0.23	0.03	0.66	0.01	0.00		0.00	0.03	0.04	0.00	0.01	0.14	0.04

Twospotted spider mite - mites/leaf, August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.24	0.52	0.62	0.85	2.14	1.27	1.67	1.60	1.82	0.01	2.31	2.41	2.61	2.97	3.33	1.35	1.87
2000	0.21	0.60	0.06	1.30	0.40	1.59	0.43	0.71	0.40	6.20	1.18	2.55	1.28	4.93	0.85	2.23	0.88
2001	0.08	0.05	0.02	0.01	0.22	0.03	0.48	0.00	0.01		0.00	0.00	0.01	0.26	0.14	0.17	0.05

Pear rust mite - per spur leaf, August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	4.50	0.00	0.00	0.00	0.00	0.00	0.59
2000	0.00	0.00	0.00	1.40	0.00	0.90	0.00	0.00	0.50	0.00	22.00	0.00	0.00	0.00	0.30	0.00	3.14
2001	0.00	0.00	0.27	1.87	0.17	5.70	0.00	0.00	1.87		1.77	0.10	0.00	0.00	3.73	0.00	1.72

Codling moth - average per trap, season

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	1.5	0.0	15.3	45.0	0.0	240.7	14.3	0.8	0.0	11.0	0.5	2.8	49.7	17.0	3.5	6.8	44.3
2000	0.5	0.7	3.0	79.0	0.0	76.0	16.0	0.3	1.0	13.0	3.0	1.0	6.0	46.0	5.0	11.1	21.6
2001	3.0	0.5	5.0	192.0	1.0	7.3	17.3	0.0	1.3		2.5	4.8	0.7	15.7	2.5	7.3	24.1

Obliquebanded leafroller - total per trap, 1st generation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	29	31	1	8	85	64	8	36	116	0	109	191	12	29	0	46.3	49.4
2000	15	27	232	14	22	71	5	113	697	0	402	140	189	5	116	43.6	217.9
2001	24	30	1	7	79	64	6	36	114		3	93	190	12	30	21.6	64.6

Pandemis leafroller - total per trap, 1st generation

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	56	43	56	534	674	25	120	13	16	3	1	9	10	8	28	36.0	168.0
2000	138	22	51	145	558	19	114	31	9	5	15	6	2	3	130	45.6	116.1
2001	10	3	0	13	147	9	7	8	9		0	1	0	2	9	6.0	20.9

Deraeocoris - per tray, July-August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.00	0.00	0.64	0.75	0.01	0.53	0.01	0.00	0.18	0.05	0.36	0.00	0.16	0.11	1.16	0.02	0.47
2000	0.00	0.06	1.19	0.57	0.52	1.01	0.02	0.00	0.31	0.00	0.595	0.00	0.50	0.01	0.79	0.01	0.69
2001	0.00	0.00	0.66	0.05	0.10	0.40	0.01	0.00	0.09		0.12	0.03	0.01	0.00	0.07	0.00	0.17

Campylomma - per tray, July-August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.10	0.00	0.04	0.00	0.60	0.00	0.10	0.00	0.11
2000	0.03	0.08	0.01	0.39	2.35	0.29	0.00	0.00	0.31	0.00	0.46	0.00	0.28	0.03	0.17	0.02	0.53
2001	0.00	0.03	0.01	0.97	0.23	0.51	0.03	0.00	0.12		0.07	0.02	0.02	0.04	0.04	0.02	0.22

Trechnites - per tray, August average

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.00	0.00	0.00	0.20	0.00	0.18	0.00	0.00	0.28	0.00	0.05	0.00	0.00	0.00	0.08	0.00	0.10
2000	0.00	0.03	0.33	1.88	0.30	2.00	0.00	0.00	0.43	0.00	0.06	0.00	0.13	0.00	0.23	0.00	0.67
2001	0.03	0.03	0.05	0.13	0.04	1.38	0.00	0.01	0.06		0.04	0.00	0.03	0.01	0.41	0.02	0.24

Earwigs - July-August trap catch (normalized for trap type)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.0	3.0	3.0	19.0	20.0	9.0	35.0	0.0	5.0	3.0	100.0	4.0	42.0	26.0	30.0	10.1	28.5
2000	2.4	0.0	21.7	3.6	3.6	3.6	9.6	0.0	63.9	2.0	20.5	6.0	100.0	18.1	21.7	5.4	29.8
2001	4.8	9.5	16.7	11.9	52.4	19.0	3.3	1.9	100.0		42.9	3.3	45.2	6.7	9.5	5.2	33.4

Fruit damage - by major culprit

Psylla	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.5%	0.3%	9.4%	-	-	20.1%	-	1.2%	3.4%	15.0%	31.9%	13.8%	47.2%	6.1%	38.0%	6.2%	25.0%
2000	1.6%	1.8%	11.6%	0.7%	8.6%	1.0%	12.9%	0.7%	0.0%	0.1%	0.1%	0.8%	1.8%	0.8%	0.5%	2.7%	3.0%
2001	0.0%	0.5%	4.2%	10.1%	12.4%	15.6%	9.9%	0.3%	0.0%		0.0%	0.1%	0.9%	1.5%	2.5%	2.4%	5.1%

GMB	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.0%	12.9%	0.0%	-	-	6.9%	-	0.4%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.2%	2.2%	1.3%
2000	0.0%	0.9%	0.0%	3.2%	14.9%	0.9%	34.4%	0.0%	0.0%	0.1%	0.0%	0.2%	1.0%	0.0%	0.9%	5.1%	2.6%
2001	0.2%	0.2%	0.0%	0.0%	4.5%	0.0%	0.9%	0.0%	0.0%		0.0%	0.7%	0.0%	0.0%	0.4%	0.3%	0.6%

Leafroller	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.0%	0.0%	0.1%	-	-	0.0%	-	0.4%	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%
2000	0.0%	0.4%	2.9%	0.6%	0.0%	0.0%	0.2%	0.3%	0.9%	0.0%	2.1%	0.1%	3.6%	0.5%	0.2%	0.2%	1.3%
2001	0.0%	0.0%	0.1%	0.0%	0.7%	0.0%	0.0%	0.0%	0.2%		0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

Box elder/ Stink bug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.0%	0.0%	0.0%	-	-	0.0%	-	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
2000	0.3%	0.4%	0.6%	0.9%	0.4%	1.8%	0.1%	0.6%	0.9%	0.8%	0.3%	1.1%	1.6%	0.0%	4.0%	0.5%	1.3%
2001	0.0%	0.4%	3.0%	1.7%	0.2%	0.9%	0.2%	1.2%	0.5%		1.8%	1.8%	1.1%	0.5%	2.1%	0.5%	1.5%

Rust mite	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	0.0%	0.0%	0.0%	-	-	0.0%	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2001	0.0%	0.0%	0.5%	4.9%	0.0%	23.1%	0.0%	0.0%	9.1%		92.7%	0.0%	0.0%	0.0%	1.0%	0.0%	14.6%

Pesticide costs - per acre

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	conv	soft
1999	$744	$473	$416	$369	$625	$592	$572	$508	$236	$742	$300	$665	$425	$459	$528	$595	$436
2000	$657	$544	$306	$592	$432	$569	$473	$631	$340	$800	$329	$762	$305	$572	$279	$634	$394
2001	$463	$411	$338	$418	$493	$400	$461	$461	$404		$570	$505	$186	$561	$187	$471	$389