UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION

UC PLANT PROTECTION QUARTERLY

January 2005 **Volume 15, Number 1**

Available online: www.uckac.edu/ppq

This newsletter is published by the University of California Kearney Plant Protection Group and the Statewide IPM Program. It is intended to provide timely information on pest management research and educational activities by UC DANR personnel. Further information on material presented herein can be obtained by contacting the individual author(s). Farm Advisors and Specialists may reproduce any portion of this publication for their newsletters, giving proper credit to individual authors.

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This material is based upon work supported by the Extension Service, U.S. Department of Agriculture, under special project section 3(d), Integrated Pest Management

IN THIS ISSUE

DECISION-MAKING TOOLS FOR PEST MANAGEMENT—ADDITIONS TO THE UC IPM PEST MANAGEMENT GUIDELINES TO HELP GROWERS CONSIDER WATER QUALITY ISSUES

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Abstract

UC Statewide IPM Program (UC IPM) staff are working with UC IPM Pest Management Guideline (PMG) authors and the USDA Natural Resources Conservation Service (NRCS) to enhance the PMGs to address water quality and other environmental issues. New features of the PMGs are year-round IPM programs that organize pest management activities and promote preventive practices, and toxicity information to help farmers in selecting pesticides when they are needed. Year-round IPM programs alert farmers to major activities they might need to be doing at each crop growing/development period to implement a comprehensive IPM program. These new programs are available on the UC IPM Web site for prunes, almonds, and cotton, and will be completed for many crops, including plums, grapes, alfalfa, strawberries, avocados, peaches, and nectarines over the next year. Recently added "compare treatment" buttons on each PMG link to graphical displays that make it easy to compare the potential of leaching and runoff for each pesticide recommended in the PMG. This information is currently available for 11 crops, but links will be added to all PMG crops in 2005.

Introduction

The UC IPM Program developed the PMGs to provide practical information on pest management techniques for controlling a broad range of California pests. Authored by UC ANR scientists, the PMGs are the University of California's official recommendations for managing pests in agriculture, floriculture, and turfgrass, including 43 different crops or crop groups. PMGs contain the best science-based information available and are intended to help farmers implement environmentally sound pest management programs. The PMGs are updated regularly and peer-reviewed.

For each important pest, and many minor or occasional pests, PMGs help farmers identify pests using illustrated descriptions of the pests and their damage, or plant symptoms, and select management tactics from available cultural, biological, and pesticide controls. Organically acceptable methods are also identified.

The PMGs are organized by pest, which often is not the most useful way to think about pest management, since a farmer often needs to take actions that affect more than one pest at a time. When presented with individual-pest information only, a farmer has to figure out what actions need to be taken, and when. But a recent UC IPM effort has added an integrated view of managing pests in crops that organizes the various activities seasonally and adds new information related to water quality.

Year-Round IPM Programs

Working with authors of the PMGs, UC IPM staff members have been developing year-round IPM plans that identify the major activities farmers need to do at each crop growing period to implement a comprehensive IPM program. Developed for specific crops, annual IPM program checklists (Figure 1) guide farmers through a year of monitoring pests, making management decisions, and planning for the following season. These new year-round IPM programs have been specifically developed to outline IPM programs that reduce water quality risks and other environmental problems.

Done?	Early squaring period activities
	• Begin weekly monitoring of plant growth. • Continue tracking degree-day accumulations for plant growth.
	Monitor for armyworms, cabbage loopers: • Treat** if needed according to PMG
	Monitor for spider mites, aphids, and whitefly: • Keep records on the monitoring form • Treat** if needed according to PMGs
	Begin sweep net sampling and square retention monitoring for lygus activity: • Keep records on the monitoring form. • Treat** if needed according to PMG.
	Survey and manage weeds: • Complete the weed survey form. • Treat** if needed according to PMG.
	Sample for both races of *Fusarium* if there is evidence of *Fusarium* in the field or if you want to plant a variety with unknown resistance.
	Manage alfalfa next to cotton.
	Adjust nitrogen to prevent rank growth.

Figure 1. Sample seasonal (early squaring period) checklist from the year-round IPM program for cotton.

On the Web, the year-round IPM programs link to:

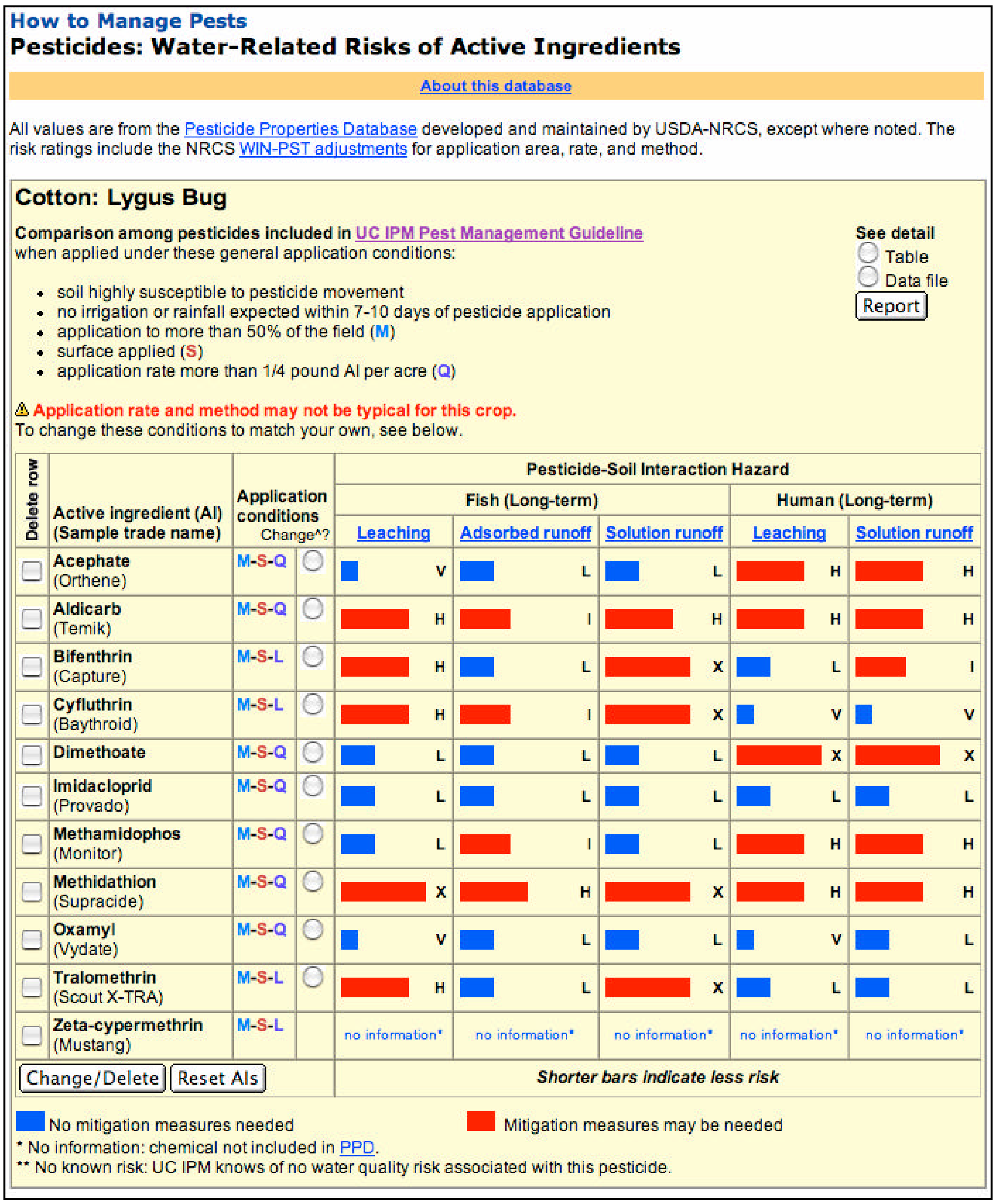
- detailed monitoring instructions that include decision thresholds;
- monitoring forms to print and use for record keeping;
- photo pages to help farmers identify pests, as well as beneficial insects, that they see while monitoring;
- pesticide application checklist to help identify ways to prevent or mitigate negative impacts of pesticide treatments; and
- pest management guidelines to determine management alternatives

These new resources can help a farmer take the right action at the right time and collect information that can help in planning for the next growing season. They help a farmer know when and how to monitor, correctly identify the pest problem, and analyze the options available after determining that control is needed. NRCS/USDA envisions using the checklists as part of their pest management program evaluation. Checklists could be used by California Agricultural Commissioners and others seeking to document that safer alternatives have been considered.

Year-round IPM programs are available under "How to Manage Pests: Agriculture" on the UC IPM Web site (www.ipm.ucdavis.edu/) for prunes, almonds, and cotton. Year-round programs will be completed for many crops, including plums, grapes, alfalfa, strawberries, avocados, peaches, and nectarines over the next year.

Pesticide Selection Using New Water Quality Impacts Database

Until recently, if a farmer decided to apply a pesticide treatment to control a pest, the PMGs had limited information to help assess possible impacts on water quality. To fill that gap, in Fall 2004, UC IPM added a new database and decision tool, called WaterTox. Using information from USDA–Natural Resources Conservation Service (NRCS), the tool evaluates potential for pesticides to move with water and eroded soil or organic matter, and to affect nontarget organisms. Its purpose is to help farmers consider risk of leaching and runoff in making pest management decisions.



How to Manage Pests

Pesticides: Water-Related Risks of Active Ingredients

About this database

All values are from the Pesticide Properties Database developed and maintained by USDA-NRCS, except where noted. The risk ratings include the NRCS WIN-PST adjustments for application area, rate, and method.

Cotton: Lygus Bug

Comparison among pesticides included in UC IPM Pest Management Guideline when applied under these general application conditions:

- soil highly susceptible to pesticide movement
- no irrigation or rainfall expected within 7-10 days of pesticide application
- application to more than 50% of the field (M)
- surface applied (S)
- application rate more than 1/4 pound AI per acre (Q)

See detail: Table / Data file / Report

⚠ Application rate and method may not be typical for this crop.
To change these conditions to match your own, see below.

Delete row	Active ingredient (AI) (Sample trade name)	Application conditions Change^?	Pesticide-Soil Interaction Hazard: Fish (Long-term) Leaching	Fish (Long-term) Adsorbed runoff	Fish (Long-term) Solution runoff	Human (Long-term) Leaching	Human (Long-term) Solution runoff
	Acephate (Orthene)	M-S-Q	V	L	L	H	H
	Aldicarb (Temik)	M-S-Q	H	I	H	H	H
	Bifenthrin (Capture)	M-S-L	H	L	X	L	I
	Cyfluthrin (Baythroid)	M-S-L	H	I	X	V	V
	Dimethoate	M-S-Q	L	L	L	X	X
	Imidacloprid (Provado)	M-S-Q	L	L	L	L	L
	Methamidophos (Monitor)	M-S-Q	L	I	L	H	H
	Methidathion (Supracide)	M-S-Q	X	H	X	H	H
	Oxamyl (Vydate)	M-S-Q	V	L	L	V	L
	Tralomethrin (Scout X-TRA)	M-S-L	H	L	X	L	L
	Zeta-cypermethrin (Mustang)	M-S-L	no information*	no information*	no information*	no information*	no information*
Change/Delete	Reset AIs		Shorter bars indicate less risk				

No mitigation measures needed (blue) — Mitigation measures may be needed (red)

* No information: chemical not included in PPD.
** No known risk: UC IPM knows of no water quality risk associated with this pesticide.

Figure 2. Sample of a risk comparison table from WaterTox.

To each PMG for a specific crop and pest, UC IPM added a Water Quality—Compare Treatments button. This button is located within the tables of possible pesticide treatments, and it links to a graphic display that compares relative risk of leaching and runoff among the listed pesticides. Using this comparison of the potential to move off site and affect nontarget organisms, farmers can make more informed choices when selecting among pesticides recommended in the PMGs.

The risk comparison table (Figure 2) lists each pesticide active ingredient included in the PMG, with a sample trade name when needed to help the user identify the pesticide. Shown in the table are potential long-term hazards to fish and humans from

- leaching, the tendency of a pesticide to move in solution with water and leach below the root zone
- adsorbed runoff, the tendency of a pesticide to move in surface runoff attached to soil particles
- solution runoff, the tendency of a pesticide to move in surface runoff in the solution phase

Ratings and values in the chart. Ratings of potential hazards are based on soils that are highly susceptible to pesticide movement and take into consideration the long-term toxicity of a pesticide to fish and humans. Hazard values are shown as bars. Bars vary in length based on low, intermediate, or high potential for off-site movement; shorter bars indicate less risk. A letter abbreviation (V=very low, L=low, I=intermediate, H=high, X=extra high) appears next to each bar.

Data values in the chart come from the USDA-NRCS Windows Pesticide Screening Tool (WIN-PST) (www.wcc.nrcs.usda.gov/pestmgt/winpst.html). If the pesticide listed in the PMG is included in the WIN-PST database, WIN-PST's risk values are used. If a pesticide is not included in WIN-PST, and the chemical poses no known risks to water quality, the table indicates "no known risk." In all other cases where a chemical is not included in the WIN-PST database, risks are labeled "no information."

Effects of irrigation and rainfall. The potential hazard ratings assume that there will be no rain or irrigation during the 7 to 10 days after a pesticide application.

Change application conditions. The potential risk of leaching and runoff may be affected by the amount of pesticide used, the area covered, and how much pesticide comes in contact with the soil. WaterTox takes a user's input about these factors to adjust the risk ratings given by the program.

The initial data in the table are computed for these standard application conditions:

- application to more than 50% of the field (M);
- surface application (S); and
- standard application rate of more than 1/4 pound active ingredient per acre (Q) (except for pyrethroids, which are always used at low rates).

Since a user's rate and method may not be the same as these standard conditions, and how one applies the pesticide can impact the risks to water quality, the program allows users to specify how much area is being treated, how much pesticide will come in contact with the soil, and the actual application rate.

<u>What area is being treated?</u> Will the pesticide be applied to more than 50% of the field, or will less than 50% of the field be treated, by using strip applications or spot sprays, for instance?

<u>How much pesticide will come in contact with the soil?</u> Surface applied means that the pesticide will be applied to bare ground or an incomplete canopy. Foliar applied means that the pesticide will be applied when the crop or weeds are at nearly full canopy. Dormant sprays are not "foliar applied." Soil incorporated means that the pesticide will be incorporated into the soil.

<u>What is the application rate?</u> Rates above 1/4 pound of active ingredient per acre are considered the "standard" rate. Rates from 1/10 to 1/4 pound active ingredient per acre are considered to be low by WIN-PST. Rates less than 1/10 pound of active ingredient per acre are considered to be ultra low by WIN-PST.

Source of the Data and Algorithms in WaterTox

WaterTox is a partial implementation of the Windows Pesticide Screening Tool (WIN-PST) developed by USDA-NRCS. All data come from their Pesticide Properties Database (http://www.wcc.nrcs.usda.gov/pestmgt/winpst.html). The program includes WIN-PST's rating adjustments for application area, rate, and method. Unlike WIN-PST, the current (2004-05) version of WaterTox does not provide information for specific soils or allow a user to consider impact of water table depth, irrigation, residue management, or other site conditions.

Summary and Future Plans

The year-round IPM programs and database of pesticide risks to water quality are new features of the UC IPM Web site, aimed at helping farmers manage their crops in an increasingly regulated environment. While almonds, cotton, and prunes are the first crops for which year-round IPM programs are available, programs for wine and raisin grapes, plums, avocados, peaches, alfalfa, and strawberries are under development, with other crops to follow. The WaterTox pesticide toxicology database lets users compare the relative risks of pesticides to water quality and will be connected to all PMG crops by Spring, 2005. Later in 2005, users will be able to select specific soil types and consider impact of water table depth, irrigation, and residue management to more accurately reflect the site-specific potential hazards of a pesticide to fish and humans.

CONTROL OF CODLING MOTH IN BACKYARD ORCHARDS WITH LAST CALL CM (PERMETHRIN AND PHEROMONE IN A PASTE FORMULATION)

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Introduction

Codling moth, the “worm” in the apple, is a serious pest of apples, pears and walnuts. It overwinters as a mature larva inside a cocoon in rough bark, debris, and the soil. In the spring it pupates and emerges as an adult, a dull colored moth about 7/16” long that flies around, mates, and lays eggs on fruit and leaves. The eggs hatch into pink larvae that enter the fruit, ultimately consuming the seeds. The feeding damage includes the dispersal of excrement and the introduction of microorganisms that cause the fruit to drop and rot. This whole sequence can occur 3-4 times during the growing season causing up to 100% damaged fruit (Vossen et al., 1994).

Codling moth control methods are expensive, complicated and very time consuming, but justifiable in a commercial venture. Due to the lack of an economic incentive, however, wormy fruit has been a persistent problem for backyard fruit tree growers. There is a lack of knowledge of when to spray based on climate - degree day models or trap catches. There are always questions too of what materials are effective, easy to use, do not have an offensive odor, are safe to use around residences and hopefully could be classified as “organic.” Most home garden sprayers also don’t cover the leaf and fruit surfaces very well, because of low pressure and the small volume of water used. Individual backyard apple, pear, and walnut trees or small-scale orchards with a few trees on a couple of acres have not been effectively protected from codling moth damage with the pheromone dispensers and mating disruption technique. This is primarily due to the inability to saturate enough of an area around the orchard to prevent the males from finding the females, mating to occur, and the females returning to the trees to lay eggs (Brown, 1996).

Codling moth larvae feeding on the seeds

Conventional growers of commercial-sized orchards use pheromone baited monitoring traps to time insecticide sprays that kill the adults and young larva. Pheromone technology has been an effective method for monitoring male codling moth numbers for over twenty-five years. The synthetic female pheromone is commonly placed in a dispenser surrounded by a cardboard trap covered with a sticky material to capture any male moths attracted to the pheromone. Many males are captured, but mass trapping has never been shown to be effective even when placing one trap per tree. Enough males always seem to survive and mate with the females.

Organic growers primarily use pheromone mating disruption combined with sanitation and beneficial insect releases. In the last ten years, synthetic female codling moth pheromone formulations were incorporated into various types of dispensers in order to saturate the air surrounding orchard trees with enough pheromone that mating was disrupted; the males could not locate the pheromone scent of the real females. This method has been demonstrated to be effective under conditions where the concentration of the pheromone could be maintained around the trees in large enough blocks, usually deemed to be about five acres, to reduce the number of border trees with inadequate pheromone air saturation (Swezey et. al., 2000; Caprile, 1995). IPM Technologies Inc. developed a sticky paste material incorporating the pheromone to attract the male moths and an insecticide (permethrin 6%) to kill the moth when it contacted the material. Its trade name is Last Call.

This study was designed to determine the effectiveness of Last Call on the control of codling moth in small-scale orchard situations and backyard fruit tree gardens. The amount of toxicant (insecticide) used and its placement make this treatment method very environmentally friendly, leaving no residue on the fruit and has no known negative effects on beneficials. Its relative safety and ease of application by backyard gardeners has the potential to make this a very widely used product.

Materials and Methods

Seven replications were used of the Last Call treatment. Each group of treated trees was accompanied by at least one untreated control tree nearby. The treated trees and untreated (control) trees experienced very similar insect pressure and climatic conditions. Three treatments were applied at five week intervals: May 21, June 27 and August 4 of 2003. Last Call was applied at the rate of 50 drops for a large tree, 30 for a medium tree and 18 for a small tree. Two-thirds of the product was applied in the upper one-third of the tree, according to label instructions, and most of the material was placed on the inside of the tree, so that it would be shaded. Last Call was applied with the normal applicator and a long-handled applicator provided by IPM Tech. The paste material with pheromone and insecticide is deposited by squeezing the plunger to leave measured droplets.

Applying Last Call

Fruit was evaluated for damage at harvest. At each site, early ripening treated trees were compared to early ripening control trees and late ripening treated varieties were compared to late ripening controls. In some cases, all of the fruit from each tree was checked, including fallen fruit. In other cases, a minimum of 100 fruit were evaluated including the cutting of 10% to identify the percentage with hidden damage.

Droplet of Last Call paste

A standard codling moth trap was placed in or near each backyard orchard in most cases and monitored weekly for trap catch numbers. Treatment means for the apples were analyzed with a Multiple Paired Comparison T-Test. We used paired comparisons from seven sites to determine the treatment means. There were nine sites originally, but one was inadvertently sprayed and the other had no damage on the treatment or control trees. The data on pears was not analyzed statistically, because there were insufficient untreated control pear trees. The pear data is presented as an interesting observation only.

Backyard orchard sites

Site 1: Four apple trees, including one Golden Delicious, and three pear trees in a semi-rural neighborhood on 2 acres surrounded by large open fields. There was a very light crop on both the apple and pear trees. A large untreated Golden Delicious control tree was located next door. This site has a warm coastal climate with some marine influence.

Site 2: Five apple trees (Gala, Golden Delicious, Fuji, Lady, and an unknown variety) and two pears (Seckel and Bartlett) integrated into the landscape in a suburban tract bordering open space. The control trees were located next door where the neighbor has both apples (Gala) and pears (Bartlett). This site had a cool climate with a significant marine influence.

Site 3: Two apple trees (Gravenstein and Jonathan) and two pear trees (Bartlett and Hosui) located on one acre in a semi-rural neighborhood with an old apple orchard located nearby. The control apple trees (Gravenstein and Golden Delicious) were located on a neighboring property. This site has a moderate coastal climate.

Site 4: Various unknown early and late ripening varieties of apples and pears located in a suburban area. The trees were planted in a small orchard configuration. The control trees were in an organic community garden containing several early and late ripening apple trees (unknown varieties) located 500 feet down the road from the treated site. This site has a warm coastal climate.

Site 5: Three apple trees (one Gravenstein and two Golden Delicious) and one Bartlett pear located on a residential street with one acre lots. This is a semi-rural garden surrounded by wine grapes, forest, and pasture. The control trees (Golden Delicious) were located on a neighboring property. This site has a moderate coastal climate.

Site 6: Four apple trees (Gravenstein, Golden Delicious, Granny Smith and Fuji) plus three pears (Bartlett, Comice and D'Anjou) on a small lot in a suburban residence backyard. The control was an untreated Red Delicious tree in the neighborhood. This site has a moderate coastal climate.

Site 7: Three apple trees (Jonathon, Golden Delicious and Fuji) and one Bartlett pear located in a suburban neighborhood. The control was a neighbor's untreated Red Delicious tree. This site has a moderate coastal climate.

Results

Sites 1, 3, and 5 had damage levels on the Last Call treated trees that were very similar to the untreated control trees. The apple trees at these three sites were quite large and application of the product was difficult because of the dense growth.

Sites 2 and 4 showed large differences between the Last Call treated apple and pear trees and the controls; the treated trees had one-third to one-fourth the amount of damage as the untreated trees. These sites had very different climates (site 2 was our coolest; site 4 was one of the hottest), but all had trees of moderate or small size. Application of the product was very easy on these compared to larger trees.

Table 1. PERCENT CODLING MOTH DAMAGE TO 'LAST CALL' TREATED AND TO UNTREATED 'CONTROL' TREES

Backyard Locations	Last Call Treated Apple Trees	Untreated Control Apple Trees	Last Call Treated Pear Trees	Total Trap Catches
Site 1	45.5%	50.0%	3.3%	-
Site 2	14.8%	43.0%	17.0%	7
Site 3	28.5%	30.4%	0%	9
Site 4	16.1%	60.1%	20.2%	-
Site 5	36.2%	40.8%	22.6%	24
Site 6	68.8%	53.3%	54.0%	24
Site 7	30.5%	53.3%	22.7%	-
Mean	34.3%	47.3%	17.7%	12.8

Site 7 showed 23% and 30.6% less worm damage in the Last Call treated apple and pear trees respectively. These were also smaller sized semi-dwarf trees. Site 6, however, with its large dense trees had greater damage on the Last Call treated apple trees by 15.5%. The Last Call treated pears at site 6 had close to the same damage level as the untreated control apple trees.

The average codling moth damage level in the Last Call treated apple trees was 34.3% and the untreated apple trees had 47.3% damage. There is no significant difference between these two damage levels. The coefficient of variation was 34.4, indicating that there was considerable variability in the levels of damage between the Last Call treated and untreated control trees at each site (Table 1). The total number of male moths caught was low, especially compared to the amount of fruit damage observed. For most of the pears, the damage level for Last Call treated trees was less than in the treated apples, but two of the pear treatment sites had codling moth damage levels slightly higher than in the apples. There is no significant difference between the treatments means at the 5% level.

Discussion

The paste dispenser was not as easy to use as it originally appeared, especially when it was attached to the pole extension for reaching into tall trees. Problems were evident right from the beginning. The applicators leaked, came apart, and often did not dispense a droplet of paste when operated. By wrapping wire around the dispenser to hold it more securely to the pole and plunger device, we were able to make it work, but it was always messy and difficult to use. It sometimes took several pumps of the dispenser in order to get a droplet of paste to come out. The instructions regarding frequency of application could also be improved to better indicate what factors determine tree size, the proper number of paste droplets to apply, and the frequency of treatment. It is possible with more frequent treatment, knowing that the insect pressure was high, that control might have been better. This was close to a worst case scenario with heavy damage levels on mostly late maturing varieties.

The efficacy of this product was extremely variable; it seemed to work at some sites but not at others. More detailed comparisons of its performance under well-controlled circumstances would be very useful. A second year of replicated trials in the field seems necessary, perhaps to compare efficacy of the product based on tree size. On the other hand, some of the same factors involved in codling moth control with the mating disruption technique in small plots or individual back yard trees are applicable with Last Call. The same problem exists, in that only those moths in the immediate vicinity of the tree and the applied droplets of paste are killed. Males that are a short distance away and unaffected by the pheromone in the Last Call paste can still mate with females. Controlling the females would be much more efficient.

Based on the results of this trial, the use of a paste formulation of Permethrin and codling moth pheromone is not effective enough to justify the cost or difficulty in application. The homeowners (Master Gardener Volunteers) had high hopes of much less damage to their fruit on treated trees. They noted that even though the application of Last Call paste was easier than spraying trees, it did not meet their expectations and they were disappointed by the control level.

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